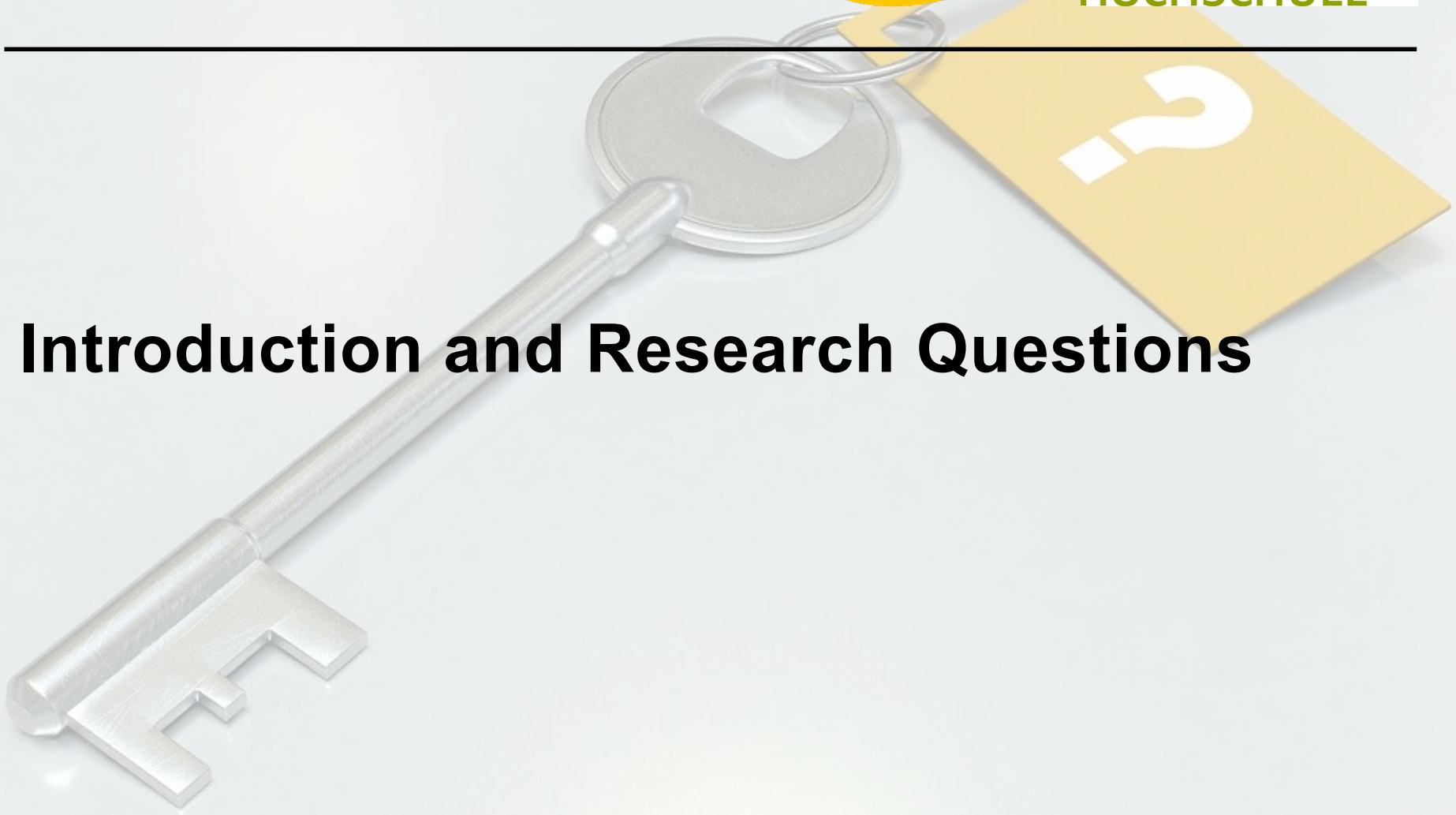
Affective Effects of Implementing Technical Research in Teacher Training

Andrea Maria Schmid, Markus Rehm & Dorothee Brovelli

University of Teacher Education Lucerne, Switzerland
University of Education, Heidelberg
ESERA 2019

weiterwissen.

Introduction and Research Questions



Promoting STEM Education

Background

In order to improve STEM teacher training in Switzerland, a national "Network for the Promotion of STEM Education" aims at pooling expertise and resources of universities of teacher education and university of applied sciences in engineering and information technology.

more information: www.mint-bildung.ch

→ Intervention study as a part of this initiative

Intervention - Semester Course

University of Engineering and Architecture Lucerne (HSLU)

University of Teacher Education Lucerne (PHLU)

1 6 context-based tasks from research projects

2 selection process: each group is randomly assigned to a context-based task

3 explanation of the task + the theoretical background

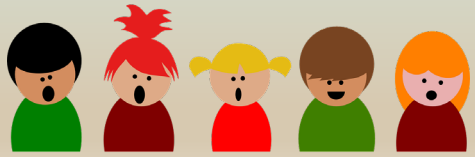
4 exploration of the task + understanding of the theoretical background

5 search of the connection between topic and curriculum-skills + preparation of a context-based task for lower secondary level students

6 presentation at HSLU: groups explain task to lower secondary level students in 20 minutes on the basis of concept cartoons, experiments, examples from everyday life

6 research associates

small groups of pre-service teachers 7. / 9. semester



lower secondary level students

Examples of Context-Based Tasks from Research Projects

PH LUZERN

- **light** for healthy and productive workplaces
- **light dosimeter** for measuring light intensity and its effect on the melatonin level
- **energy harvesting**
- **material testing** in small dimensions (tensile test)
- **latent storage** for heating and cooling applications
- **measurement** of sound power level values

light dosimeter

Impression

presentations for secondary level students

Research Questions

pre-service teachers for lower secondary school

- How does a context based on research in physics and engineering have to be structured in order to trigger and maintain the interest of pre-service teachers?
- Does the preparation and delivery of a teaching unit on research topics in physics and engineering influence the situational and individual interest, attitudes towards physics and technology and the corresponding self-concept?
- What relationships can be established between the constructs?

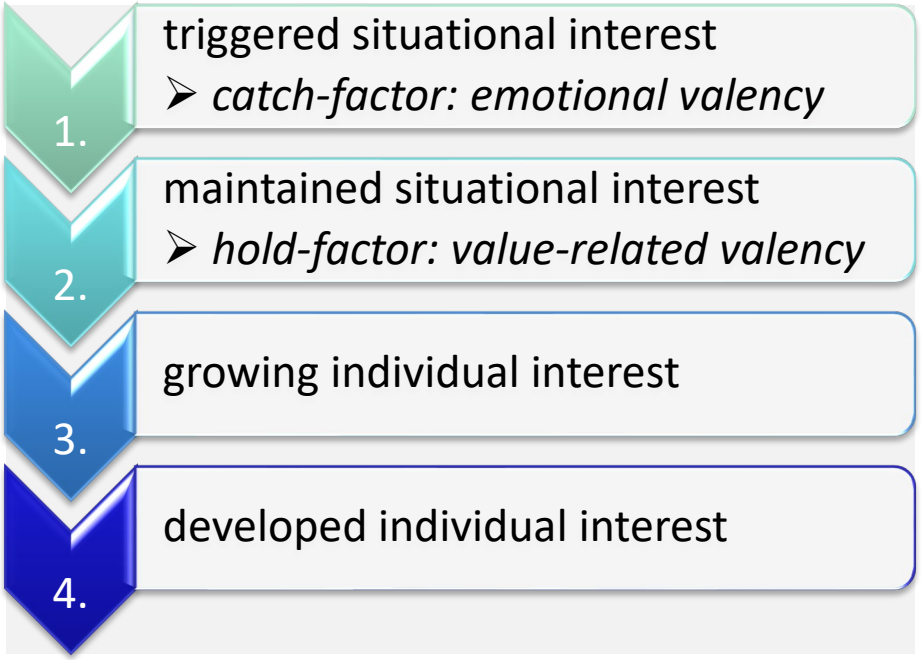
Theoretical Background

Person-Object-Theory according to Krapp & Prenzel (2011), Pawek (2009):

- emotional valence: feelings / emotions evoked by the topic or the action
- value-related valence: individual relevance of a topic
- epistemic-related valence: wanting to know more about a topic

Context-Orientation influences cognitive and affective student characteristics (Bennett et al., 2007):

- context characteristics (Habig et al., 2018)
- perceived authenticity of the learning environment (Betz, 2018; Pawek, 2009; Engeln, 2004)



development of interest: 4-phase-model according to Hidi & Renninger (2006), Mitchell (1993), Harachiewicz et al. (2000)

Pädagogische Hochschule HEIDELBERG University of Education

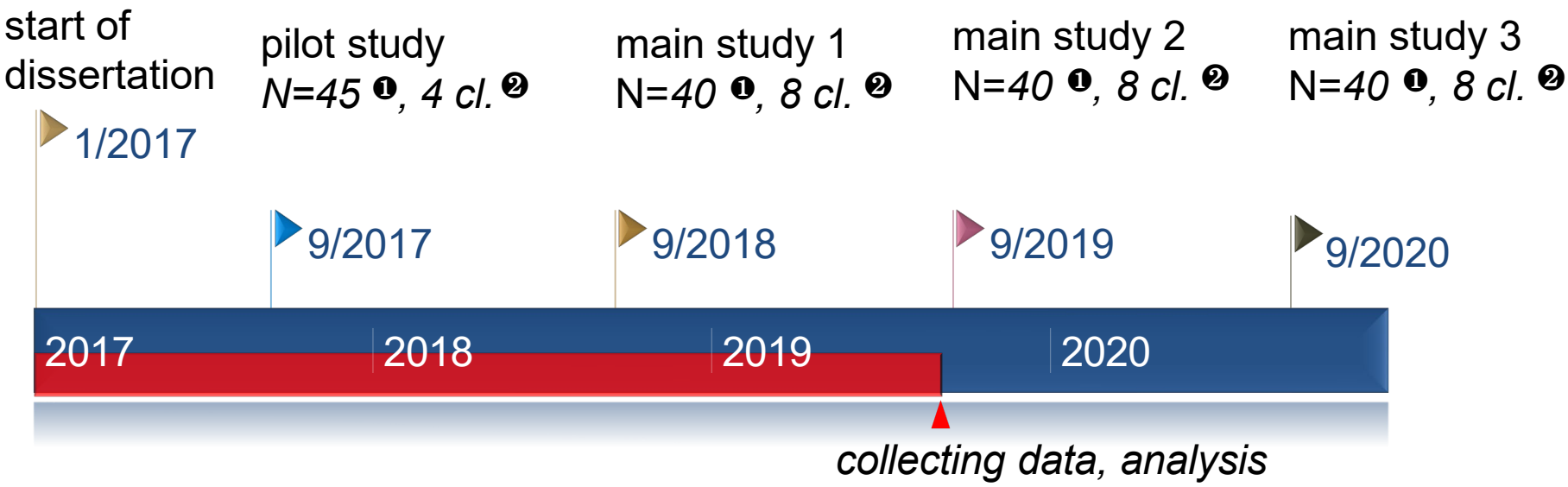
PH LUZERN PÄDAGOGISCHE HOCHSCHULE

Design & Methods

Design & Methods (1)

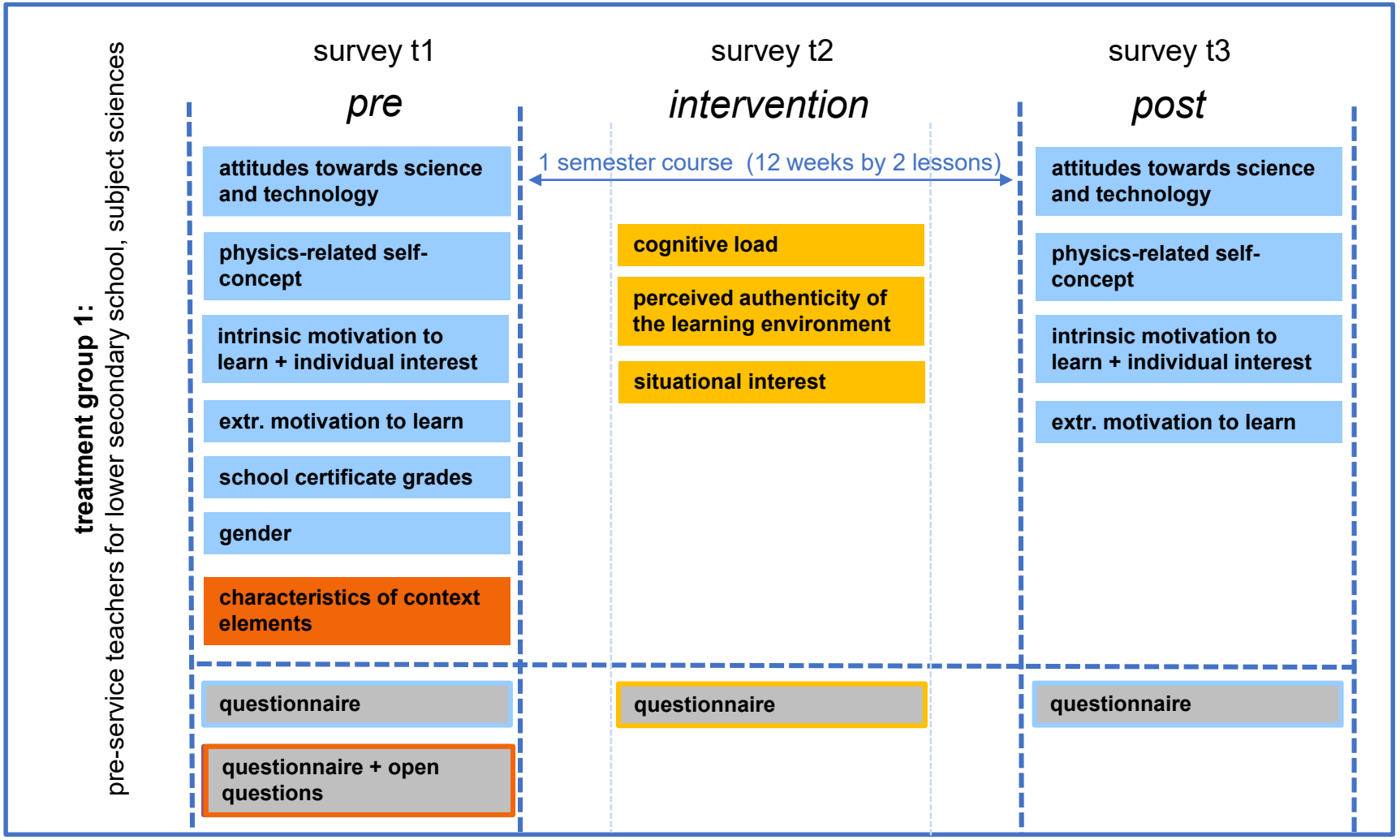
intervention study

- **survey:** three measurement time points
- **Treatment groups:** pre-service teachers for lower secondary school❶, lower secondary students❷
- **intervention period:** semester course, 12 weeks by 2 lessons (4x)
- **timetable:**



Design & Methods (2)

pre-service teachers for lower secondary school

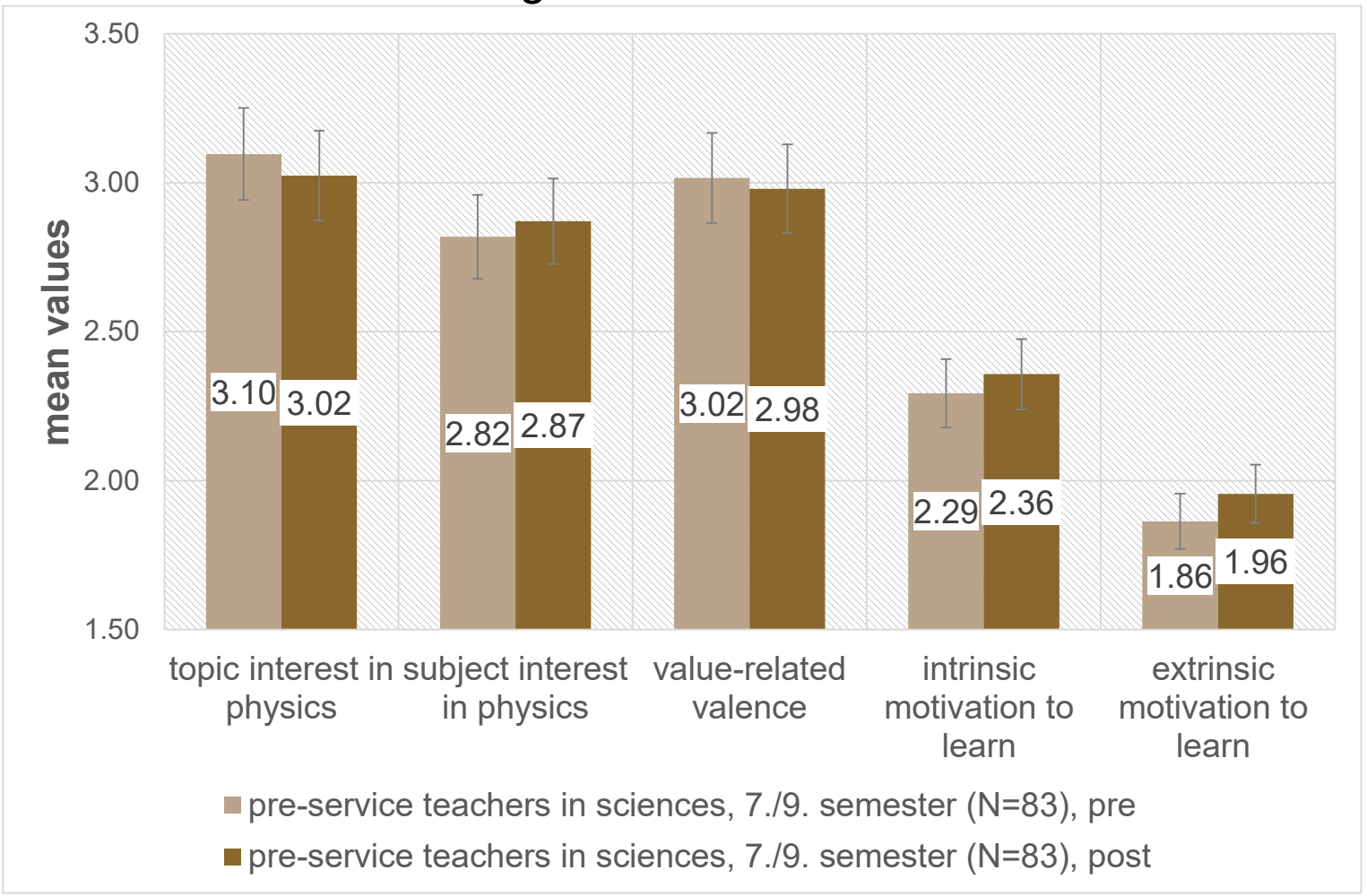


Results and Discussion

First Results and Discussion (data colletion 2017+2018)

individual interest + motivation to learn

control variables → no significant differences



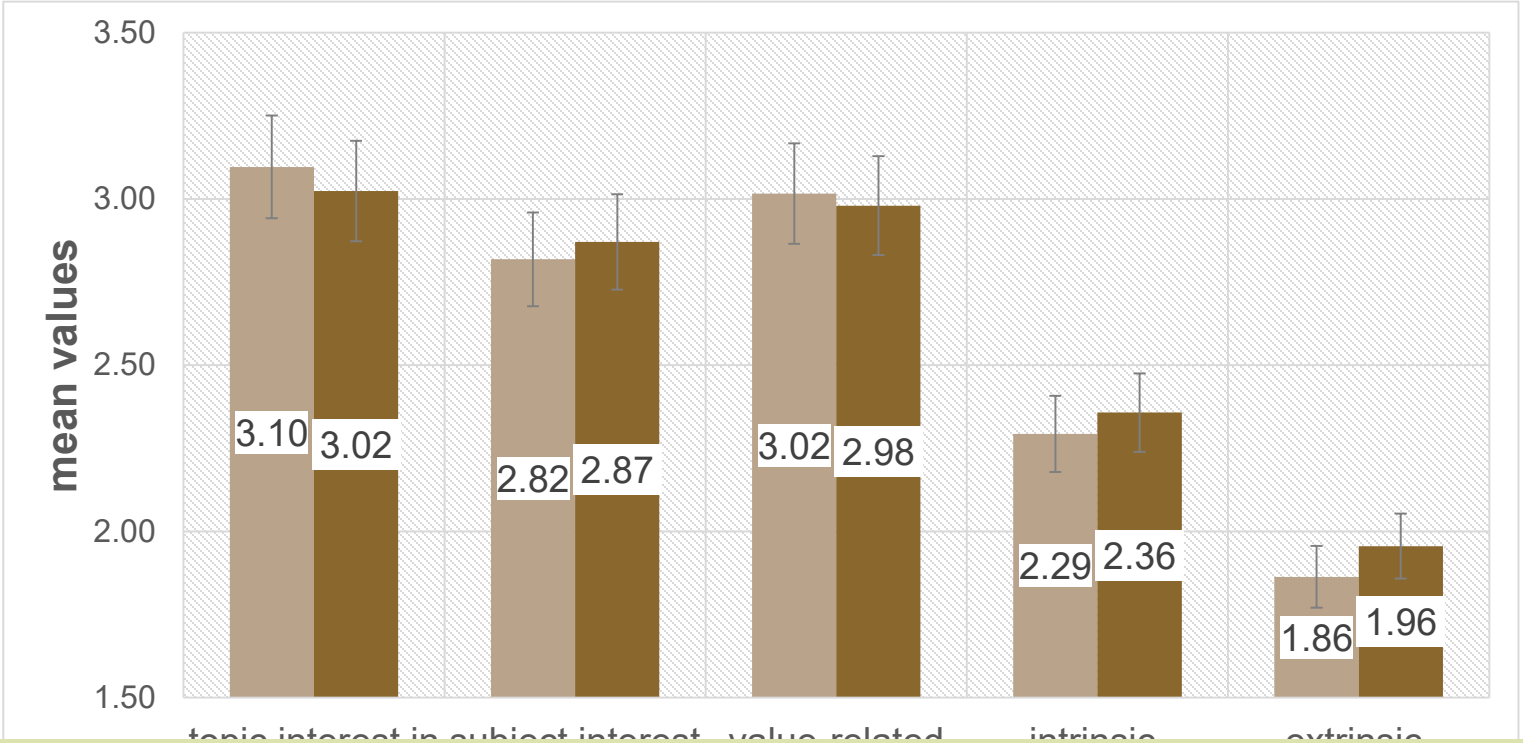
1 = low
4 = high

error bar:
95% confidence interval

First Results and Discussion (data colletion 2017+2018)

individual interest + motivation to learn

control variables → no significant differences

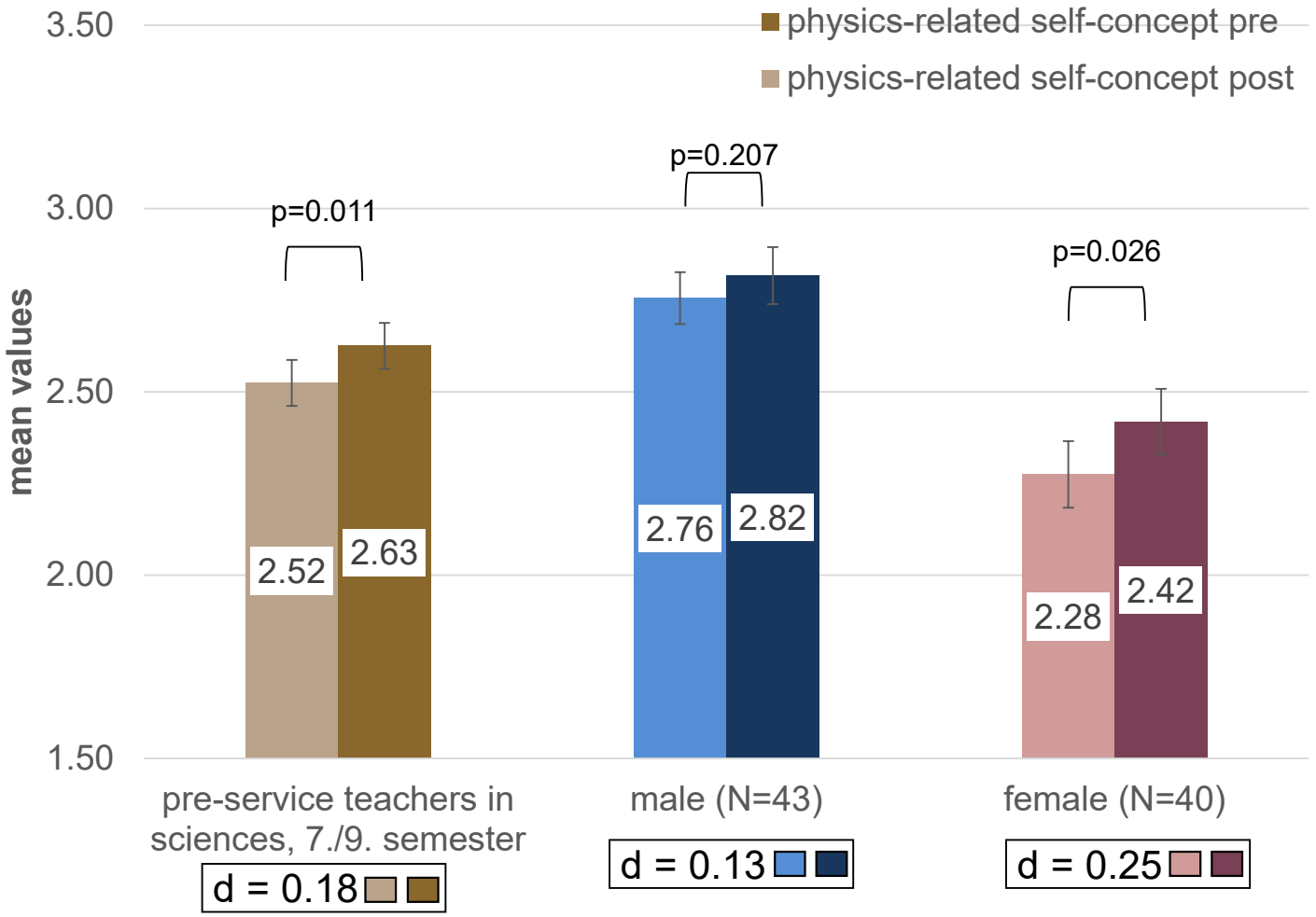


- Already high input values were expected because the subject natural sciences (biology, chemistry, physics integrative) was chosen voluntarily.

First Results and Discussion (data colletion 2017+2018)

physics-related self-concept

→ significant differences



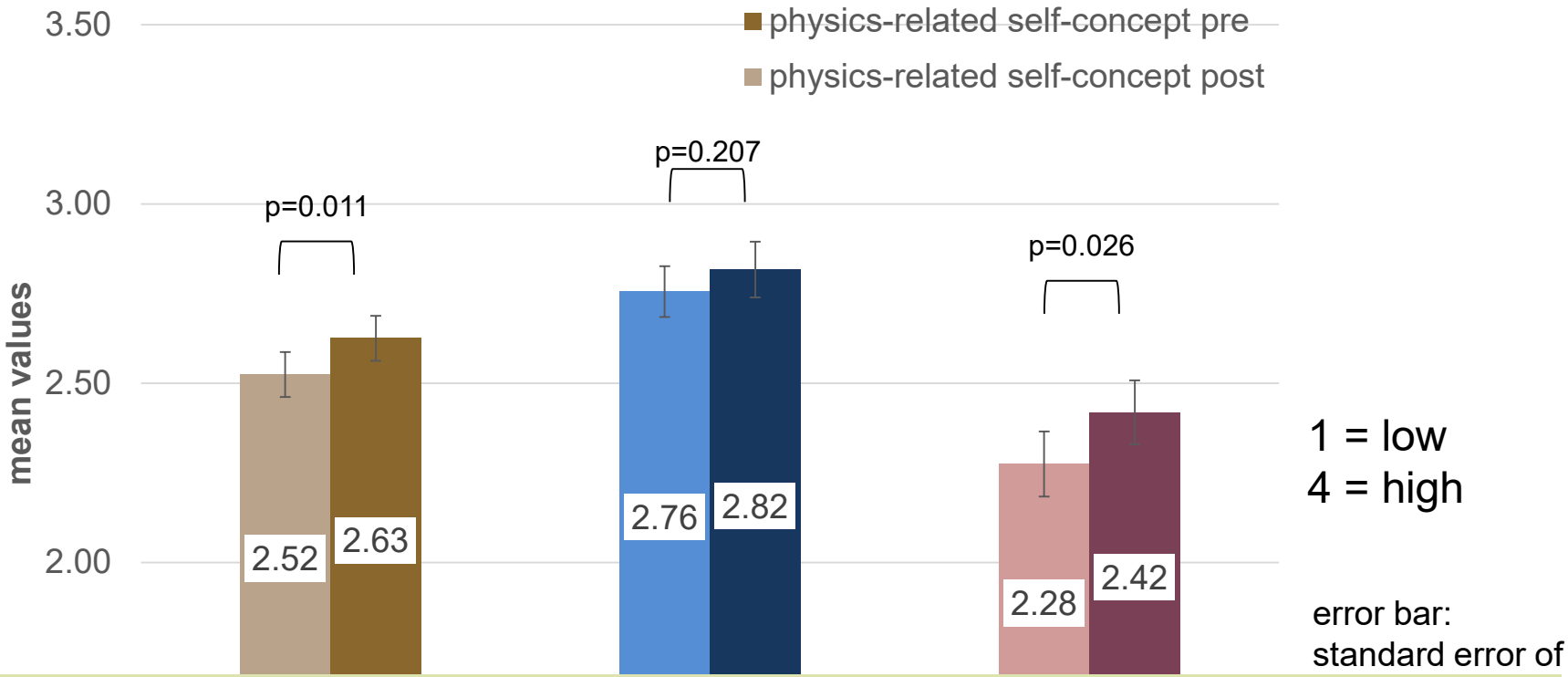
1 = low
4 = high

error bar:
standard error of the mean value

First Results and Discussion (data colletion 2017+2018)

physics-related self-concept

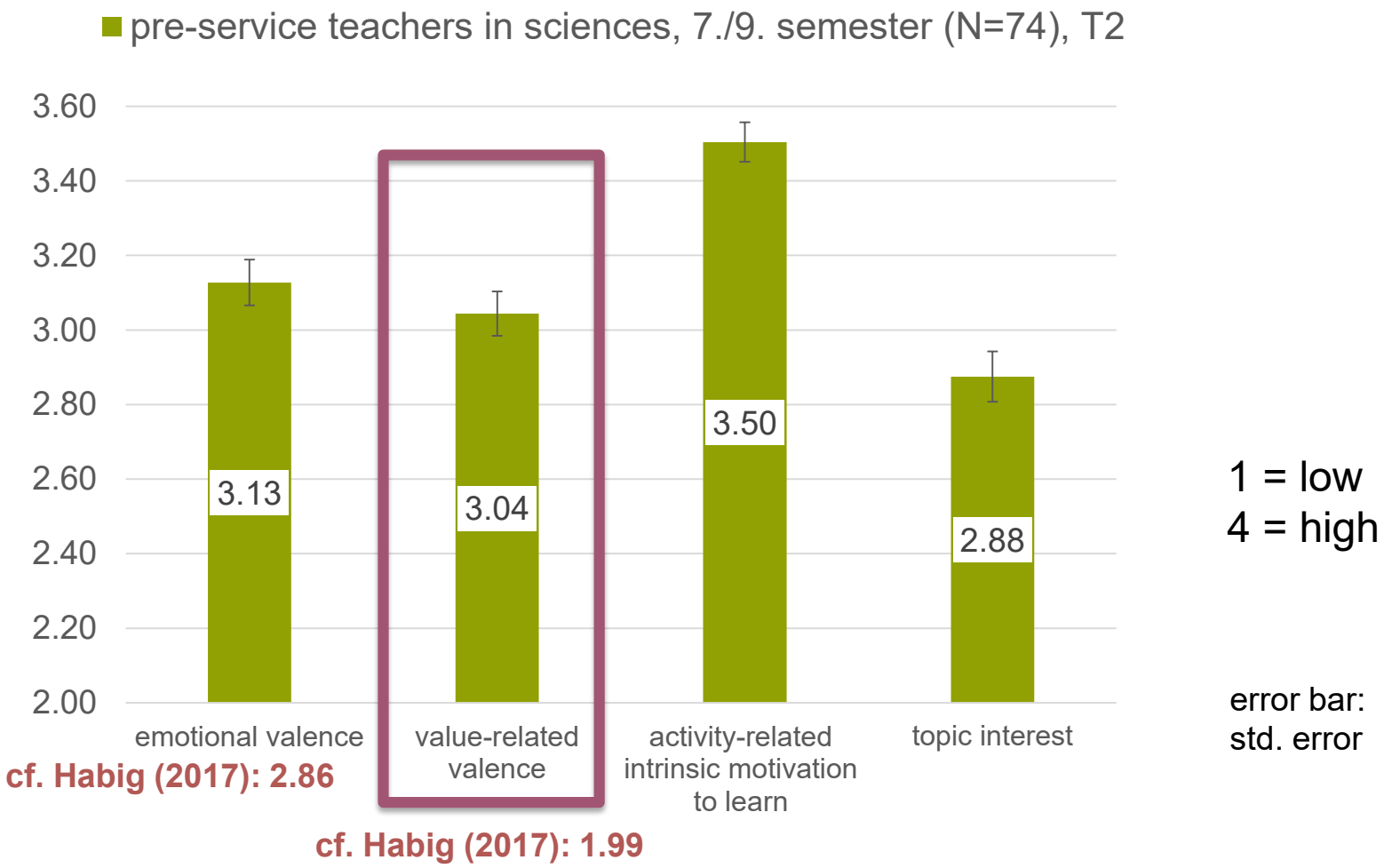
→ significant differences



► The intervention has a significant, gender-specific effect on the positive development of the physics-related self-concept.

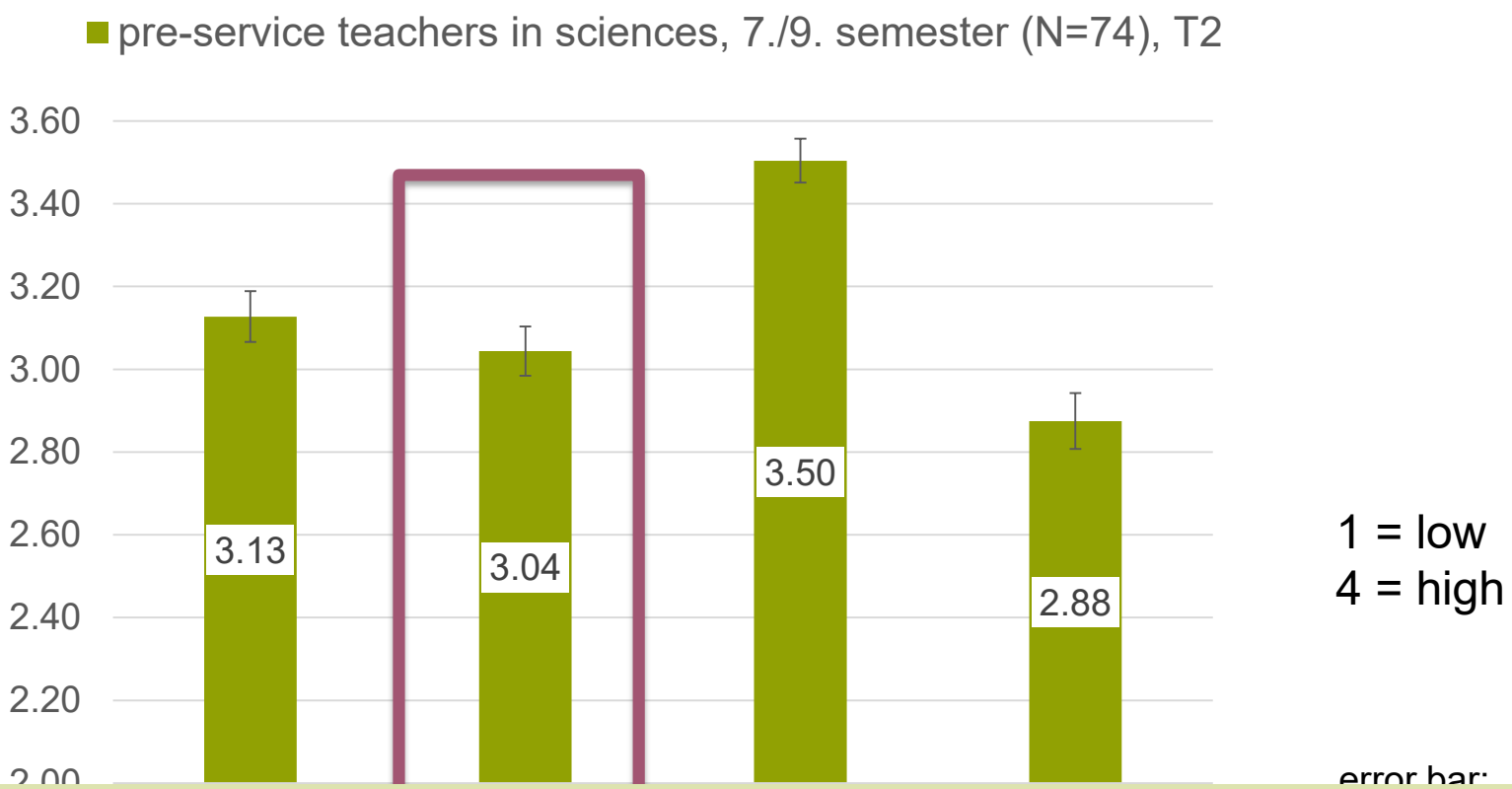
First Results and Discussion (data colletion 2017+2018)

situational interest



First Results and Discussion (data colletion 2017+2018)

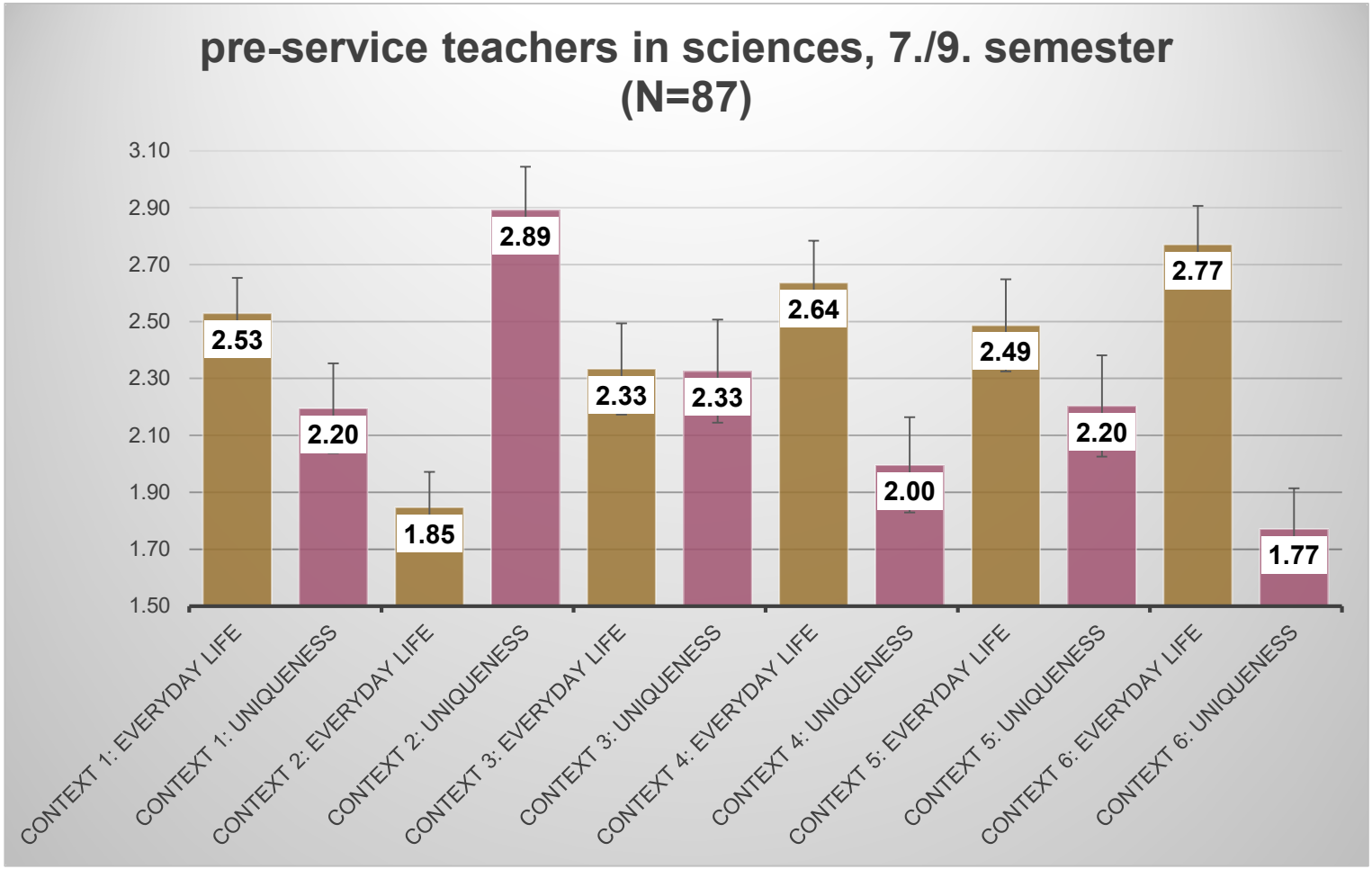
situational interest



► High values in the exploration of contexts were measured. Correlations and differences in the six contexts need to be clarified.

First Results and Discussion (data collection 2017+2018)

context characteristic everyday life / uniqueness



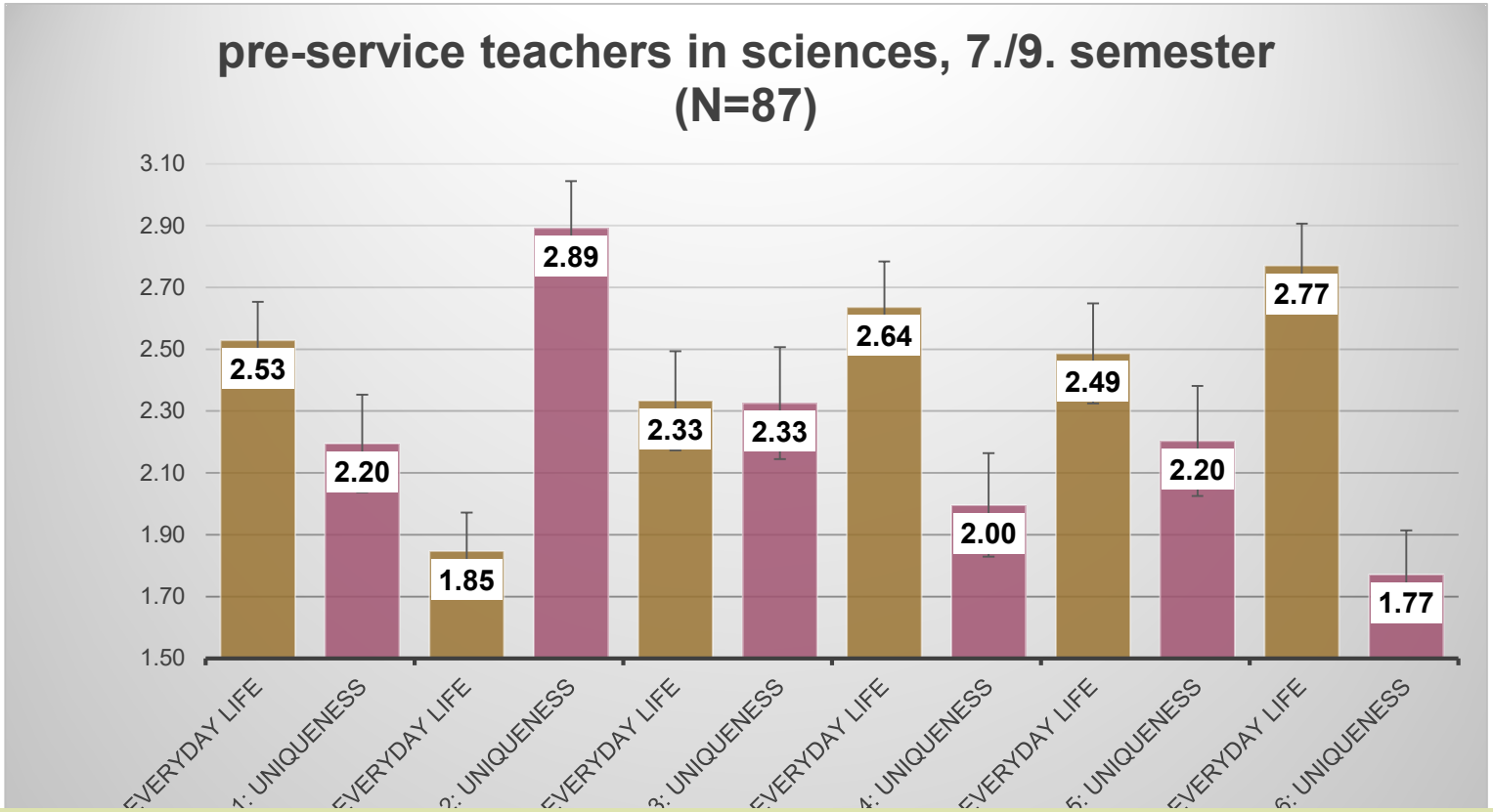
1 = low
4 = high

error bar: :
95% confidence interval

context 1: energy harvesting, context 2: latent storage for heating and cooling applications, context 3: material testing in small dimensions (tensile test), context 4: light dosimeter for measuring light intensity and its effect on the melatonin level, context 5: measurement of sound power level values, context 6: light for healthy and productive workplaces

First Results and Discussion (data collection 2017+2018)

context characteristic everyday life / uniqueness



1 = low
4 = high

error bar: :
95% confidence interval

► The six contexts have different context characteristics. A connection with components of interest must be clarified.

First Results and Discussion (data collection 2017+2018)

further results

- **emotional valence → no sig. differences between context 1-6**

- **value-related valence → sig. differences between context 1-6** ($F(5/68)=2.66$ $p<0.05$, $N=73$), although these differences can only be attributed to **female students** ($F(5/31)=3.02$, $p<0.05$, $\eta^2=.328$, $N=37$)
  - **focus:** Which context elements / context characteristics are responsible for this?

- **cognitive load → no significant effects between context 1-6**
  - perceived task difficulty ($M=3.15$, scale 1-7) / invested mental effort ($M=4.82$, scale 1-7)

Conclusion

- Already high input values of individual interest and motivation to learn were expected because the subject natural sciences (biology, chemistry, physics integrative) was chosen voluntarily.
- The intervention has a significant, gender-specific effect on the positive development of the physics-related self-concept.
- High values of situational interest (emotional and value-related valence) in the exploration of contexts were measured. Correlations and differences in the six contexts need to be clarified.
- The six contexts have different context characteristics. A connection with components of interest must be clarified.
- **Outlook**: Development of an identity construct for prospective physics teachers with structural equation models (e.g. Rabe & Krey, 2018)

References

Ardies, J., De Maeyer, S., and Gijbels, D. 2013. Reconstructing the Pupils Attitude towards Technology-survey. *Design and Technology Education: An International Journal, 18* (1), 8–19.

Bennett, J., Lubben, F. & Hogarth, S. (2007). Bringing science to life. A synthesis of the research evidence on the effects of context-based and STS approaches to science teaching. *Science Education, 91*(3), 347–370.

Betz, A. (2018). Der Einfluss der Lernumgebung auf die (wahrgenommene) Authentizität der linguistischen Wissenschaftsvermittlung und das Situationale Interesse von Lernenden. *Unterrichtswissenschaft Zeitschrift für Lernforschung, 46*(3), 261–278.

Fechner, S. (2009). Effects of context-oriented learning on student interest and achievement in chemistry education (Studien zum Physik- und Chemielernen, vol. 95). Zugl.: Duisburg-Essen, Univ., Diss., 2009. Berlin: Logos-Verl.

Habig, S., van Vorst, H. & Sumfleth, E. (2018). Merkmale kontextualisierter Lernaufgaben und ihre Wirkung auf das situationale Interesse und die Lernleistung von Schülerinnen und Schülern. *Zeitschrift für Didaktik der Naturwissenschaften, 24*(1), 99–114.

Hazari, Z., Sonnert, G., Sadler, P. & Shanahan, M. (2010). Connecting High School Physics Experiences, Outcome Expectations, Physics Identity, and Physics Career Choice: A Gender Study. *Journal of Research in Science Teaching, 47*(8), 978–1003.

Kelava A., Schermelleh-Engel K. (2008). Latent-State-Trait-Theorie (LST-Theorie). In: Moosbrugger H., Kelava A. (Hrsg.). *Testtheorie und Fragebogenkonstruktion*. Heidelberg: Springer.

Kessels, U. (2015). Bridging the Gap by Enhancing the Fit: How Stereotypes about STEM Clash with Stereotypes about Girls. *International Journal of Gender, Science and Technology, 7*(2). 280–296.

Krapp, A. & Prenzel, M. (2011). Research on Interest in Science. Theories, methods, and findings. International Journal of Science Education, 33 (1), S. 27–50.

Pawek, Ch. (2009). *Schülerlabore als interessefördernde außerschulische Lernumgebungen für Schülerinnen und Schüler aus der Mittel- und Oberstufe (Dissertation).* Kiel: Universität Kiel.

Rabe, T. & Krey, O. (2018). Identitätskonstruktionen von Kindern und Jugendlichen in Bezug auf Physik - Das Identitätskonstrukt als Analyseperspektive für die Physikdidaktik? *Zeitschrift für Didaktik der Naturwissenschaften, 24*(1), 201–216.

Rheinberg, F., Vollmeyer, R. & Burns, B. D. (2001). FAM: Ein Fragebogen zur Erfassung aktueller Motivation in Lern- und Leistungssituationen. *Diagnostica, 47,* 57–66.

Van Vorst, H. (2013). *Kontextmerkmale und ihr Einfluss auf das Schülerinteresse im Fach Chemie* (Studien zum Physik- und Chemielernen, Bd. 145). Zugl.: Duisburg, Essen, Univ., Diss., 2012. Berlin: Logos-Verl.