Pre-service teachers’ use of, attitudes towards, competence beliefs relating to AI for teaching and learning in Germany

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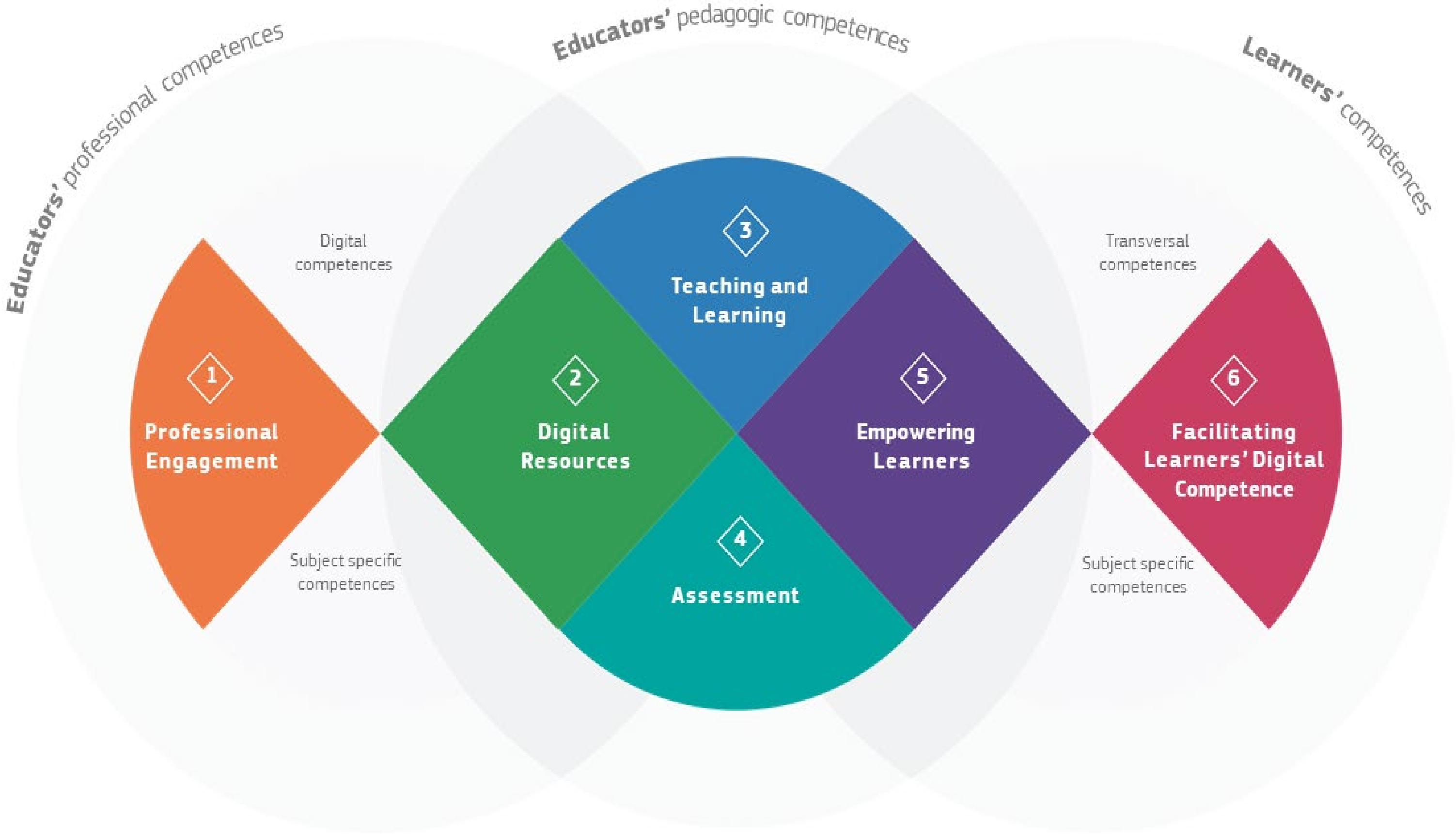
Research Context

- Digital transformation has been ongoing since 1989 (Stengel et al., 2017).
- Adaptation remains a challenge: one-third of German 8th graders show only rudimentary ICT skills (Eickelmann et al., 2019).
- Pre-service teachers exhibit below-average attitudes and ICT competence (Senkbeil et al., 2020).
- Curricula in German higher education neglect digital competencies (Monitor Lehrerbildung, 2022).
- Digital competence demands are severely increased by AI technology (UNESCO, 2024).
- Digital competence beliefs are a predictor for AI competence beliefs (Schneider & Müller, 2025).

Research Framework



AI Use

AI use (prep)

AI use (prac)

Research State

Research on relations between digital and AI attitudes and competences is comprehensive, using diverse instruments for similar constructs:

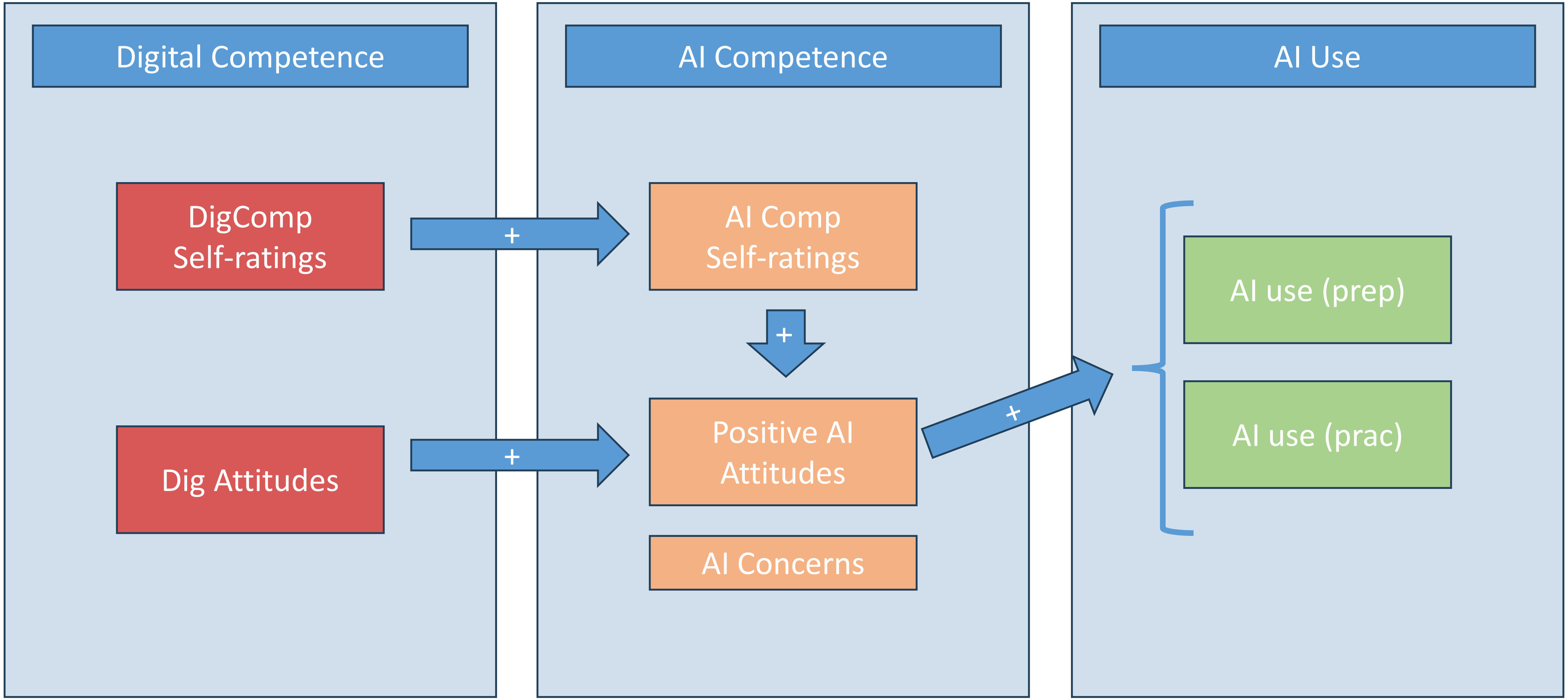
- Positive associations have been found between general digital competence beliefs and attitudes and their AI-specific counterparts (Lucas et al., 2024; Galindo-Domínguez et al., 2024).
- AI-related attitudes are positively linked to usage and intention to use (Zhang et al., 2023; Runge et al., 2025; Kaplan-Rakowski et al., 2023; Wang et al., 2021).

➢ Per our research no longitudinal studies have investigated the development of these AI constructs or how they can be predicted.

Research Questions

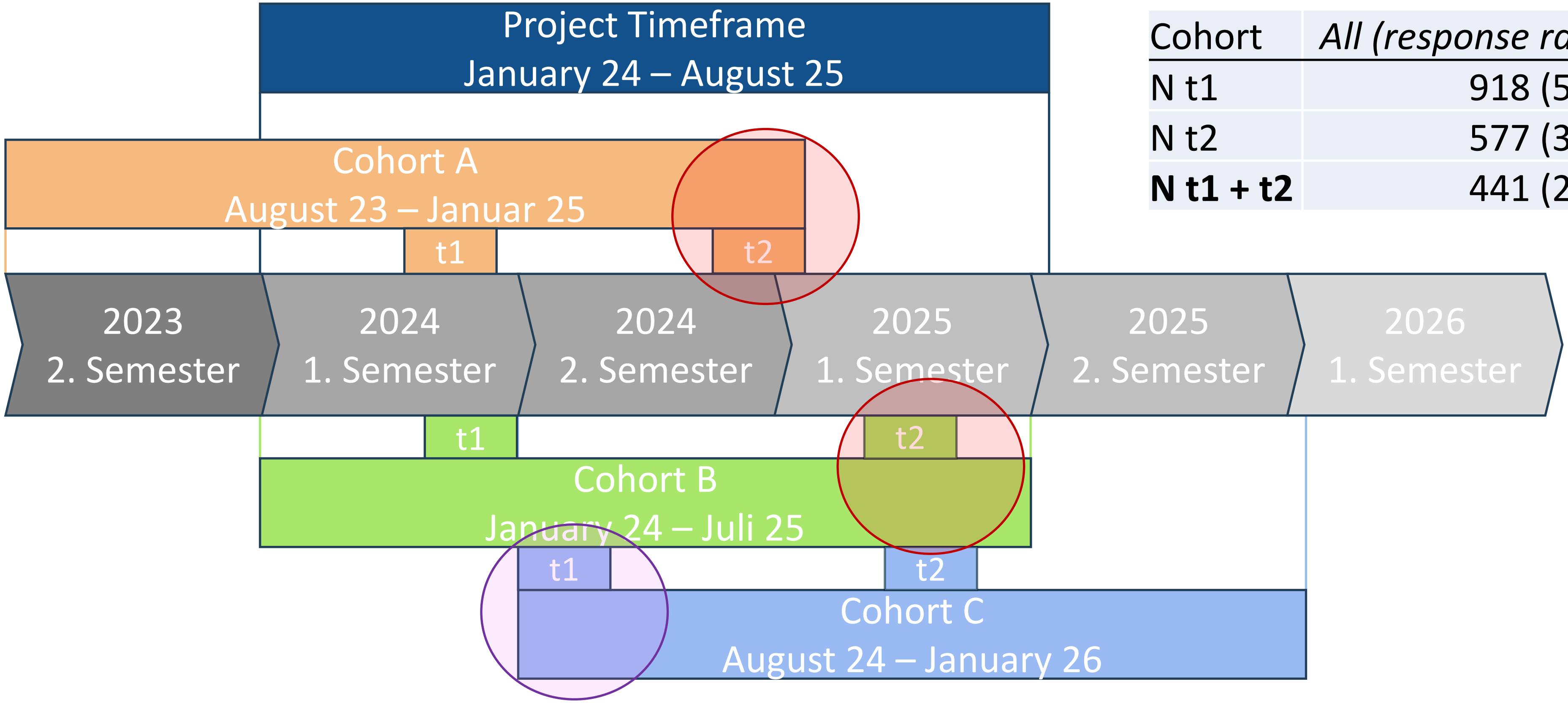
1. How does competence in using digital technology in pre-service teachers develop?
    a. Competence beliefs
    b. Attitudes
2. How does their competence in using AI for teaching purposes develop?
    a. Competence beliefs
    b. Attitudes
    c. Concerns
3. How does the usage of AI for teaching purposes develop?
4. **How can the AI competence beliefs, positive attitudes, concerns and usage be predicted?**

RQ4 Hypotheses



Methods and Study Design

Design



Cohort	*All (response rate)*	*A + B*	*C*
N t1	918 (56%)		
N t2	577 (36%)		
N t1 + t2	441 (27%)	**203 (46%)**	**238 (54%)**

Sample

Demographics				
Gender	**Female**	**Male**		
	80.5%	19.5%		
Age	**Mean**	SD	Min	Max
	27	±3	23	52
School type	**Primary education**	**Lower Secondary**	**Upper Secondary**	
	64%	3%	33%	
Subject domains	**Language**	**MINT**	**Social**	**Mixed**
	18%	27%	53%	2%

Instruments

- Digital competence beliefs: Quast et al. (2023), based on DigCompEdu.
- Attitudes towards teaching with digital technology: Rubach & Lazarides (2019).
- AI Attitudes: adapted from Rubach & Lazarides (2019).

New instruments (self-developed items with Likert scales)

- AI competence beliefs, concerns and use
    - Reliability: Cronbach’s alpha > .7 (acceptable)

Instruments

- Digital competence beliefs: Quast et al. (2023), based on DigCompEdu.
- Attitudes towards t... with digital technology: Rubach & Lazarides (2019)
- AI Attitud...

New instrum...

- AI competence be...
  - Reliability: Cronbach's alpha > .7 (acceptable)

How competent do you feel (with regard to your future teaching activities) in planning and designing the use of digital media in the classroom in a didactically meaningful way?

Instruments

- Digital competence beliefs: Quast et al. (2023), based on DigCompEdu.
- Attitudes towards teaching with digital technology: Rubach & Lazarides (2019).
- AI Attitudes: adap

New instrume

- AI compete
  - Reliability: Cron

I believe that I could better support students in school-related matters if I used digital media in the classroom.

Instruments

- Digital comp
  DigCompE
- Attitudes tow
  Lazarides (201

Using AI professionally improves the quality of teaching and learning processes in schools.

- AI Attitudes: adapted from Rubach & Lazarides (2019).

New instruments (self-developed items with Likert scales)

- AI competence beliefs, concerns and use
  - Reliability: Cronbach's alpha > .7 (acceptable)

Instruments

- Digital compe
  DigCompE
- Attitudes to
  Lazarides (2019).
- AI Attitudes: adapt ubach & Lazarides (2019).

I know how to craft prompts and instructions for AI tools to achieve different goals.

New instruments elf-developed items with Likert scales)

- AI competence beliefs, concerns and use
  - Reliability: Cronbach’s alpha > .7 (acceptable)

Instruments

I believe that students are unlearning how to think independently due to the use of AI.

- Digital c
  DigCor
- Attitudes &
  Lazarides (2019).
- AI Attitudes: adapted from & Lazarides (2019).

New instruments (self-develop items with Likert scales)

- AI competence beliefs, concerns and use
  - Reliability: Cronbach's alpha > .7 (acceptable)

Instruments

- Digital compete
  DigCompE
- Attitudes
  Lazarides (20
- AI Attitudes: adapted fro

I regularly use AI tools to plan teaching units.

New instruments (self-developed items Likert scales)

- AI competence beliefs, concerns and use
  - Reliability: Cronbach’s alpha > .7 (acceptable)

AI Competency Framework for Teachers (UNESCO, 2024)

Aspects	Progression		
	Acquire	Deepen	Create
1. Human-centred mindset	Human agency	Human accountability	Social responsibility
2. Ethics of AI	Ethical principles	Safe and responsible use	Co-creating ethical rules
3. AI foundations and applications	Basic AI techniques and applications	Application skills	Creating with AI
4. AI pedagogy	AI-assisted teaching	AI–pedagogy integration	AI-enhanced pedagogical transformation
5. AI for professional development	AI enabling lifelong professional learning	AI to enhance organizational learning	AI to support professional transformation

UNESCO (2024, p. 22)

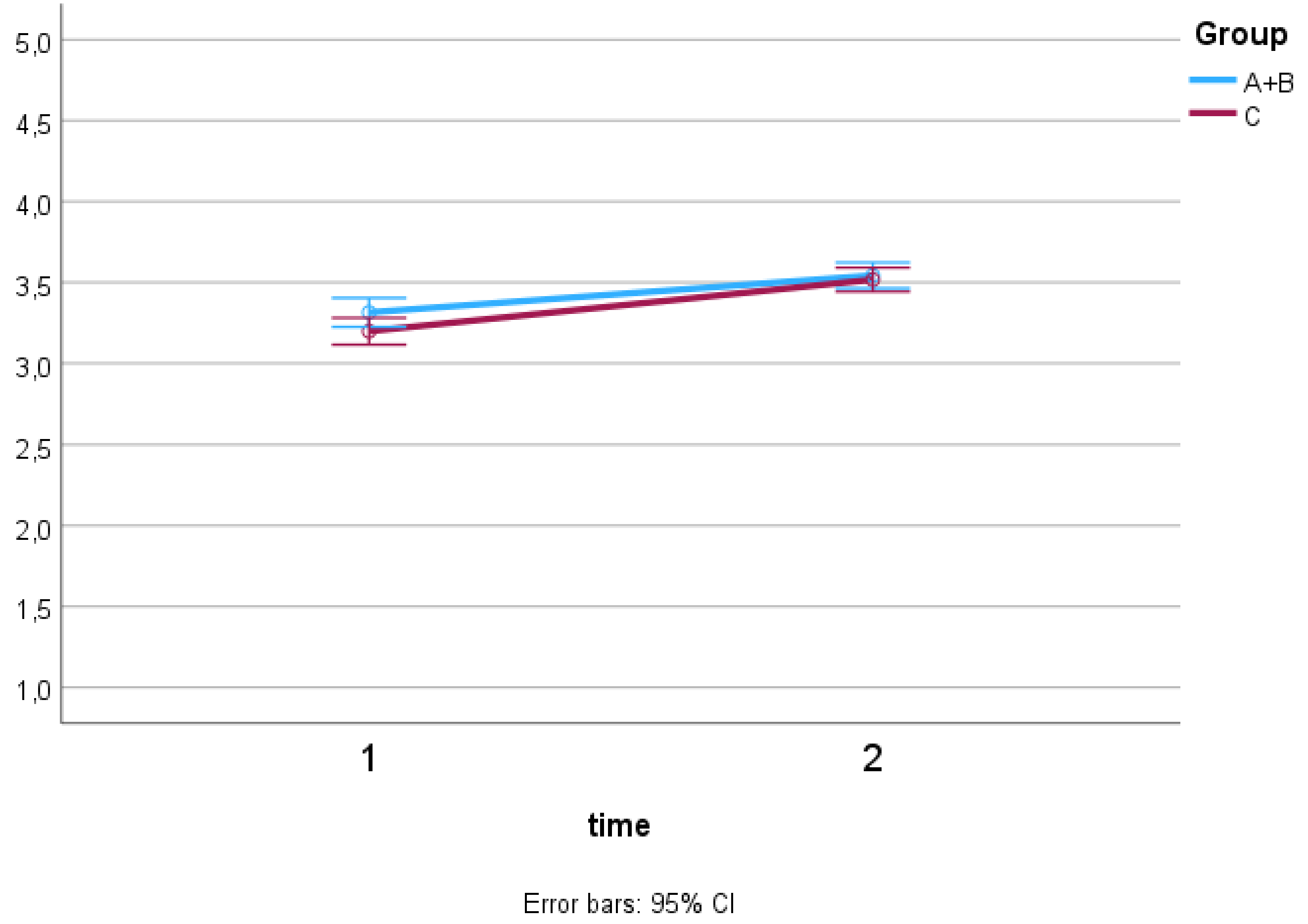
Analyses

- RQ 1-3: Repeated measures cohort ANOVAs
- RQ 4: Hierarchical Multiple Regressions
  - DV: AI-related constructs
  - IV: Demographics, DigCompEdu and attitudes towards teaching with digital technology

Results

- **RQ 1:** Development of Digital Competence & Attitudes

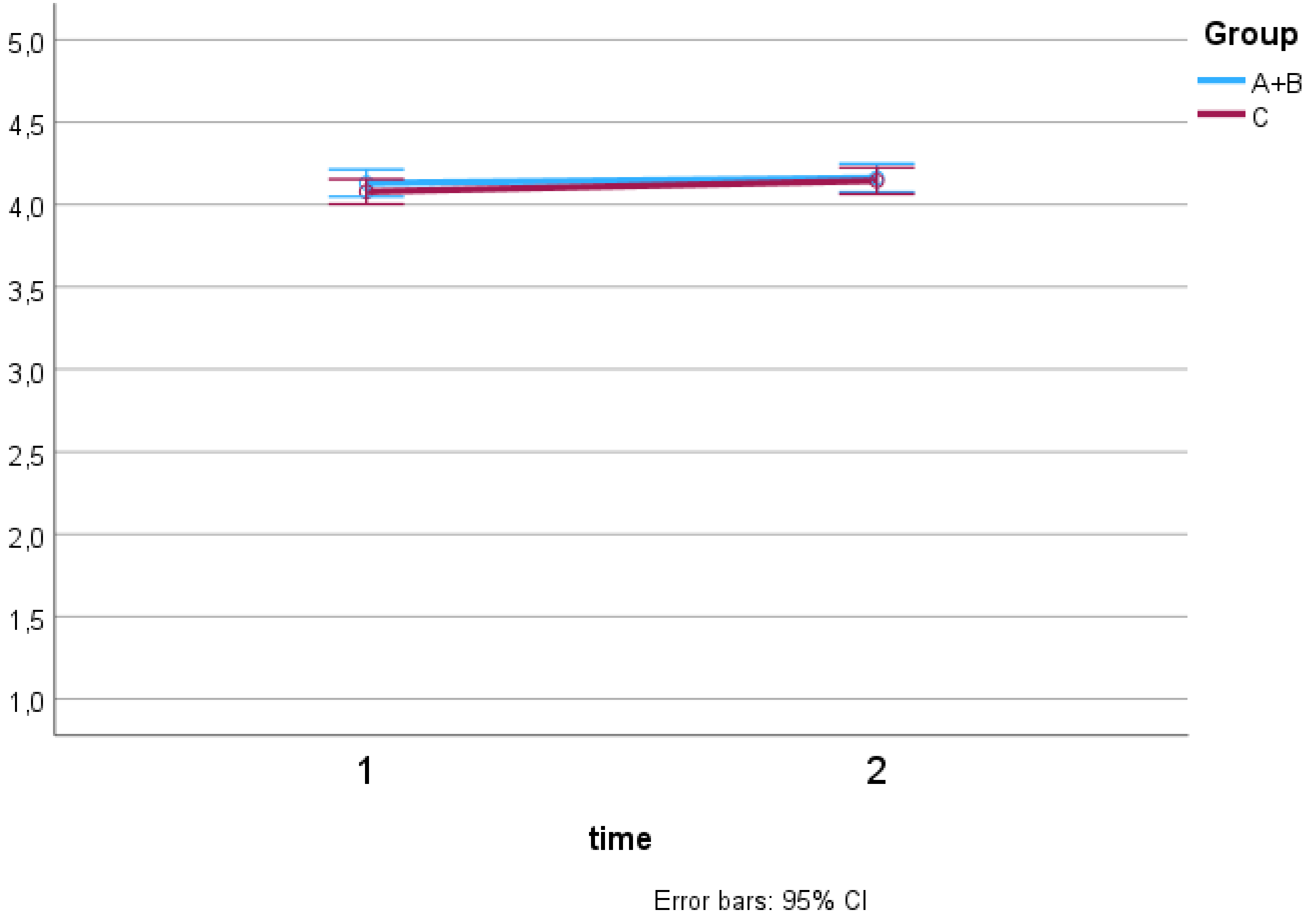
RQ 1a: Development of DigCompEdu (overall)



ANOVA-WS	*F*	*df*	*p*	η^2
time	94.694	1	**<.001**	.173
time*cohort	2.571	1	.110	.006
ANOVA-BS				
cohort	1.895	1	.169	.004

- Smaller time effect with General Self-Efficacy control: $F(1, 454) = 5.385$, $p = .021$, partial $\eta^2 = .012$

RQ 1b: Development of Positive Digital Attitudes

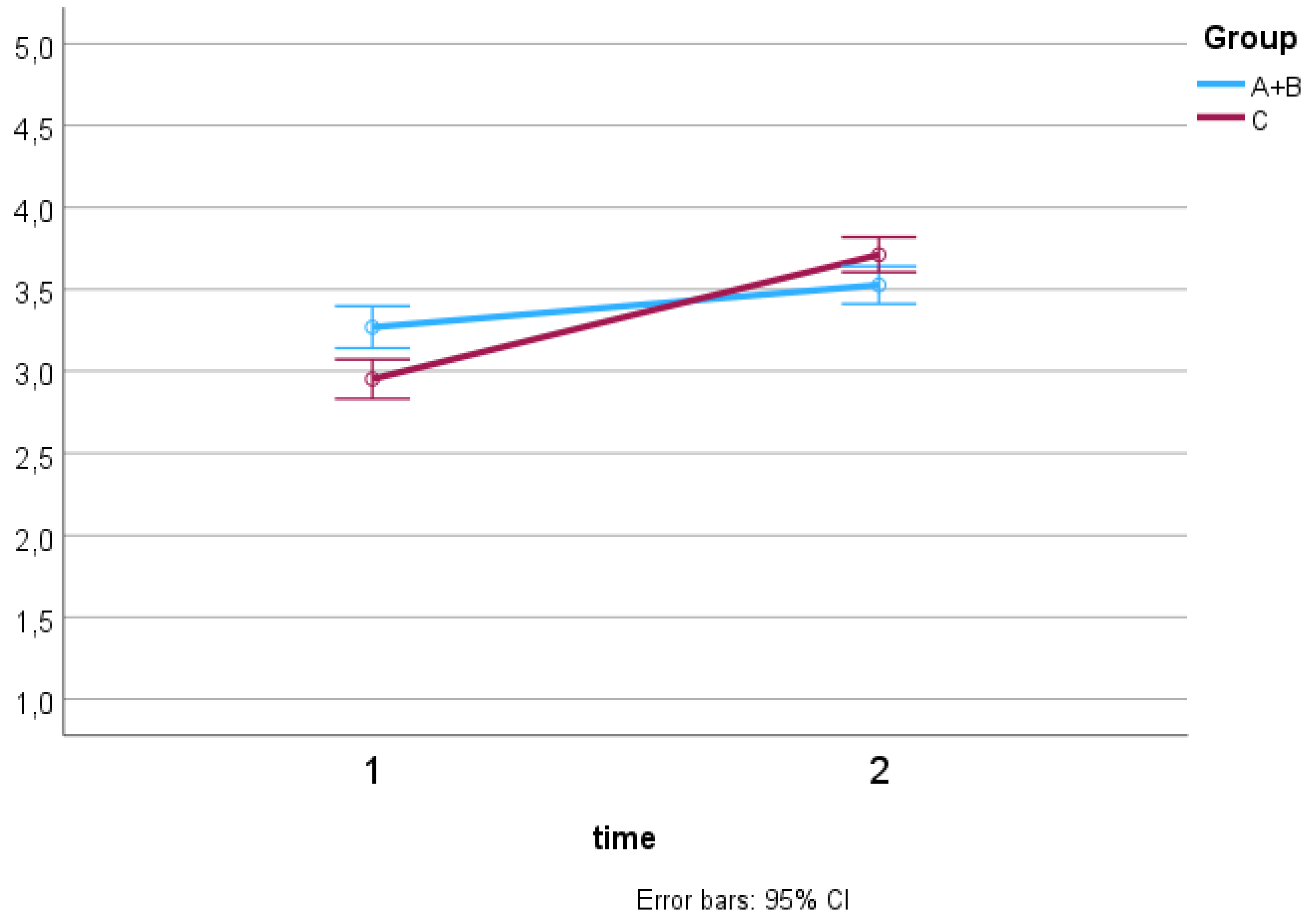


ANOVA-WS	*F*	*df*	*p*	η^2
time	3.568	1	.060	.007
time*cohort	0.463	1	.497	.001
ANOVA-BS				
cohort	0.434	1	.511	.001

Results

- **RQ 1:** Development of Digital Competence & Attitudes
- **RQ 2:** Development of AI Competence & Attitudes

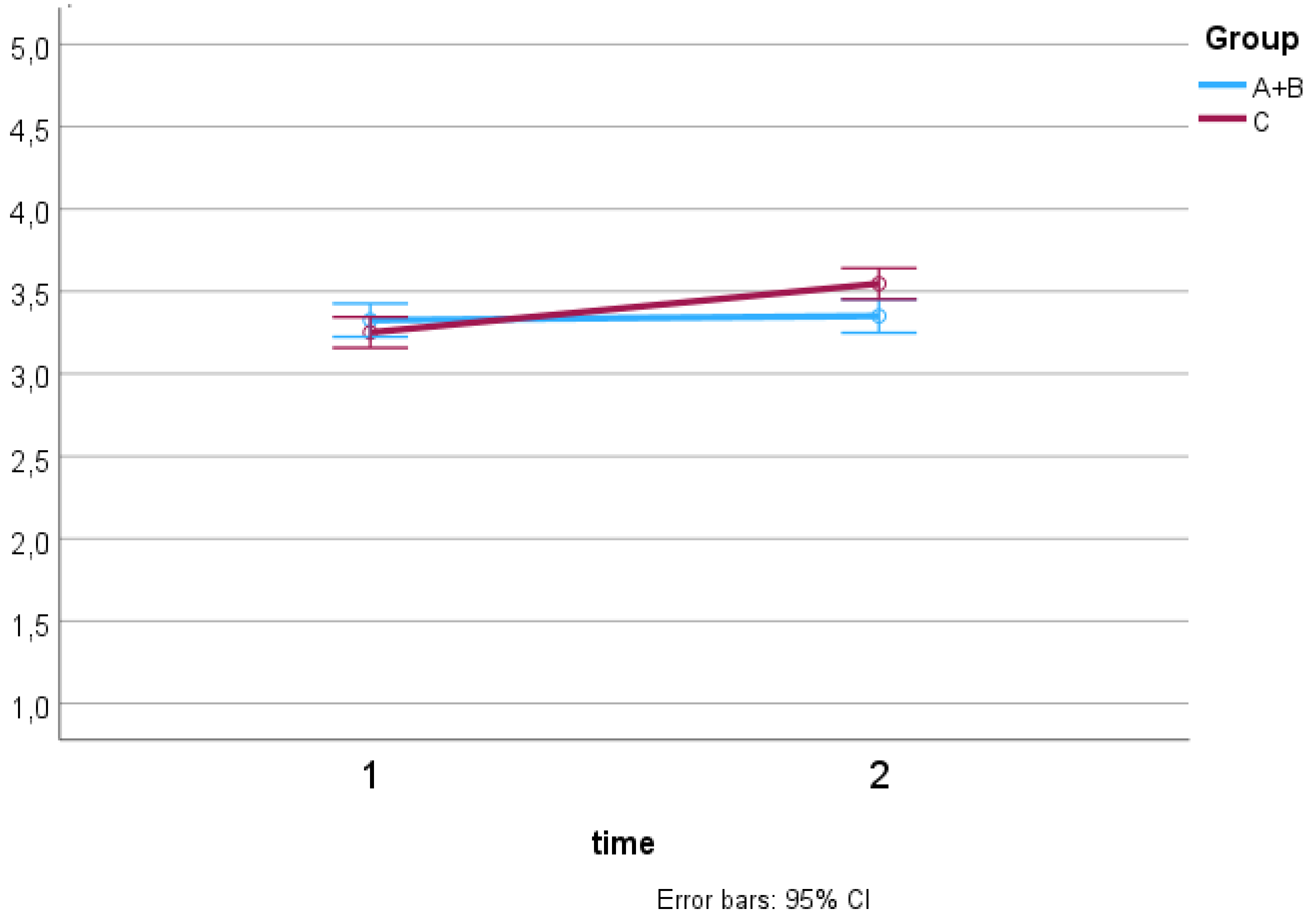
RQ 2a: Development of AI Competence Beliefs



ANOVA-WS	*F*	*df*	*p*	η^2
time	123.017	1	<**.001**	.219
time*cohort	29.962	1	<**.001**	.064
ANOVA-BS				
cohort	.851	1	.357	.002

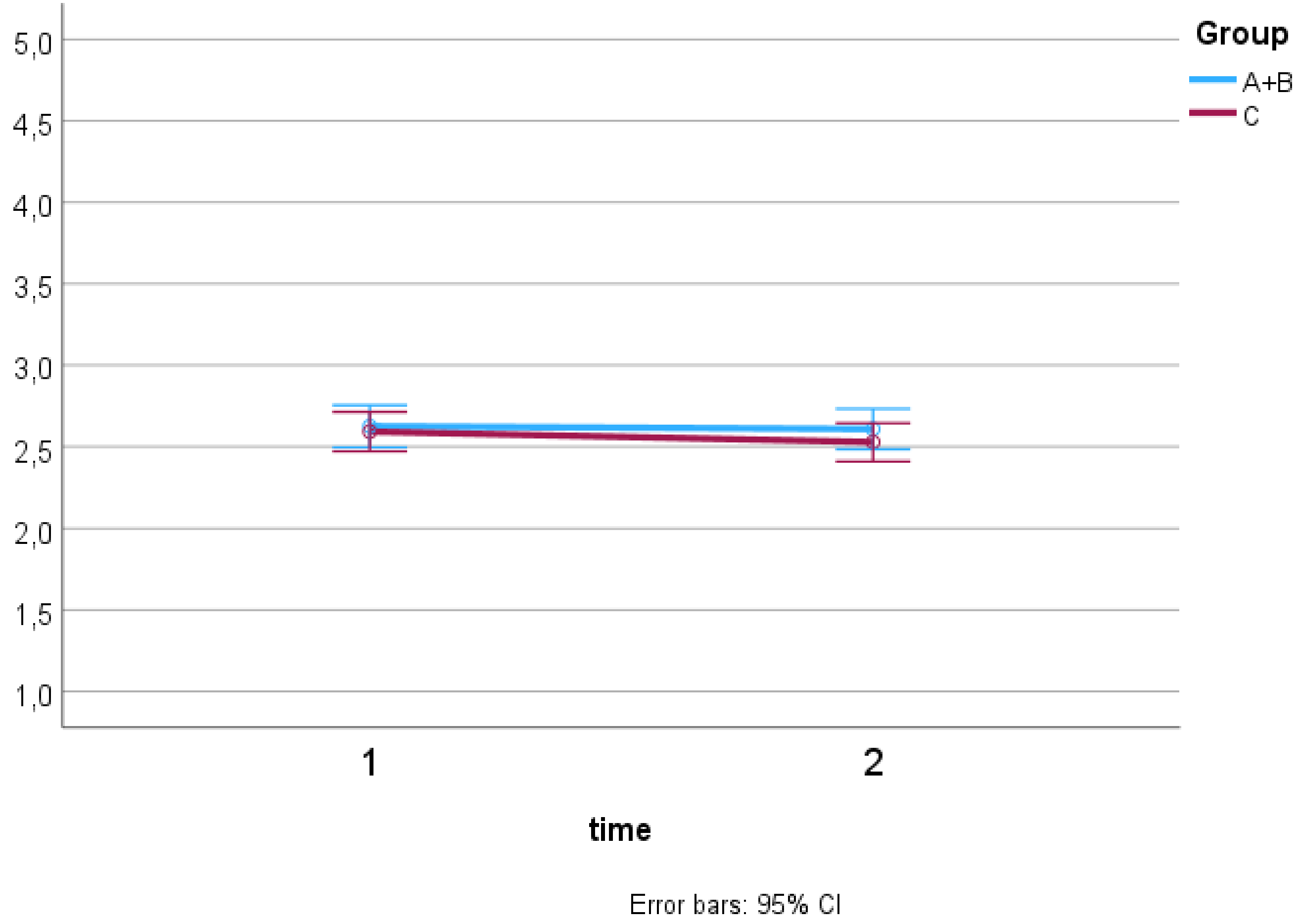
- Smaller time effect with General Self-Efficacy control: $F(1, 454) = 4.265$, $p = .039$, partial $\eta^2 = .010$

RQ 2b: Development of Positive AI Attitudes



ANOVA-WS	*F*	*df*	*p*	*η²*
time	19.865	1	<**.001**	.043
time*cohort	14.196	1	<**.001**	.031
ANOVA-BS				
cohort	1.013	1	.315	.002

RQ 2b: Development of AI Concerns

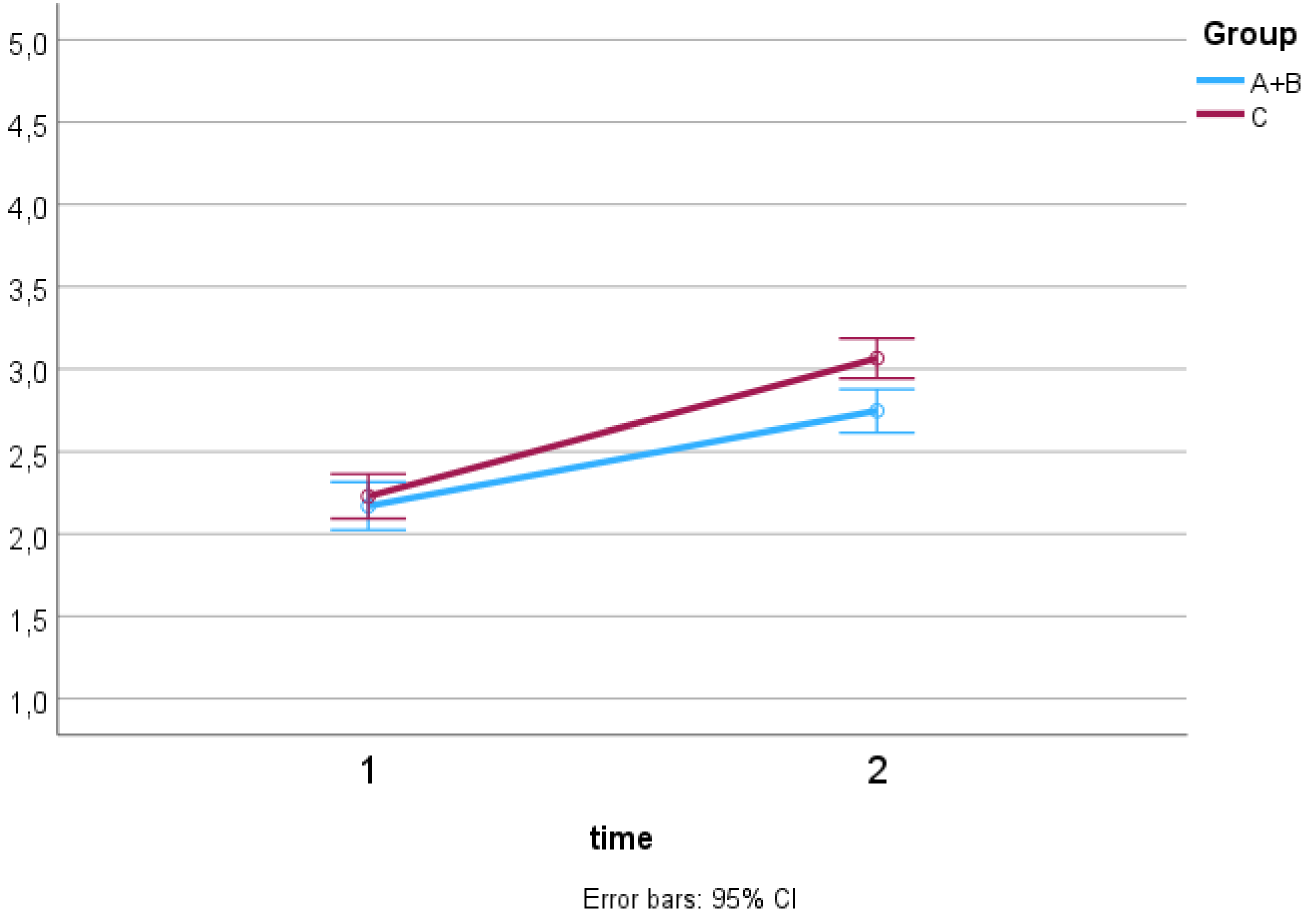


ANOVA-WS	*F*	*df*	*p*	*η²*
time	.599	1	.440	.001
time*cohort	.200	1	.655	.000
ANOVA-BS				
cohort	.633	1	.427	.001

Results

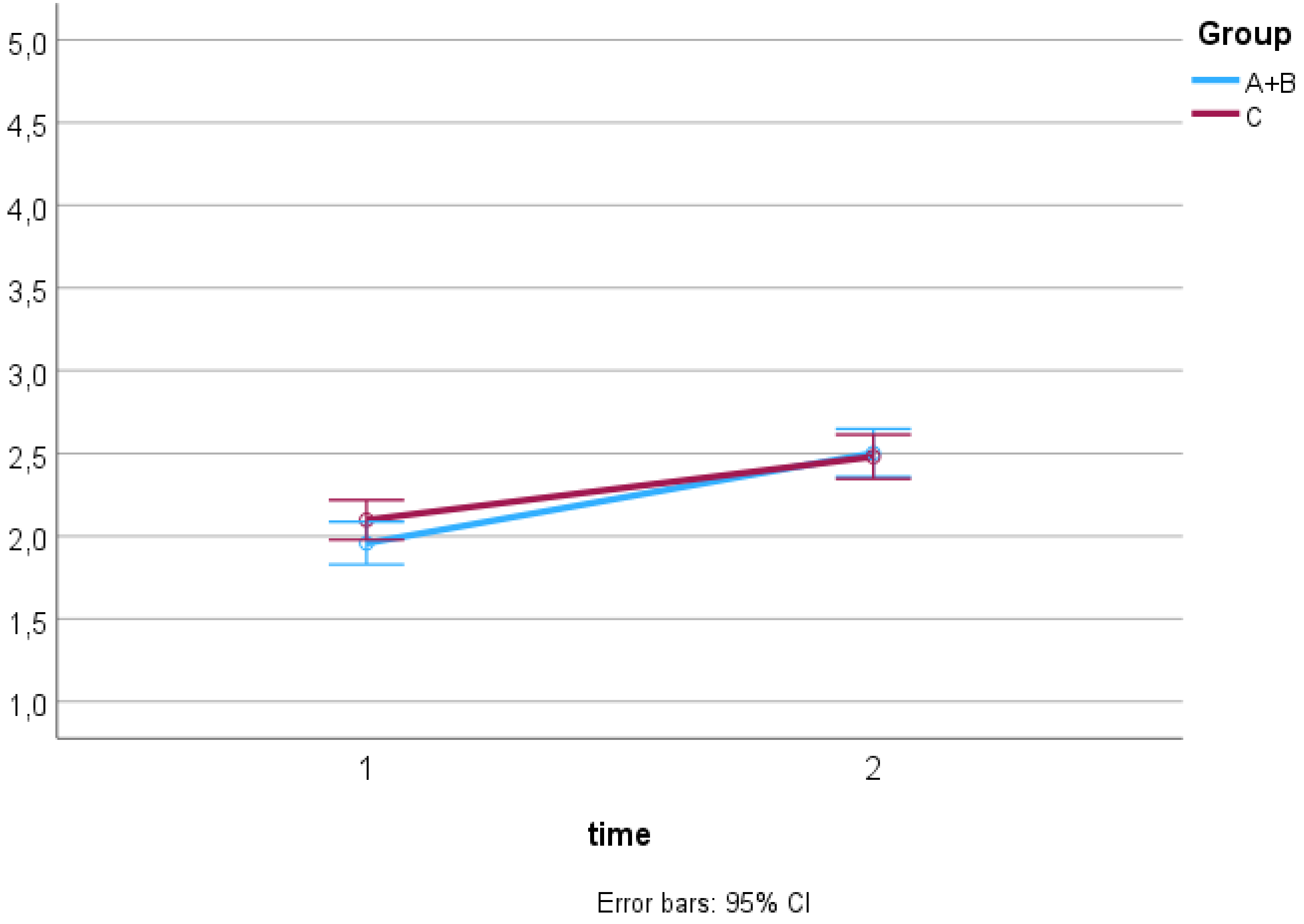
- **RQ 1:** Development of Digital Competence & Attitudes
- **RQ 2:** Development of AI Competence & Attitudes
- **RQ 3:** Development of AI usage

RQ 3a: Development of AI Use (prep)



ANOVA-WS	*F*	*df*	*p*	η^2
time	162.051	1	<**.001**	.271
time*cohort	5.491	1	**.020**	.012
ANOVA-BS				
cohort	5.759	1	**.017**	.013

RQ 3a: Development of AI Use (prac)



ANOVA-WS	*F*	*df*	*p*	η^2
time	74.373	1	**<.001**	.146
time*cohort	2.268	1	.133	.005
ANOVA-BS				
cohort	.574	1	.449	.001

Results

- **RQ 1:** Development of Digital Competence & Attitudes
- **RQ 2:** Development of AI Competence & Attitudes
- **RQ 3:** Development of AI usage
- **RQ 4:** Predictors of AI-related constructs

Research Framework

Digital Competence

- DigComp Self-ratings
- Dig Attitudes

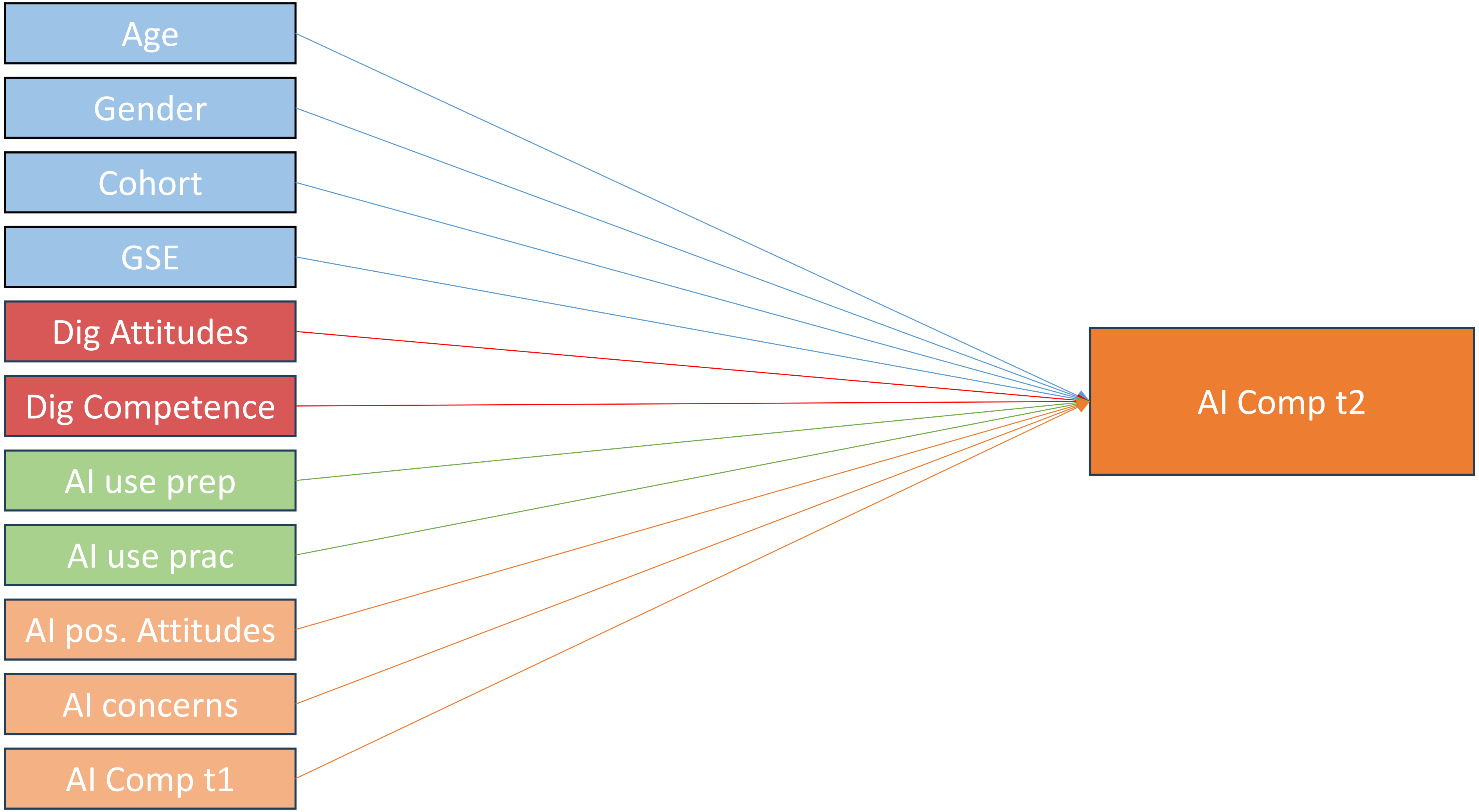
AI Competence

- AI Comp Self-ratings
- Positive AI Attitudes
- AI Concerns

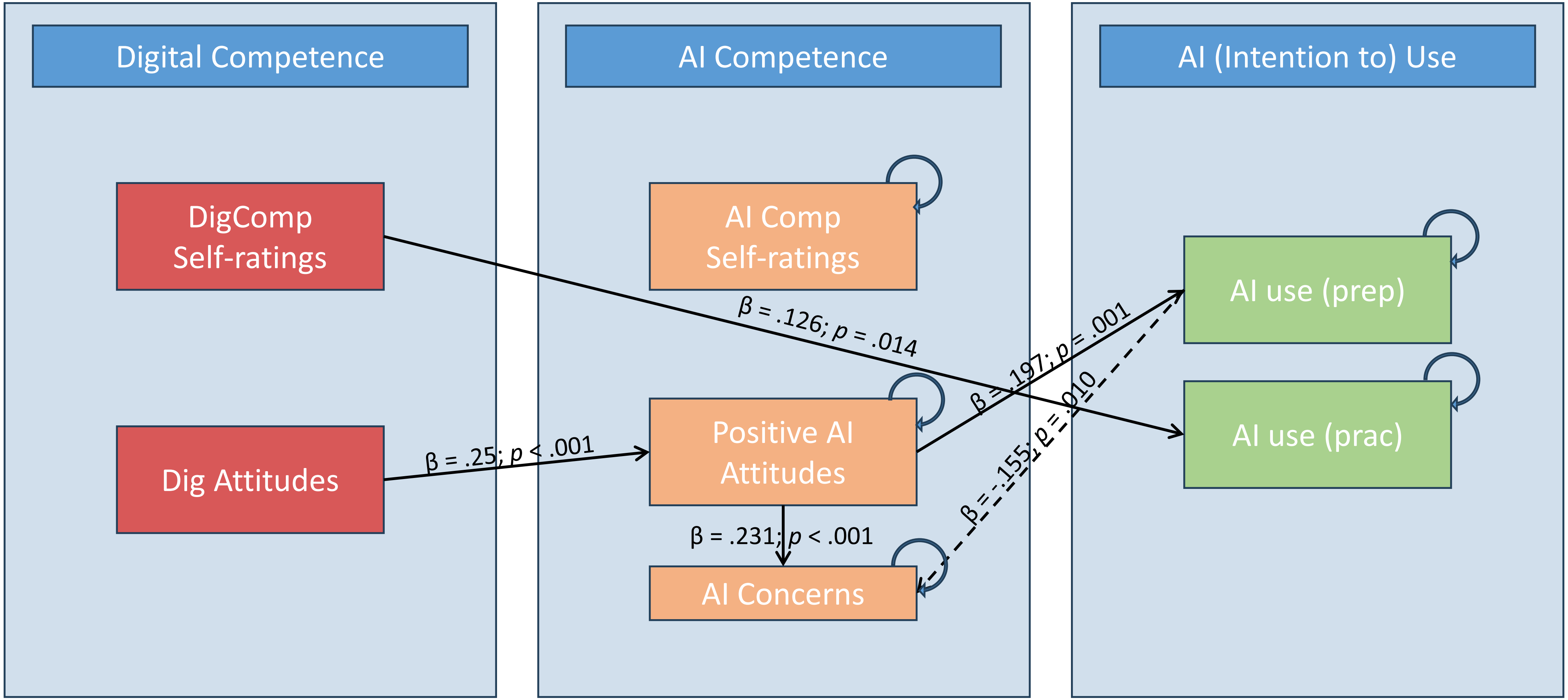
AI Use

- AI use (prep)
- AI use (prac)

RQ 4: Prediction of AI-related Constructs



Research Results (Predictions t1 → t2)



RQ 4: Prediction of AI concerns at t2

- Predictors:
  - Use of AI for planning lessons
  - Positive attitudes towards AI
  - Concerns towards AI

t1 predictor	B	SE	β	t	p
Age	-.024	.014	-.082	-1.750	.081
Gender	-.056	.107	-.025	-.517	.605
Cohort	-.075	.085	-.042	-.886	.376
Dig Att	-.127	.077	-.086	-1.656	.098
DigCompEdu	-.055	.072	-.039	-.757	.450
AI use prep	-.133	.051	-.155	-2.581	**.010**
AI use prac	-.040	.052	-.042	-.775	.439
AI pos Att	.287	.077	.231	3.751	**<.001**
AI Concerns	.282	.045	.293	6.314	**<.001**
AI Comp	-.035	.058	-.037	-.606	.545

Discussion: News for Teaching

News for Teaching with Digital Technology

- Rather high competence beliefs and attitudes regarding teaching with digital technology
  - High motivation to use and learn about digital technologies for teaching
  - High competence beliefs might lead to complacency inhibiting progress
- Consistent development in Generalized Self-Efficacy
  - Preparatory service is working well for competence beliefs
- No development in attitudes to teach with digital technology
  - Probably a ceiling effect

News for Teaching with AI

- Mixed attitudes and competence beliefs about teaching with AI
  - ➢ Pre-service teachers are rather neutral facing the possibilities and challenges of AI
- General digital competence supports AI development, but is not sufficient
  - AI-specific training and experience are needed to increase use and confidence
- Hands-on use of AI tools predict both competence and concerns
  - A more differentiated perspective develops through actual engagement

Limitations and Future Directions

- Competence beliefs are prone to bias
- Data is from Rhineland-Palatinate (Germany) only
- Selection bias due to voluntary participation
- Middle class school orientation of Realschule plus is underrepresented
- Additional Indications for changes over time (beginning to middle vs. middle to end of VBD), but could be due to other reasons
- No standardized program, differences over colleges
- A next step in this research would be to develop a structural equation model to gain more comprehensive understandings of the dynamics between the constructs

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Thank you!