TAMPERE UNIVERSITY OF TECHNOLOGY
LEAD Graduate School
EBERHARD KARLS UNIVERSITÄT TÜBINGEN
Leibniz-Institut für Wissensmedien

Contact: m.ninaus@iwm-tuebingen.de

GAME-BASED TRAINING OF RATIONAL NUMBER KNOWLEDGE

Manuel Ninaus[1,2], Simon Greipl[1], Kristian Kiili[3], Korbinian Moeller[1,2,4]

[1] Leibniz-Institut für Wissensmedien, Tuebingen, Germany
[2] LEAD Graduate School, Eberhard-Karls University Tuebingen, Germany
[3] TUT Game Lab, Tampere University of Technology, Pori, Finland
[4] Department of Psychology, Eberhard-Karls University Tuebingen, Germany

INTRO

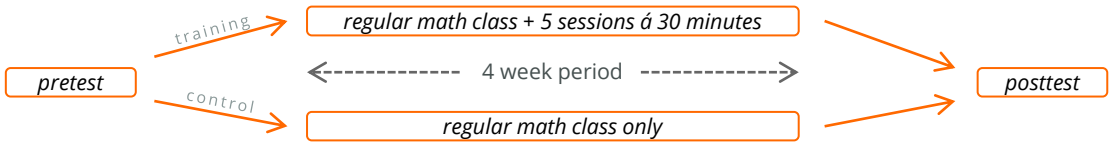
BACKGROUND

- previous studies indicated that digital learning games support mathematics learning (e.g. ter Vrugte et al. 2017)
- number line based trainings seem to support the development of conceptual rational number knowledge
- the current study employs a game-based number line training and evaluates its effectiveness in young students

METHODS

training group: *N* = 54 fourth graders, Mean age = 10.24 years, *SD*=0.43, 25 males
control group: *N* = 41 fourth graders, Mean age = 10.02 years, *SD*=0.27, 25 males

MEASURES
- paper pencil test with 28 items (20 minutes editing time) as pre-/posttest
- training sessions with tablet:
  - ✓six game worlds including 62 levels
  - ✓difficulty increases with players' progress
- in-game metrics monitoring behaviour, performance, and achievement (see results table)



TRAINING - TASKS

Estimation Task

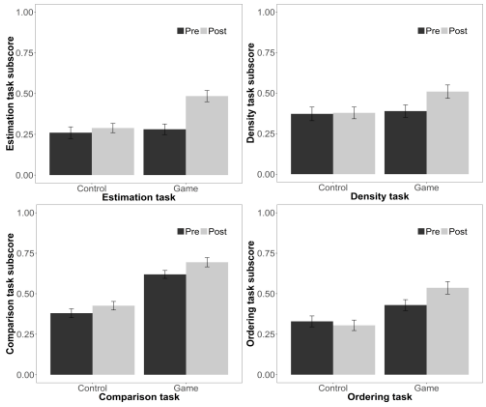
Comparison Task

Ordering Task (Equivalency)

Ordering Task (Density)

RESULTS

PERFORMANCE



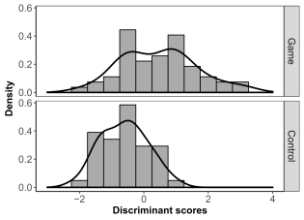
MANOVA on gain scores: [Pillai-trace = .225, F(4,90) = 6.53, p < .001, ηp^2 = .23]

IN-GAME METRICS

	1	2	3	4	5	6	7	8	9	10	11
1 pretest score	1										
2 posttest score	.80**	1									
3 est. correctness (pretest)	.76**	.59**	1								
4 gain score	.07	.60**	-.02	1							
5 overall game performance	.79**	.78**	.54**	.24	1						
6 star ratio	.36**	.33	.22	.07	.58**	1					
7 collected coins	.41**	.43**	.37**	.17	.44**	.50**	1				
8 effective playing time	-.02	-.01	-.15	.00	.03	.20	.40**	1			
9 est. accuracy (game)	.70**	.73**	.46**	.27*	.88**	.47**	.47**	-.00	1		
10 max level achieved	.64**	.72**	.49**	.36**	.63**	.34*	.71**	.21	.54**	1	
11 nr. of played games	.05	.10	.07	.10	-.14	.05	.63**	.47**	-.14	.49**	1

*=p<.05 | **=p<.01

DISCRIMINANT ANALYSIS



LDA analysis with 68.4% discrimination accuracy

CONCLUSION

- results clearly indicated usefulness and effectiveness of our game-based approach to train and improve aspects of students' conceptual rational number knowledge (primarily estimation and ordering performance)
- the maximum level students achieved while playing the game was associated positively with training gain in conceptual rational number knowledge
- in-game metrics reliably predicted posttest performance

References: Ninaus et al. Comput. in Hum. Beh. (2017) 70:197–206 | Siegler et al. Trends Cogn. Sci. (2013) 17:13–19 | ter Vrugte et al. Learn. Instr. (2017) 50:44–53

DISCUSSION/REFERENCES