Investigating cognitive, affective, and motivational effects of game elements for learning

Huber, S.E.[1], Lindstedt, A.[2], Kiili, K.[2], Ninaus, M.[1,3*]

Background

- Interest in using game elements for instruction has increased over the last decades [1]
- Main reasons: foster learning outcomes by increasing motivation, engagement and user experience [2]
- Game elements may also hinder learning by overloading limited cognitive capacities [3,4]
- Meta-analyses on the use of game elements in education report high degree of heterogeneity in studies [5,6]

→ ***Research questions***: What are the exact mechanisms? When have game elements (what kind of) effect?

Methods

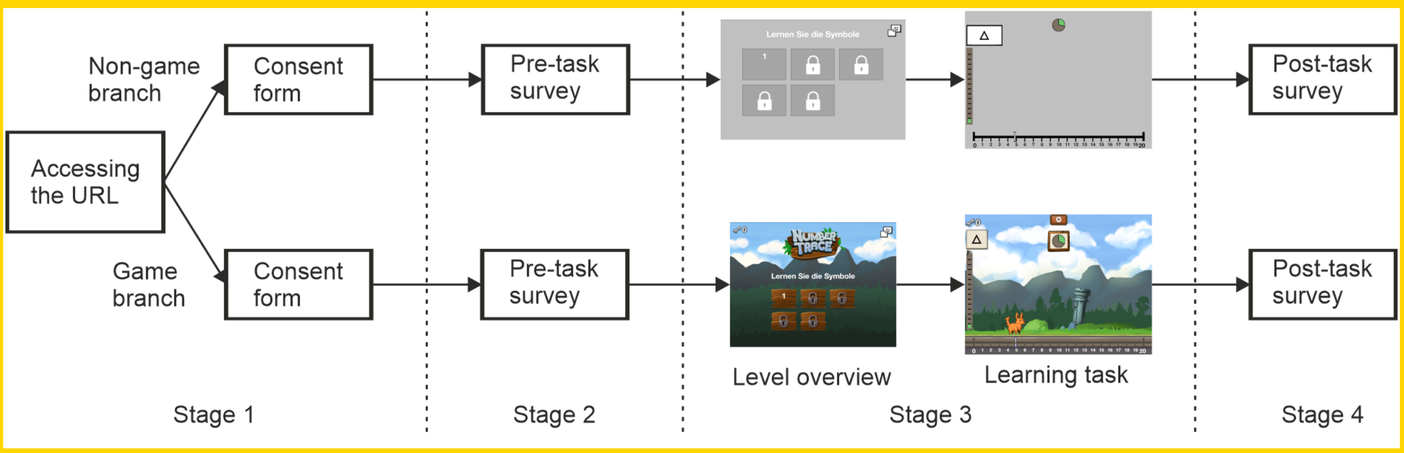
Three experiments using the same kind of **learning task in two versions** (gamified and non-gamified)

Experiments differ in **boundary conditions**:

- **Online** study 1 (*n* = 385) [7]: little incentive (raffle of 5 times 10 EUR)
- **Online** study 2 (*n* = 61) [8]: "sufficient" incentive (course credit)
- **Lab** study (*n* = 121): laboratory context/situation

Used questionnaires: PANAS, KIM, SIMS, UEQ, ASKU, NASA-TLX

Procedure



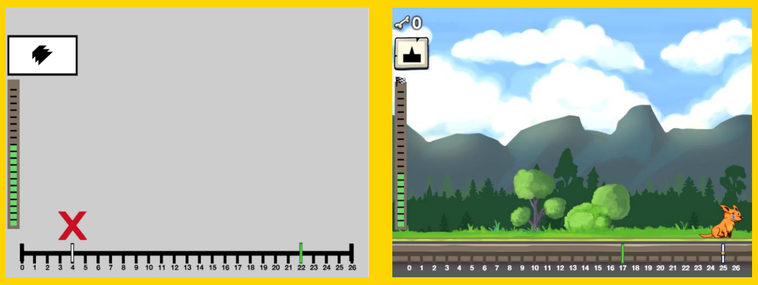
Learning task

Associative learning task (pairs of symbols and numbers)

Example: = 9

Goal: Learn number/position of as many symbols as possible over 5 levels

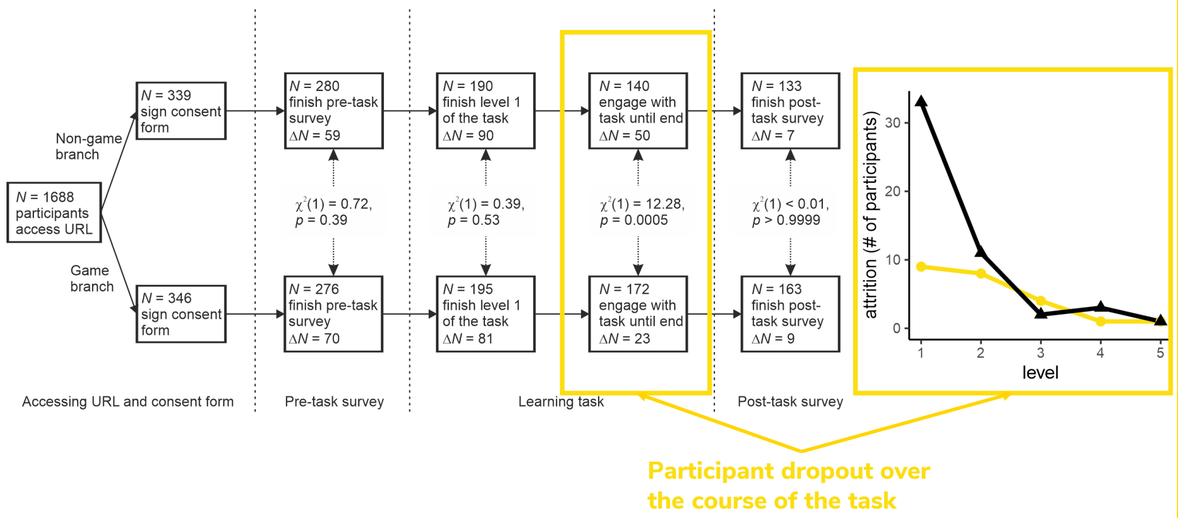
Game elements: Narrative + corresponding visual aesthetic, virtual incentives (i.e. bones for the dog)



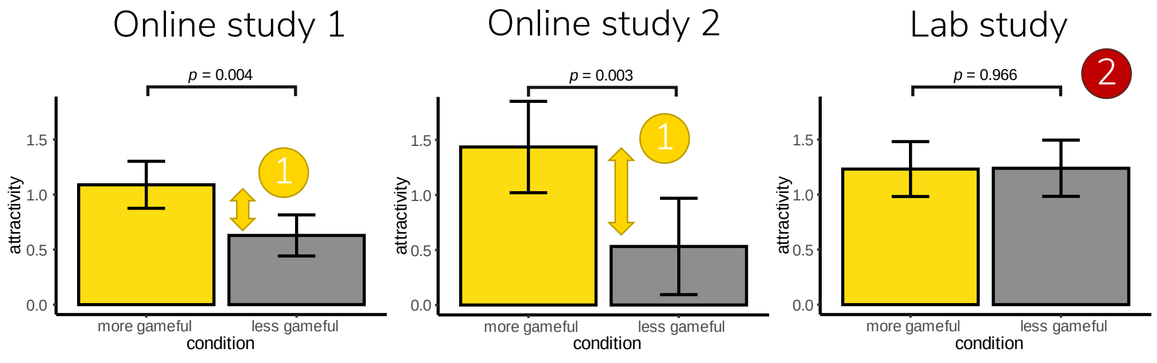
less gameful more gameful

Results

Behavioral engagement – Attrition (Online study 1)



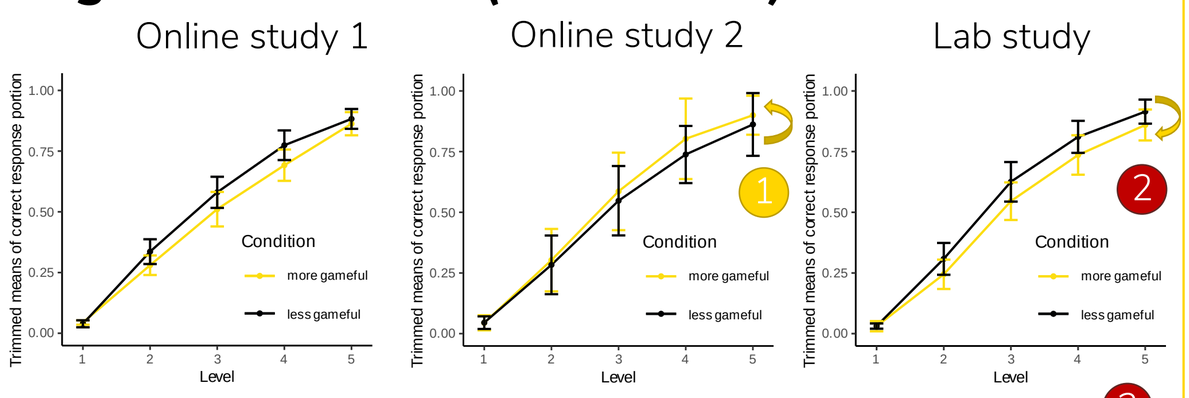
Motivational outcomes (Studies 1-3)



Online study 1	Online study 2	Lab study
δ ≈ 0.37 [0.13, 0.57]	δ ≈ 0.82 [0.31, 1.30]	δ ≈ -0.01 [-0.41, 0.37]
d ≈ 0.31 [0.08, 0.54]	*d* ≈ 0.78 [0.26, 1.44]	*d* ≈ 0.01 [-0.37, 0.35]
B_{21} = 3.88	B_{21} = 15.62	B_{12} = 12.93
$P(H_1\|D)$ = 0.205	$P(H_1\|D)$ = 0.060	$P(H_2\|D)$ = 0.072

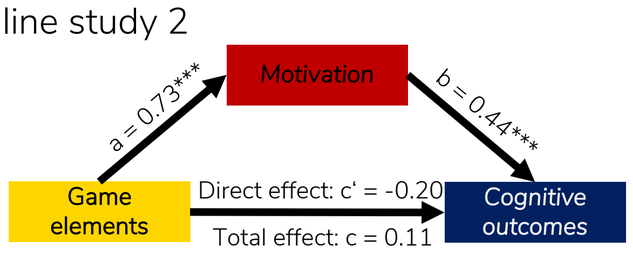
H_1: $\mu_{mg} = \mu_{lg}$, H_2: $\mu_{mg} > \mu_{lg}$

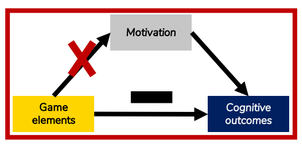
Cognitive outcomes (Studies 1-3)



Online study 2

Cognitive effects are partially mediated via motivation





Indirect effect: ab = 0.45*** [0.15, 0.85]

*** p < .001

However, overall, cognitive effects (cost) practically negligible!

Conclusions

- **Context matters. Eventually a lot.**
- If your goal is **research** about game elements:
- *Game elements can have various effects interacting with each other.*
- *Effects of game elements can differ between lab, online, classroom(?), homework(?) settings.*
- If your goal is learning or **education**:
- *Devise your learning activity as an intrinsically appealing activity.*
- *For how appealing a learning activity appears overall, again, context matters. Possibly a lot.*

Affiliations and cooperation partners

[1] Department of Psychology, University of Graz, Graz, Austria; [2] Faculty of Education and Culture, Tampere University, Tampere, Finland; [3] LEAD Graduate School and Research Network, University of Tübingen, Tübingen, Germany;.

University of Graz | Digital Psychology Lab

Contact: stefan.huber@uni-graz.at

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