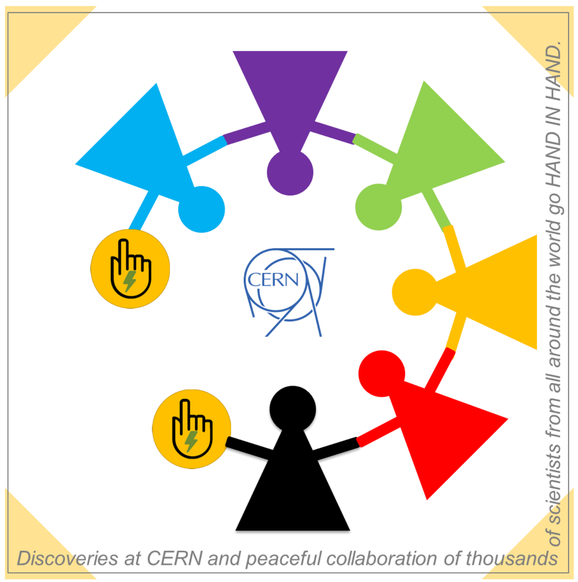
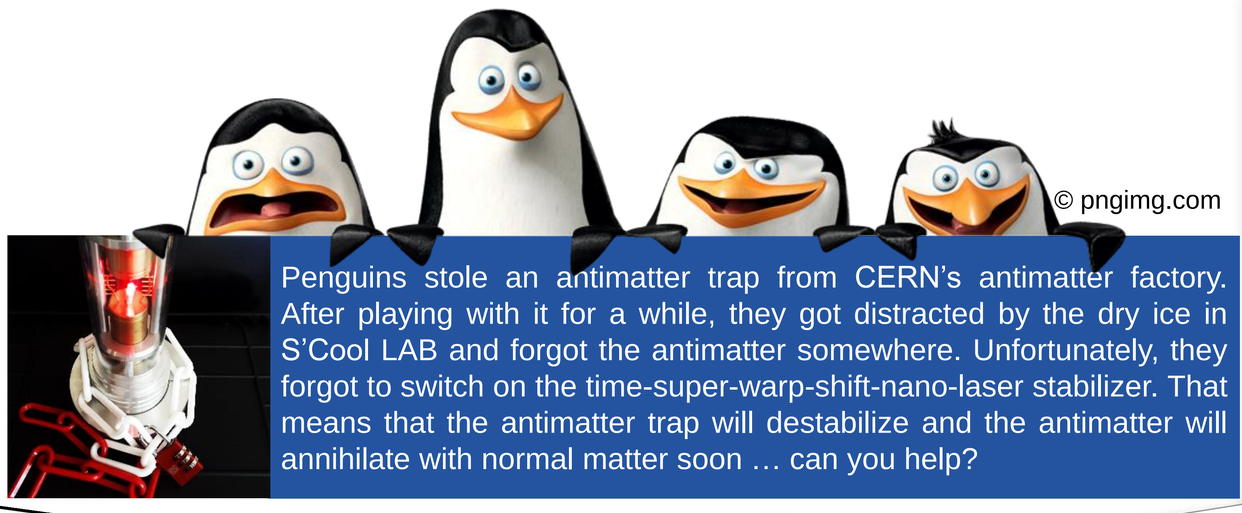
Escape Games in Physics Education
Students' Attitudes and Flow Experience

Julia Woithe, CERN, Geneva, Switzerland





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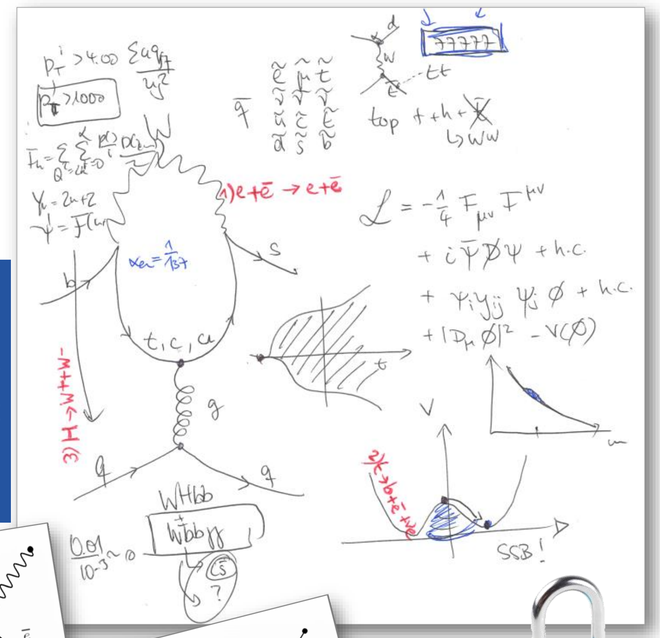
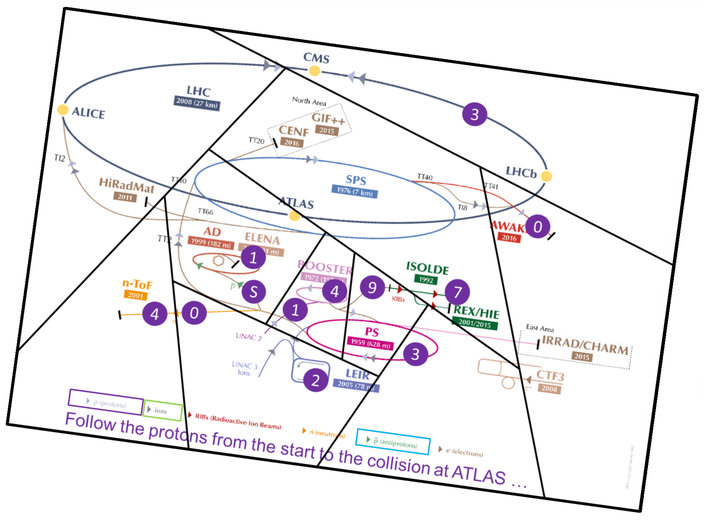
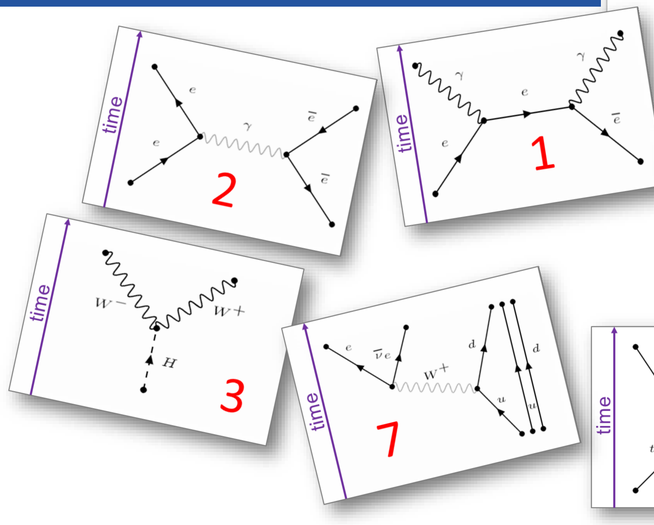
Penguins stole an antimatter trap from CERN's antimatter factory. After playing with it for a while, they got distracted by the dry ice in S'Cool LAB and forgot the antimatter somewhere. Unfortunately, they forgot to switch on the time-super-warp-shift-nano-laser stabilizer. That means that the antimatter trap will destabilize and the antimatter will annihilate with normal matter soon … can you help?







stable with:

EscapeED Framework: Development of Escape Games

The escape game has been developed in an iterative process following the escapED framework [1] which suggests a 6-level approach:

Participants	Objectives	Theme	Puzzles	Equipment	Evaluation
• User type • Time • Difficulty • Mode • Scale	• Learning objectives • Solo/multi-disciplinary • Soft skills • Problem solving	• Escape mode • Mystery mode • Narrative design • Stand alone/ nested	• Puzzles design • Reflect objectives • Instructions/ manual • Clues/hints	• Location/ space design • Physical props • Technical props • Actors	• Testing • Reflection • Evaluate learning objectives • Adjust • Re-set

Research Questions

- How does students' escape game experience change over time?
- Does this educational escape game foster a mental state of flow?
- How do students describe their (learning) experience?

Theoretical Background & Methods

Mental state of flow: characterized by intense and focused concentration, distortion of temporal experience, and an intrinsically rewarding experience [2]

Game-based learning: refers to a type of games characterized by specific learning goals. Learners practice new skills and acquire new knowledge in a playful way while being absorbing in an enjoyable game without noticing time passing [3]

Fostering flow in educational games: engaging activities, defined goals & progress indicators, immediate & clear feedback, balance perceived challenge & perceived skills [3]

Game Experience Questionnaire: assesses the multi-facet nature of game experience [4] before, during and after the game (14/43 5-level items, completely disagree - completely agree)

Positive affect, e.g "I enjoyed it"
Immersion, e.g "I was interested in the story"
Flow, e.g "I felt completely absorbed"
Competence, e.g "I felt successful"
Challenge, e.g "I thought it was hard"
Tension, e.g "I felt frustrated"
Negative affect, e.g "I felt bored"

Involvement, e.g "I paid close attention to the others"

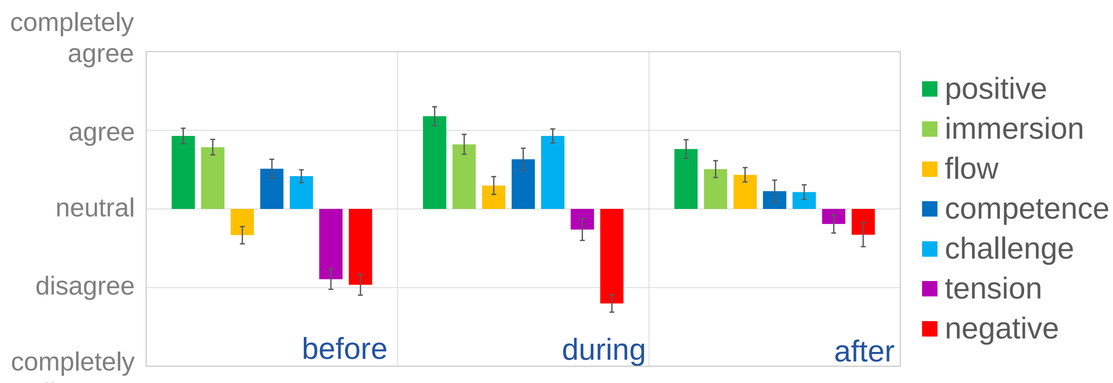
In addition:
age, gender, physics interest and physics self-concept

Interviews: four focus groups (4-5 students) with discussion guide about game experience

First Results

Game experience before, during & after the escape game

Mean & SE, N = 42,
26% female,
Ø age 17 years,
9 groups of 4-5 students



Sub-dimensions of game experience after the escape game, Pearson's r

* p ≤ 0.00091 ** p ≤ 0.00018 Bonferroni correction m=55	immersion	flow	competence	challenge	tension	negative	involvement	interest Ph	self-concept	escape time
positive affect	0,5	0,2	0,7**	-0,1	-0,5*	-0,6*	0,5*	0,4	0,4	-0,5*
immersion		0,6**	0,3	0,2	-0,2	-0,3	0,3	0,4	0,2	-0,2
flow			0,1	0,1	0,1	0,1	0,1	0,2	-0,1	0,0
competence				0,0	-0,6**	-0,4	0,6**	0,3	0,3	-0,6**
challenge					0,1	-0,1	0,1	0,0	-0,1	0,3
tension						0,6**	-0,3	-0,3	-0,3	0,6**
negative affect							-0,2	-0,3	-0,3	0,4
involvement								0,4	0,4	-0,2
interest Ph									0,7**	-0,3
self-concept Ph										-0,3

Do you think that you can learn physics while playing?

S1: In general, yes. In this case, in particular at A-level, it's more difficult but at lower grades – sure, especially if it's about magnetism.
S2: Well, understanding the Compton effect while playing for 4 hours is difficult (all laughing). But as he said, at that level – definitely.
S3: The topics get more theoretical and therefore, I think, it's more difficult to learn while playing.
S4: For complex topics, you have to read first, which then takes a while. And then playing games …
S3: It's maybe more an introduction.

What do you think, how much time did you need to solve the escape game?

All: No idea. I do not know. (mumbling) We started at 10 to (..) it must have been 40 minutes.
S1: It seemed like 10 min (all: yes) because you just got stressed all the time but (..) "stress" …
S2: Because you are always doing something and you are not just sitting there bored
S3: and because it's fun

How would you describe your experience in 3 words?

positive stress – fun – creative

Summary

- Escape games can provide fun and engaging activities for students
- Iterative design to balance challenge and competence experience
- Immersion and flow experience are correlated, but independent of physics interest, self-concept & other game experience dimensions
- Successful game even with little storytelling / immersive atmosphere

Literature

[1] S. Clarke, D. J. Peel, S. Arnab, L. Morini, H. Keegan & O. Wood, EscapED: a framework for creating educational escape rooms and Interactive Games For Higher/Further Education, International Journal of Serious Games **4** (2017) 73-86.
[2] M. Csikszentmihalyi & I. S. Csikszentmihalyi (Eds.), Optimal experience: Psychological studies of flow in consciousness, Cambridge university press, 1992.
[3] N. Whitton, & A. Moseley (Eds.), Using games to enhance learning and teaching: a beginner's guide, Routledge, 2012.
[4] K. Poels, Y. De Kort, & W. IJsselsteijn. Game Experience Questionnaire: development of a self-report measure to assess the psychological impact of digital games, 2007

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julia.woithe@cern.ch