Particle physics course for high-school students (PPC)

Jeff Wiener & Julia Woithe

cern.ch/PPC

Particle Physics Course for High-School Students

Motivation

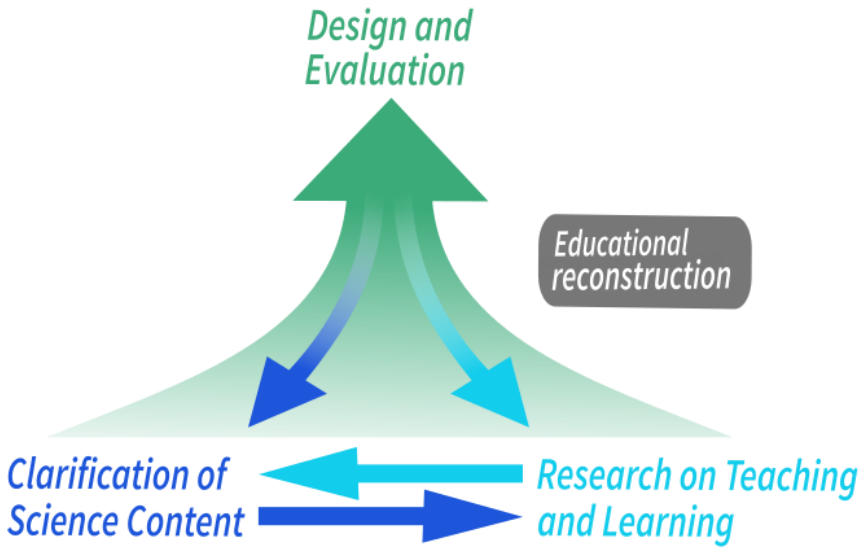
- high demand for educational offers targeting high-school students

Goals

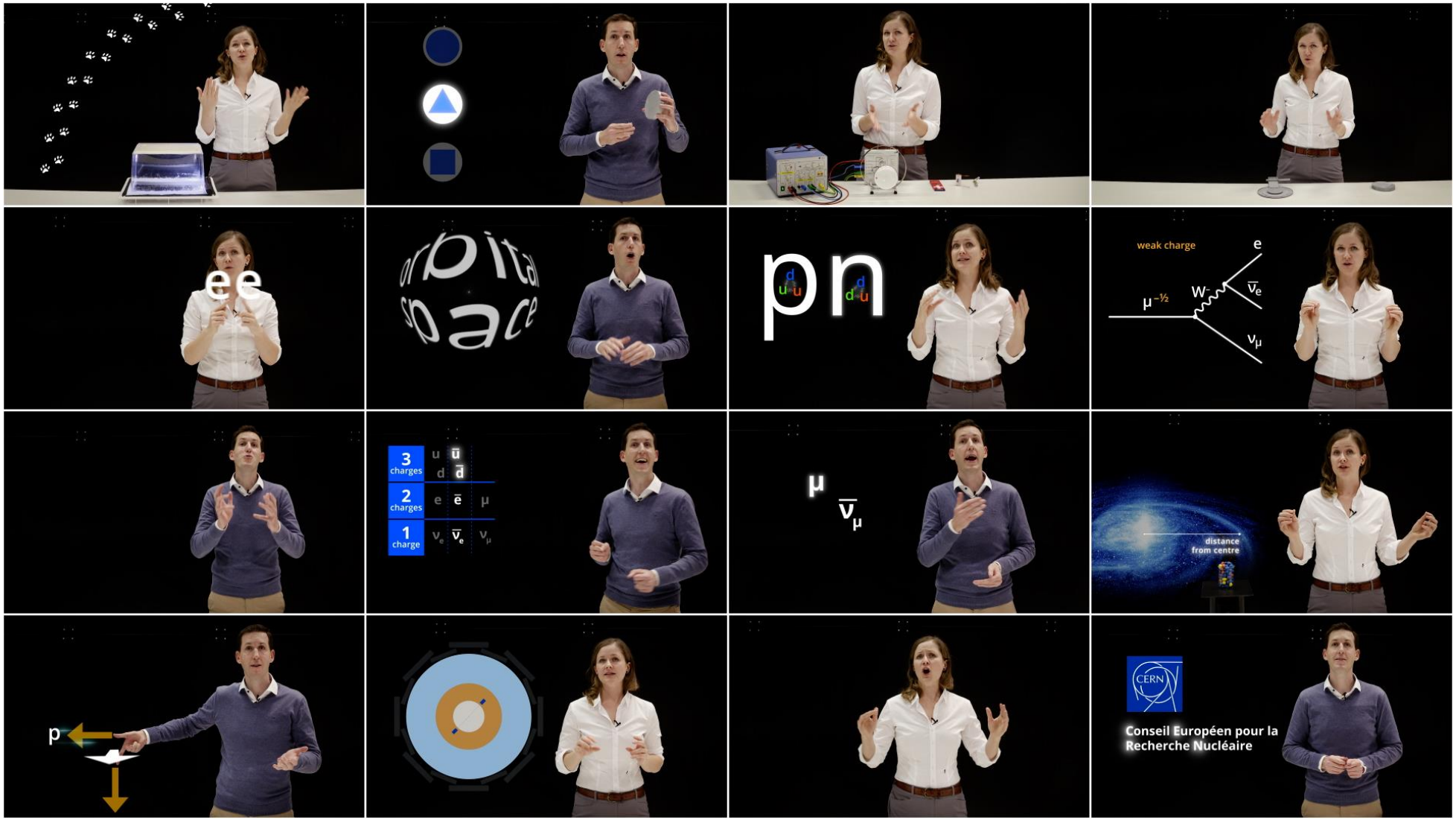
- develop online learning offer for high-school students (14+) from around the world
- provide teachers with educational ideas and materials for their classroom
- narrow the research-practice gap in particle physics education research

Educational framework

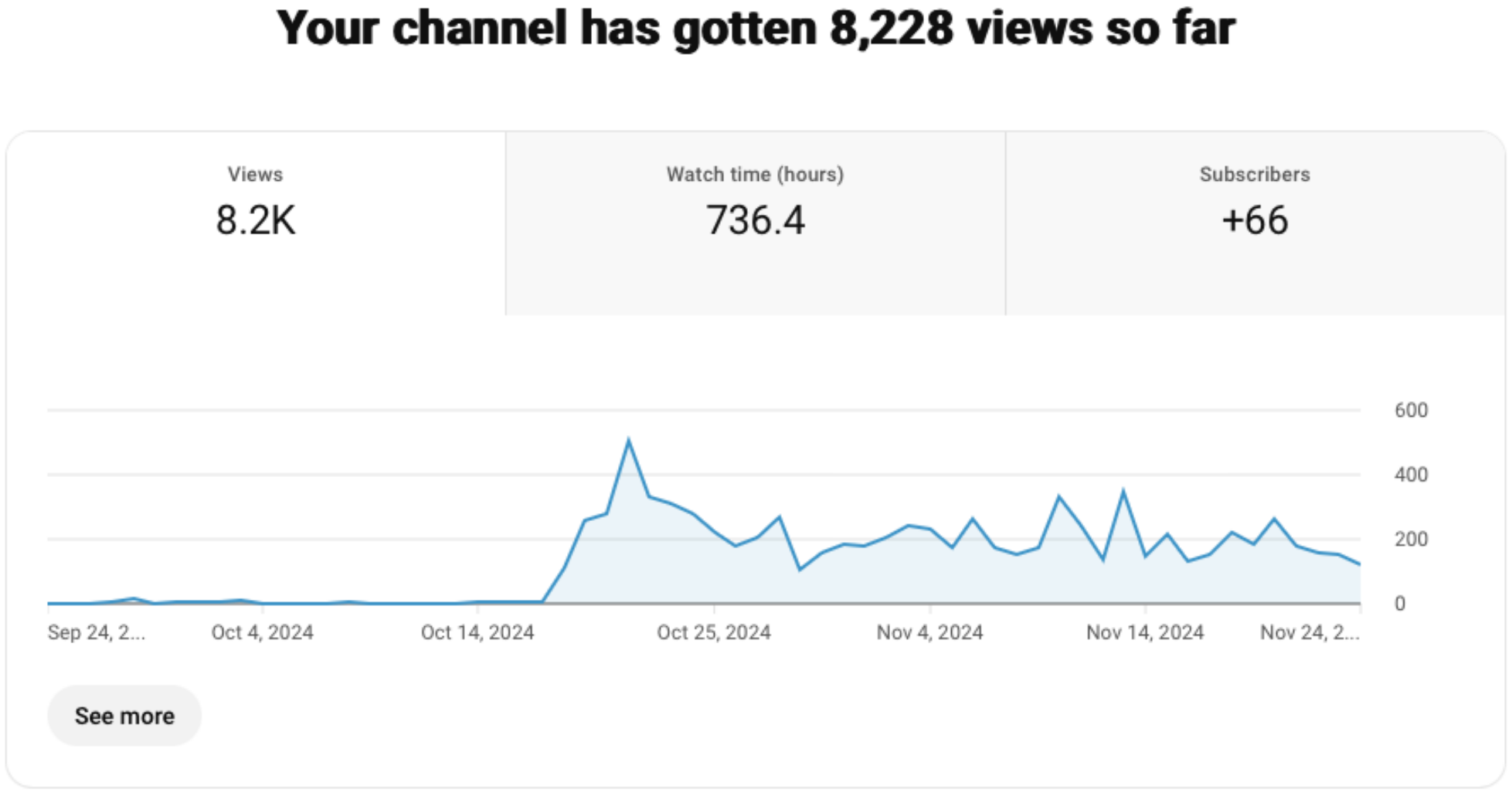
- Key messages derived from educational reconstruction
- Learning progression: balancing cognitive load and curiosity
- Nature of science and scientific models
- Linguistic accuracy
- Typographic representations
- Core curriculum



(Duit et al. 2012)


ee
orbital space
pn
weak charge
e
$\bar{\nu}_e$
$\mu^{-½}$
W^-
ν_μ
3 charges
2 charges
1 charge
u $\bar{u}$
d $\bar{d}$
e $\bar{e}$ μ
ν_e $\bar{\nu}_e$ ν_μ
μ
$\bar{\nu}_\mu$
distance from centre
p
CERN
Conseil Européen pour la Recherche Nucléaire

Pilot version



Pilot version

Feedback form

N = 2303 (over 16 chapters)

- **Enjoyment 92% (SD 14%)**
- **Easiness 92% (SD 15%)**
- **Interest 90% (SD 16%)**

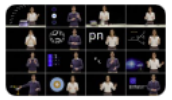
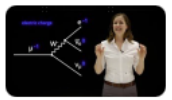
Please rate the following statements to help us improve the online course.

	Completely disagree	Disagree	Disagree a little	Agree a little	Agree	Completely agree
I enjoyed watching this video.						
I enjoyed answering the quiz questions.						
I enjoyed connecting what I was learning to things I already knew.						
It was easy to understand the concepts covered in the video.						
It was easy to answer the quiz questions.						
It was easy to connect what I was learning to things I already knew.						
I would like to watch more videos like this.						
I did not notice time passing when watching the video.						
I want to learn more about the concepts covered in the video.						
I want to discuss what I have learned with my friends or family.						
The content of the video was well organised.						
The illustrations or demonstrations were helpful.						

	0	1	2	3	4	5	6	7	8	9	10
How likely are you to recommend this course to a friend?											

Completion rates

- **MOOCs usually struggle with very low completion rates around 5%**
- **PPC viewers tend to be very motivated to complete each chapter (and the course)**
  - 1557 started the course
  - 725 completed at least one chapter
  - 259 already received a certificate (17%)

	Content	Average view duration	Views
1	 PPC Trailer	0:26 (72.5%)	2,083
2	 Chapter 1	5:37 (54.6%)	1,338
3	 Chapter 2	7:06 (62.0%)	664
4	 Chapter 3	7:29 (62.6%)	538
5	 Chapter 4	6:59 (62.4%)	468
6	 Chapter 5	6:49 (65.2%)	407
7	 Chapter 6	8:05 (58.6%)	351
8	 Chapter 7	9:17 (51.7%)	307
9	 Chapter 8	8:10 (54.8%)	280

Merci bien!

Questions?

Quiz questions: example 1

Kim and Jim want to bake a "Universe Cake" to explain the components of the energy content of our Universe to their friends. They decide that the cake base will represent dark energy, the cream layer will represent dark matter, and the “galaxy and star” topping will represent ordinary visible matter. If the total height of their cake is 100 mm, how thick should each layer be to match our current understanding of the Universe's composition? (single choice)

- ○ Cake base: 95 mm, cream layer: 3 mm, galaxy and star topping: 2 mm
- ○ Cake base: 50 mm, cream layer: 40 mm, galaxy and star topping: 10 mm
- ○ Cake base: 68 mm, cream layer: 27 mm, galaxy and star topping: 5 mm
- ○ Cake base: 27 mm, cream layer: 68 mm, galaxy and star topping: 5 mm

Check

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- ✔ Cake base: 68 mm, cream layer: 27 mm, galaxy and star topping: 5 mm

  Correct! The cake base represents dark energy (68%), the cream layer represents dark matter (27%), and the thin topping symbolizes visible matter (5%).
- Cake base: 27 mm, cream layer: 68 mm, galaxy and star topping: 5 mm

1/1

Quiz questions: example 2

Even after their skateboard break, Kim and Jim continue discussing conservation laws. Jim writes down a hypothetical particle transformation:

$p^+ + p^+ + e^- \rightarrow p^+ + e^- + e^-$ (2 protons and 1 electron transform into 1 proton and 2 electrons)

Jim asks Kim whether this process is possible anywhere in our Universe. What can Kim answer? (single choice)

- ○ "Yes, this process should be possible somewhere in our Universe. After all, anything is possible somewhere in our Universe."
- ○ "Well, I would need to check first if this process violates any of the conservation laws. For example, the total electric charge is not conserved in this process. Therefore it is not possible."
- ○ "The total electric charge is not conserved in this process. However, this process can still be possible somewhere in the Universe under extreme conditions, for example, in a star explosion."
- ○ "The total electric charge is not conserved in this process. That means that this process is still possible, but the result would only be able to exist for an extremely short time."

Check

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"Well, I would need to check first if this process violates any of the conservation laws. For example, the total electric charge is not conserved in this process. Therefore it is not possible."

✖ "The total electric charge is not conserved in this process. However, this process can still be possible somewhere in the Universe under extreme conditions, for example, in a star explosion."

Nope. No matter where in the Universe, all processes in our Universe have to follow all conservation laws. Even under extreme conditions such as star explosions these fundamental laws apply.

"The total electric charge is not conserved in this process. That means that this process is still possible, but the result would only be able to exist for an extremely short time."

0/1 Retry

References

- Duit, R., Gropengießer, H., Kattmann, U., Komorek, M., & Parchmann, I. (2012). The model of educational reconstruction–A framework for improving teaching and learning science. In *Science education research and practice in Europe* (pp. 13-37). Brill.

- Palmer, K., & Devers, C. (2018). An evaluation of mooc success: Net promoter scores. In Edmedia+ innovate learning (pp. 1648-1653). Association for the Advancement of Computing in Education (AACE).

- Lucero, K. S. (2022). Net Promoter Score (NPS): what does net promoter score offer in the evaluation of continuing medical education? *Journal of European CME*, *11*(1), 2152941.