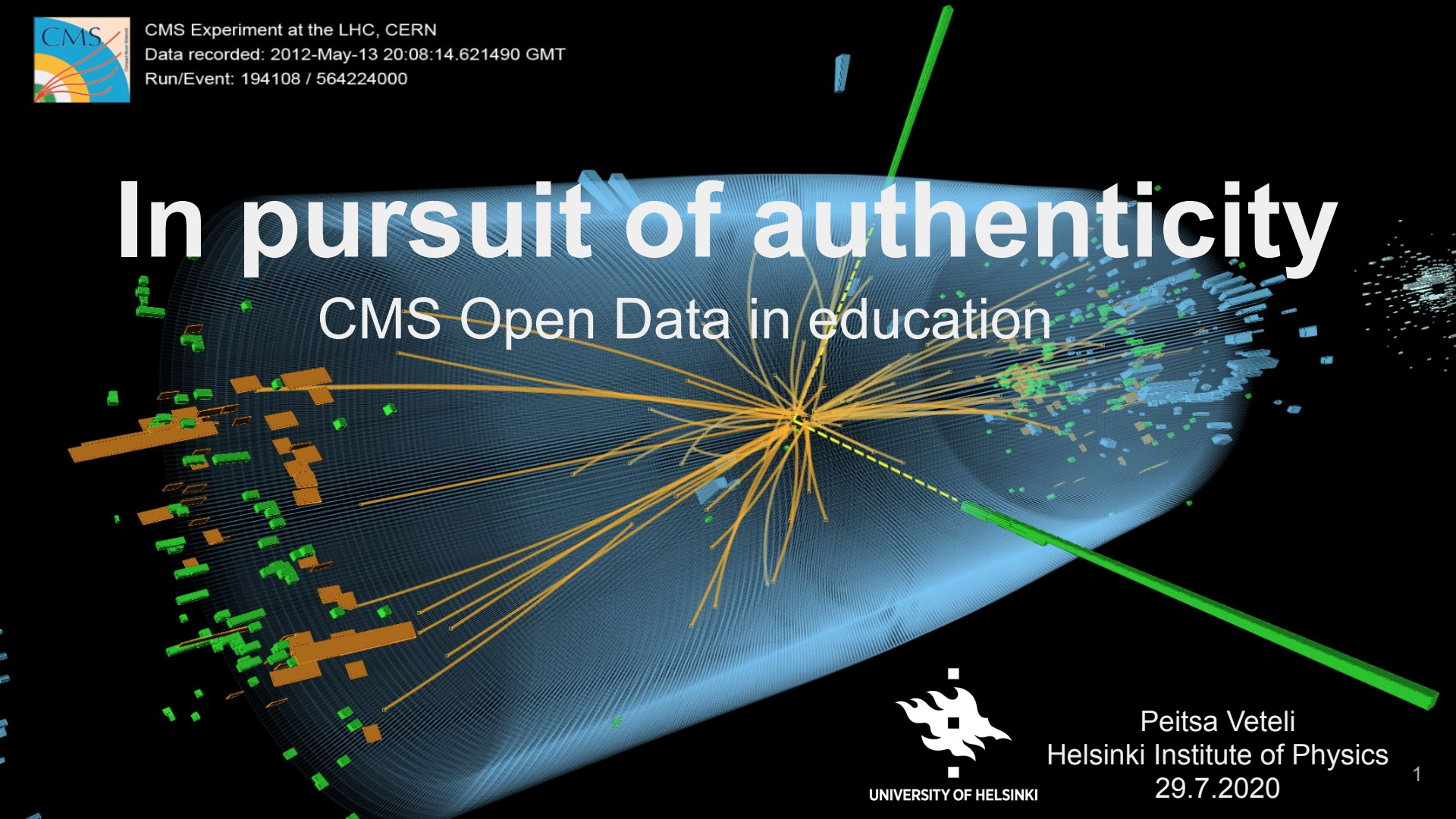

In pursuit of authenticity

CMS Open Data in education

UNIVERSITY OF HELSINKI

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Hi!

- Peitsa Veteli, 27 y.
- Dabbling with educational use of CMS' and other data under Kati Lassila-Perini at CMS Open Data.
- Combining the worlds of cutting edge physics research and pedagogical expertise with a passion for scientific literacy and authenticity in lifelong learning.
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The slow-burning crisis of science education

- Decline of motivation towards learning science is a widely seen phenomenon around the globe, especially in developed countries (Hellgren & Lindberg, 2017; ROSE...)
- Exact reasons are debated, but the list of potential causes is long: controlling environment, perceived difficulty of the subjects combined with general anxiety, decontextualized content, feeling of irrelevance, lack of relatable work goals or a sense of meaning in the activities or methods utilized...

(*Draw a scientist test,* Chambers 1983)

Changing society through educational revolution?


SPOILER:
ITS HARD

Inquiries, SST, collaborations… towards authenticity

- Everyone wants education to be authentic and reflective of the real world. No-one can agree on what “authentic” means.
- Anker-Hansen & Andree 2019:
  - Comparable with practices of professional scientists
  - Grounded in the world of students
  - Involving inquiry practices
  - Contributing to out-of-school-practices
  - Involving a challenge of transferring knowledge
  - Comparable with non-professional citizen practices
  - Alignment with curricula and stated purposes
  - Involving a pedagogy of caring between students and teachers

(High schoolers at CERN S’cool summer camp 2018)

Inherent hardships in science education

(Docktor & Mestre, 2014)

- Previous misconceptions and everyday intuition often run counter to accepted scientific understanding of nature.
- High-flying nature of modern research is often pretty opaque to a layman or students without higher education.
- Humanity's cognitive architecture seems to be wired to assign concepts and laws into specific examples instead of general cases → novice / expert
- Fostering natural curiosity instead of authoritative fact pushing is hard and tasking for teachers when many are already struggling with lack of equipment, time, support or other resources as well as changing curricula.

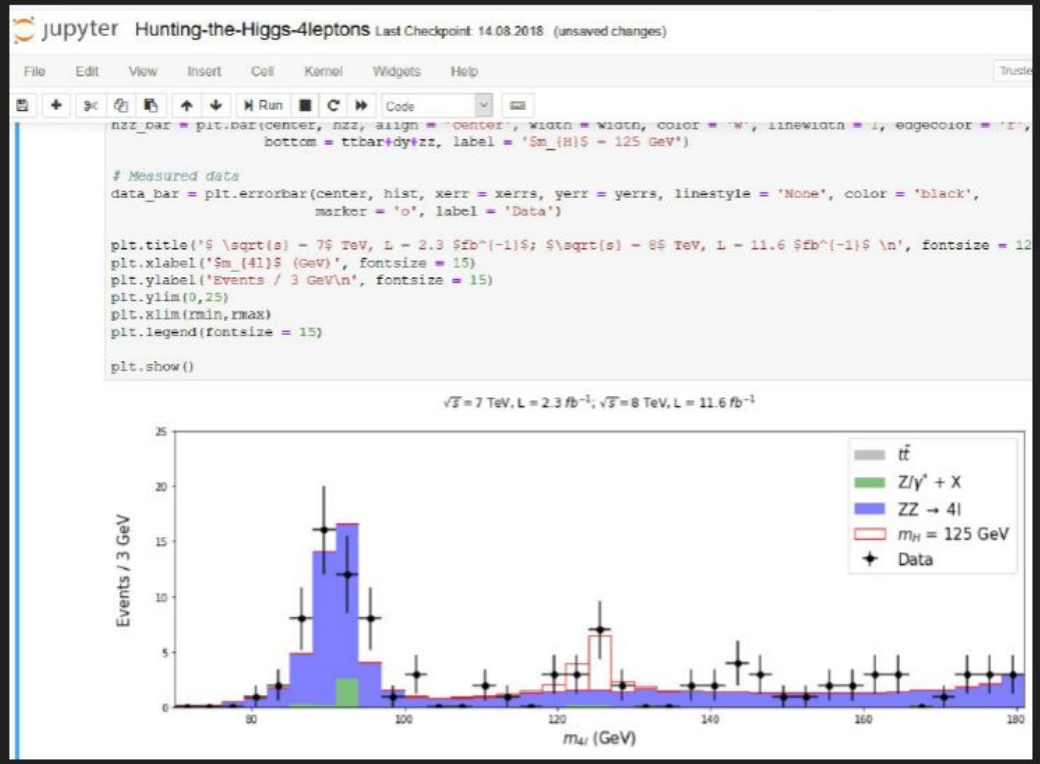
(XKCD)

Doing our bit - CMS Open Data project

- Leading the charge with large amounts of open access datasets put out for public use: http://opendata.cern.ch/
- Providing freely usable programming materials with high school level in mind: https://github.com/cms-opendata-education/
- Actual data used by professional scientists, now at the fingertips of anyone.
- Hammering home the contextualisation, all is done with a purpose in mind. “Meaningful coding”.
- Using Python and generalizable methods allows teaching scientific thinking and data analysis skills for any purpose, not only particle physics.

Jupyter Notebooks are awesome.

- Easy to run externally without any installations.
- Powerful enough to quickly brush through hundreds of thousands of rows of data, manipulate and visualize the contents.
- Trivial for teachers to take and modify for their own style and purposes.



Practical: teacher training workshops

- Motivate a teacher to take up your methods and they will make an impact on hundreds of students.
- International workshops at CERN, training in-service teachers in Finland, keeping an eye out for similar programs elsewhere (Fermilab)…

(Our teacher gang of IHST 2018)

Shock and horror - what happens there?

- Most teachers aren't researchers nor programmers. First day, in conjunction with physics lectures, tends to be quite taxing and many mostly browse through various existing materials.
- Second day sees more variation between those who want to dig deeper into the particle data and those who are already expanding to other subjects.
- An excellent opportunity for science teachers to exchange ideas and talk shop about collaborations etc.

(Finnish teachers at the Jyväskylä workshop 2018)

Finnish teachers speak (answers n ≈ 30, participants n ≈ 70)

- Every ⅘ were previously not fluent in programming.
- A bit over half noted programming as a part of their students' education. This is in flux as Finland instated programming in some form into the mandatory national curriculum after 2016.
- Only ⅙ felt that their school activities correlated well with the world out there. About as many questioned if such relation was even necessary, while the majority felt a detachment existing between the classroom and "real world".
- After the workshops, ⅔ felt that they'd like to use these types of tools in their teaching while the remaining ⅓ was on the fence. Only 1/32 answered "no".

Finnish teachers speak (answers n ≈ 30, participants n ≈ 70)

- “I knew [open data] existed, but hadn’t thought that it could be used in teaching, at least in demonstrations.”
- “It’s very good that it’s real data instead of some artificial and made up like you so often see in math and physics problems. A challenge lies in learning the basics first, maybe, with those made up examples… or should they?”
- “I already use it. Real world materials bring interest and realism to the exercises.”
- “I do believe authentic data increases the students’ interest. Real data has an advantage in the large number of data points, unlike you’d usually see in textbook examples to showcase why programming is needed.”
- “Using real world data would give the students a realistic picture of what it means to do science and research.”
- “Science comes closer to the student. Their confidence rises. A sense of ‘I too can do this!’ ‘I can understand this!’ can come to the fore if you can present the topics well.”
- “Using open data in teaching particle physics helps the students understand the challenges and possibilities of modern physics.”
- “I feel the way these exercises are made is more important than the content of the data. If you can analyse it scientifically, it advances their understanding of doing science in general.”

A sidenote on American teachers at Fermilab:

- “I wish there were more opportunities in school to have the students tackle real world problems. A lot of the experiments that are done are either rushed through because of time pressures, or so superficial that they're basically cookbook labs. I love the idea of using some open data sets to engage students with actual questions and methods that scientists are tacking today.”
- “...That being said, high school science is not always strongly correlated to the processes from the "real world" of STE. We need to do MORE student directed inquiry and more coding!”
- “… students are bombarded with completing requirements. There is no room (time) left to explore current topics and contemporary research. At its best, by watching a YouTube video (shows like "How is Made") brings industrial applications into the classroom. ”
- “Bringing more open data into the classroom contextualizes the content in profound ways. I use these in a limited way now, and hope to do more.”
- “We spend teaching most of the Physics curriculum in a school year with phenomena discovered up to about 1900's. There is little emphasis on Modern physics, Quantum Mechanics, Particle Physics. Students are missing the contemporary science that unveils during their life time. Tools such as Python allows them to be a little bit part of the current game. ”

Fermilab

(QuarkNet virtual camp at Fermilab summer 2020)

Closing remarks compared to the PER field:

- A lot remains to be done, but for now the answers seem to line quite well with ideas like those presented by Havemas and Atenas (2017) on some of the benefits of open data:
  - Fostering critical thinking skills.
  - Increasing data analysis skills.
  - Understanding research methods and nature of scientific work.
  - Linking the above into societal growth by enabling democratic and equal practices.
- Working more directly with data presentation could be used to alleviate Aikenhead's worry that school practices tend to be aimed solely for producing academic candidates instead of enlightened members of society (2005 etc.)

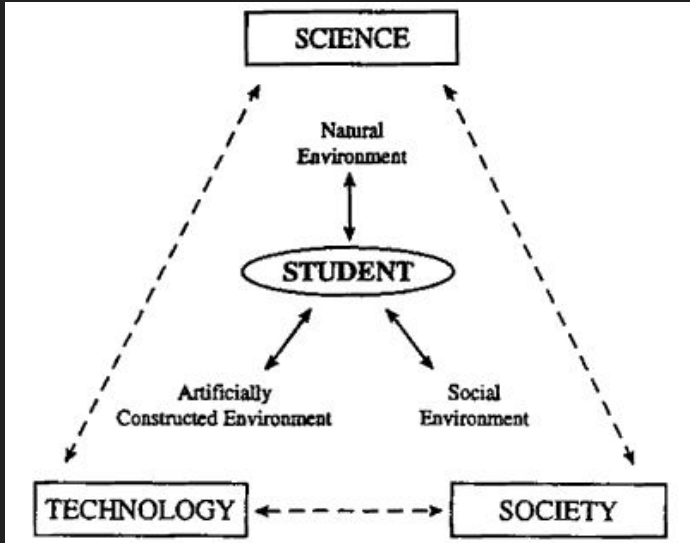


FIGURE 5.1 *The essence of STS education*

(Aikenhead, 1994)

References for the curious

- Docktor & Mestre (2014): *Synthesis of discipline-based education research in physics*

- Aikenhead (2005): *Research into STS science education*

- Anker-Hansen, Andree (2019): *In pursuit of authenticity in science education*

- Havemann, Atenas, 2017: *OER and use of open data to develop transversal and citizenship skills*

- Myrbo et al. 2018: *Outreach and educational opportunities created by open-data resources*

Thank you for your interest!

Any questions? Ask away or throw me a mail at peitsa.veteli@helsinki.fi