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Gravitational Waves and Citizen Science for Education

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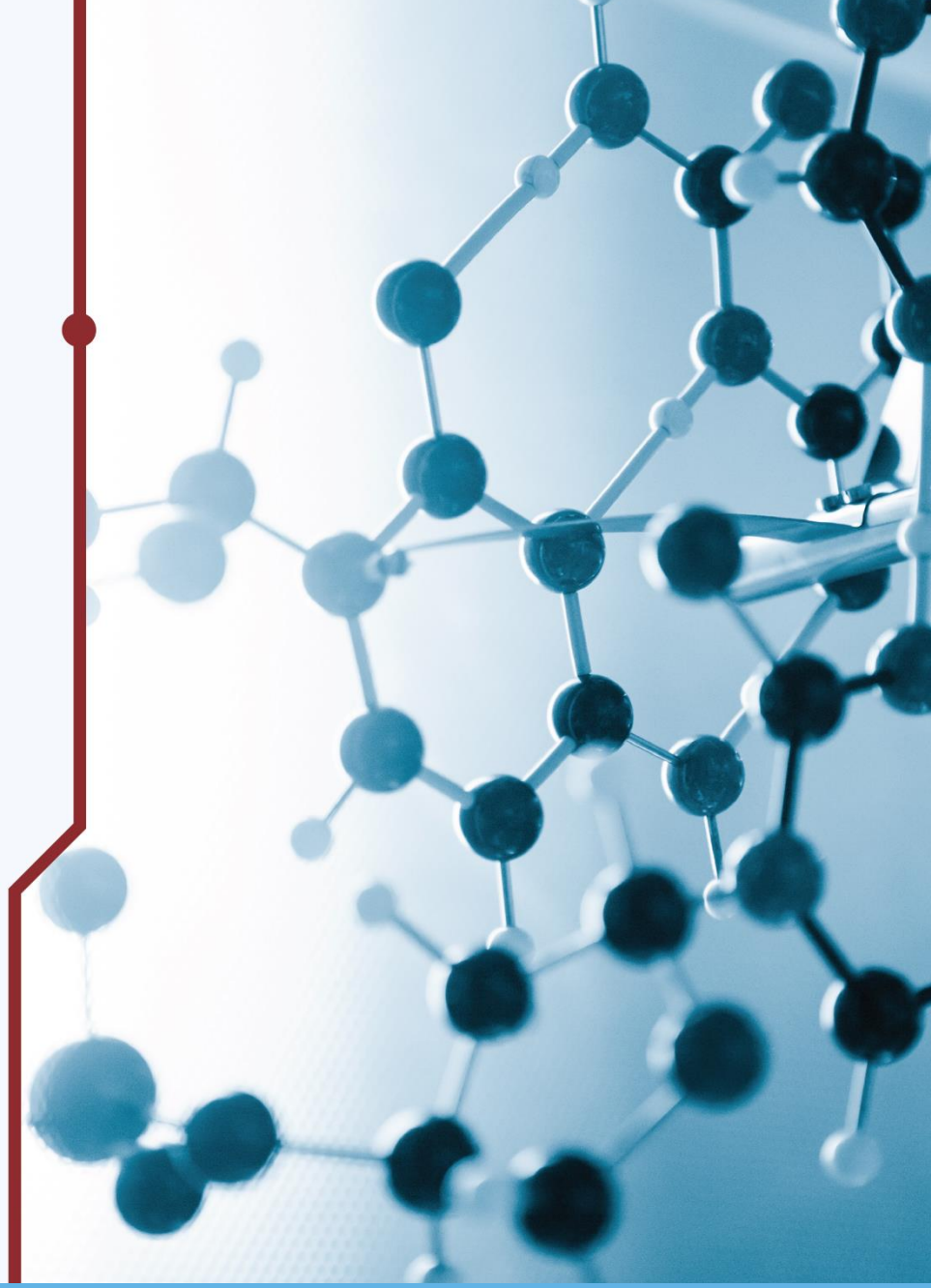

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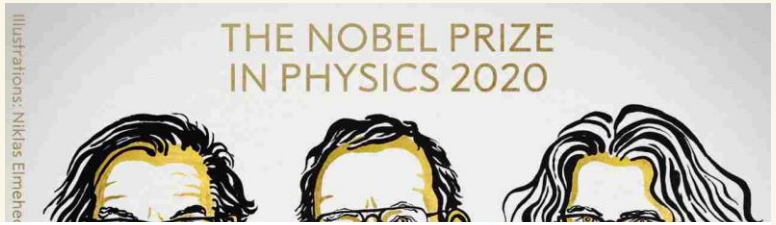
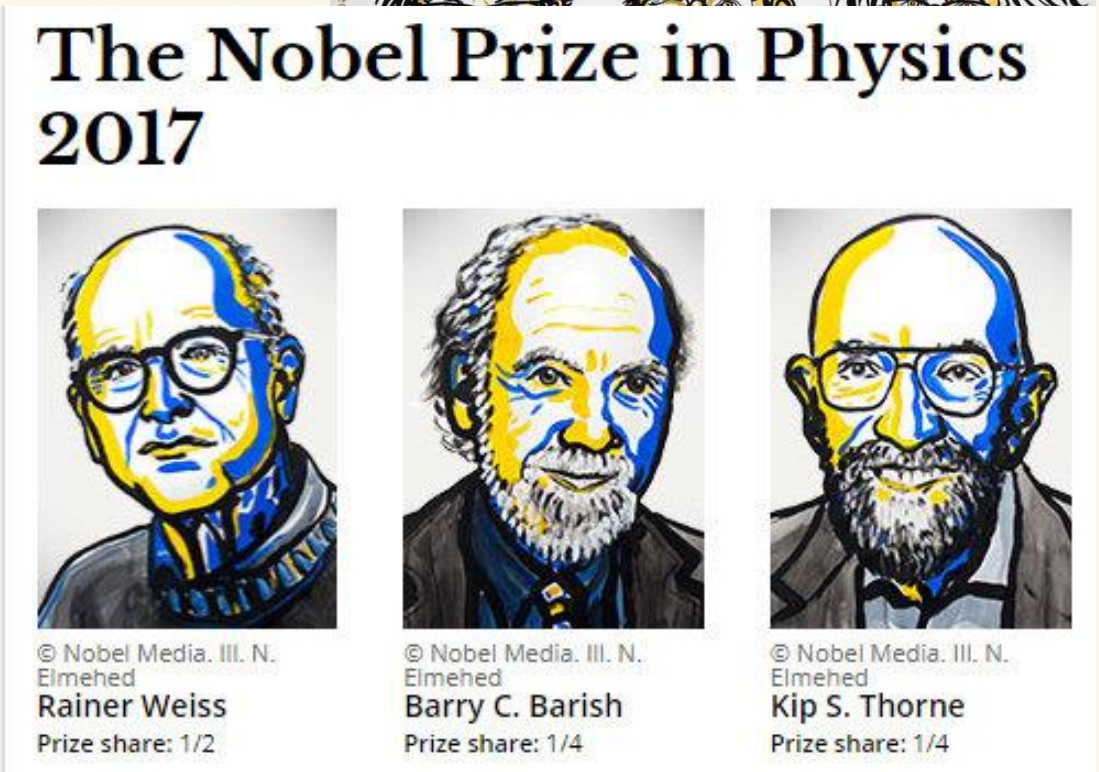
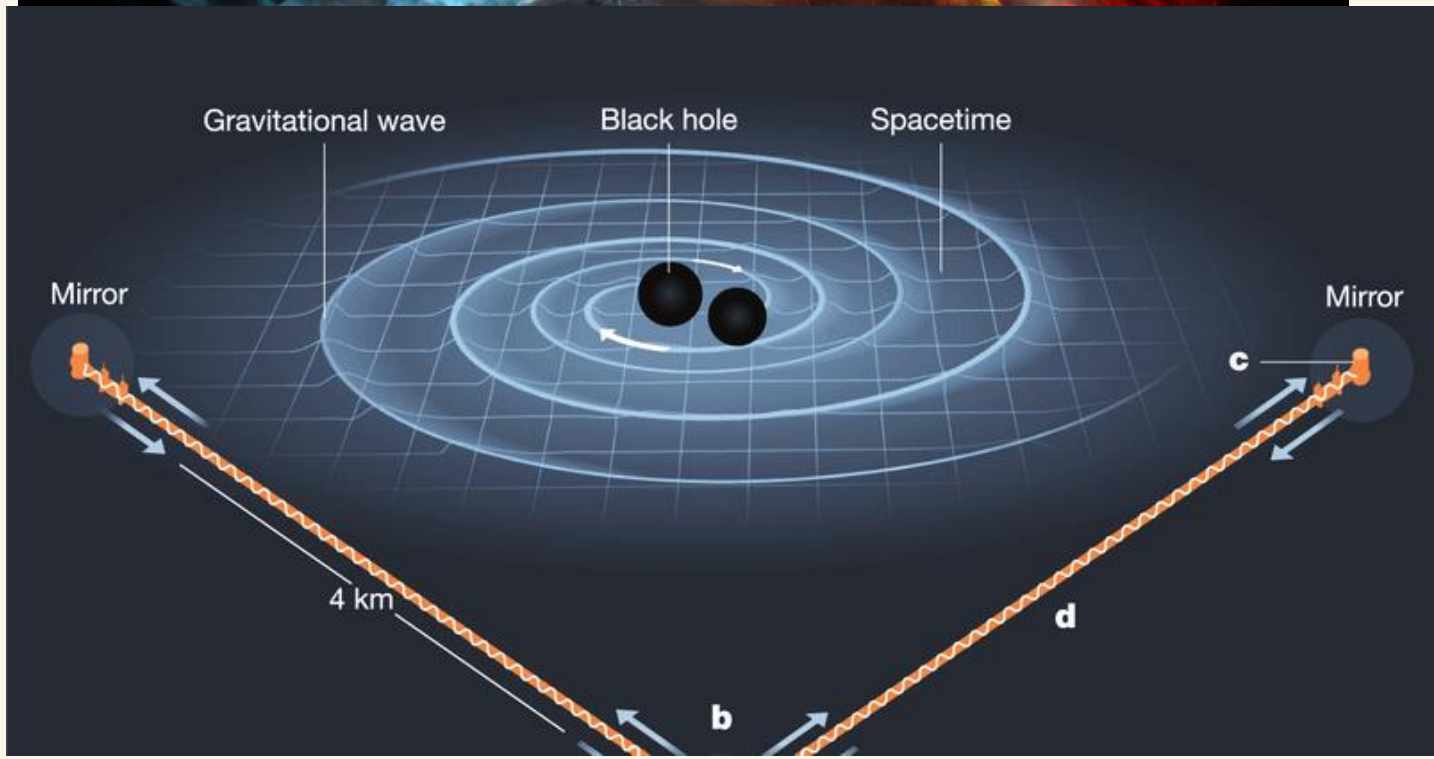
Game Changing Discoveries in Physics with great media coverage







And unprecedented impact in humankind

Yet if you browse the web..

And this goes beyond hard science as well…

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Or investigate school curricula you will identify a *gap* between frontier scientific research with society and education

20th – 21st Century Physics not systematically integrated in K12 formal education!

Teachers don't feel confident to address students' questions regarding newest discoveries in modern science

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To address the gap between frontier scientific research and school education we go beyond outreach and connect schools with Large Research Infrastructures through citizen science

The interplay of Large Research Infrastructures, Citizen Science and School education in REINFORCE

- Offering authentic research experiences for students
- Helping increase relevance and meaning of school science
- Supporting the increase of students' science literacy

LARGE RESEARCH INFRASTRUCTURES IN FRONTIER PHYSICS

CITIZEN SCIENCE

SCHOOL EDUCATION

- Contributing in the production of new knowledge
- Supporting the Optimization of Large Research Infrastructures
- Helping raise awareness acting as multipliers

Goals

Students are envisioned to..

- contribute in the optimization of Large Research Infrastructures in Physics
- become partners in the research enterprise
- increase sense of meaning in school science
- increase disciplinary knowledge and overall science literacy
- increase science motivation

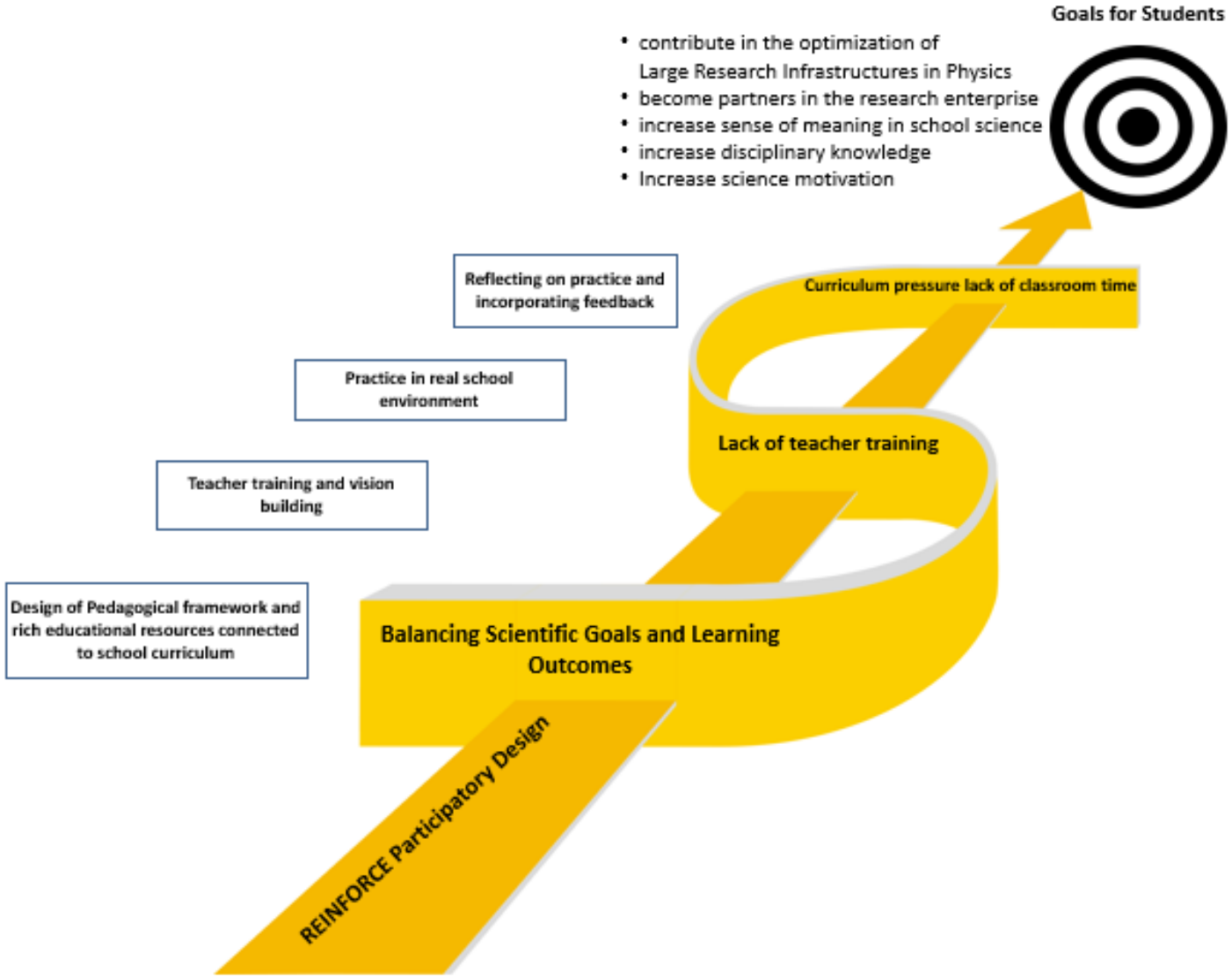
Challenges: The doors we need to open

- Introducing new topics beyond school curriculum.
- Balancing Scientific Goals and Learning outcomes.
- Lack of teacher training and support.
- Curriculum pressure and lack of classroom time

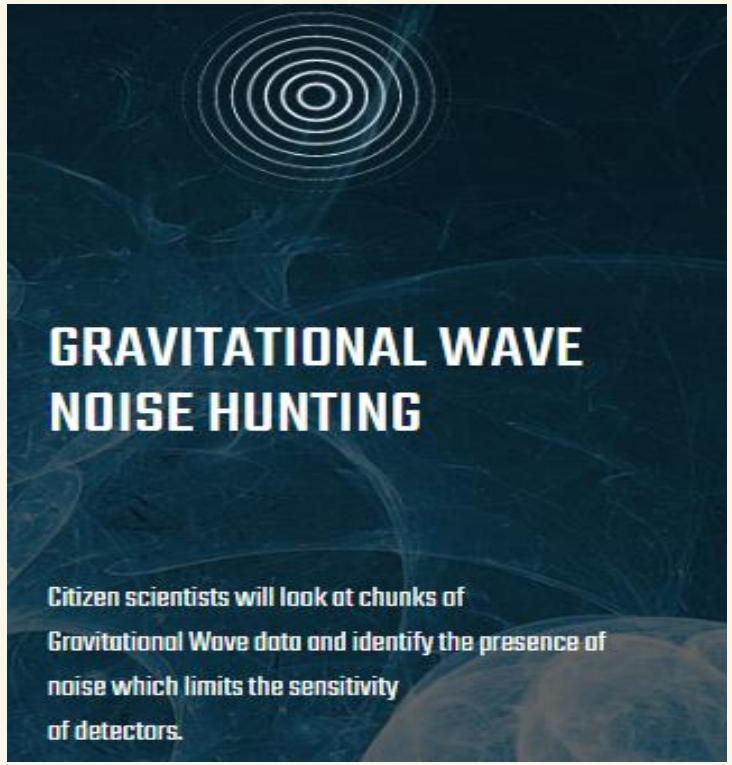
The REINFORCE participatory methodology: the key to overcome the challenges

- Design of Pedagogical framework and rich educational resources connected to school curriculum
- Teacher training and vision building
- Practice in real school environment
- Reflecting on practice and incorporating feedback

REINFORCE for education in a nutshell

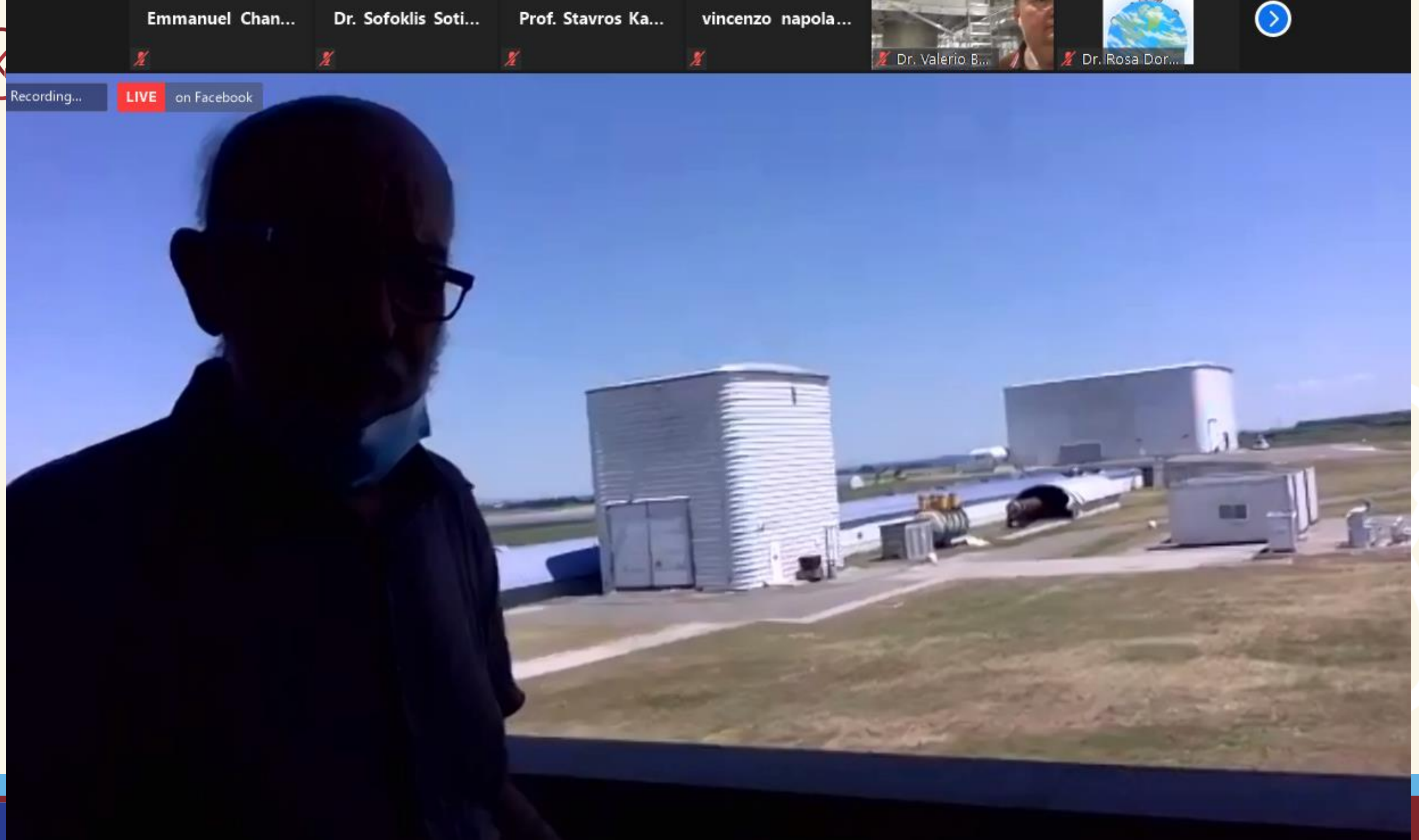


Example: Gravitational Wave Noise Hunting for schools



Pedagogical Design

- Orientation
- Hypothesis generation
- Planning investigation
- Investigation and Analysis
- Communication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Dr. Sofoklis Soti...
Prof. Stavros Ka...
vincenzo napola...
Dr. Valerio B...
Dr. Rosa Dor...
Recording...
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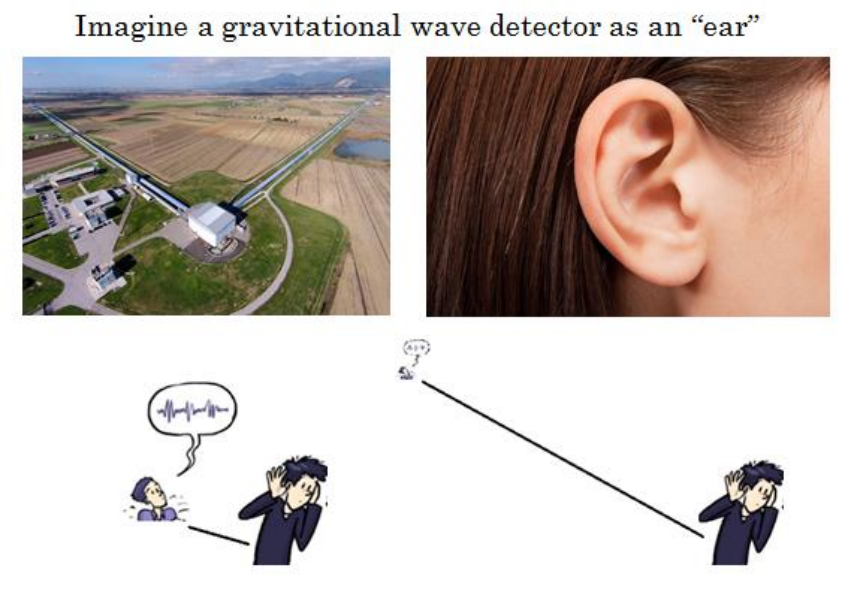
Pedagogical Design: Hypothesis generation and design

Using analogies and bridging GW detection principles to school science



"more sensitive ears" → "can identify signals from larger distances". Similarly, a gravitational wave detector's sensitivity corresponds to how far in the universe it can reach and thus to its discovery potential! Sources of noise need to be controlled in order to maximize our detector's sensitivity.

Pedagogical Design: Planning Investigation

- Explaining the Signal and Noise Characteristics in GW- Detectors
- Identifying sources of noise: Environmental-Detector noise and transient noise (Glitches)
- Discussing how noise affects detector sensitivity
- Introducing the tools to identify noise patterns and support scientists in the optimization of their detector
- Describing the challenge

Different sources of “noise” affect the gravitational wave detector’s sensitivity

Adapted from : Laser Labs’ Spacetime Quest: https://www.laserlabs.org/spacetimequest.php

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A few examples of environmental noise..

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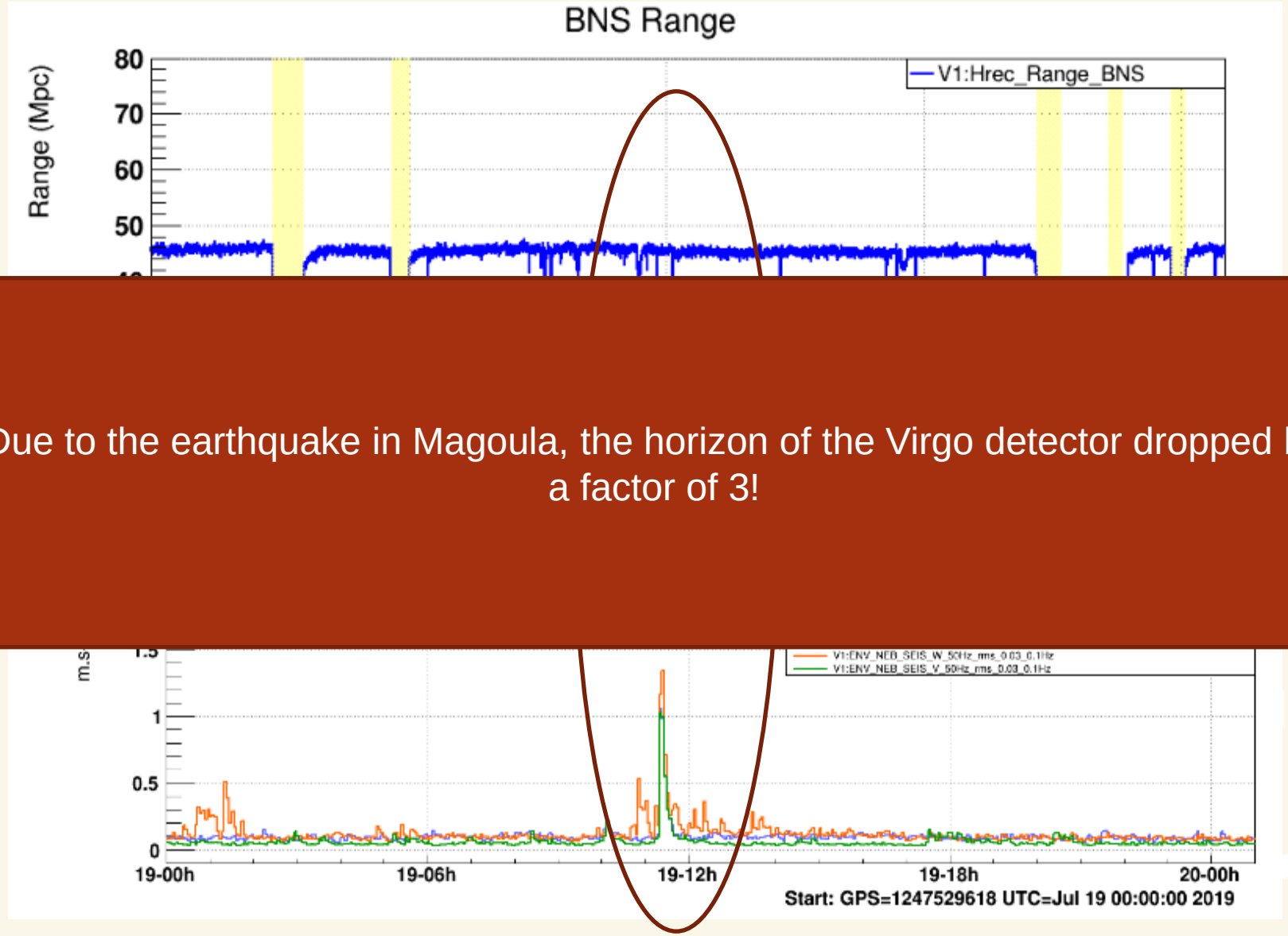
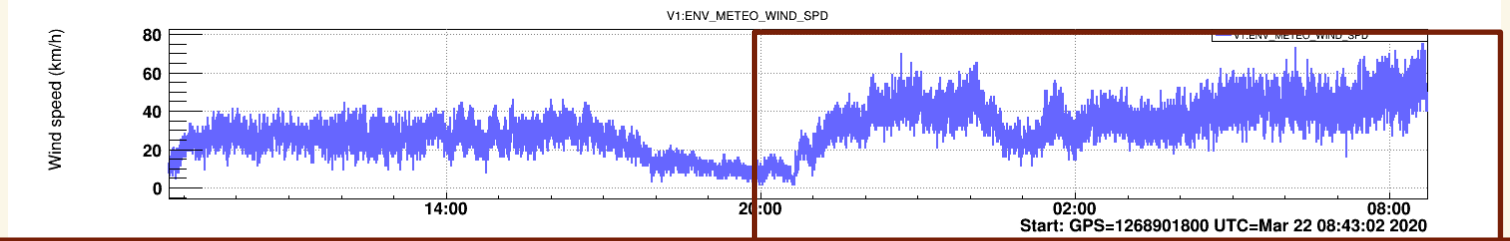
*A measure of How far in the detector “hear”



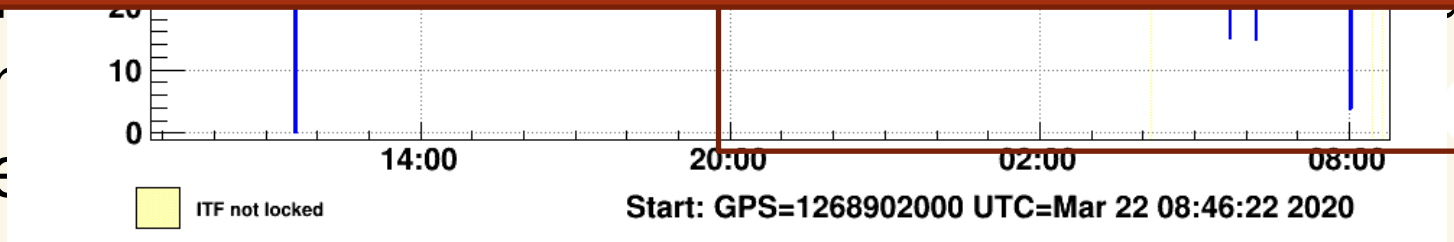
Due to the earthquake in Magoula, the horizon of the Virgo detector dropped by a factor of 3!

* BNS range is defined as the distance up to which a single detector could observe the coalescence of a pair of 1.4solar masses neutron stars with signal to noise ratio of 8.

Does the wind blowing, affect a gravitational wave detector?



What does this plot tell us?
"If two neutron stars with mass equal to 1.4 solar masses merged in distance higher than 50 MPc and a signal arrived to our detector around 08.00 A.M, we wouldn't be able to detect it because the wind was blowing furiously!"



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performance.

- There are sources of “noise” in Gravitational Wave detectors that are poorly understood.. The so called “Glitches”!

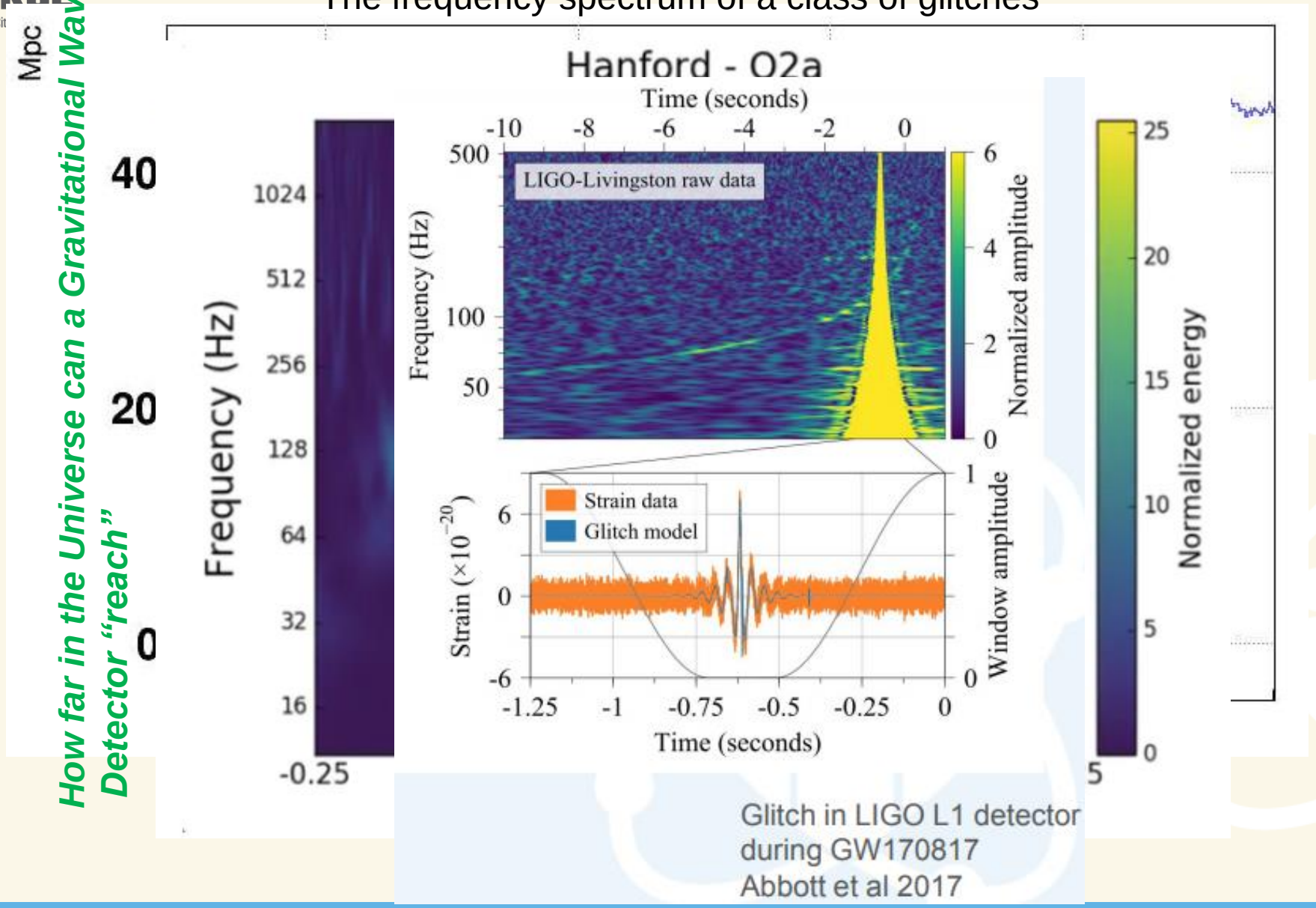
- Description of the challenge:

“Classifying glitches using computers has proven to be an exceedingly difficult task. A family of data analysis algorithms known as *machine learning* have made huge strides over the past decade in classification problems, though they usually require a large pre-classified dataset to operate effectively. However, human intuition has proven time and time again to be a useful tool in pattern recognition problems such as this.
This is where citizen science comes to the rescue!”

Familiarization with the tools

The frequency spectrum of a class of glitches

How far in the Universe can a Gravitational Wave Detector "reach"



Glitch in LIGO L1 detector during GW170817
Abbott et al 2017

Pedagogical Design: Investigation and Analysis

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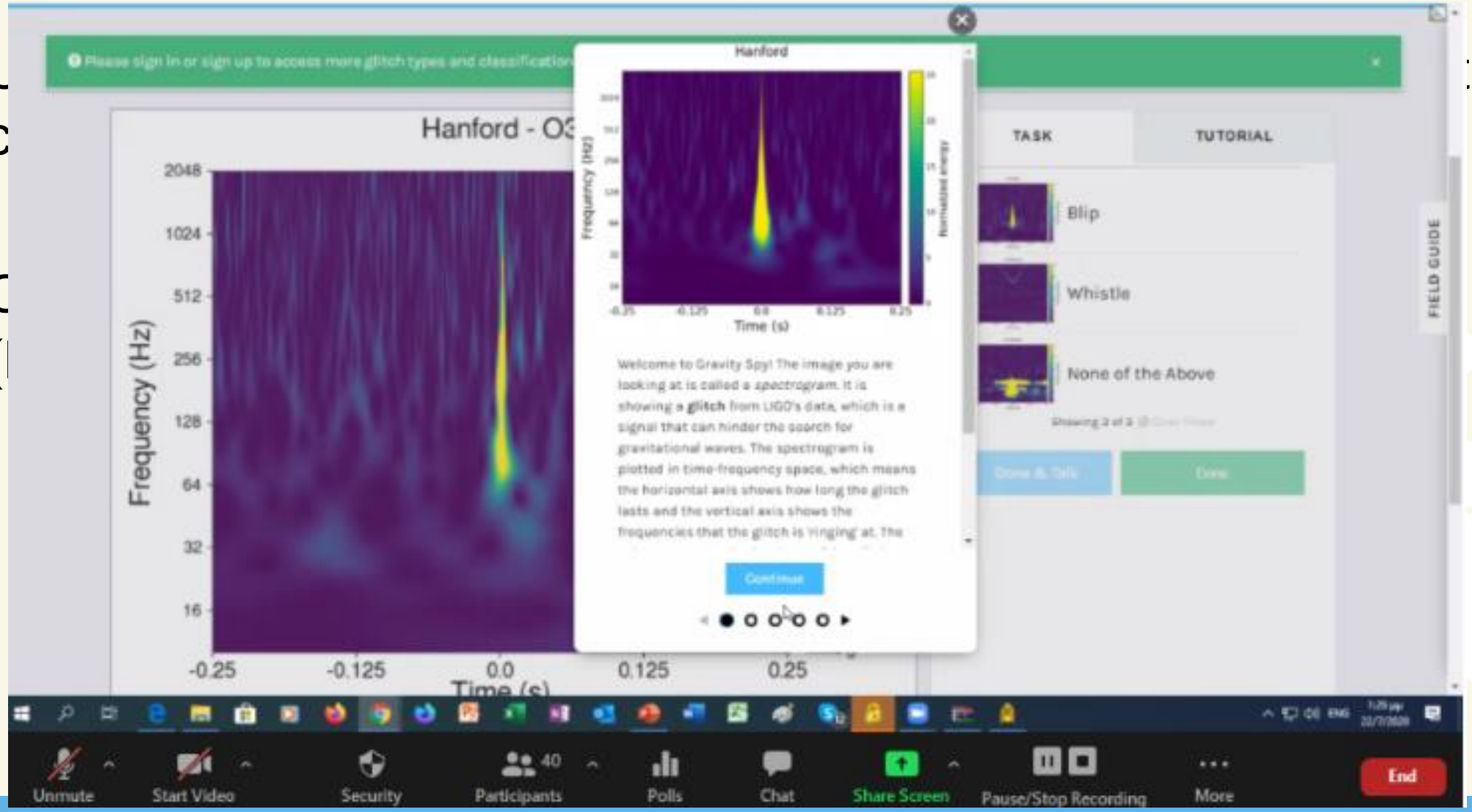
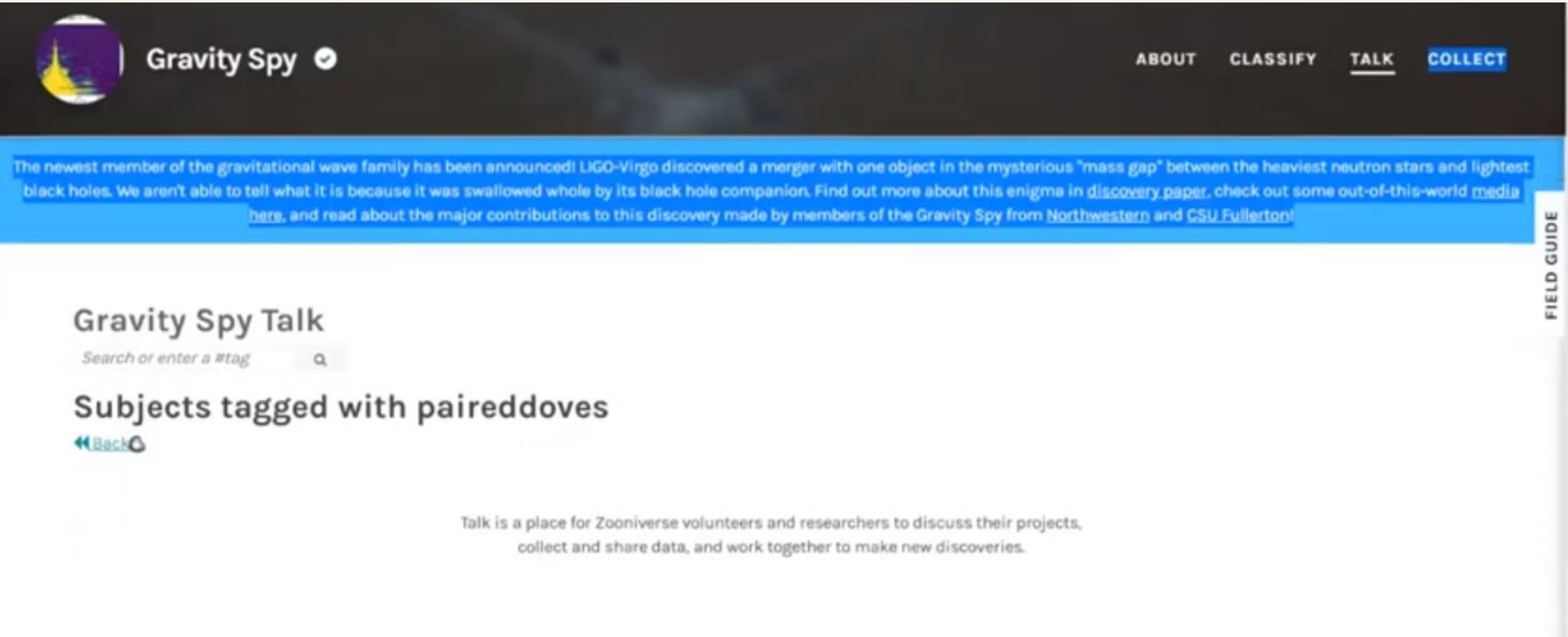


Pedagogical Design: Communication



Preliminary findings from a visionary workshop with teachers about Gravitational Wave Noise Hunting

https://www.reinforceeu.eu/events/training-workshop/vision-building-workshop-citizen-science

Programme

- Citizen science in education (+mentimeter session) – 1hr
- Citizen science and REINFORCE – 20 mins
- Hands on session: GW noise hunting in the classroom (1 hr)
- Final mentimeter session and teacher feedback (20mins)

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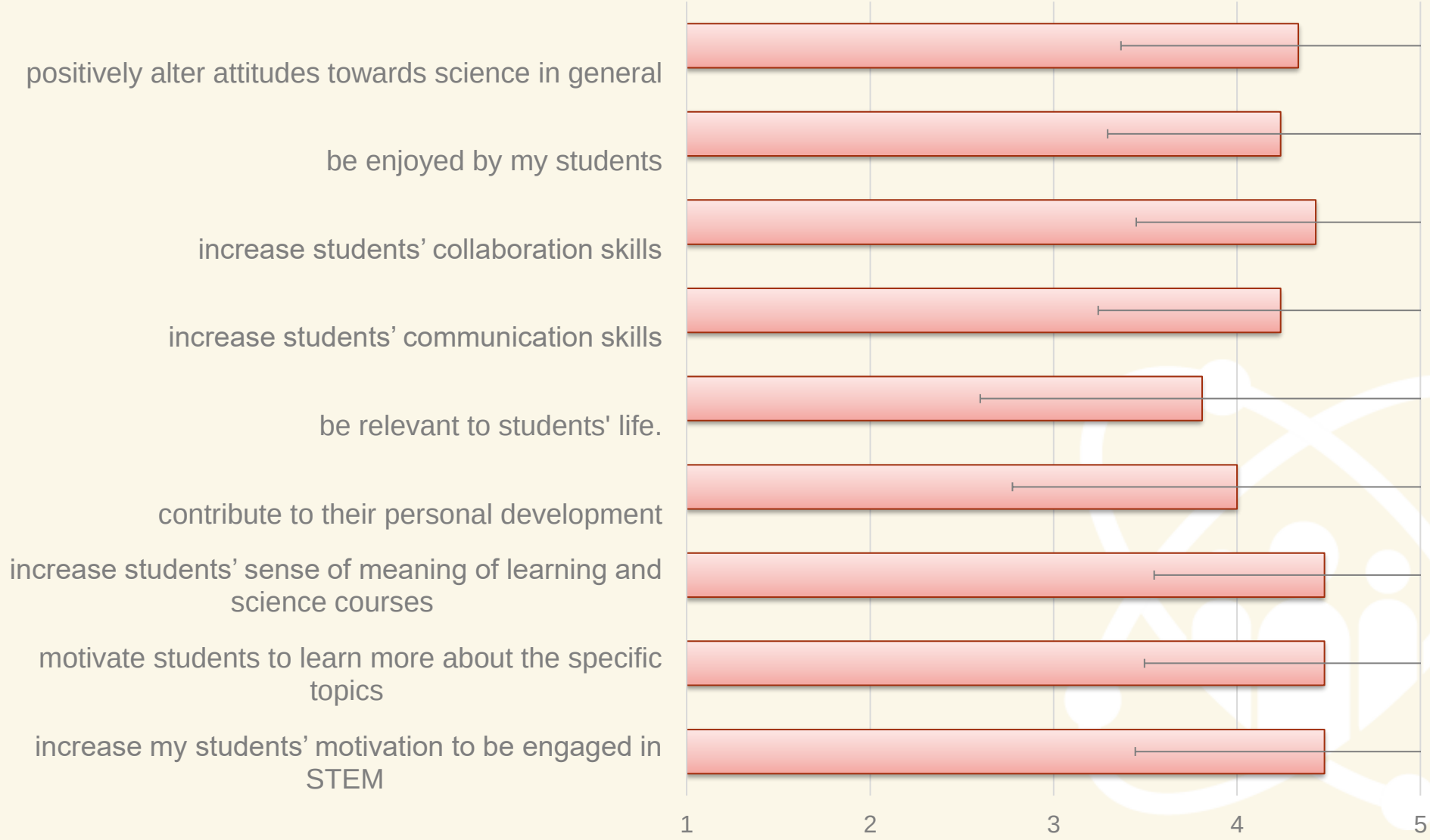
THE REINFORCE CITIZEN SCIENCE ACTIVITIES WILL



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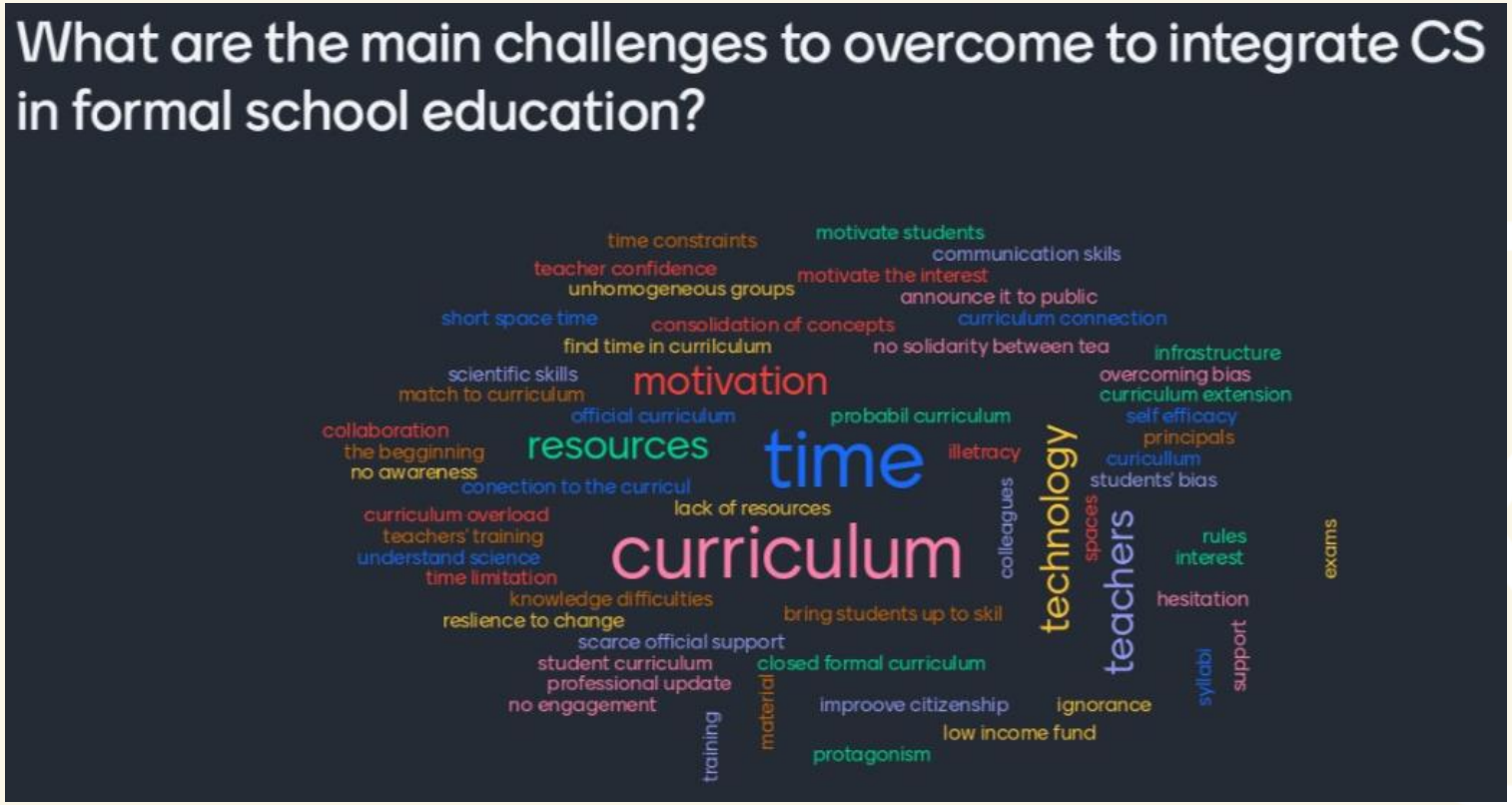
Main challenges (N=26)

“Curriculum”; “Lack of resources”; “Time”; “Lack of Training”; “infrastructures (PC’s)”



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Desired Learning outcomes
“Scientific way of thinking”; “Cooperation”

Future steps

- Launching the REINFORCE projects.
- Initiating a series of 2 year long participatory engagement activities to support the implementation of the REINFORCE Citizen Science projects with schools and with citizens overall.
- Engaging 100,000 citizens out of which 5,000 are students

Looking forward to working with you!

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