ITW 2022
Group 5
Higgs Physics & Neutrino Physics

Thilagavathi @Top Quark
Malaysia

Allen @ Charm Quark
USA

Tatiana @ Electron Neutrino
Slovakia

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Cameroon
Curriculum & Classroom Connections

**Neutrino physics**
Connects with energy, momentum conservation, beta decay, and standard model

**Higgs physics**
Connects with inertia and standard model

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**The Universe as We Know It:**

Everything we know, everything we see, all the atoms in your body and in our galaxy, all the stars and dust and planets within and outside of our solar system.

We have no freaking idea.

https://phdcomics.com
The standard model attempts to explain most matter and interactions. Knowledge of Neutrinos and Higgs is not critical to classical understanding of energy and momentum. It is critical to deeper understanding of “What are we?”

There is structure beyond the atom.

What is a particle?

The standard model attempts to explain most matter and interactions.

Neutrinos and Higgs are part of this model.

Higgs: Mechanism which gives mass to particles, Your mass is not given to you because of Higgs,

Neutrinos: Existence needed to conserve momentum and energy, extremely little mass, mass values still uncertain.
Potential Student Conceptions & Challenges

1. Neutron is heavier than a neutrino
2. Neutrino is a fundamental particle but neutron is made up of fundamental particle
The higgs boson and neutrino have shapes and structure
Neutrinos are dangerous because they are radiation

Trying to teach about something the students cannot directly observe
Helpful Material & Resources

Particle Adventure
Standard Model Poster
What’s the smallest thing in the universe? - Jonathan Butterworth

Particle Identities | S'Cool LAB

The Invisible Soccer Ball.docx

The Higgs Field, explained - Don Lincoln

Happy birthday! Ten years of Higgs Bosons – past, present, and future!

Your Mass is NOT From the Higgs Boson

Neutrinos: Nature's Ghosts?

Neutrinos, the Standard Model misfits | symmetry magazine

iSpy WebGL
Every classroom should have a poster of the Standard Model. It should be big and as common as the periodic table. Normalize the idea of the Standard Model in the classroom.

https://sleeplessphysicists.org/
Best Practice Example - Standard Model

CONGRATULATIONS!

According to your answers, the particle which fits your personality best is a/an

The bottom quark (also called beauty quark) is the second heaviest quark. It only exists for 0.000000000001 seconds before transforming into a different quark. Therefore, the bottom quark is not easily found in nature but was instead discovered using particle accelerators.

Have Standard Model displayed in the classroom

Activity: What are we?

Working definition of particle

The Invisible Soccer Ball

S’Cool Lab: Particle Identities

Student Study Group: Higgs Boson

Student Study Group: Neutrinos
Students who were a higgs boson (perhaps all bosons as a group) will be responsible for short presentation. Time this for just after mass-inertia is covered. Guide students toward key ideas F.

Key Questions:

- How does the higgs boson relate to what we are currently studying?
- How does the higgs boson fit into the Standard Model?
- What unanswered questions do scientists have about the higgs boson?

Extension question: Is the higgs boson responsible for your mass?
Best Practice Example - Neutrino Physics SSG

Students who were any flavor of neutrino or antineutrino will be responsible for short presentation. Time this for just after energy conservation is covered. Guide students toward key ideas G.

Key Questions:

● How do neutrinos relate to what we are currently studying?
● How do neutrinos fit into the Standard Model?
● What unanswered questions do scientists have about neutrinos?


https://www.symmetrymagazine.org/article/how-heavy-is-a-neutrino
Thank you!
Do you have any questions?