Leveraging Drones to Increase Engagement with STEM in the School Community

A professional development session for STEM educators

Benson Wallace - American College of Education - SCI5213

The Demand

- Consumer drone market in Sri Lanka has seen 5x growth since 2014 and is predicted to approximately double again by 2027 (Statista, 2022)
- CAA legislation and registration requirements has been in place since 2007 (UAV Coach, 2022)

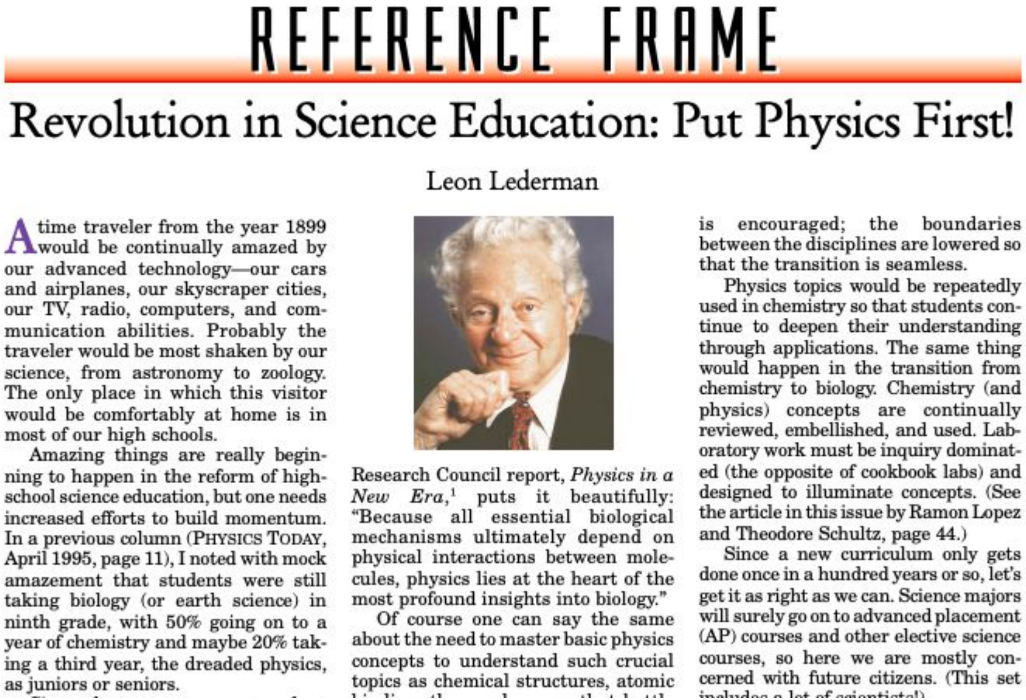
The Need

- For the May 2022 session, less than ¼ of IB Diploma candidates studied physics, and the number of physics HL candidates was less than half those taking biology (International Baccalaureate Organization, 2022).
- This has not changed much since Leon Lederman wrote about the problem in 1995

Leon's Legacy

Figure 1

Extract from Lederman's 2001 article advocating a "physics first" approach



REFERENCE FRAME

Revolution in Science Education: Put Physics First!

Leon Lederman

A time traveler from the year 1899 would be continually amazed by our advanced technology—our cars and airplanes, our skyscraper cities, our TV, radio, computers, and communication abilities. Probably the traveler would be most shaken by our science, from astronomy to zoology. The only place in which this visitor would be comfortably at home is in most of our high schools.

Amazing things are really beginning to happen in the reform of high-school science education, but one needs increased efforts to build momentum. In a previous column (PHYSICS TODAY, April 1995, page 11), I noted with mock amazement that students were still taking biology (or earth science) in ninth grade, with 50% going on to a year of chemistry and maybe 20% taking a third year, the dreaded physics, as juniors or seniors.

Research Council report, *Physics in a New Era*,[1] puts it beautifully: "Because all essential biological mechanisms ultimately depend on physical interactions between molecules, physics lies at the heart of the most profound insights into biology."

Of course one can say the same about the need to master basic physics concepts to understand such crucial topics as chemical structures, atomic

is encouraged; the boundaries between the disciplines are lowered so that the transition is seamless.

Physics topics would be repeatedly used in chemistry so that students continue to deepen their understanding through applications. The same thing would happen in the transition from chemistry to biology. Chemistry (and physics) concepts are continually reviewed, embellished, and used. Laboratory work must be inquiry dominated (the opposite of cookbook labs) and designed to illuminate concepts. (See the article in this issue by Ramon Lopez and Theodore Schultz, page 44.)

Since a new curriculum only gets done once in a hundred years or so, let's get it as right as we can. Science majors will surely go on to advanced placement (AP) courses and other elective science courses, so here we are mostly concerned with future citizens. (This set

Note. Adapted from Physics Today (2001). For Lederman's original ARISE (American Renaissance in Scientific Education) white paper, see here.

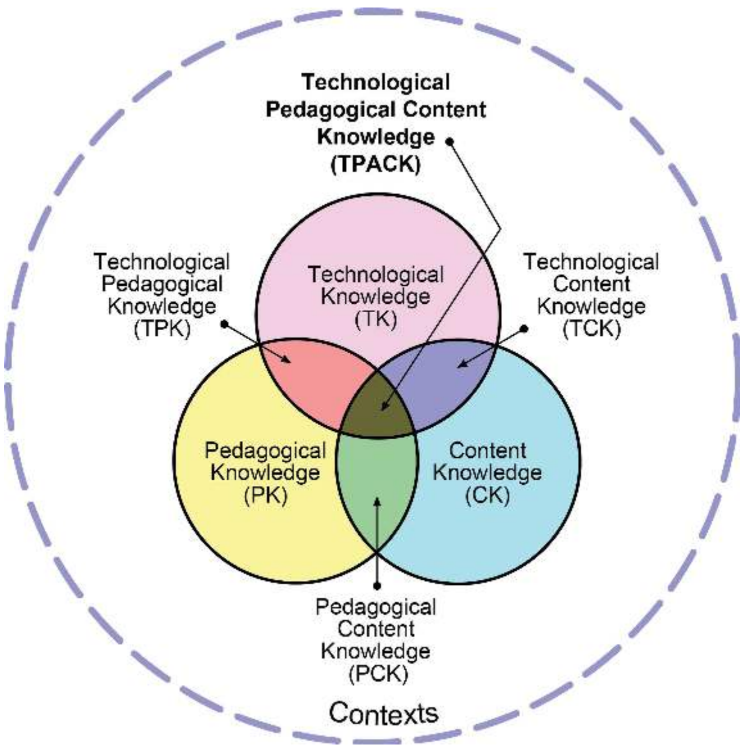
The Plan

- Move from “parental involvement” to “parental engagement” (Fenton et al., 2017)
- Increase the size of the overlap in teachers’ TPACK (Mishra and Koehler, 2006) Venn diagrams
- Foster collaborative learning between teachers, students AND parents

The TPACK sweet spot

Figure 2

The seven components of TPACK



Note. Reproduced by permission of the publisher, © 2012 by tpack.org

Physics for all the family!

Note. Video title "Best Drone for your kids", LiteBee (2021).

Authentic Science

Figure 3

The ten components of the Individual Activity Authentic Science Rating Instrument

By engaging the learner in the proposed activity, will the learner...

1. Work toward a solution to a real-world problem, provide the scientific community with answers to current or new science-related questions, or contribute in a meaningful way to the body of knowledge the scientific community has access to?
2. Thoroughly explore and summarize the current information available on the subject being studied?
3. Use science instruments and technology (e.g., rulers, thermometers, computers, digital cameras, I-phones, data analysis software, microscopes, telescopes, spectrometers, etc.) to collect and analyze data?
4. Use "grade-appropriate" mathematics (e.g., math functions, graphing, plotting coordinates on map, derive equations, etc.) in the analysis of data?
5. Analyze evidence and use the analysis as a basis for drawing conclusions?
6. Have the opportunity to develop or refine the question driving the activity and to present new questions that come about as a result of their work?
7. Have the opportunity to develop and/or refine procedures or methods being used?
8. Communicate the methods used and results of their work to their peers/colleagues for review and critique, and engage in the review and critique of the work of their peers/colleagues?
9. Collaborate with others in meaningful ways throughout the process?
10. Record the results of their work where it is accessible to the broader scientific community?

Note. Adapted from French and Burrows (2018).

Articulating the "MR" in SAMR in a STEM context

Figure 4

Technology use strategies in integrated STEM learning environments

Category	How was Technology Used?
Authentic Learning Context	Providing learning contexts based on an authentic setting using 3D printing, modeling, etc.
Web-Based Inquiry Environment	Providing online inquiry and collaboration platforms
Immersive and Interactive Technology	Providing simulations and extending physical learning settings via computer technology
Creating Content	Helping students learn specific skills to construct knowledge and build products

Note. Adapted from Yang and Baldwin (2020).

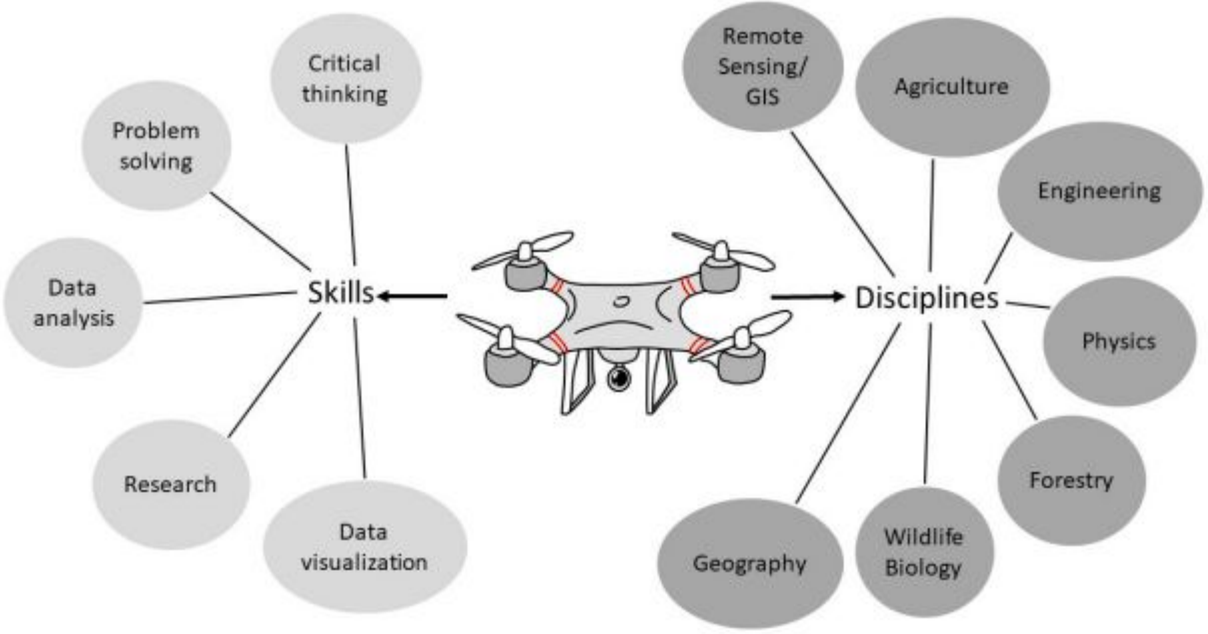
ATL Skills and Digital Citizenry

- Effective use of technology is a suggested strategy for the development of Approaches to Learning (ATL) skills (International Baccalaureate Organization, 2015)
- The ethics of drones and surveillance technology can provide a stimulus and context for digital citizenship discussions and potential civic engagement projects

Activity #1 - where could drones fit in your curriculum?

Figure 5

Concept map of skills and disciplines that can be taught through drones

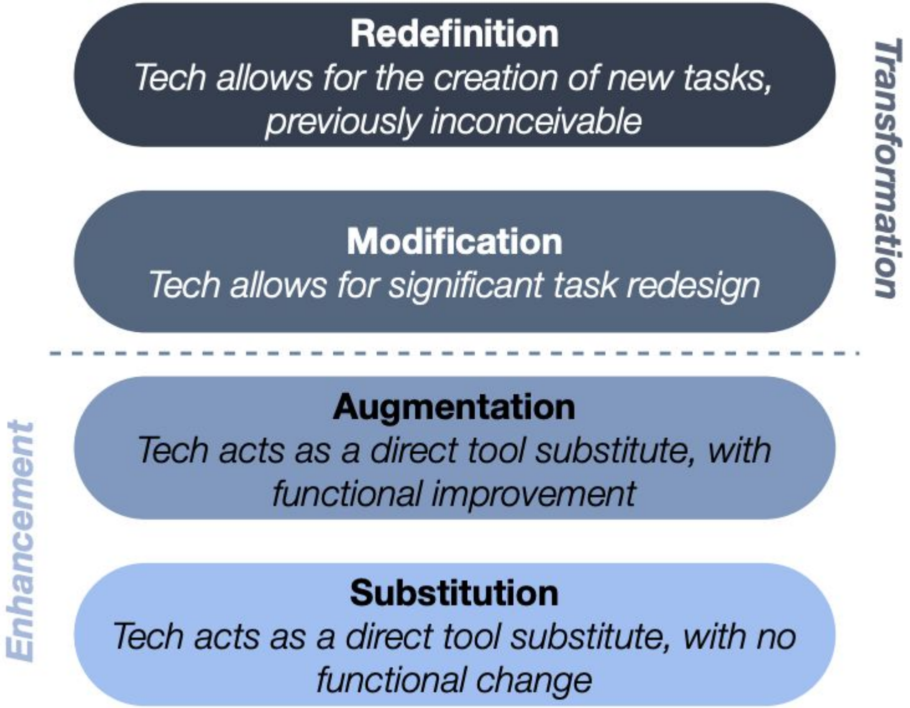


Note. Adapted from Bolick et al. (2022)

Activity #2 - move an existing activity up the SAMR scale

Figure 6

The SAMR Model

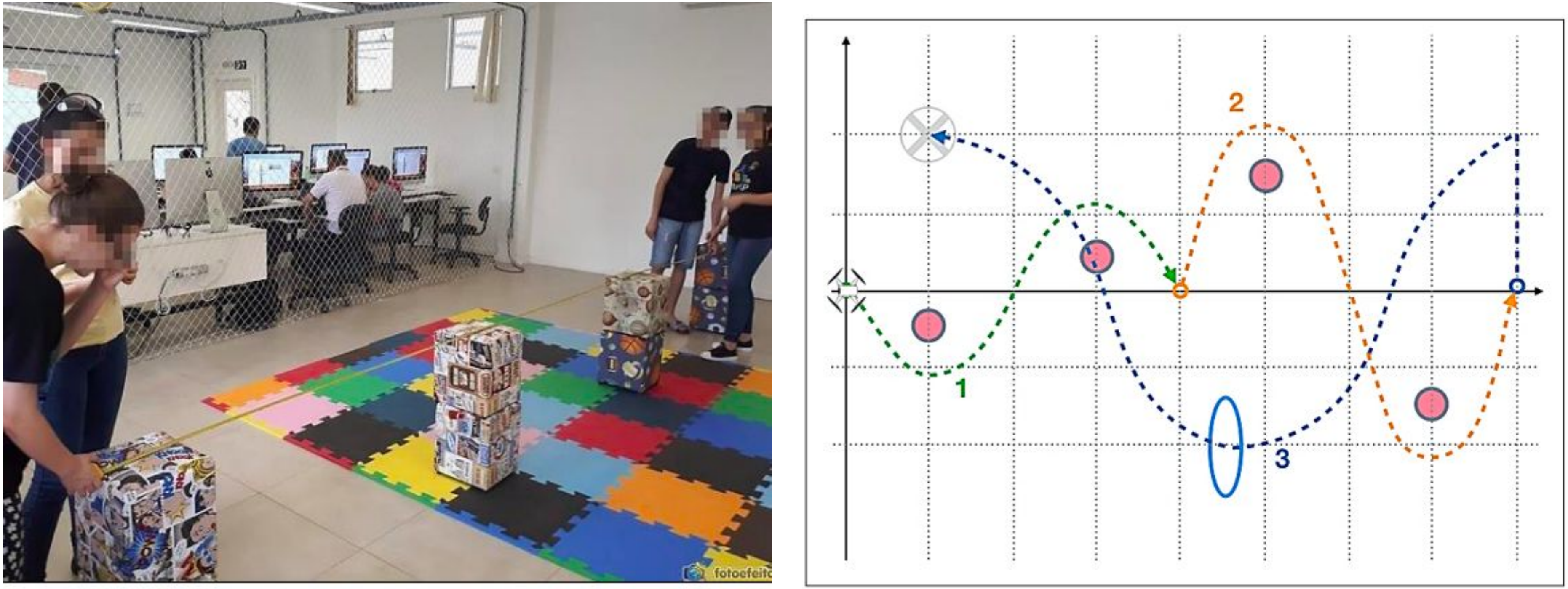


Note. Adapted from Puentedura (2015).

Example 1 - Grade 10/11 Mathematics

Figure 7

Programming drones to avoid obstacles using sinusoidal functions

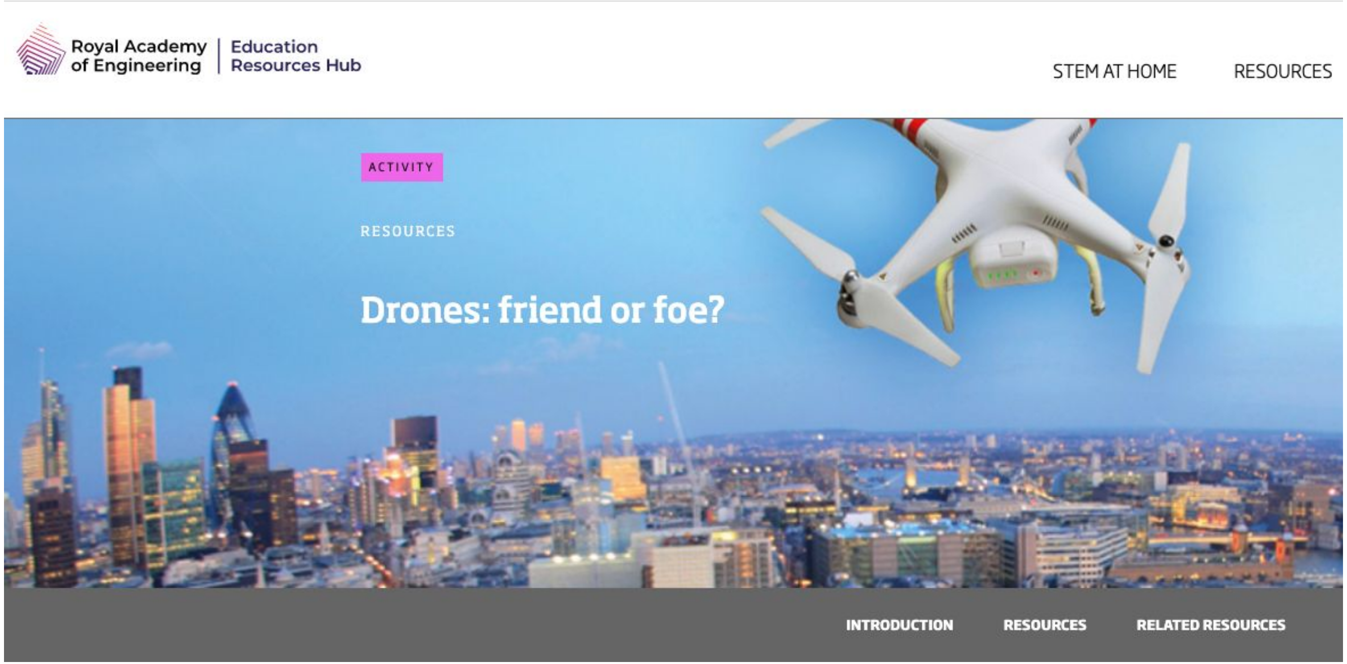


Note. Adapted from Yepes et al. (2021)

Example 2 - Grade 9/10 Science or Grade 11 Physics

Figure 8

Drone Resource Set Homepage



Note. Available at Royal Academy of Engineering's Education Resources Hub. Educators can download a series of six integrated STEM lessons designed for grades 6-10 on the theme of drones.

Common ground for diverse cultures?

Note. Video title "Drone and Wo: Cultural Influences on Human-Drone Interaction Techniques", ACM SIGCHI (2017). Drones can provide common cultural ground but also highlight cultural differences.

Reflections

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- "Hacking" drones can provide authentic learning experiences for students, teachers and parents alike (Schroyer, 2013)
- Cultural responsiveness and parental engagement are complementary (Fenton et al., 2017)

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