

# **Teachers' Conference and ExCEL Fest 2023**

## **Teaching Sustainability through Project-Based Learning**

**Lauren Marce Hubert**



**FULBRIGHT**

Distinguished Awards in Teaching



## Presentation Goals:

- to compare current approaches to teaching Sustainability between Singapore and the USA
- to offer project-based learning (PBL) as an effective teaching strategy to focus students on real-world challenges and collaborative problem-solving
- to share an outline for a proposed project-based Sustainability course for concurrent grade 9-12/university credit that promotes critical thinking and engages students to think deeply about sustainability

# **Lauren Marce Hubert**

B.S. Biology, B.A. French

M. Ed. Curriculum & Instruction

National Board Certified Teacher, AYA Science

Fulbright Distinguished Awards in Teaching, 2022-23

Earthwatch Fellow 2022, Senior Fellow 2023

ASU / Underwriters Laboratory Fellowship 2023

## **Camelback High School, Arizona (1999-)**

Science Department Chairperson (7 yrs)

Biology PLC Leader (5 yrs)

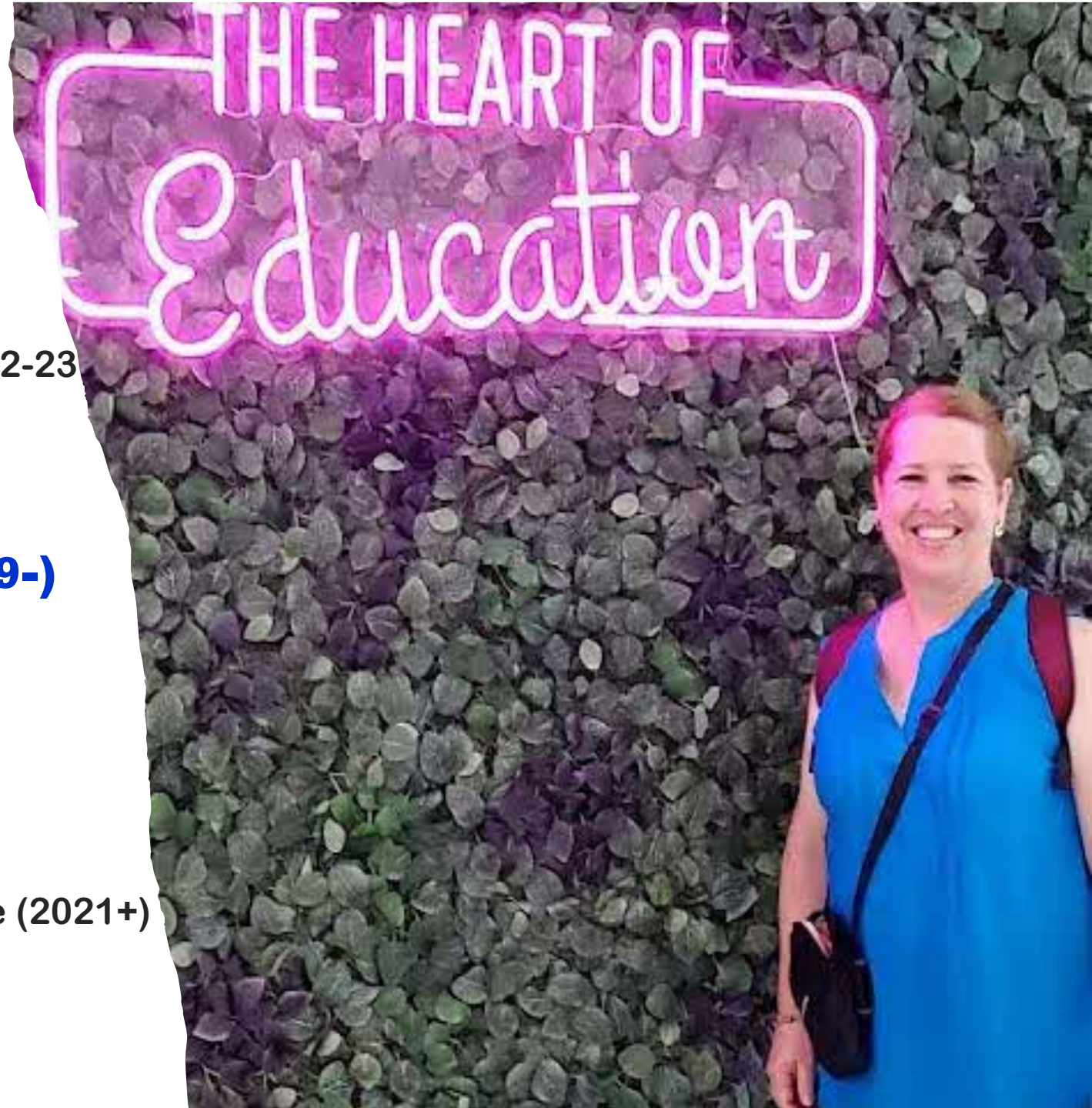
PXU Curriculum & Exam Committee (12 + yrs)

ASU Promod Grant Teacher, 2018-22

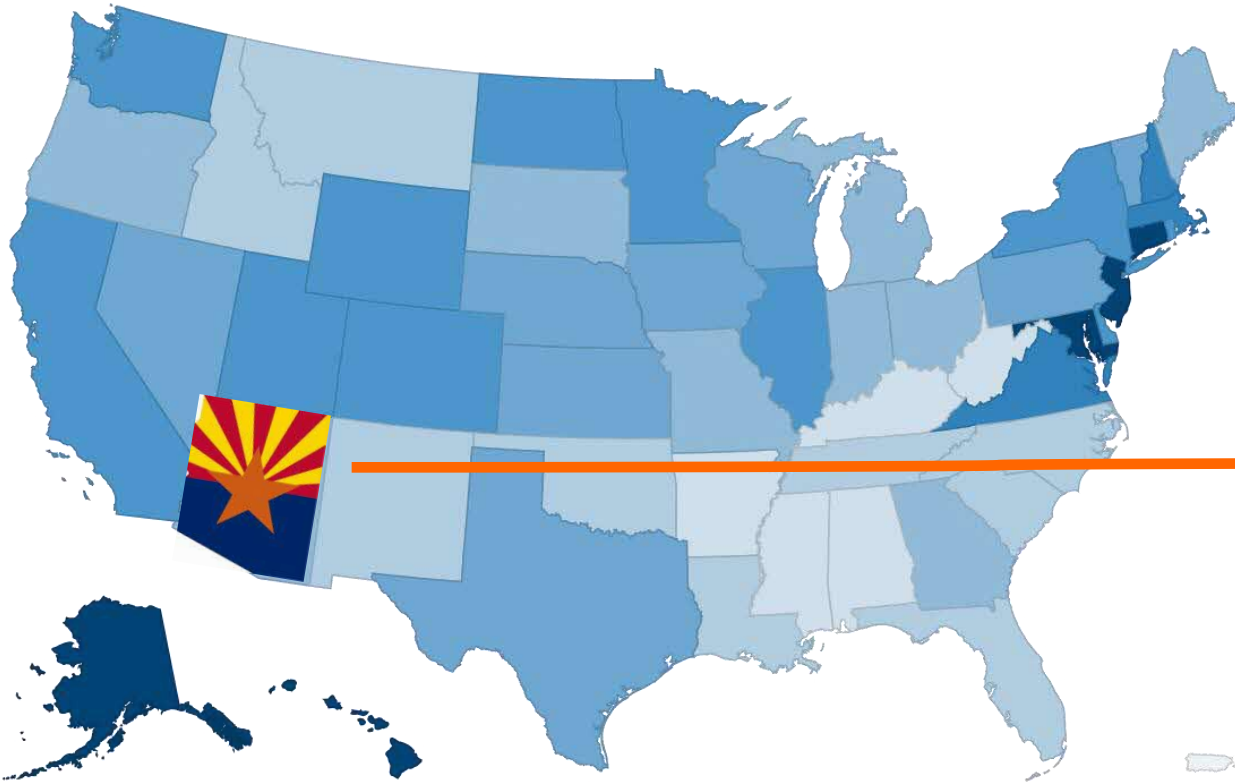
Club Sponsor: Science (1999+), Travel Adventure (2021+)

Courses Taught: Biology, French, Earth Science,

Anatomy, Environmental, Sustainability



**Attachments in Singapore:**  
**January 1 – April 1, 2023**  
to observe how sustainability is being  
taught in grades K-12 (~ ages 6-18)



AST

Dunman

Punggol

MOE  
CPDD



Related site visits: Tampines Secondary, Eunoia JC, Northlight Academy, Czongzheng Primary, Temasek Polytechnic, Commonwealth Secondary, Science Center Singapore, Sustainable Singapore Gallery, The Green Collective @ Funan, MOE Heritage Gallery, Singapore City Gallery @ URA, NIE, SEAB Gallery, MacRitchie Reservoir, Jurong Lake Park, Berlayer Creek, Pulau Ubin, Gardens by the Bay, Sungei Buloh Wetland

# Education System Comparisons



# Size of education system (pre-university)

	Area	Population	K-12 Public/Charter Schools (+ Private/Int'l)		# students K-12 (pre-U + poly)
<b>Singapore</b>	729 km <sup>2</sup>	4.6 million	344	(+ 80 private)	~ 422,000
<b>Arizona</b>	295,000 km <sup>2</sup>	7.3 million	2700+	(+ 477 private)	~ 1.2 million
<b>USA</b>	9,830,000 km <sup>2</sup>	332 million	~ 99,000	(+30,000 private)	~ 49.5 million

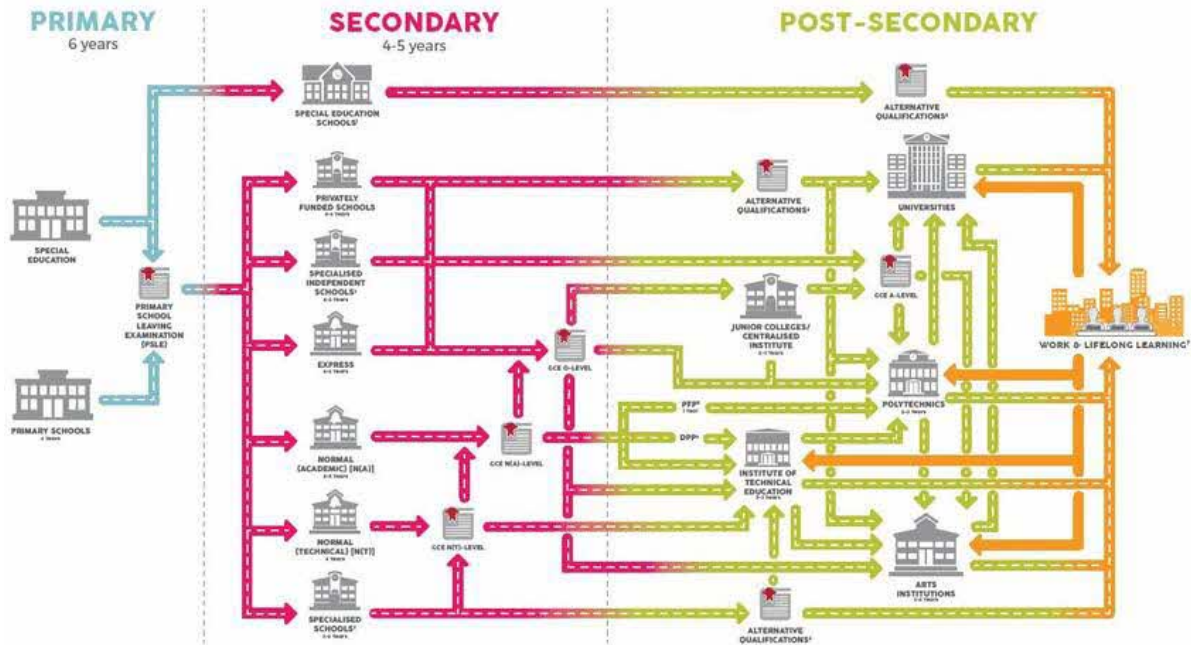
# Typical school grade groupings (pre-university)

Country	Pre-K Ages	Compulsory Ages Start to End	Most Common School Groupings on a Campus													
				Primary						Secondary				JC / Poly / ITE		
Singapore	5 – 6	6 - 16	K	P1	P2	P3	P4	P5	P6	S1	S2	S3	S4 (5)	1	2	3
USA	3 - 5	(5-6-7-8)		Elementary				Middle(5-8) Junior(7-9)				High School (9-12)				
		6 to 16	K	1	2	3	4	5	6	7	8	9	10	11	12	+
			K	1	2	3	4	5	6	7	8	9	10	11	12	+
			(16-18)	K	1	2	3	4	5	6	7	8	9	10	11	12
			K	1	2	3	4	5	6	7	8	9	10	11	12	+

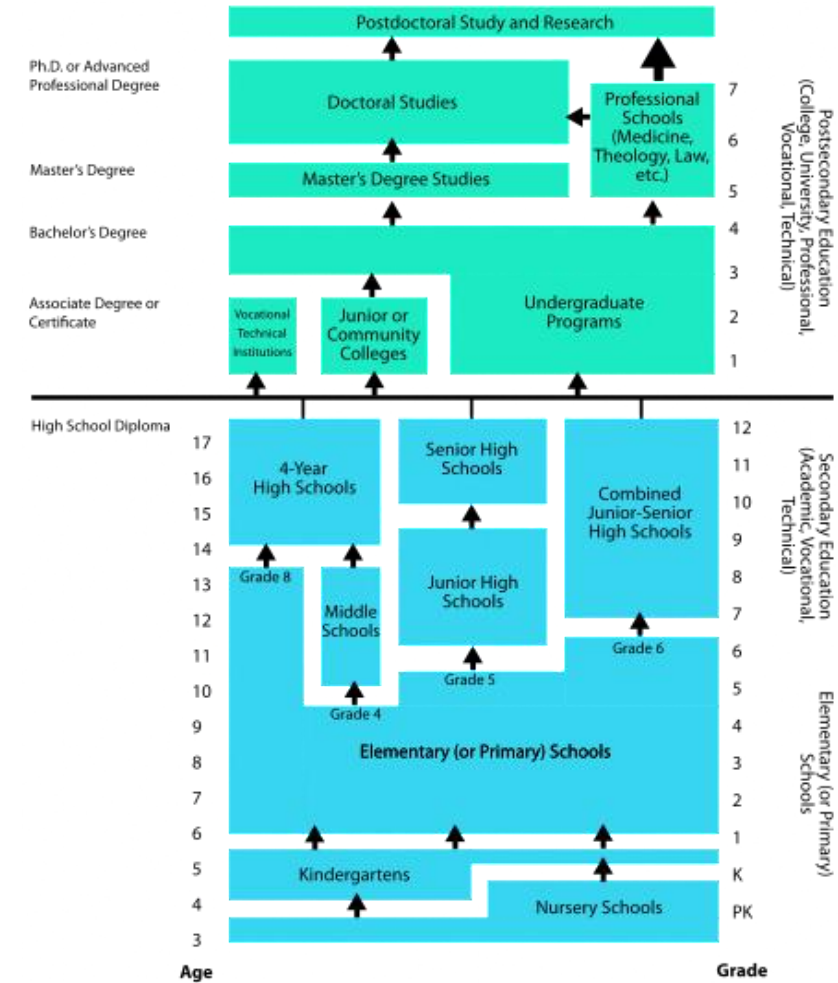
# Similar Paths, Different Outcomes – Why?

	% Holding Bachelor's Degree
Singapore	~ 50 %
USA	~ 30 %

## Singapore



## USA





## Teacher Agency



	# Clusters or Districts	Standards	Curriculum	+/-
<b>Singapore</b>	28	MOE	CPDD	Uniform vs Variable Personalization Focused vs Creative
<b>Arizona</b>	~220	State (mandated)	School Districts	Time, Cost, Labor Agency
<b>USA</b>	~13,800	National (suggested)	∅	Narrow vs Broad Pedagogy variation



# Teaching Sustainability Concepts ... sense of urgency?

## Arizona, USA (no)

urban sprawl

1-2 story homes + big cars

→ Carbon emission rank = 10<sup>th</sup>



## Singapore (yes)

Urban jungle

HDBs + public transport

→ Carbon emission rank = 27<sup>th</sup>





Rooftop garden of CapitaSprings

# POLL

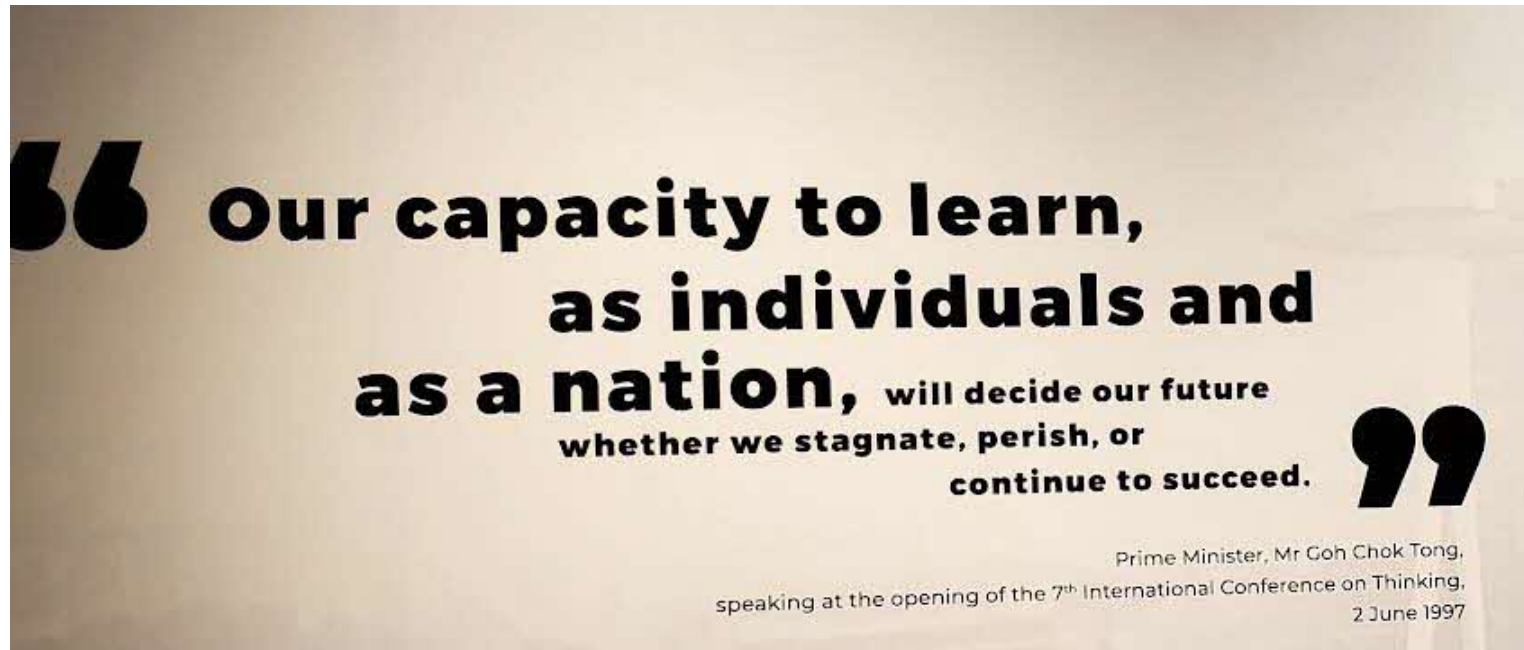
At what grade level should we start to teach sustainability concepts?

# Sustainability concepts

<b>3 Pillars</b>	<b>UN Sustainable Development Goals</b>	<b>Topic Examples</b>
<b>SOCIETY</b>	<ul style="list-style-type: none"><li>1 End Poverty</li><li>2 Zero Hunger</li><li>3 Good Health &amp; Well-being</li><li>4 Quality Education</li><li>5 Gender Equality</li><li>7 Affordable &amp; Clean Energy</li><li>11 Sustainable Cities &amp; Communities</li><li>16 Peace, Justice &amp; Strong Institutions</li></ul>	<ul style="list-style-type: none"><li>Agriculture, nutrition, food security</li><li>Rural development vs Urbanization</li><li>Female education, leadership, empowerment</li><li>Child protection, immunizations, education</li><li>Disaster resilience, mitigation vs adaptation</li><li>Public transportation, green streets initiatives</li><li>Renewable energy, urban heat islands, resources, Equity, access, environmental justice</li></ul>
<b>ECONOMY</b>	<ul style="list-style-type: none"><li>8 Decent Work &amp; Economic Growth</li><li>9 Industry, Innovation &amp; Infrastructure</li><li>10 Reduced Inequalities</li><li>12 Responsible Consumption &amp; Production</li></ul>	<ul style="list-style-type: none"><li>Green economy, equal wages, fair trade</li><li>Tourism, building materials, green building</li><li>Brownfields, tragedy of the commons, Product life cycle, circular economy, LEED</li></ul>
<b>ENVIRONMENT</b>	<ul style="list-style-type: none"><li>6 Clean Water &amp; Sanitation</li><li>13 Climate Action</li><li>14 Life Below Water</li><li>15 Life on Land</li></ul>	<ul style="list-style-type: none"><li>Carbon footprint, zero waste, pollution, plastics</li><li>Global climate change, Islands, rising sea levels</li><li>Biodiversity, forest protection, desertification, ocean acidification, conservation, preservation</li></ul>
	<ul style="list-style-type: none"><li>17 Partnerships for the Goals</li></ul>	<ul style="list-style-type: none"><li>Indicators, finance, technology, trade, collaboration, sense of place, city planning</li></ul>

# 2021 UNESCO study “Learn for Our Planet”:

- only 21 percent of the new or updated plans submitted by 95 countries as their Paris Agreement goals mentioned climate change education
- Only 45% of national education documents studied made little-to-no reference to environmental themes



# National efforts towards sustainability education

## **USA (2022 SDG rank: #41/163)**

### **Federal, State & Local**

- Sustainability & Climate Action plans
- C-free and Net Zero goals
- Environmental Protection Agency

### **US Dept of Ed - Green Ribbon Schools**

- Reduce environmental impacts
- Improve health & wellness
- Environmental & Sustainability education

### **University/College**

- Degree or certificate

### **Pre-University curriculum**

- NGSS: 5 human sustainability standards in Earth/Environmental = elective (adopted by only 20/50 states)

## **Singapore (2019 SDG rank: #60/163)**

### **Singapore Green Plan 2030**

- City in Nature
- Green energy (solar, transport)
- Green economy (innovation)
- Resilience (30by30, coastlines, UHI)
- GreenGov.SG

### **EcoStewardship Programme**

- Curriculum (geography)
- Campus (solar, LED, gardens)
- Culture (VIA, CCE, CCA)
- Community (empathy)

### **School Green Awards**

### **University**

- Degree or certificate

### **Pre-University curriculum**

- Geography (S1-JC) = all students

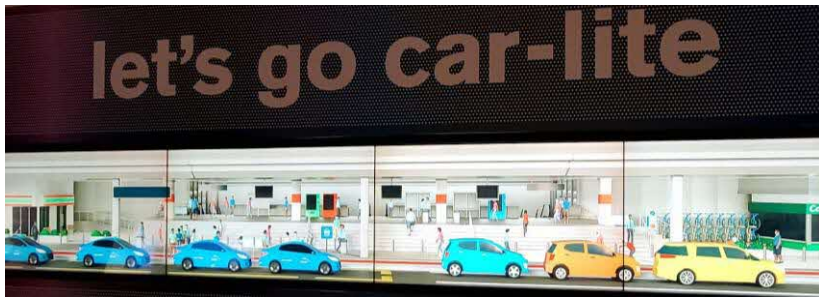
# Eco-Stewardship – Curriculum (Geography, CEA, CEE, ALP, VIA, DT)



# Eco-Stewardship - Campus



# Eco-Stewardship - Culture



## IMPACT OF MAN'S ACTIVITIES ON THE ENVIRONMENT

We share this planet with the countless living things that together make up the living eco-system of the Earth. We rely on this eco-system, including all the other organisms, for food, clean air and water and a livable environment.

Humans are the dominant species on Earth. By our actions, we are able to make a big impact (positive or negative) that could change the Earth's environment. The rapid rise in human population, together with advances in technology and our desire for more material things are resulting in negative changes to the Earth's environment. If they continue, these changes will affect the Earth's ability to support life in future.

Almost everything we do today result in some impact on the environment. Here are some major human activities that have a negative impact on the environment.

**MAN'S ACTIVITIES**

- Deforestation
- Overpopulation
- Overconsumption
- Overuse of fossil fuels
- Overuse of land
- Overuse of water
- Overuse of resources
- Overuse of energy
- Overuse of land
- Overuse of water
- Overuse of resources
- Overuse of energy

**NEGATIVE IMPACT OF MAN'S ACTIVITIES**

- Global warming
- Acid rain
- Ozone depletion
- Global warming
- Acid rain
- Ozone depletion
- Global warming
- Acid rain
- Ozone depletion
- Global warming
- Acid rain
- Ozone depletion

## RECYCLE YOUR BOOKS AND STATIONERY HERE!

Recycling saves energy because the manufacturer does not have to produce something new from raw natural resources. By using recycled materials, we save on energy consumption, which keeps production costs down.

## BYOB: LET'S PACK A WASTE-FREE LUNCH!

A plastic bag can take 1,000 years to break down.

So, bring a cookie jar & lunch-box for your meal in school! Use it to store your food and takeaways!

Reduce the usage of plastics, which are not biodegradable to save the earth from global warming.

**SMRT**

This escalator is temporarily switched off to reduce electricity usage and our carbon footprint for a greener Singapore.

Our apologies for the inconvenience caused.

**SMRT IS GREEN** **SG GREEN PLAN**

## FOR THE LOVE OF SAVINGS

POWER OFF WHEN NOT IN USE

Shut standby power to further save on electricity bill

MOVING PEOPLE WITH TOMORROW IN MIND

**SMRT**



USE ONLY WHAT YOU NEED

## REPORT WATER LEAKS

Please contact:  
Building Management  
SMH PTE LTD 67797966

Download App: OPUS

OPUS

www.pub.gov.sg facebook.com/PUBsg

**OPUB**

## FOR THE LOVE OF CLEANER AIR

TAKE THE TRAIN

Reduce carbon footprint by 90%\*

MOVING PEOPLE WITH TOMORROW IN MIND

**SMRT**

## PRACTISE THESE SIMPLE W-A-T-E-R TIPS AT HOME

**W**ASH clothes on full load

**A**LWAYS use half-flush when possible

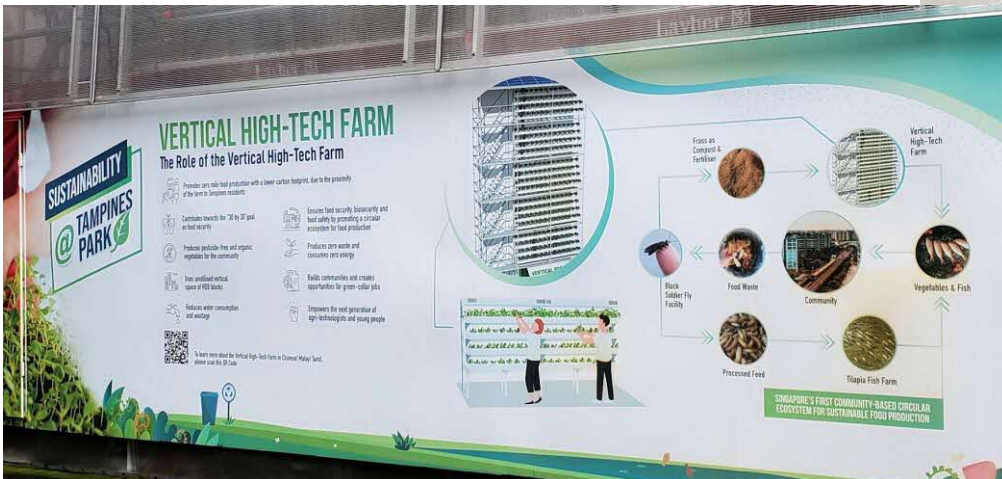
**T**URN off shower when soaping

**E**NSURE tap is off when brushing teeth

**R**INSE vegetables in container



# Eco-Stewardship - Community



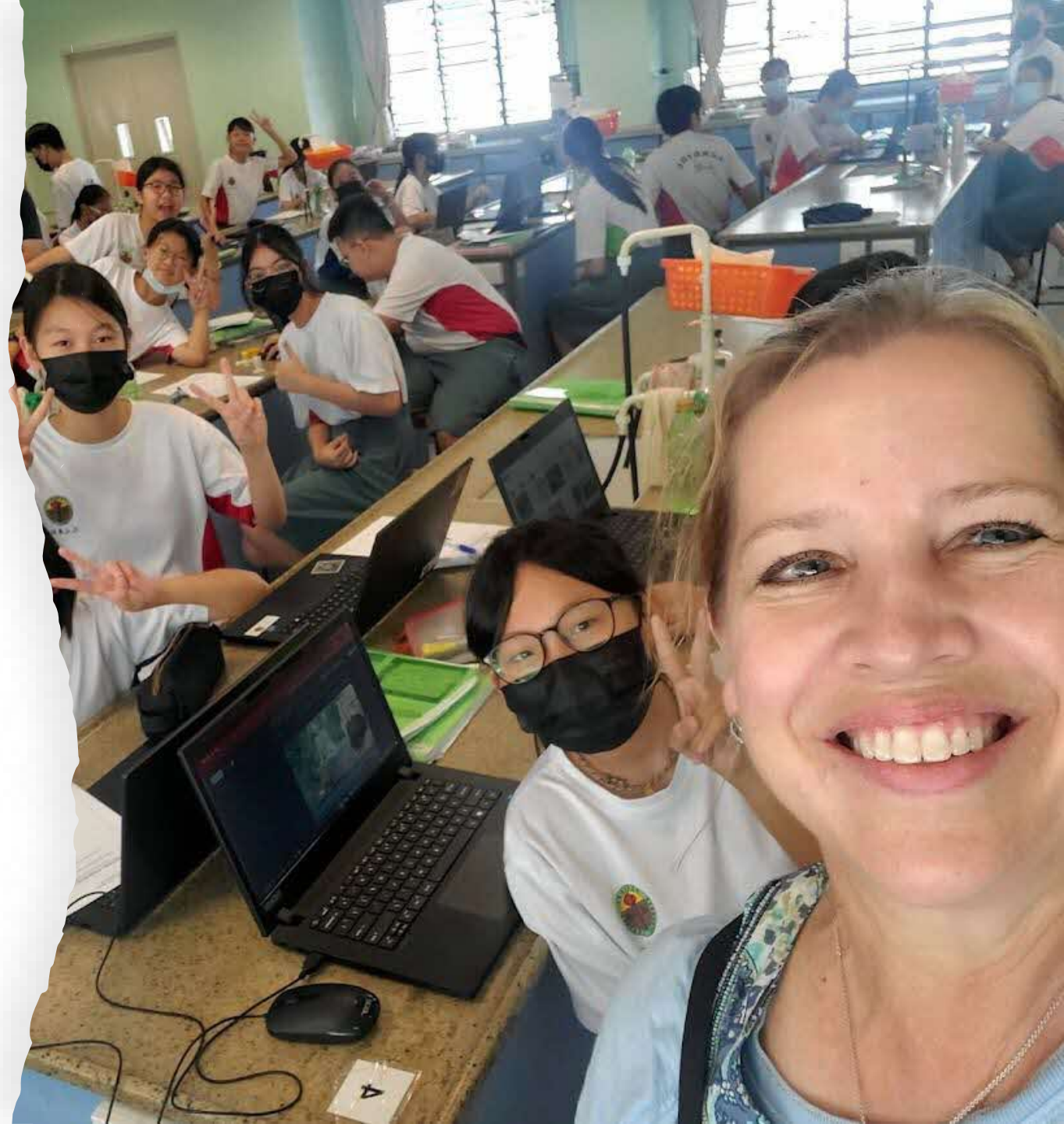
# POLL

True or False?

Project work

=

Project-Based  
Learning



# Project Work vs Project-Based Learning

## **Project Work (MOE, 1999+)**

“Interdisciplinary Project Work is a learning experience that provides primary and secondary school students with the opportunity to synthesize knowledge from various areas of learning and apply it to real-life situations. Students collaborate with their peers and communicate their ideas effectively to achieve a common objective.”

### A-Level

- Time: 28 weeks, 60-75 hrs
- Written Work (2500-3000 words)
- Reflection (500 words)
- Oral Presentation (25 min. per group)

## **Project-Based Learning**

Project Based Learning, or PBL, is an instructional approach built upon learning activities and real tasks that have brought challenges for students to solve.

- ❖ driven by student interest (Dewey)
- ❖ foster capable, adaptive citizens and problem solvers (Montessori)
- ❖ asking questions, investigating, interacting, and reflecting (Piaget)
- Time: 2-4 weeks within a unit
- Choice of format
- Presentation to relevant audience

## **Shared Goals:**

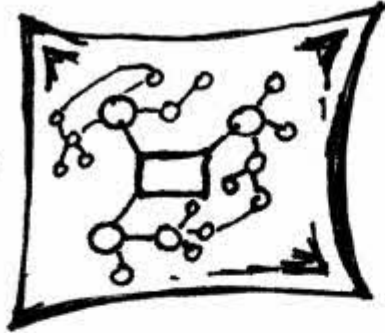
Communication + Collaboration + Knowledge Application + Independent Learning



## Key Elements of Project-Based Learning

- **Driving question:** a complex problem with multiple solutions
- **Authentic:** real-world project, connects students to others/ community
- **Deep learning** over the course of days/weeks/months
- **Learner focused:** student interest, self-directed, teacher as facilitator
- **Collaboration** with partners in all aspects of the project (**SDG #17**)
- **Peer review** and metacognitive reflection
- **Presentation** to a relevant audience beyond classmates and the teacher (performance, publication, posters, community event, film...)

# WHAT DO STUDENTS LEARN WHEN THEY ENGAGE IN COLLABORATIVE PROJECTS?



SYSTEMS THINKING



CRITICAL THINKING

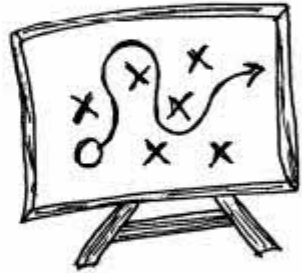
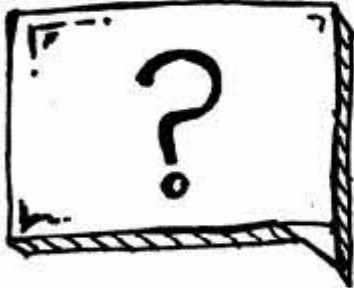


COMMUNICATION



EMPOWERMENT

SKETCH-NOTE BY JOHN SPENCER



ADAPTABILITY AND ITERATIVE THINKING



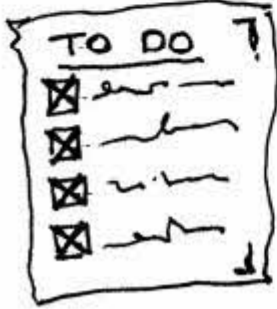
MAKER MINDSET



EMPATHY



PASSION FOR LEARNING



PROJECT MANAGEMENT



INQUIRY



PERSEVERANCE

# PBL Example Project

**Driving Question:** How can we reduce food waste in our school cantina?

**SDG #12.3** *“By 2030, halve per capita global food waste at the retail and consumer levels and reduce food losses along production and supply chains, including post-harvest losses.”*

## Student Project:

- Analyze the problem & brainstorm data/observations/survey questions to collect
- Collect data/observations/survey responses
- Organize data
- Research food waste solutions
- Draft a proposed solution / seek peer review / re-draft
- Create a product/presentation in mode of choice
- Present to stakeholder groups for feedback
- Write a follow-up reflection/self-evaluation for the project, proposal and presentation



# POLL 3

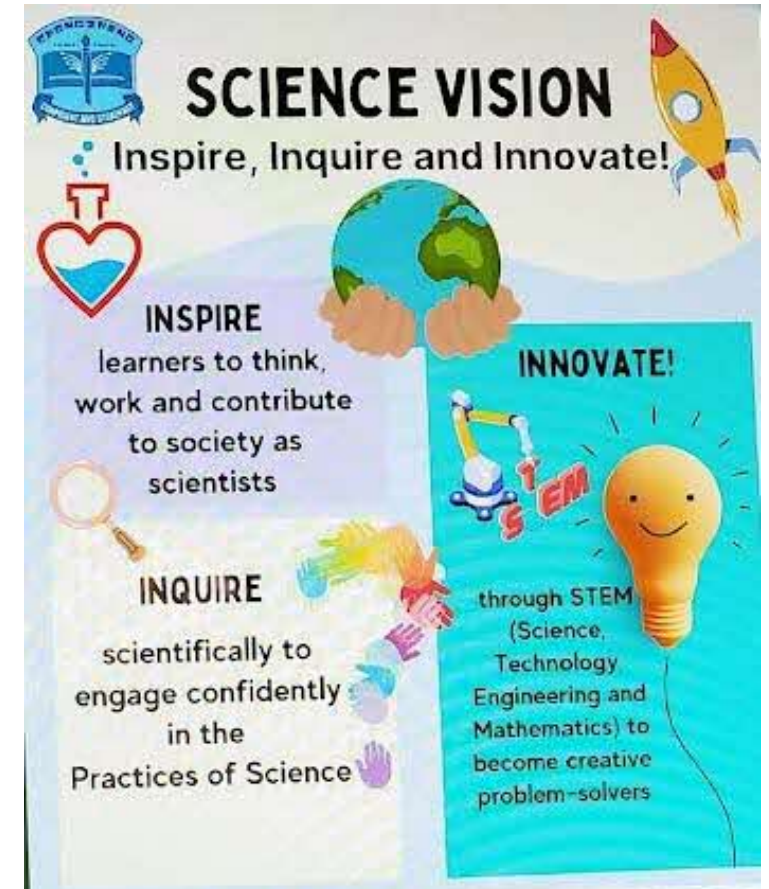
What  
21<sup>st</sup> Century  
Competencies  
can be derived  
from this  
example?



MacRitchie Reservoir

# Sustainability is all about collaboration and “thinking”.

- Futures Thinking
- Collaborative Thinking
- Systems Thinking
- Values Thinking
- Strategic Thinking





# Partnerships are important

**CRADL**  
Centre for Research and Applied Learning in Science

This laboratory supports workshops and project work for students and adults to learn science through its application in experimentation, research, and engineering design. It comprises classroom space, research equipment, and prototyping facilities. For more information on our offerings and how to book our programmes, please visit <http://www.science.edu.sg/CRADLE>

**Industry Partners**

DSO NATIONAL LABORATORIES, KURVE, ROHDE & SCHWARZ, SHIMADZU

**School Partners (2020)**

ANDERSON SERANGOON, ANG MO KIO, ANSONIA, HILLGROVE, HWA CHONG, SUNG AI, YONG KUN



ROOFTOP FARMING®  
**COM CROP**  
FEEDING OUR COMMUNITY

WORLD ECONOMIC FORUM

And no chemicals or pesticides are used

**THE GREEN COLLECTIVE**

CRUST GROUP  
**SUP CRUST BUDS!**

THANKS FOR THE TRUST IN CRUST & FOR BELIEVIN' IN US.

Scan to visit our website & follow us on social media

@crustgroup, @crustsingapore, @cropsingapore, @crustgroup

**RECYCLING HEROES**

PUT CLEAN HARD PLASTICS WITH THESE:

PET HDPE LDPE PP

ALMOST THERE!  
GETTING CLOSER...  
FILL UP THE BIN!

ALLIANCE FOR THE RECYCLING ECONOMY, ESA, ALBA, WII, WIRAS

# My Sustainability course plan:

- Grades 9-12 = S3-S4-JC1-JC2
- 1 year = 4 terms = 36 weeks
- Dual-enrollment for college credit
- Project-Based (1-3 projects per term)
- Linked to SDG targets
- Community partnerships & grants
- Project Green Challenge (October)
- Learning Journeys (1 per term) to sites related to sustainability
  - Waste/recycling facility
  - Solar/wind/renewable energy provider
  - Tiny homes construction site
  - Homeless or refugee shelter
  - Local farmers market or hydroponic farm
  - City planning office
  - Conservation center, regional park, wildlife refuge



# **PBL Driving Questions related to Sustainability**

**How can our school become a carbon-neutral facility?**

**What can be done to mitigate the climate refugee crisis?**

**How can we celebrate and create a movement for healthy, affordable, sustainable food in our community?**

**How can we support the indigenous Orang people of Malaysia?**

**What is a learner's role in fighting against injustice?**

**How can we use our school garden to create a maximum impact on our community?**

**How do we reduce the negative impact of plastics in our freshwater/ oceans?**

**How can we design a zoo of the future?**

**How can my city be designed to combat the urban heat island?**

# Links, Resources

- US Federal Sustainability Plan <https://www.sustainability.gov/federalsustainabilityplan/>
- Singapore Green Plan <https://www.greenplan.gov.sg/>
- US Dept of Ed. Infrastructure and Sustainability <https://www2.ed.gov/about/inits/ed/infrastructure-sustainability/index.html>
- Sustainable Development rankings <https://www.sdgindex.org/reports/sustainable-development-report-2022/>
- Arizona Forward <https://arizonaforward.org/what-we-do/statewide-sustainability-roadmap/>
- City of Phoenix <https://www.phoenix.gov/sustainability>
- Climate Education in the US <https://news.climate.columbia.edu/2023/02/09/climate-education-in-the-u-s-where-it-stands-and-why-it-matters/>
- Learn for Our Planet <https://unesdoc.unesco.org/ark:/48223/pf0000377362>
- PBL History <https://www.edutopia.org/project-based-learning-history>
- 50 Ideas for Genius Hour <https://www.fizzicseducation.com.au/articles/50-ideas-for-genius-hour/>
- PBL Works <https://www.pblworks.org/>
- E2 Foundation <https://www.e2-project-based-learning.org/7-Key-elements-of-PBL-41.html>
- 13 Brilliant Outcomes Of Project-Based Learning <https://www.teachthought.com/education/outcomes-project-based-learning/>
- Dr. John Spencer <https://www.youtube.com/user/oursocialvoice> & <https://spencerauthor.com/start-pbl/>
- Project Green Challenge <https://projectgreenchallenge.com/>



# Thank you Singapore

