Citizenship Education through the Lens of Science: The Transformative Potential of Socio-Scientific Issues (SSI)

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Teaching: Pedagogy of physics I & II

Research: Socio-scientific Issues (SSI), citizenship skills in science lessons, education for sustainable development, gender inclusivity in STEM

What is similar?

Banning: Vaping-Electronic cigarettes?

Nuclear energy: an option?

Should we ban sugary drinks?

Laughing gas? Party drug?

Scientific Literacy for all

Scientific literacy for all citizens (Wellington, 2003; Zeidler & Sadler, 2008).

Science education: to contribute to the scientific literacy of all students, not only future scientists, and technicians (Bayram-Jacobs, et al., 2019).

Students: understand **concepts, principles, and scientific processes** and actively use them in everyday life (DeBoer, 2000).

Students: skills such as **argumentation, reasoning, assessing the reliability of information sources**, etc. (Bybee, 2014).

Socio-scientific Issues (SSI)

What is SSI?

- controversial social issues which relate to science
- ✓ill-structured
- ✓open-ended problems
- ✓have multiple solutions

Students → **dialogue, discussion, debate**

Skills: argumentation, informed decision-making, critical thinking, etc.

SSI: context → engaging students in meaningful learning experiences that promote scientific literacy, critical thinking, and responsible citizenship.

Example:

- e-cigarettes
- The nitrogen policy
- Nuclear reactors: yes or no?
- Is green energy the future?
- Space travel
- Climate change
- Covid-19 Vaccine: Yes or no?

Why SSI

developing students' ability to **apply** scientific knowledge to **real-world problems**

encouraging students to consider **multiple perspectives**

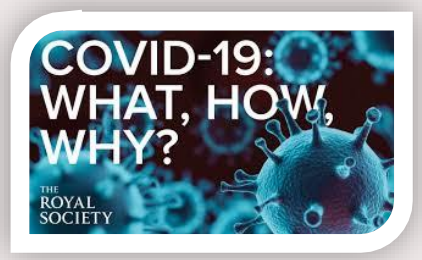
engaging in **evidence-based reasoning**

making **informed decisions**

understand the **interconnectedness** of scientific, social, and environmental **systems**

Integrating SSI in teaching: promising strategy for skill development

Why SSI-based teaching



Classrooms should be spaces in which learners **explore complex issues** and **how disciplinary ideas** can be used **to inform societal solutions** and p**ersonal decision-making.**

A third of all students at our school are addicted to vaping.

Teaching Socio-scientific Issues (SSI)

Teaching SSI: promotes the development of skills

(Simonneaux & Simonneaux, 2009; Zeidler et al., 2005).

In practice: science teachers often integrate SSI in their lessons

(e.g. Climate change, green energy, SDGs, etc.),

Teaching SSI systematically is difficult for teachers, despite the availability of in-service training activities

Because of their emerging and controversial nature, inherent uncertainty, the interdisciplinarity of issues, SSI differs from other educational content

(Sadler & Zeidler, 2004).

Citizenship competences

Viewing problems from **multiple perspectives**, considering **ethical and moral dimensions** & **applying relevant scientific and technological knowledge**

Incorporating SSI in science lessons

Effective approach for **developing students' skills** to be **responsible citizens**

Leraar24 – Burgerschap in de bètavakken

*Science subjects provide excellent opportunities to develop citizenship skills because students learn to **investigate, think critically**, and **analyse** societal dilemmas.*

Topics such as climate change, sustainability, energy, and vaccinations offer natural entry points for citizenship education in the sciences.

*Teachers can make citizenship meaningful by linking **scientific inquiry to real-world social issues.***

Bèta Burgerschap – Kunstzone (mei 2025)

Bèta citizenship encourages students to connect scientific understanding with social and ethical questions.

By exploring issues related to technology, climate, and AI, students develop not only knowledge but also democratic skills such as argumentation and perspective-taking.

Investigating the world through making and experimenting becomes a way to practice responsibility in a complex society.

Citizenship Education-The Netherlands

Primary & secondary schools: since **February 1st, 2006,** to promote active citizenship and social integration (Primary education act, article 8, paragraph 3).

No concrete goals & guidelines

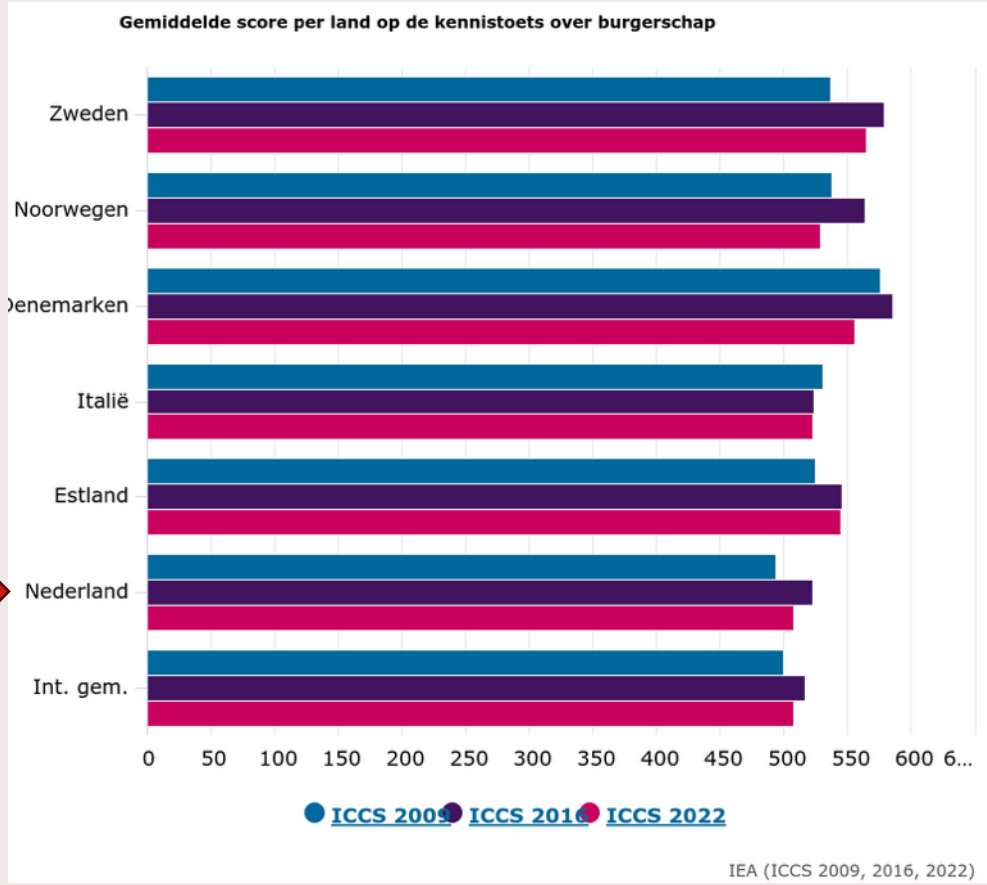
Since 2021: new law promoting citizenship education. However, the main goals do not contain explicit goals for citizenship

March 2024: draft core objectives for citizenship- SLO

July 2025: finalized (draft) core objectives for citizenship -SLO

International Civic & Citizenship Study

Dutch students score around the international average in their knowledge of political and societal issues (a score of 508)



De Staat van het Onderwijs 2025 – Expertisepunt Burgerschap

In many schools, citizenship education is still not sufficiently goal-oriented, coherent or structurally embedded.

Schools often lack a shared vision on what citizenship entails and how it should be implemented across the curriculum.

The inspectorate highlights the need for cross-curricular approaches, where citizenship goals are integrated into regular subject teaching.

EU Education & Training Monitor (2025)

Dutch students perform at an average level in civic knowledge, but concerns remain about their civic engagement.

The European Commission stresses the need for stronger links between **citizenship competences** and **digital** and **scientific skills.**

Global challenges such as **climate change** and **emerging technologies** increase the urgency to integrate citizenship with STEM education.

Citizenship Education-The Netherlands

Citizenship education: embedded in the core objectives of both primary education and the lower grades of secondary education.

Citizenship competencies: included in the final attainment targets for the upper grades of secondary education & citizenship knowledge and skills can be assessed through the central exam.

Citizenship education: not a separate subject, various school subjects are expected to contribute to it in their own way.

Citizenship Education-The Netherlands

Citizenship education: promotes the broad development of students, enabling them to grow into **responsible and critically thinking citizens.** It provides **knowledge, skills**, and **experiences** that help students discover how they can contribute to a democratic and diverse society and help shape it.

Goal: to make students **aware of their role** and **opportunities** to actively contribute to this society and a democratic culture, together with others.

(SLO, July 2025)

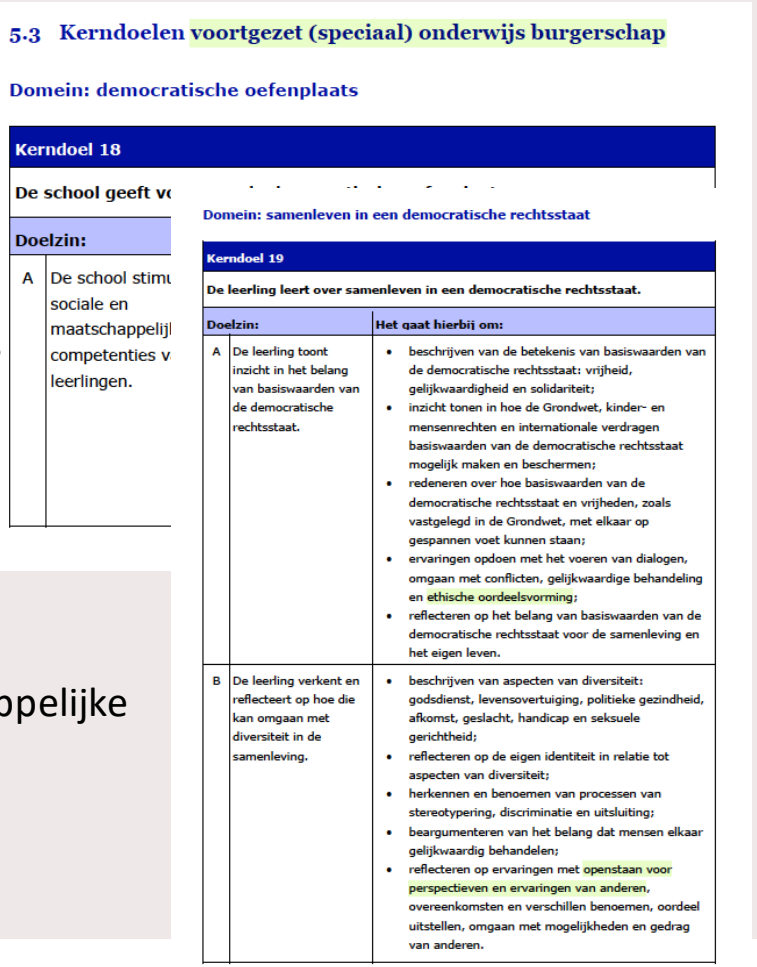
Core Goals

Skills:

- Critical thinking
- Ethical decision-making
- Being open to the perspectives and experiences of others
- Exploring contemporary societal and sustainability issues

Concepts:

- Sustainability issues (Duurzaamheids-vraagstukken)
- Ethical reasoning (Ethische oordeelsvorming)
- Critical thinking skills (Kritische denkvaardigheden)
- Societal issues /Socio-scientific/techical issues (maatschappelijke vraagstukken)



5.3 Kerndoelen voortgezet (speciaal) onderwijs burgerschap

Domein: democratische oefenplaats

Kerndoel 18	
De school geeft v	
Doelzin:	
A	De school stimu sociale en maatschappelijk competenties v leerlingen.

Domein: samenleven in een democratische rechtsstaat

Kerndoel 19		
De leerling leert over samenleven in een democratische rechtsstaat.		
Doelzin:		Het gaat hierbij om:
A	De leerling toont inzicht in het belang van basiswaarden van de democratische rechtsstaat.	• beschrijven van de betekenis van basiswaarden van de democratische rechtsstaat: vrijheid, gelijkwaardigheid en solidariteit; • inzicht tonen in hoe de Grondwet, kinder- en mensenrechten en internationale verdragen basiswaarden van de democratische rechtsstaat mogelijk maken en beschermen; • redeneren over hoe basiswaarden van de democratische rechtsstaat en vrijheden, zoals vastgelegd in de Grondwet, met elkaar op gespannen voet kunnen staan; • ervaringen opdoen met het voeren van dialogen, omgaan met conflicten, gelijkwaardige behandeling en ethische oordeelsvorming; • reflecteren op het belang van basiswaarden van de democratische rechtsstaat voor de samenleving en het eigen leven.
B	De leerling verkent en reflecteert op hoe die kan omgaan met diversiteit in de samenleving.	• beschrijven van aspecten van diversiteit: godsdienst, levensovertuiging, politieke gezindheid, afkomst, geslacht, handicap en seksuele gerichtheid; • reflecteren op de eigen identiteit in relatie tot aspecten van diversiteit; • herkennen en benoemen van processen van stereotypering, discriminatie en uitsluiting; • beargumenteren van het belang dat mensen elkaar gelijkwaardig behandelen; • reflecteren op ervaringen met openstaan voor perspectieven en ervaringen van anderen, overeenkomsten en verschillen benoemen, oordeel uitstellen, omgaan met mogelijkheden en gedrag van anderen.

Core Objectives

Overview of domains and goals of citizenship

Socio-scientific Issues (SSI)

Goal 6. Societal Issues

Lower secondary eduaction
Goal: The student considers what options s/he has to act on societal issues.

- Recognizing different perspectives (perspective taking)
- Reflecting on how one's own identity and values can influence actions
- Expressing personal views
- Exploring what individual and collective contributions to solutions are possible

Kerndoel 20 **De leerling doet ervaringen op met democratische en maatschappelijke betrokkenheid.**

20B **De leerling verkent en reflecteert op mogelijkheden om bij te dragen aan de samenleving.**

Het gaat hierbij om:

- beschrijven hoe burgers met taken, rollen, rechten en plichten bijdragen aan de samenleving;
- onderzoeken van de rol en de impact van maatschappelijke initiatieven, bewegingen en organisaties en de middelen die zij aanwenden om bij te dragen aan de samenleving of veranderingen in de samenleving teweeg te brengen;
- verkennen van actuele, maatschappelijke en duurzaamheidsvraagstukken;
- ervaringen opdoen met verantwoordelijkheid nemen voor en bijdragen aan het welzijn van anderen;
- reflecteren op mogelijkheden om vanuit eigen idealen of overtuigingen bij te dragen aan de samenleving, nu en in de toekomst.

Bèta Burgerschap

Actively participating in discussions about socio-scientific/technological issues.

Encouraging students to actively engage with scientific topics and understand their implications for society.

Empowering students to be informed and responsible citizens who can contribute thoughtfully to discussions about science and technology.

It's not just about learning facts; it's about understanding how science intersects with ethical, environmental, and societal issues.

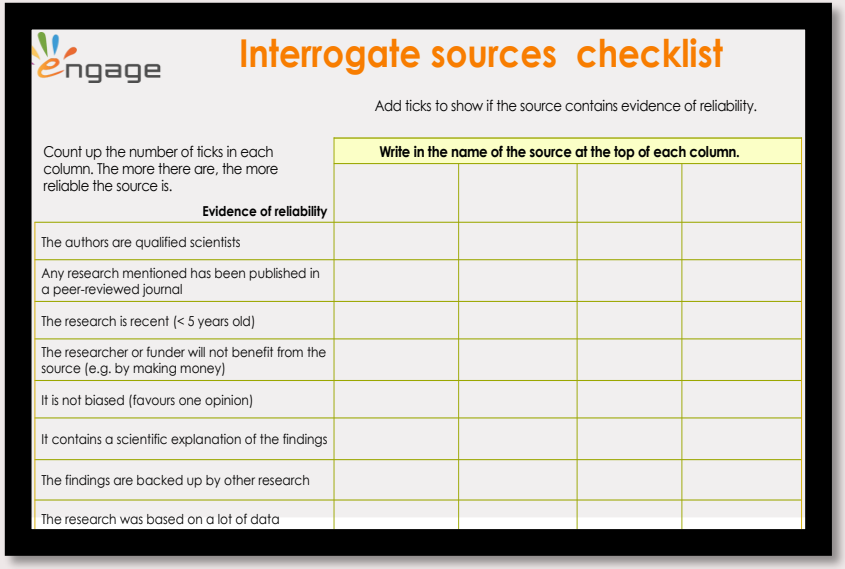
Developing students' skills (argumentation, critical thinking, informed decision-making, etc.).

Guérin, 2018; Tolkamp et al., 2019)

How

Research & (EU) projects:

- Ready to use lesson materials (OER, editable; (e.g. ENGAGE materials)
- Tools



engage

Interrogate sources checklist

Add ticks to show if the source contains evidence of reliability.

Count up the number of ticks in each column. The more there are, the more reliable the source is.	Write in the name of the source at the top of each column.			
Evidence of reliability				
The authors are qualified scientists				
Any research mentioned has been published in a peer-reviewed journal				
The research is recent (< 5 years old)				
The researcher or funder will not benefit from the source (e.g. by making money)				
It is not biased (favours one opinion)				
It contains a scientific explanation of the findings				
The findings are backed up by other research				
The research was based on a lot of data				

Local & global SSI
You can link SSI to the textbook

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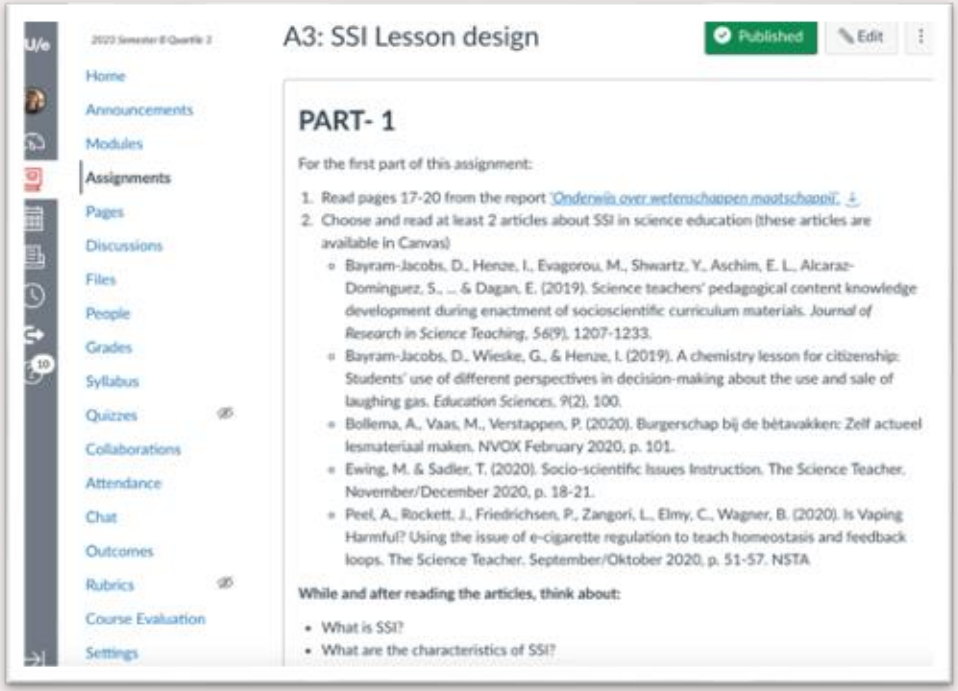
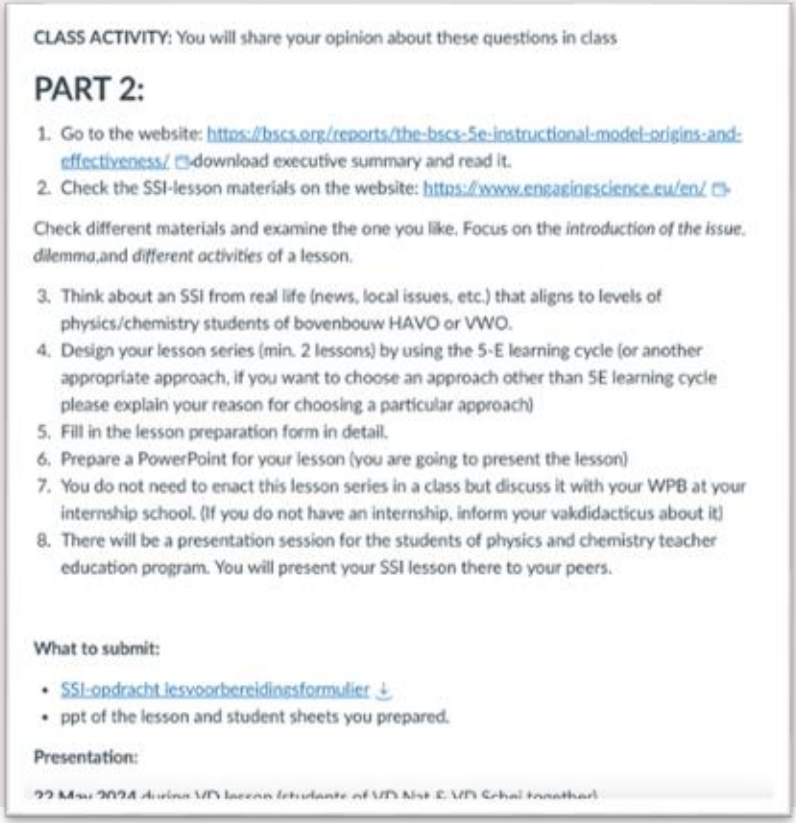
ESoE

Pedagogy of Physics II & Pedagogy of Chemistry II: **Common assignment**





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Hackathon

Programma 30 oktober

9:00-9:15	Opening en introductie van de hackathon-opdracht door Nienke
9:15-9:45	**Checkpoint 1:** Ieder team verwerkt de kern van het artikel/rapport dat als voorbereiding is gelezen tot één PowerPoint slide. Vervolgens geeft ieder team in een pitch de belangrijkste boodschap van het artikel (max. 1,5 min)
9:45-12:30	Ieder team werkt aan de hackathon-opdracht
12:30-13:15	Lunch
13:15-13:45	**Checkpoint 2:** vertel over teamvisie op bètaburgerschap, welke competenties etc.
13:45-15:00	Weergeven van de ideeën dmv een poster (er wordt voor stiften, gekleurd papier etc. gezorgd)
15:00	Jury aanwezig
16:00-16:30	Posterpresentatie, 10 minuten per poster
16:30-17:00	Juryberaad
17:00	Uitslag Hackathon en daarna een drankje.

Uitnodiging Hackathon voor Burgerschapsonderwijs in de Bètavakken

(for English scroll down)

Datum: 30 Oktober 2024
Location: Qubit 1.014, 9:00-17:30 uur

Wat is een Hackathon?

Een hackathon is een intensieve en creatieve bijeenkomst waarin deelnemers samenwerken n innovatieve oplossingen te bedenken voor een specifiek probleem of uitdaging. Tijdens eze hackathon werken we in multidisciplinaire teams en combineren we onze kennis, reativiteit en vaardigheden om binnen een korte tijd tot nieuwe ideeën te komen. Het doel is n in een inspirerende en energieke omgeving te brainstormen, ontwikkelen en uiteindelijk oncrete plannen of concepten te presenteren aan een jury. (dankjewel ChatGPT 😊)

oel van onze Hackathon

et doel van onze hackathon is om te bedenken hoe we in onze (eerste en tweedegraads) rarenopleidingen studenten kunnen ondersteunen in het ontwikkelen van de competenties e nodig zijn om effectief bètaburgerschapsonderwijs te geven aan hun (toekomstige) erlingen.

Vat ons betreft is het winnende Hackathon team erin geslaagd:

1. helder te omschrijven hoe zij tegen bètaburgerschap aankijken;
2. het belang van bètaburgerschap in de lerarenopleiding onder de aandacht te brengen;
3. te laten zien hoe bètaburgerschap ingebed wordt in ons opleidingsprogramma;
4. haalbare leerdoelen voor studenten te formuleren;
5. met een creatieve aanpak te komen die samenwerking tussen de opleiders bevordert;
6. een voor studenten en opleiders uitvoerbaar ontwerp te komen.

Voorbereidende opdracht en samenstelling teams

We werken tijdens de hackathon in drie gemengde teams. Ieder team leest **vooraf** een artikel over burgerschapsonderwijs. Bij de start van de hackathon moet ieder team dit artikel kort presenteren (zie ook programma 30 oktober, checkpoint 1) Flip your classroom 😉

Team 1	Leden: Nienke, Lesley, Marjan, Alex, Marieke Leeswerk:

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ENGAGE project

Equipping the Next Generation for Active Engagement in Science

Project reference: 612269

Call (part) identifier:
FP7-SCIENCE-IN-SOCIETY-2013-1

Citizenship Skills

Informed decision-making (oordeelkundigheid)

Informed decision-making (Ratcliffe, 2007)	1) The ability to **correctly interpret** scientific information
	2) Dealing with **conflicting** information
	3) Being able to recognize and consider **different perspectives**
	4) Weighing of probability and risk
	5) (moral) **argumentation**
	6) Dialogue skills and **reflection** on own values

Three Competencies for Citizenship (Boerwinkel et al., 2009)

Collecting and Analysing Information	Informed Opinion- and Decision-Making	Acting Based on Opinions and Decisions
• Applying relevant scientific concepts • Critically interpreting information sources • Explaining how science, technology, and society influence one another	• Reflecting on one's own values and judgement Dealing with uncertainty and risk information Communicating values Dialogue and discussion skills	• Identifying relevant societal structures Formulating action perspectives Supporting others in decision-making and action Reflecting on one's own societal actions

5E learning cycle - Instructional Model for IBSE

(Bybee, Powell, & Towbridge, 2007)

Engagement	Object, event or question used to engage students Connections facilitated between what students know and can do
Exploration	Objects and phenomena are explored Hands-on activities, with guidance
Explanation	Students explain their understanding of concepts and processes New concepts and skills are introduced as conceptual clarity and cohesion are sought
Elaboration	Activities allow students to apply concepts in contexts and build on or extend understanding and skill
Evaluation	Students assess their knowledge, skills and abilities. Activities permit evaluation of student development and lesson effectiveness

Dilemma

Ebola vaccine: Looking for volunteers to test

Will you be voluntary or No? Why? Why not?

Science in-the-news lesson materials & SSI

How can we decide which action is a good idea?

Next year's

DAILY NEWS

The EU has announced new **strict legal limits** on home electricity use.

Can **you** make big enough cuts?

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Vapen (e-sigaretten)

Gebruik van e-sigaretten (vapes) onder jongeren stijgt, vooral in de leeftijd 12–25 jaar.

Ongeveer **1 op de 5 middelbare scholieren** heeft wel eens

een vape geprobeerd.

Verkoop aan jongeren onder de 18 is verboden.


Now health campaigners want a Europe-wide ban.
Will you support a European ban on indoor vaping in public places?
DAILY NEWS
Passive vaping as risky as passive smoking, claims health charity.
DAILY NEWS
Long-term risks of passive vaping not yet known, say scientists.

Eat insects

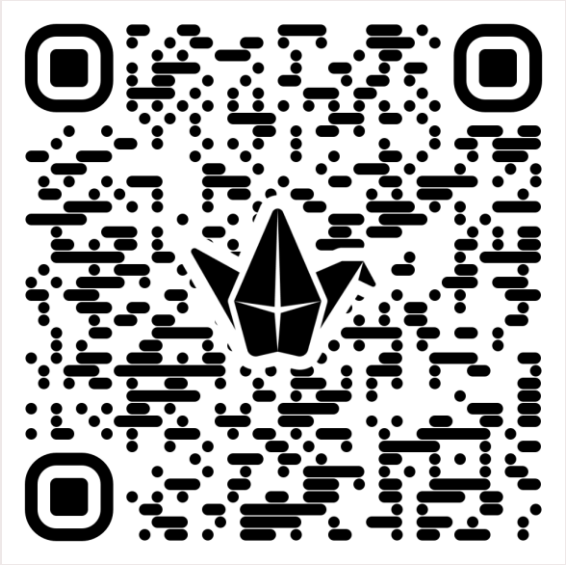
The human population is **growing**

We need to produce **more food**

Can we persuade people to swap meat for insects?

ENGAGE materials-1 lesson

https://padlet.com/durutue/engage-ssi-materials-1-lesson-2xmi5js97aqqdwg8



ENGAGE materials- lesson series

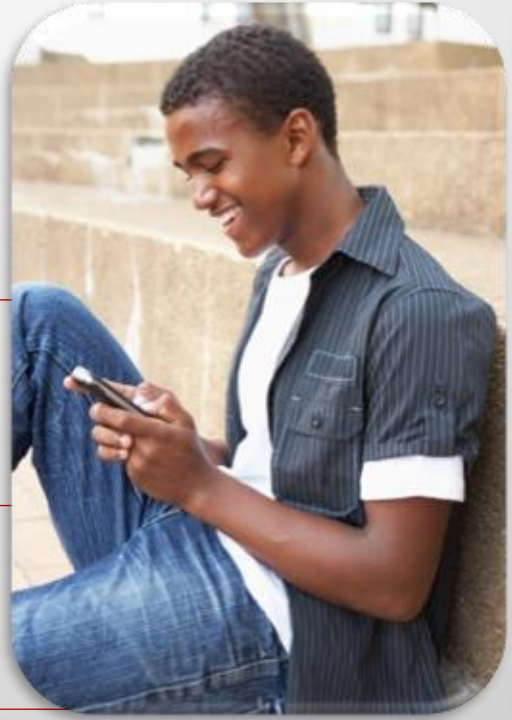
https://padlet.com/durutue/engage-ssi-lesson-series-ejn4j3qvb715yxy

Equipping the Next Generation for Active Engagement in Science

Text Neck

Daily News

Save your neck: stop texting



New research shows that using your phone may seriously damage your neck.

Scientists recommend cutting time spent online, texting and watching videos.

Bending your neck adds to the **force** exerted by your head on your spine.

At 60° the extra force is 220 N...

...about the weight of a 6-year old.

Will you use your phone less to save your neck?

In this activity, you will

Make a decision about whether to use your phone less to prevent neck damage:

Forces: Identify forces on objects

Science in society: Define a problem and devise a plan to investigate it

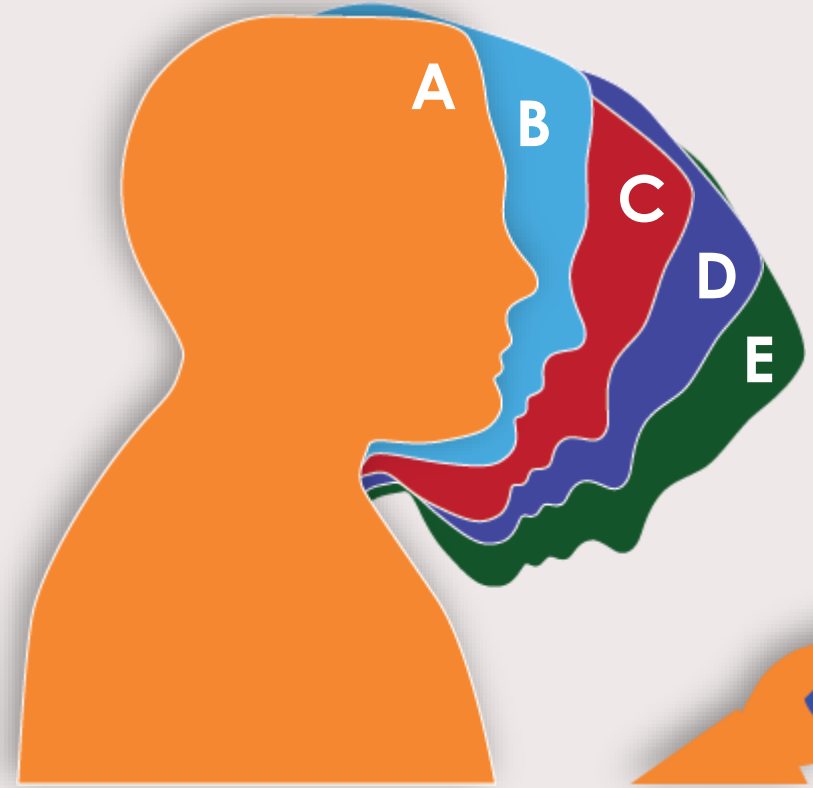

Big Idea


Working Scientifically

The forces on your neck – 1

Why does bending your neck add to the force on the bones at the top of your spine?

The forces on your neck – 2



In which position is the force on the neck biggest?

Will using your phone damage your neck?

Plan how to investigate this question:

- Choose variables that might affect the outcome.
- For each variable
  - identify at least one way of obtaining data.
  - then decide the **best** way of collecting **reliable** data for the variable.
- Work out how to use the data to decide if using your phone will damage your neck.

Will you use your phone less to save your neck? Why?

Student sheets

Text neck

Sheet no.	Title	Notes
SS1	Variables	Reusable. Cut into cards. one per group.
SS2	Obtaining data	Reusable, one per group.
SS3	Assessment	Consumable.

Variables

A

Amount of time using phone to text, watch videos and use the internet.

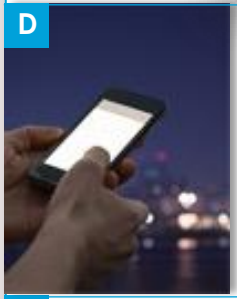
B

Angle of head when using phone.

C

Weight of body.

D



Phone screen brightness.

E

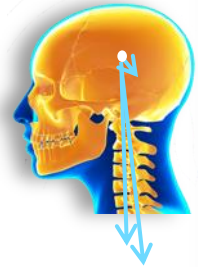
Time your neck can be kept at an angle before your spine is damaged.

F

The amount of force on your spine that causes damage.

G

Force exerted by your head on your spine at different neck angles.



H

Weight of head

I

Neck muscle strength.

Obtaining data – 1

Ask people with neck pain how much they use their phones.

Measure neck circumference.

Ask people to tell you their phone settings.

Ask people to write down when they use their phones.

Use bathroom scales.

Find the data in a scientific journal or medical text book.

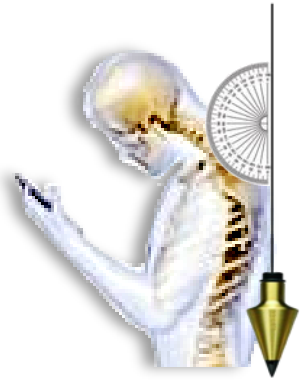
Ask people which sports they do, and how often.

Create an app that records when you text, watch videos and use the Internet.

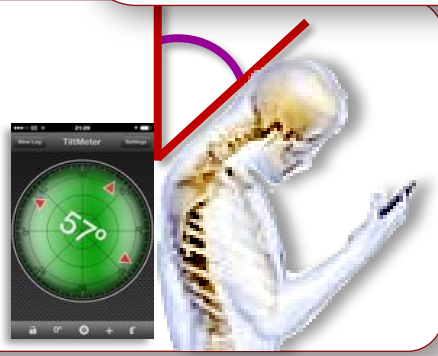
Obtaining data – 2

Use force diagrams and do calculations

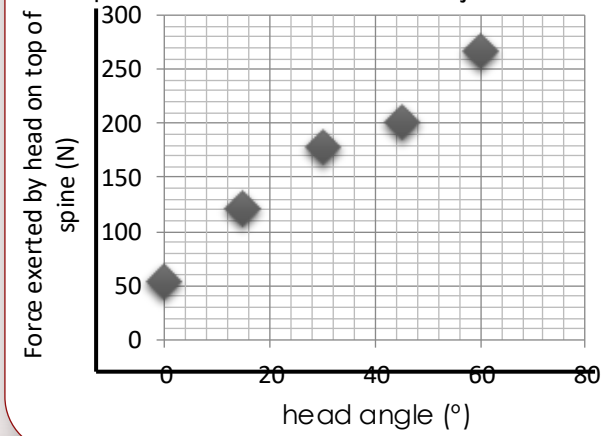
Use a protractor and plumb line.



Use an app that measures inclination to find out the angle shown.



Select data from this graph, published in a scientific journal.



Assessment

The scientific question I am investigating is:

These variables might affect the outcome:

Circle the most important variables above.

Draw rectangles around the variables you can measure.

Draw triangles around the variables for which you can find data from secondary sources:

Underline in pencil the variables for which it may not be possible to find data.

This is how I can use the data to answer the question:

Examples: ENGAGE TOOLS

Interrogate sources checklist

Add ticks to show if the source contains evidence of reliability.

Count up the number of ticks in each column. The more there are, the more reliable the source is.	**Write in the name of the source at the top of each column.**			
Evidence of reliability				
The authors are qualified scientists				
Any research mentioned has been published in a peer-reviewed journal				
The research is recent (< 5 years old)				
The researcher or funder will not benefit from the source (e.g. by making money)				
It is not biased (favours one opinion)				
It contains a scientific explanation of the findings				
The findings are backed up by other research				
The research was based on a lot of data				

Estimate risks thinking guide

Use your sources to choose two benefits and two risks of the action.
Add up the scores and compare. Do the benefits outweigh the risks?

Benefit	
Size of benefit	1 2 3
Likelihood of it happening	1 2 3
Size x likelihood	

Risk	
Size of risk (seriousness)	1 2 3
Likelihood of it happening	1 2 3
Size x likelihood	

Benefit	
Size of benefit	1 2 3
Likelihood of it happening	1 2 3
Size x likelihood	

Risk	
Size of risk (seriousness)	1 2 3
Likelihood of it happening	1 2 3
Size x likelihood	

Total score for benefits	

Total score for risks	

Use ethics thinking guide

Ethical thinking help us to decide is something is right or wrong.

Rights and duties is one type of thinking we can use.

Rights and Duties

Follow rules

Do not worry about the outcome.

Base your decisions on rules which you believe should always be followed, for instance:

- It is wrong to lie or cheat
- It is wrong to steal
- All living things have the right to life
- All humans have a right to good health
- Help others
- Respect people's opinions

Example:

- A man's wife is very ill but he cannot afford the medicine to cure her. On a hospital visit he sees it in an unlocked cupboard.

  Should he take it?

What to do:

1 List the rules that are relevant:

It is wrong to steal

All humans have a right to good health

Help others

2 Decide which rule is most important to **you**

3 Follow the rule

Leave it

Take it

KWHL Grid

What I **K**now		
What I **W**ant to know	**H**ow I will find out	What I have **L**earnt

Action A: Use nuclear

Action: Replace all fossil fuel powered power plants with nuclear power plants.

The facts

- Nuclear power plants **do not produce any greenhouse gases** but a lot are produced as they are built.
- They use a **non-renewable resource** called uranium. This will eventually run out.
- They are very **expensive** to build.
- They can **generate electricity 90% of the time**, even when the sun does not shine or the wind does not blow.
- The waste produced by nuclear power plants is **highly radioactive** and needs to be stored deep underground for thousands of years before it is safe.
- There is a risk of a **meltdown** which releases dangerous, radioactive chemicals into the air.

Action B: Go vegan

Action: Stop the farming of animals. People must go vegan.

The facts

- A diet with no animal fat is **healthy,** reducing the incidence of heart disease and some cancers.
- Currently an area the **size of a football pitch** can be used to produce 250 kg of beef or 15,000 kg of fruit and vegetables.
- If people ate no meat, there would be **no animal farms.**
- People might struggle to eat a **balanced diet.**
- Land used for farming animals could be **replanted as forest** or used to grow biofuels (plants that can be used to generate electricity or make fuels for cars).
- The meat and dairy industry is responsible for **14.5% of global greenhouse gas emissions**. That's more than is produced by all cars, trains, planes and ships in the world.

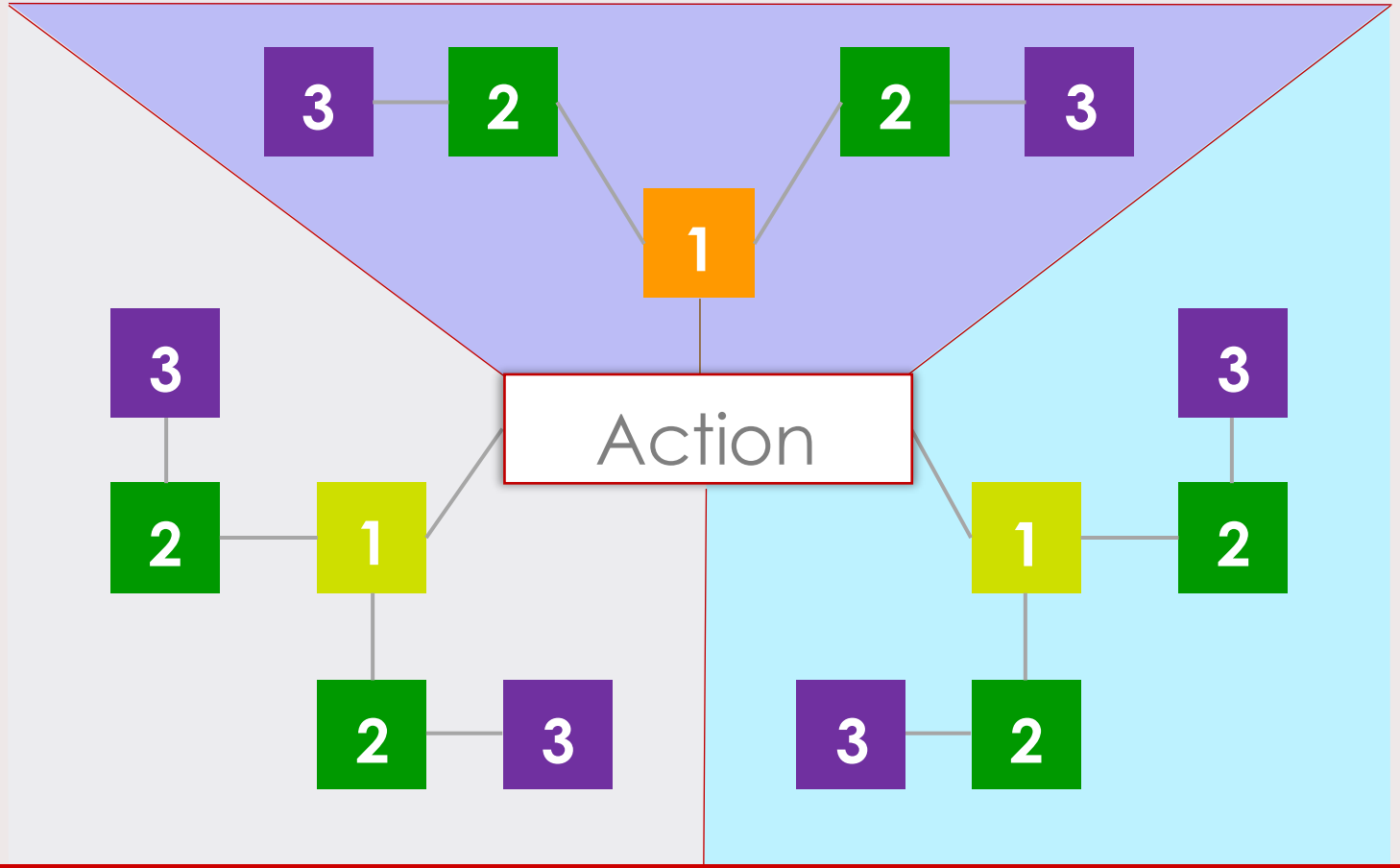
Action C: Ban cars

Action: No one is allowed to own a car – you have to walk, cycle or use public transport instead

The facts

- Cycling and walking are good **exercise.**
- Air pollutants from cars have a **damaging effect** on the health of people, animals and plants.
- Road transport accounts for 22% of total UK emissions of **carbon dioxide.**
- For many people, travelling by car is often the **only practical way** to travel.
- With no cars to make or sell, car manufacturing plants and garages would **shut down**.
- **Noise** from road traffic affects 30% of people in the UK.
- Banning cars altogether will **stop the development** of electric or hydrogen powered cars.

A game of consequences



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