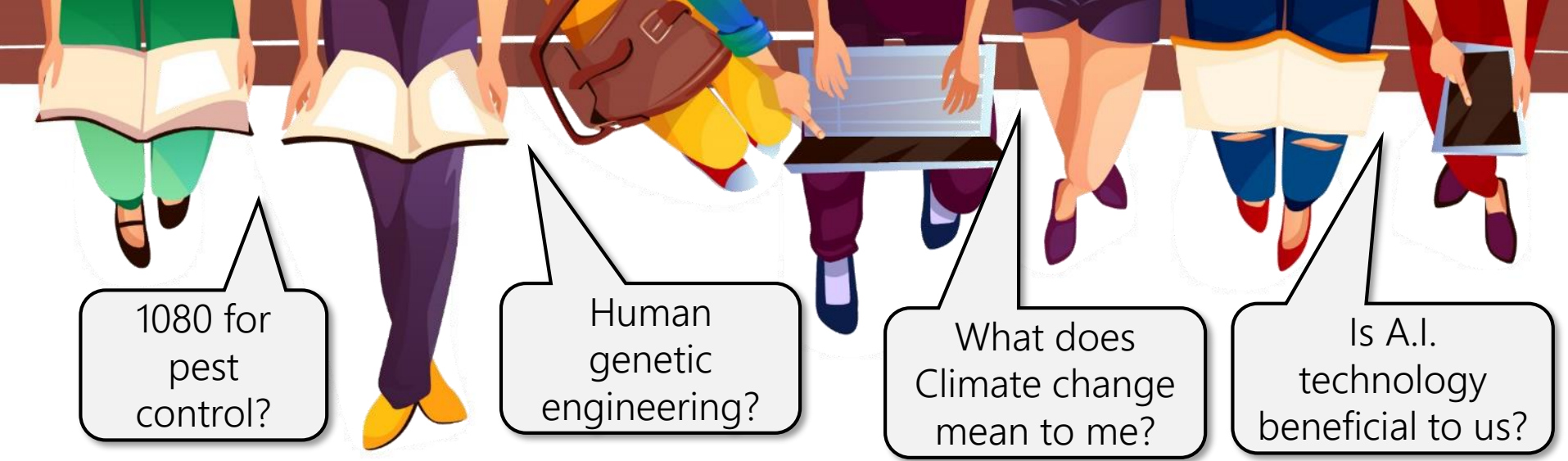


Full
referenced
notes under
each slide



Making the case for teaching Socio-Scientific Issues in Junior Secondary Science



As science educators, we must ensure learners are prepared to engage with, and navigate through, numerous contentious, open-ended, and complex socio-scientific issues, both local and global, confronting them as participating citizens.

Gluckman (2013)



no obvious and clear-cut solutions

inherent moral and ethical connotations

real-world issues

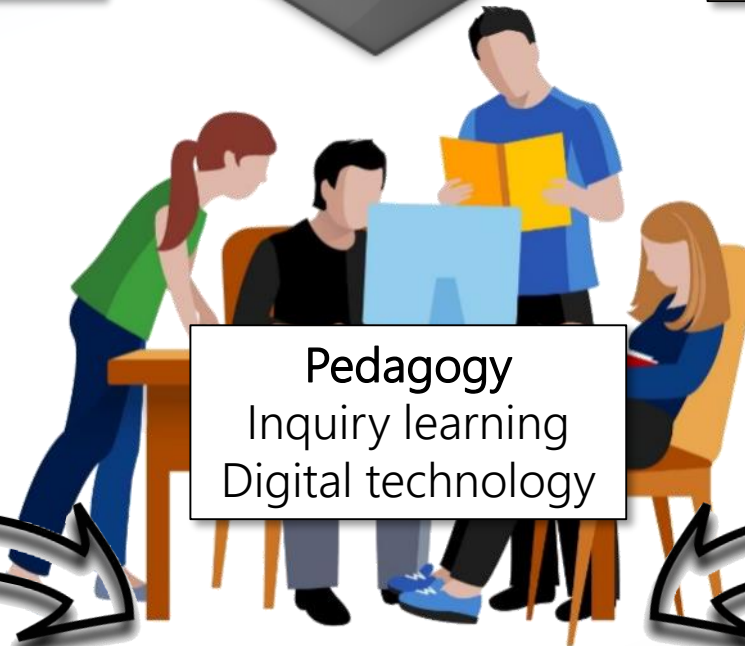
global or local

contemporary and relevant

Socio-Scientific Issues

controversial

dilemmas linked to science and the Nature of Science



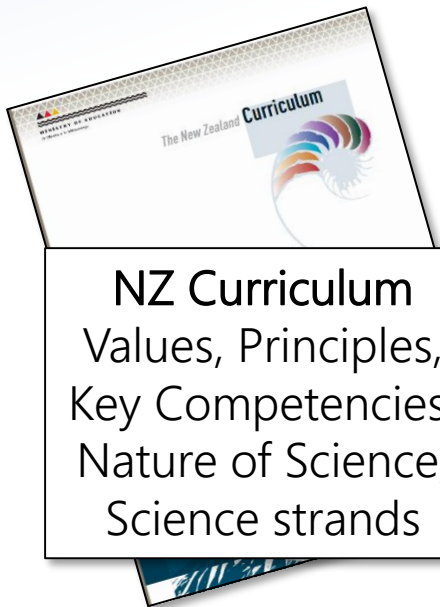
Pedagogy
Inquiry learning
Digital technology

NZ Curriculum
Values, Principles,
Key Competencies,
Nature of Science,
Science strands

Developing skills
Problem solving
Decision making
Science processes



- ❑ engagement in science
- ❑ scientific literacy skills
- ❑ participation and active contribution in important socio-scientific challenges



Exploring Socio-Scientific Issues as a pedagogical approach

MOTIVATION

Contexts that are engaging, and relevant real-world experiences



SETTING

Cross-curricular Junior science inquiry-based learning class



CONTEXT

climate change

GOALS

Developing scientific literacy

Transfer skills and make relevant connections between what they are taught and what they experience in their own lives

MY POSITION

Investigate the benefits of SSI, and discussing possible issues, to promote this pedagogical approach as being valid and worthy for inclusion in our future mainstream junior science programmes, using literature review and reflections from my own teaching practice



SSI has become a significant pedagogical means to approaching science education, and developing scientific literacy in our learners

Scientific Literacy



SSI framework

Scientific Literacy combines questioning, making evidence-based conclusions, and knowledge about science "in order to understand and help make decisions about the natural world and the changes made to it through human activity." (OECD, 2003)

"identify scientific issues; explain phenomena scientifically; and use scientific evidence"
OECD (2013)

Targeted to all students, not just future career scientists

Makes use of relevant real-life contexts that are meaningful to learners

Ensures the connections to ethical, social and economic aspects are evident



If we want learners to **engage** and develop scientific literacy then we must shift from stand-alone and siloed disciplines....

...towards replicating how science and scientists exist in the **real world**, with SSI contexts providing a means to integrate many socio-economic aspects Barab et al. (2007)

For students to be active and engaged participants in SSI they must "be interested in science and able to see its **relevance** to their world", clearly **linking** to the science skills and content knowledge stipulated in most school curricula. Bull et al. (2010)



Engagement of students in science is a long-standing challenge in our New Zealand schools, and even more so for Maori students.

Glynn, Cowie, Otrrel-Cass, & Macfarlane (2010)

.....where 'science' taught in many classes is experienced as distant and removed from the students' own worldview and knowledge base.



Much of our current science programme in our mainstream year 9 and 10 classes derives from the 'content' strands of L4-5 of the NZC, with the goal of preparing our students for future years in science and NCEA assessment.



"why do I need to know this for?"

"when will I ever use this?"



"I don't need science for my job!"

The value of including SSI into a junior science programme, is that it **caters for all students,**

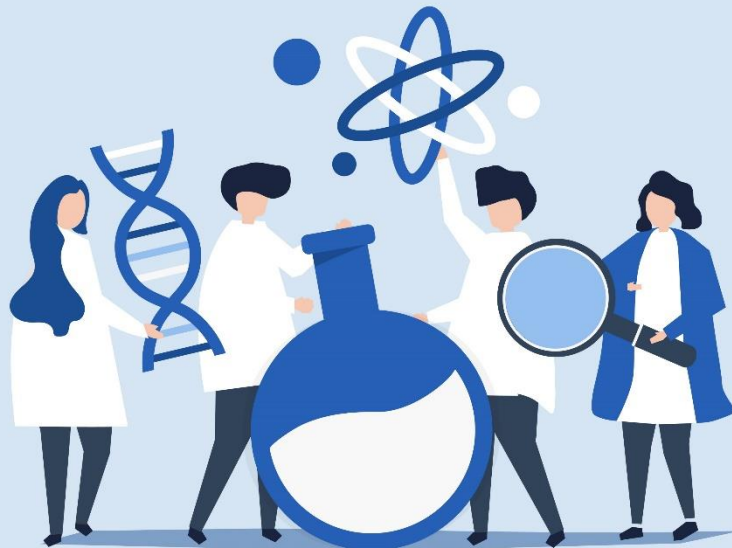
not just the minority funneled into career science (Sadler et al., 2007), and focuses on genuine and real-world issues "to which students can relate and which have potential to generate enthusiasm and purpose for learning" Sadler & Zeidler (2009, p.912).

The **purpose of science education** can be catergorised into two broad areas:

Roberts (2007)

Vision I

To develop scientific skills and knowledge in a learner for future scientific endeavours and employment



Vision II

Developing scientific literacy that would enable effective participation in society as a citizen, to confront, negotiate, and make decisions in everyday situations that involve science



Vision I

Science literacy of Vision I

which is orientated
towards the
processes and
products *within* the
science discipline

Vision II

Scientific literacy of Vision II

explained as “learning how
science fits appropriately with
... personal and societal
perspectives for a more
complete grasp of the issues”

many of those being complex
socio-scientific issues



Vision II

Democratic and citizenship purpose

Enables learners to be “aware of the issues, have some ability to critically evaluate information, and be equipped to participate in debates and influence policy”

(Bull et al., 2010, p.9).

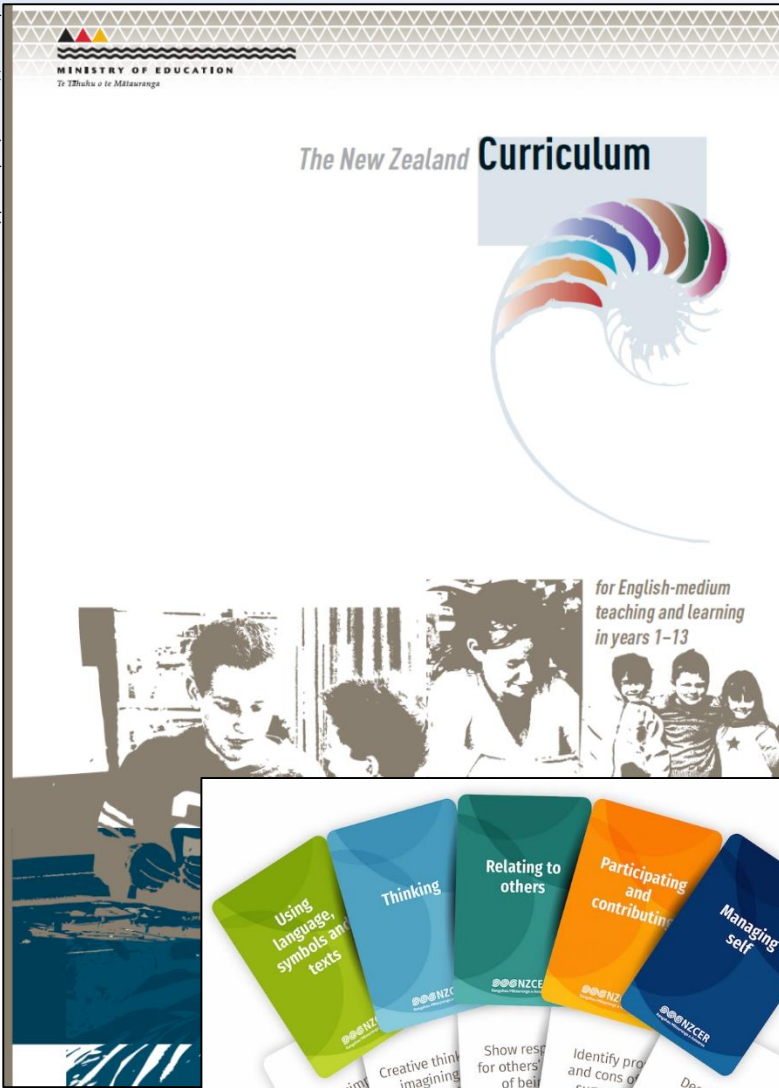


SSI as a teaching approach

SSI allows learners to make **connections** between the science taught in class and the science experienced in everyday lives fulfilling a democratic citizenship purpose because the focal issues are **relevant** and can bridge school science and students' lived experiences

(Zeidler et al., 2005).

The New Zealand Curriculum (Ministry of Education , 2007c) tells us:



Lifelong learners need to be informed decision makers,

that are future focussed on significant issues,

who make ethical decisions and act on them

Key Competencies

are also essential components of an effective SSI teaching and learning programme, moving from an 'add-on' to meaningful drivers of context rich learning programmes

(McDowall & Hipkins, 2018).

The New Zealand Curriculum

Level Three

Level Four

Nature of Science

Students will:

Understanding about science

- Appreciate that science is a way of explaining the world and that science knowledge changes over time.
- Identify ways in which scientists work together and provide evidence to support their ideas.

Investigating in science

- Build on prior experiences, working together to share and examine their own and others' knowledge.
- Ask questions, find evidence, explore simple models, and carry out appropriate investigations.

Communicating in science

- Begin to use a range of scientific symbols, conventions, and vocabulary.
- Engage with a range of science texts and begin to question the purposes for which these texts are used.

Participating and contributing

- Use their growing science knowledge when considering issues of concern to them.
- Explore various aspects of an issue and make decisions about possible actions.

In science, students explore how both the natural physical world and science itself work so that they can participate as critical, informed, and responsible citizens in a society in which science plays a significant role.

NZC articulating the need for the inclusion of SSI in a robust junior science teaching programme

is this mirrored in our schools?

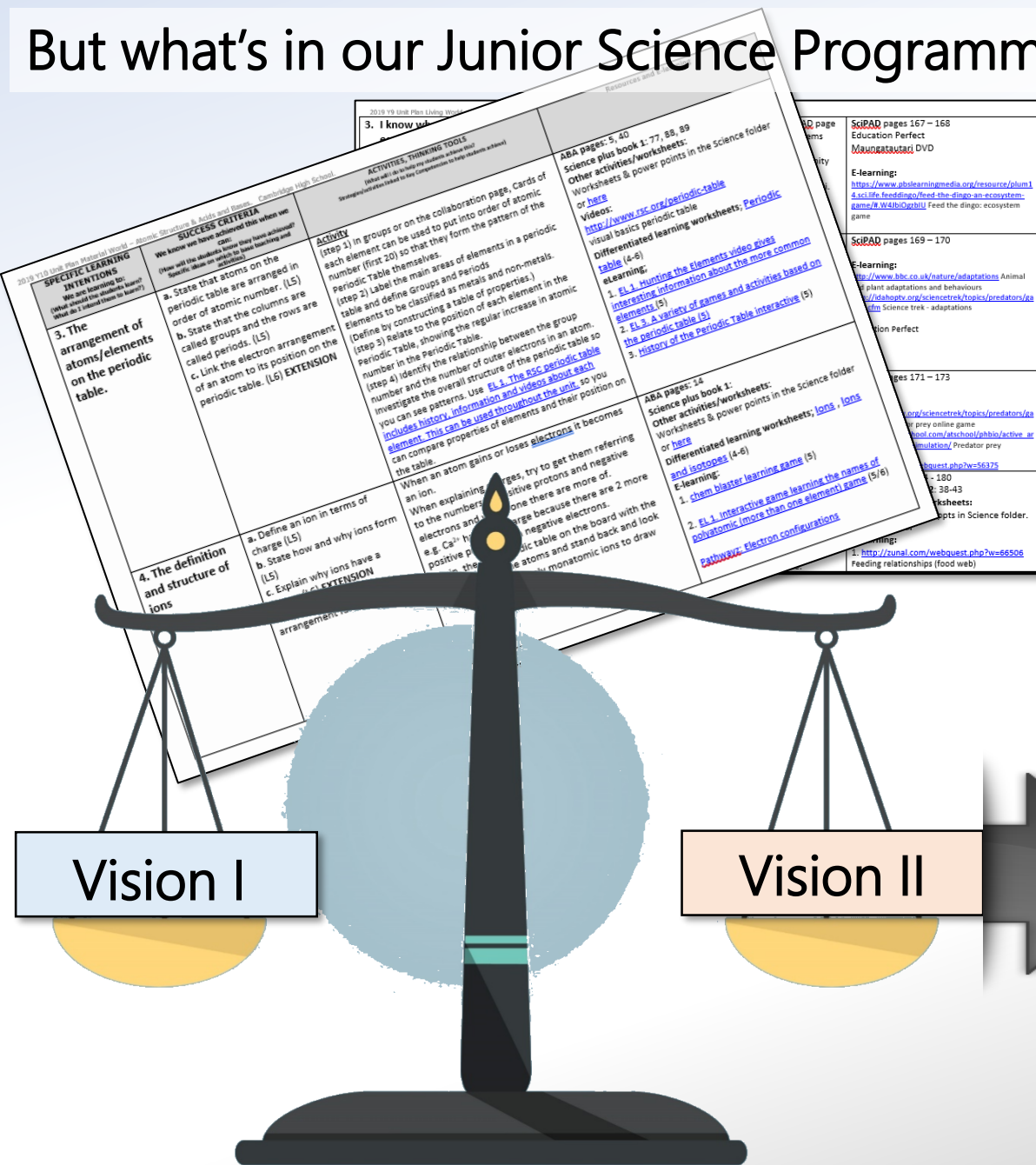
Case Study: United States Educational curriculum

“although general statements contribute to the SSI agenda, “the bulk of the documents tend to support more Vision I goals [namely the] acquisition of scientific content knowledge” Sadler & Zeidler (2009)

But what's in our Junior Science Programmes?

Promotes Vision I

Learning Objectives
Material World
Planet Earth and Beyond
Physical World
Living World
Content Strands



Vision I

Vision II

Inclusion of SSI, as either smaller modules or larger contextual learning blocks, would reduce the imbalance of Vision I and II
Zeidler (2007)

Tension to **balance** the dual purposes Haglund & Hultén (2017)

Science Capabilities



The Ministry of Education developed **five science capabilities**

to create stronger connections between the NZC statement on “why study science?”, the KCs, the NoS, and the core content strands, considering not just a student’s abilities but their social and economic situation as well.

Hipkins (2014).



For students to effectively engage with real-life contexts, such as those found in SSI, a combination of capabilities to gather and interpret data, use, and critique, as well as understand the evidence and its representations, is required.

Hipkins, Bolstad, Boyd, & McDowall (2014)

Effective Socio-Scientific Issues Pedagogy

Collaborative discussion of open-ended questions, supported with **genuine science** and authentically assessed
Wilmes & Howarth (2009)

Replicating **authentic real-world situations**, science, and scientific processes
Chinn & Malhotra (2002)

Moving from a mostly content-driven teaching programme towards a contextual emphasis, used by SSI, can be achieved with **inquiry-based learning**
McDowall & Hipkins, (2018)

Situated within **SSI contexts**; “societal issues with connections to science”
Sadler et al. (2017)
where inquiry learning can be used to establish those **connections** in a more meaningful way
Sadler et al. (2007)

Inquiry-based learning

can be utilised as a stand-alone, student-led pedagogical approach, especially useful for the development of scientific literacy, as well “as a vital component in building a scientifically literate community”

Pedaste et al. (2015)



IBL has also shown to be an effective pedagogy to connect scientific knowledge with “a **kaupapa Maori worldview.**”

Glynn et al. (2010)



Combined with SSI contexts, IBL enables better **understanding of problems**, even if SSI problems often do not have a consensus to solve them

Ariza et al. (2014)

requiring students to **explore, ask and develop questions, search for evidence-based answers, and consider alternatives and impacts**

Barab et al. (2007)



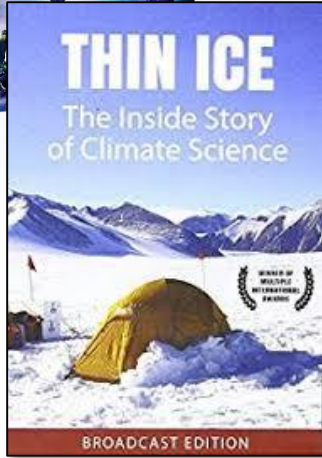
IBL can provide the tools to **“engage students** in an authentic scientific discovery process”

Pedaste et al. (2015)

while SSI provides an opportunity for many different questions that **tether science to societal and ethical aspects**

Sadler et al. (2007)





<https://www.amazon.com>

A **narrative** used as a context to engage the students and create relevant links

Use of **inscriptions**, scientific resources that students can use to make evidence-based conclusions

the process of **inquiry-learning** itself.

Components of an SSI Inquiry

Barab et al. (2007)

Clear links to social, moral, and economic aspects for the learners
Sadler et al. (2007)

Scientific processes



*An example of a possible inquiry model:
BSCS 5E instructional model Bybee (2009)*

Digital technology (DT)/ICT for e-learning
is a recommended method for students to explore the focal SSI
Sadler et al. (2017)

“information and
knowledge **quickly and
flexibly accessible.**”

Wright (2010)

SSIs are by their nature, future-
focussed and **contemporary**, with
many printed resources being out
of date within a few years, and DT
provides an opportunity for
students to connect with
numerous scientific resources and
differing points of view from
social media

Klosterman, Sadler & Brown (2012)

Inquiry-based learning
can also be more
successfully
implemented when
students have access
to digital technology

Pedaste et al (2015)





The NZC recommends the use of e-learning to make “connections by enabling students to enter and explore new learning environments”

Digital Technology provides opportunities to participate in communities beyond the classroom, both important components of SSI teaching and learning
Sadler et al. (2017)



ICT can be used to investigate issues that have “more than one possible solution” to engage the students
Otrell-Cass, Cowie, & Khoo (2011)
and assist students to communicate their ideas.

Future Studies year 9 2019 Notebook
1. Science

Climate Change Inquiry Projects - Assessment Ready Player One Material World Living

Page 9. Climate Change Predictions

Success Criteria:

- ☐ I can explore how carbon dioxide atmospheric concentration data can be collected, in both prehistoric times and recent times.
- ☐ I can graph atmospheric carbon dioxide concentration data from pre-industrial time and recent times.
- ☐ I can link the rapid increase of CO₂ concentrations in recent times to human activity, and refer back to possible sources of emissions from the carbon cycle activities.

What else might interest me?

- ☐ The Earth, Sun and Moon - Planet earth and Beyond p. 1-3

Climate signals

Temperature rise predictions

Predicted increase in average temperature (°C) by 2090, relative to 1986-2005, (for highest CO₂ emissions prediction)

Features of the climate system (climate signals) affected by climate change. The arrows show the direction of change. (PCC, 2013)

Within my school, there is a requirement that junior science students to have 'factual recall' assessment, sometimes **conflicting** with meaningful and balanced SSI inquiry Barab et al. (2007)

Page 2. Day, Night and Years

Success Criteria:

- ☐ I can describe the daily and annual movements of Earth (day and night) (L6)
- ☐ I can identify that the Earth orbits the sun. (L4)

The daily and annual movements of Earth

Apparent movement of the sun across the sky during the day.

Actual movement of Earth and Sun

Actual movement of heavenly bodies occurs when they are moving from one point to another through space. Apparent movement occurs when stationary objects appear to move across the sky due to the motion of the Earth.

The length of a day depends upon the speed of its rotation on its axis

The length of a planets year depends upon its time taken to orbit the sun once

1 Earth Year = 365 days
1 Mars Year = 687 Earth days or 669 sols (martian days)

The Earth completes one orbit around the Sun in one year.

ICT can reduce tension, between the external expectation of incorporating a traditional Vision I purpose of 'content learning' when focusing on a more engaging, Vision II purpose including SSI Haglund & Hultén (2017)

Page 15. My Climate Change inquiry

Thinking Using language, symbols and text Managing self Relating to others


Success Criteria:

- ☐ I can select, and adapt, a suggested mitigation project, or plan their own with support.
- ☐ I can action their mitigation project, either individually, or in small groups
- ☐ I can present their projects at a parents evening at school
- ☐ I can complete an end of unit survey, reflecting on their learning, engagement and next steps.

The digital environment allows me to move from a teacher-centred distribution of knowledge towards **student-centred ownership**, where student learning, and in many cases, collaboration between students, is extended **outside the classroom**

There are plentiful online resources for many SSI, but creation of **specific resources** based on the NZ curriculum is **time-consuming** and could be off-putting to new teachers or schools initiating these SSI for the first time. Sadler et al. (2017)

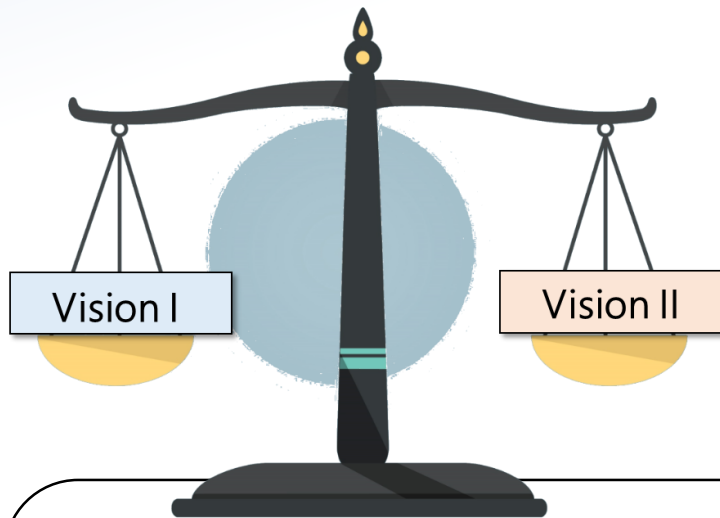
Professional learning development time, both online and face-to-face, has been a vital component of building effective SSI teaching units for my class this year.

Professional learning development time, both online and face-to-face, has been a vital component of building effective SSI teaching units for my class this year. 

Summary

Many **traditional** junior science teaching programmes, including those at my school, are **influenced by their focus on science content**, and introducing the socio elements of SSI may seem to diverge from this path

Barab et al., (2007)



However, the need for both **Vision I and Vision II** is clearly called for by the NoS of the NZC, and students need an opportunity to explore different perspectives and make their contribution to issues that they will encounter in their present and future lives which is why the **inclusion of SSI** as part of their learning programme is so **important**.

Sadler & Zeidler (2004)



Summary

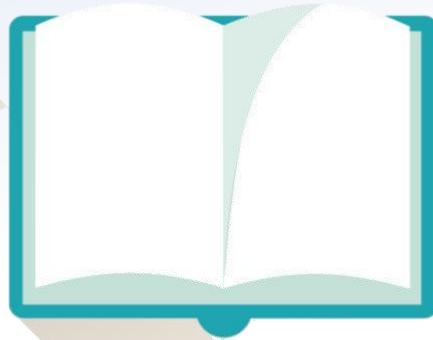
SSI, used as a teaching approach in science, can be used to build **scientific literacy** in students, encompassing collaboration and communication, decision-making and evidence-based reasoning

Sadler & Zeidler (2004)

Students need to be able to **engage** in science, so that not only do they understand the underlying science concepts, as prescribed in the NZC, but so they become **informed participants** and problem solvers with the many SSI they will encounter in their lives as **future citizens**.

Sadler et al. (2017)





References

