Advising teachers on what to do: what evidence is relevant?

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Key Questions

1. What are the strengths and limitations of an 'evidence based', 'scientific' agenda for education work? How should education researchers contribute?
2. What sorts of evidence of learning, and of teaching quality, can inform and support teacher practice?

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Evidence-based research on education “won’t work” because:

1. Education is not “an intervention or treatment” and cannot be separated from questions of what is ultimately desirable individually and collectively for participants.
2. Therefore education is about values rather than technocratic solutions to pre-determined goals.
3. Education is about educational professionals making judgments about desirable outcomes in particular situations.
4. Education research tells us what worked somewhere, but not what will work everywhere in future.
5. Education research can inform and enrich educational practice and policy, but not dictate what should happen.

Biesta (2007)

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Faith in Science

Scientists develop models to predict the future or explain system functioning and outcomes, but there are problems with models. They are always simplified maps, not the territory. Woods & Rosales (2009) explain models in science as generative distortions:

“Abstractions are achieved by suppressing what is known to be true. Idealizations over-represent empirical phenomena. Abstractions under-represent them. We might think of idealizations and abstractions as one another’s duals. Either way, they are purposeful distortions of phenomena on the ground.”

Despite (or because of) these distortions, scientific models inform and create plausible realities that shape our lives.

…and model-making in science has proliferated:

Models in Science

Probing models, phenomenological models, computational models, developmental models, explanatory models, impoverished models, testing models, idealized models, theoretical models, scale models, heuristic models, caricature models, didactic models, fantasy models, toy models, imaginary models, mathematical models, substitute models, iconic models, formal models, analogue models and instrumental models (Frigg & Hartman, 2018)

So which model could or should inform research in education?

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Two dominant competing models of the future of our planet are in play, both with scientific provenance:

- Economic Darwinism, or survival of the fittest national economies (Santone, 2017)

- Collaborative interdependence and sustainability including anti-growth (steady state) economics, and new globally shared ways with energy and water.

Economic Darwinism assumes competition for limited resources, winners/losers, growth as a condition for survival, TINA, groups either maintain, gain or lose dominance, hierarchies over equity, ideas as resources.

Sustainability model focuses on global interdependence and transparent sharing of resources including ideas across the planet. “Social and individual wellbeing is the purpose of economic success” (PISA, 2013).

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Business Appropriation of Educational Values and Language

- Creativity is recast as innovation for economic advantage.
- Empathy and sensitivity are recast as emotional intelligence (how to manage others through “reading” them).
- Social justice is recast as productivity and accountability, where underperformers are the poster folks for the need for change for “everyone’s gain”.
- Individual variation is recast as employability distinctiveness.

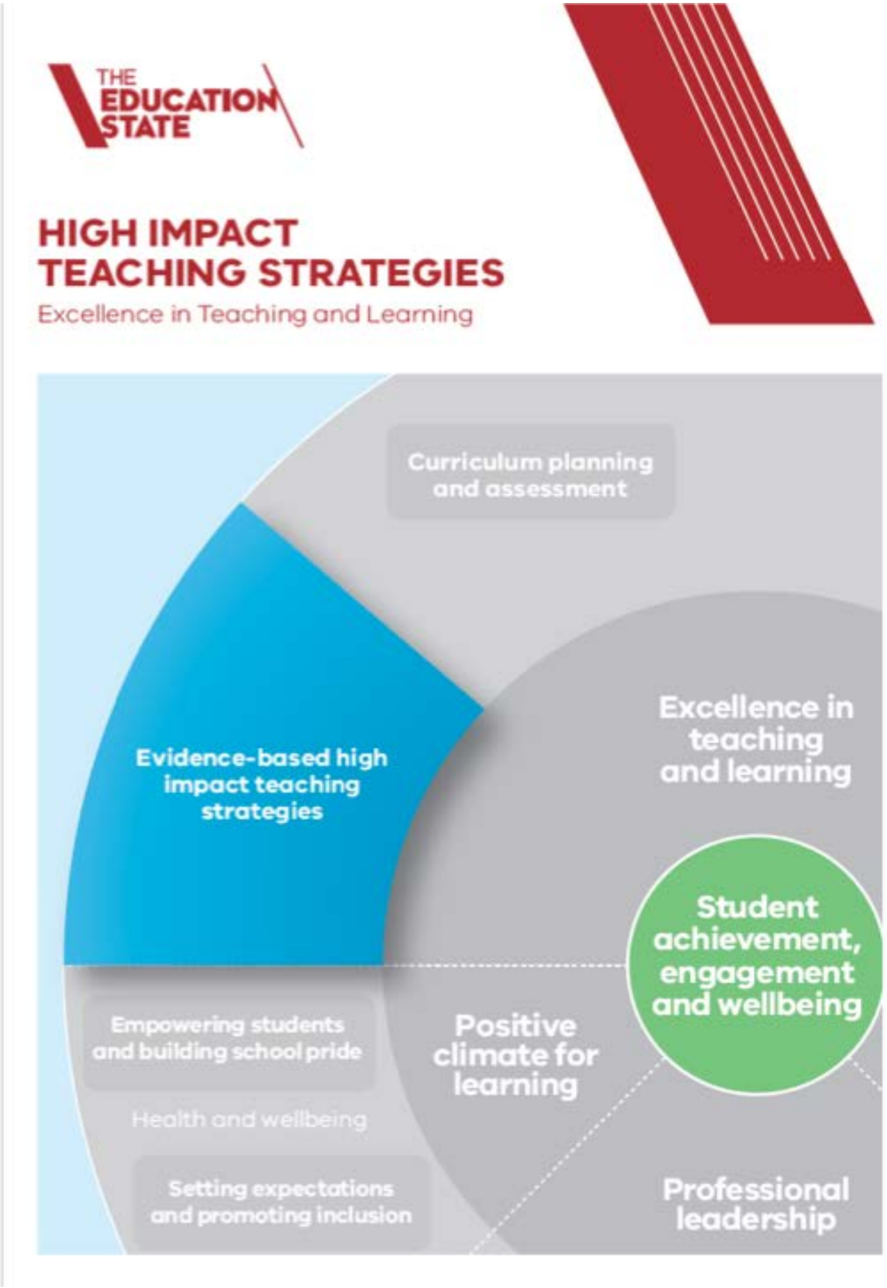
Given the overwhelming success of this tactic, what should educators do?

Re-appropriate in the other direction?

Limitations of current “scientising” of education research

- By measuring a narrow range of learning goals, current standardized tests ignore other educational objectives, like physical, moral, civic and artistic development, narrowing what education is and ought to be about, such as preparing students to participate in democratic self-government, moral action and a life of personal development, growth and wellbeing (Andrews, et al, 2014).
- This “scientising” does not conceptualise, identify key conditions for, or provide leads for teachers in how to nurture and support individual and collective student creativity in addressing sustainability problems.
- This approach has an unjustified faith that universal principles can be identified and applied to ensure all learners learn pre-determined goals in any context.
- This approach compounds problems around what should be learnt, why, and how, and how this “learning” should be assessed.

High Impact teaching strategies: Victorian DET



1. Setting Goals

Overview

Lessons have clear learning intentions with goals that clarify what success looks like.

Lesson goals always explain what students need to understand, and what they must be able to do. This helps the teacher to plan learning activities, and helps students understand what is required.

Key elements

- Based on assessed student needs
- Goals are presented clearly so students know what they are intended to learn
- Can focus on surface and/or deep learning
- Challenges students relative to their current mastery of the topic
- Links to explicit assessment criteria

Related effect sizes

- Goals – 0.56
- Teacher clarity – 0.75

2. Structuring Lessons

Overview

A lesson structure maps teaching and learning that occurs in class.

Sound lesson structures reinforce routines, scaffold learning via specific steps/activities. They optimise time on task and classroom climate by using smooth transitions. Planned sequencing of teaching and learning activities stimulates and maintains engagement by linking lesson and unit learning.

Key elements

- Clear expectations
- Sequencing and linking learning
- Clear instructions
- Clear transitions
- Scaffolding
- Questioning/feedback
- Formative assessment
- Exit cards

Related effect sizes

- Scaffolding – 0.53
- Formative evaluation – 0.68
- Teacher clarity – 0.75

3. Explicit Teaching

Overview

When teachers adopt explicit teaching practices they clearly show students what to do and how to do it.

The teacher decides on learning intentions and success criteria, makes them transparent to students, and demonstrates them by modelling. The teacher checks for understanding, and at the end of each lesson revisits what was covered and ties it all together (Hattie, 2009).

Key elements

- Shared learning intentions
- Relevant content and activities
- New content is explicitly introduced and explored
- Teacher models application of knowledge and skills
- Worked examples support independent practice
- Practice and feedback loops uncover and address misunderstandings

Related effect sizes

- Goals – 0.56
- Worked examples – 0.57
- Time on task – 0.62
- Spaced practice – 0.60
- Direct instruction – 0.59
- Teacher clarity – 0.75

4. Worked Examples

Overview

A worked example demonstrates the steps required to complete a task or solve a problem.

By scaffolding the learning, worked examples support skill acquisition and reduce a learner's cognitive load.

The teacher presents a worked example and explains each step. Later, students can use worked examples during independent practice, and to review and embed new knowledge.

Key elements

- Teacher clarifies the learning objective, then demonstrates what students need to do to acquire new knowledge and master new skills
- Teacher presents steps required to arrive at the solution so students' cognitive load is reduced and they can focus on the process
- Students practice independently using the worked example as a model

Related effect sizes

- Worked examples – 0.57
- Spaced practice – 0.60

5. Collaborative Learning

Overview

Collaborative learning occurs when students work in small groups and everyone participates in a learning task.

There are many collaborative learning approaches. Each uses varying forms of organisation and tasks.

Collaborative learning is supported by designing meaningful tasks. It involves students actively participating in negotiating roles, responsibilities and outcomes.

Key elements

- Students work together to apply previously acquired knowledge
- Students cooperatively solve problems using previously acquired knowledge and skills
- Students work in groups that foster peer learning
- Groups of students compete against each other

Related effect sizes

- Peer tutoring – 0.55
- Reciprocal teaching – 0.74
- Small group learning – 0.49
- Cooperative learning vs whole class instruction – 0.41
- Cooperative learning vs individual work – 0.59
- Cooperative learning vs competitive learning – 0.54

6. Multiple Exposures

Overview

Multiple exposures provide students with multiple opportunities to encounter, engage with, and elaborate on new knowledge and skills.

Research demonstrates deep learning develops over time via multiple, spaced interactions with new knowledge and concepts. This may require spacing practice over several days, and using different activities to vary the interactions learners have with new knowledge.

Key elements

- Students have time to practice what they have learnt
- Timely feedback provides opportunities for immediate correction and improvement

Related effect sizes

- Time on task – 0.62
- Spaced practice – 0.71
- Feedback – 0.73

7. Questioning

Overview

Questioning is a powerful tool and effective teachers regularly use it for a range of purposes. It engages students, stimulates interest and curiosity in the learning, and makes links to students' lives.

Questioning opens up opportunities for students to discuss, argue, and express opinions and alternative points of view.

Effective questioning yields immediate feedback on student understanding, supports informal and formative assessment, and captures feedback on effectiveness of teaching strategies.

Key elements

- Plan questions in advance for probing, extending, revising and reflecting
- Teachers use open questions
- Questions used as an immediate source of feedback to track progress/understanding
- Cold call and strategic sampling are commonly used questioning strategies

Related effect sizes

- Questioning – 0.46

8. Feedback

Overview

Feedback informs a student and/or teacher about the student's performance relative to learning goals.

Feedback redirects or refocuses teacher and student actions so the student can align effort and activity with a clear outcome that leads to achieving a learning goal.

Teachers and peers can provide formal or informal feedback. It can be oral, written, formative or summative. Whatever its form, it comprises specific advice a student can use to improve performance.

Key elements

- Precise, timely, specific, accurate and actionable
- Questioning and assessment is feedback on teaching practice
- Use student voice to enable student feedback about teaching

Related effect sizes

- Feedback – 0.73

9. Metacognitive Strategies

Overview

Metacognitive strategies teach students to think about their own thinking.

When students become aware of the learning process, they gain control over their learning.

Metacognition extends to self-regulation, or managing one's own motivation toward learning. Metacognitive activities can include planning how to approach learning tasks, evaluating progress, and monitoring comprehension.

Key elements

- Teaching problem solving
- Teaching study skills
- Promotes self-questioning
- Classroom discussion is an essential feature
- Uses concept mapping

Related effect sizes

- Teaching problem solving – 0.63
- Study skills – 0.60
- Self-questioning – 0.64
- Classroom discussion – 0.82
- Concept mapping – 0.64

10. Differentiated teaching

Overview

Differentiated teaching are methods teachers use to extend the knowledge and skills of every student in every class, regardless of their starting point.

The objective is to lift the performance of all students, including those who are falling behind and those ahead of year level expectations.

To ensure all students master objectives, effective teachers plan lessons that incorporate adjustments for content, process, and product.

Key elements

- High quality, evidence based group instruction
- Regular supplemental instruction
- Individualised interventions

Related effect sizes

- RTI – 1.07
- Piagetian programs – 1.28
- Reading recovery – 0.5

A critique of the HITS

- Effect sizes imply an unwarranted confidence in the effect of these fundamentally complex strategies
- They fail to suggest how teachers might promote student creativity, critical thinking and problem-solving
- Student agency, reasoning outside those orchestrated by the teacher are discounted
- There is no conception of a generative learning environment
- ‘Differentiation’ is characterized as variable performance. Culture, gender, socio economic dimensions are silent.
- The whole is more than the sum of the parts- what does this all add up to?

https://theconversation.com/simplistic-advice-for-teachers-on-how-to-teach-wont-work-86706

For contrast: Principles of Learning and Teaching

1. **The learning environment is supportive and productive**
   i. The teacher builds positive relationships through knowing and valuing each student.
   ii. The teacher promotes a culture of value and respect for individuals and their communities.
   iii. The teacher uses strategies that promote students' self-confidence and willingness to take risks with their learning
   iv. The teacher ensures each student experiences success through structured support, the valuing of effort, and recognition of their work.
2. **The learning environment promotes independence, interdependence and self motivation**
   i. The teacher encourages and supports students to take responsibility for their learning.
   ii. The teacher uses strategies that build skills of productive collaboration
   iii. The teacher involves students in decision-making on a variety of aspects of the learning program.
3. **Students' needs, backgrounds, perspectives and interests are reflected in the learning program**
   i. The teacher uses strategies that are flexible and responsive to the values, needs and interests of individual students ….

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Critiques of mega analyses

Identifying teaching strategies that are most successful in supporting learning outcomes is a powerful strategy … but:

- There are technical issues with what is meant by ‘effect size’, and pooling disparate studies raises significant challenges.
- Differences of context, for instance, are inevitably planed over, leading to distortions in advice.
- Restriction to a narrow range of research, with strictly defined variables and quantitative outcome measures, raises questions about:
  - How innovation is supported in the system
  - Consistency in the constructs being measured - ‘feedback’, ‘inquiry’ …
  - Uncontrolled variables.
  - The narrowness/depth of measures being applied

Problematising evidence

Melbourne Declaration

Successful learners:

– develop their capacity to learn and play an active role in their own learning

– have the essential skills in literacy and numeracy and are creative and productive users of technology, especially ICT, as a foundation for success in all learning areas

– are able to think deeply and logically, and obtain and evaluate evidence in a disciplined way as the result of studying fundamental disciplines

– are creative, innovative and resourceful, and are able to solve problems in ways that draw upon a range of learning areas and disciplines

– are able to plan activities independently, collaborate, work in teams and communicate ideas ……

Confident and creative individuals:

– have a sense of self-worth, self-awareness and personal identity that enables them to manage their emotional, mental, spiritual and physical wellbeing

– have a sense of optimism about their lives and the future

• Victorian Curriculum: Science

- **Chemical sciences**
  - Mixtures, including solutions, contain a combination of pure substances that can be separated using a range of techniques
  - The properties of the different states of matter can be explained in terms of the motion and arrangement of particles
  - Differences between elements, compounds and mixtures can be described by using a particle model
  - Chemical change involves substances reacting to form new substances
- **Questioning and predicting**
  - Identify questions, problems and claims that can be investigated scientifically and make predictions based on scientific knowledge
- **Planning and conducting**
  - Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments, ensuring safety and ethical guidelines are followed

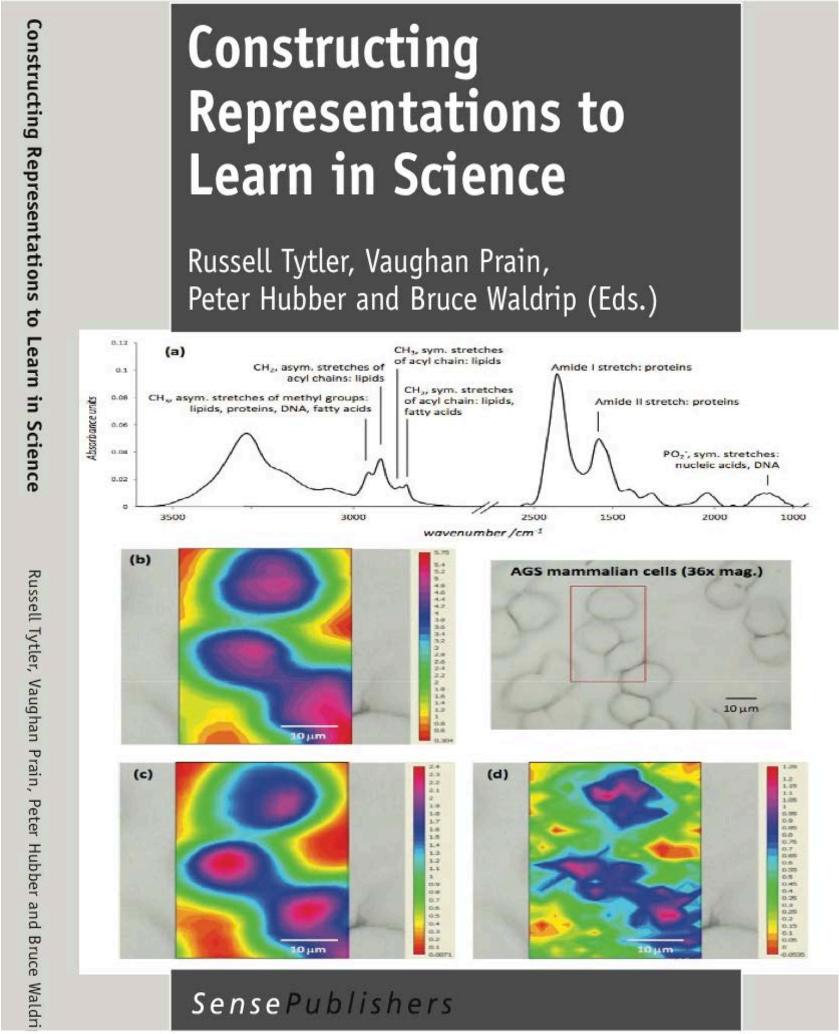
Assessing the impact of innovation

- What do we measure?
- What is our point of comparison?
- How do we account for complexity?

- Some distinctions
  - The grain size of outcomes
  - Inputs, outputs and outcomes
  - Outcomes in the moment, and long term
  - Process vs product
  - Outcomes vs impact

Innovation: Inquiry through a Representation Construction Approach

- Representational work constitutes a crucial element of disciplinary literacy in science.
- Informal reasoning through representation construction and interpretation.



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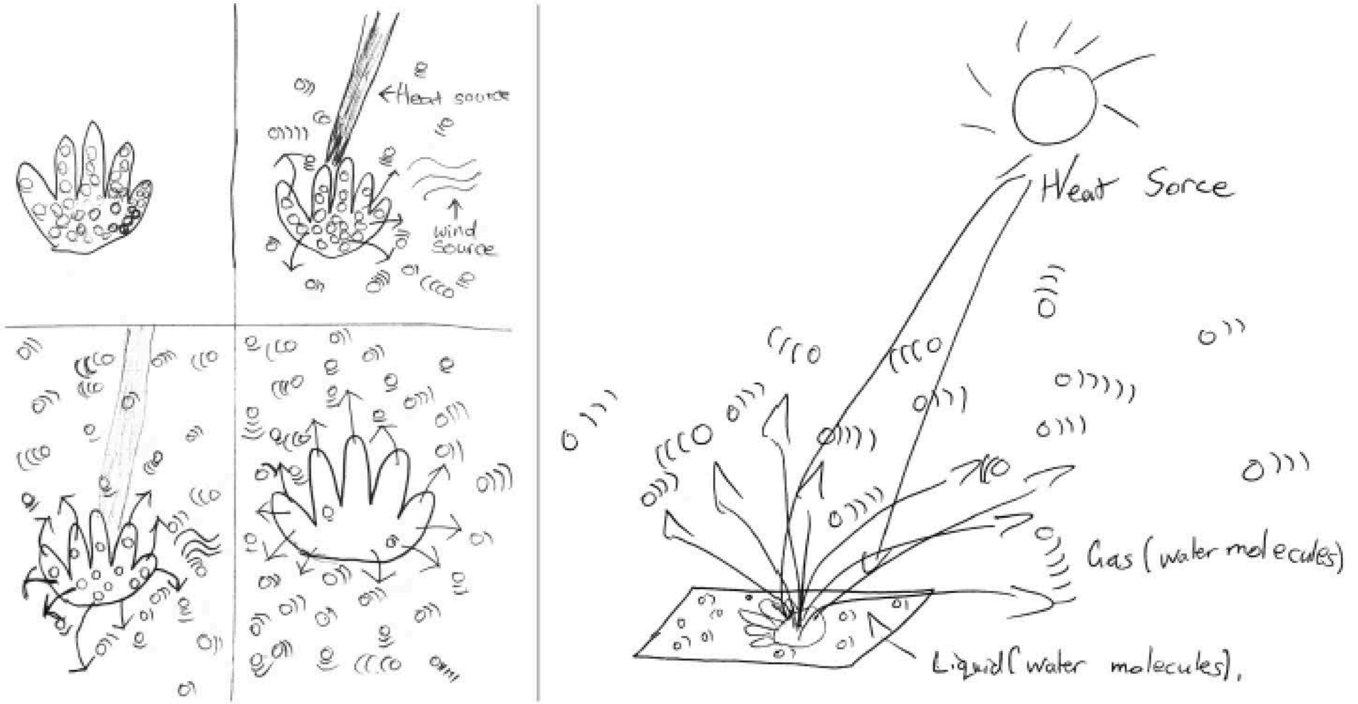
SCIENCE EDUCATION

Drawing to Learn in Science

Emerging research suggests drawing should be explicitly recognized as a key element in science education.

Shaaron Ainsworth[1]*, Vaughan Prain[2], Russell Tytler[3]

Should science learners be challenged to draw more? Certainly making visualizations is integral to scientific thinking. Scientists do not use words only but rely on diagrams, graphs, videos, photographs and other images to make discoveries, explain findings, and excite public interest. From the notebooks of Faraday and Maxwell (*1*) to current professional practices of chemists (*2*), scientists imagine new relations, test ideas, and elaborate knowledge through visual representations (*3–5*).



Revealing understanding. Drawings by two 11 year olds (left and right) of an evaporating handprint show representational choices that guide and communicate individual understandings.

However, in the science classroom, learners mainly focus on interpreting others' visualizations; when drawing does occur, it is rare that learners are systematically encouraged to create their own visual forms to develop and show under-

tional topics reduce them to passive roles

Drawing to Reason in Science

Impact of the RCA approach

- Process outcomes
  - Teacher perceptions and video records of high level class discussion
  - Informal evidence of student meta representational sophistication
  - Student engagement with reasoning within tasks
  - Student collaborative evaluation of quality of representations
  - Teacher change in epistemological beliefs, pedagogy

- Product outcomes (but: compared to what?)
  - Quality of student journal work
  - Pre- and post-test comparisons – quantitative, and qualitative

1. How can we design and validate innovation in a rigorous way?
2. How can we establish that the process outcomes have ongoing value?
3. What mix of methodologies and assessments, will support evolution in educational purposes and practices?