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Education

Understanding quality in science teaching and learning in Australia

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Policy & practice in Australia

- Science teaching and learning has constantly been reviewed but the overall findings continue to be similar:

[the] actual picture of science teaching and learning is one of great variability but, on average, the picture is disappointing … In some primary [elementary] schools … it is generally student-centred and activity-based, resulting in a high level of student satisfaction. When students move to high school, many experience disappointment … Traditional chalk-and-talk teaching, copying notes, and "cookbook" practical lessons offer little challenge or excitement to students. Disenchantment with science is reflected in the declining numbers of students who take science subjects in the post-compulsory years of schooling. (Goodrum, Hackling, & Rennie, 2000, p. viii)

What does it mean to learn science?

Science learning should include:

- Curiosity
- Creativity
- Questioning
- Confusion
- New ideas and information
- Challenging alternative conceptions
- Building new knowledge and understandings

Three great challenges in science teaching

Developing an understanding of:

Content – *it is not always helpful to simplify complex and sophisticated ideas*

Teaching – *transmitting information is easier than creating meaningful pedagogic situations ("telling isn't teaching")*

Learning – *knowing is not the same as understanding ("listening isn't learning")*

How do we typically seek to link teaching and learning?

- Hands on
- Minds on
- Experiments
- Inquiry based approach
- Fun activities
- Relevant
- Interesting
- Science as a Human Endeavour (Australian Curriculum)
- *However, despite our best intentions, teaching for engagement can easily be misunderstood.*

Alternative conceptions/misconceptions

- Something a person knows and believes but that does not match what is known to be scientifically correct.

- Typically people hold misconceptions but they do not know that their ideas are incorrect. Being told they are wrong doesn't change misconceptions, especially if they have been held for a long time.

- People continue to build knowledge on their current understandings therefore misconceptions can impact learning.

Teaching *for* learning

- Pedagogical purpose matters. It underpins what is being done, how and why in creating a teaching-learning situation.

- Framing practice is crucial to advancing a teaching and learning agenda.

- Pedagogical Content Knowledge (PCK) is one way of framing knowledge of science teaching and learning.

PCK: Framing teaching and learning

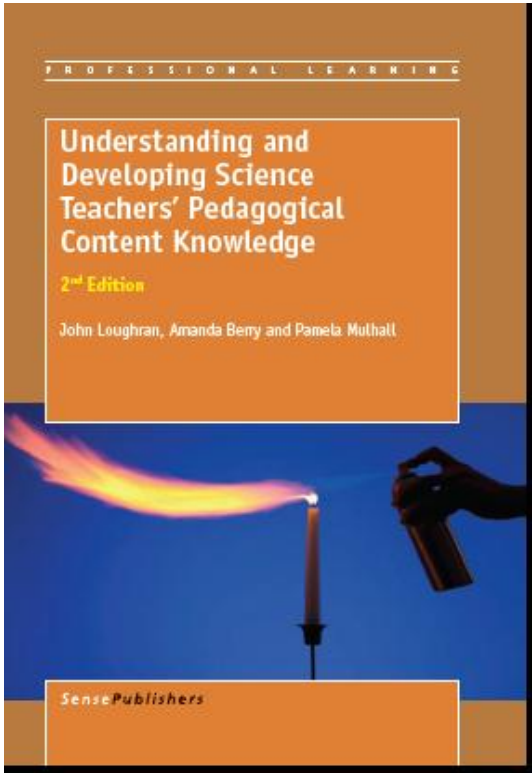
- When Shulman introduced the concept of Pedagogical Content Knowledge (PCK) he was partly responding to a view at the time that tended to position teaching as the delivery of information.
- Through PCK, teaching was seen as not only complex and problematic, but that it required skills, knowledge and abilities beyond transmission.
- PCK is a seductive academic construct but how it might be captured and represented, remains somewhat elusive.
- PCK sounds good in theory, but what does it really mean in practice?

PCK: Moving beyond activities that work

- Articulating the critical links between practice and knowledge often proves to be difficult because such knowledge/ideas are often tacit.
- When teaching becomes ‘routinized’ quality in teaching (e.g., engagement, challenge, etc.) can be diminished.
- PCK is about choosing a particular teaching procedure for a particular pedagogic reason linked to the particular content/concept.
- Knowledge of practice is developed by seeing into teaching and learning with new eyes and articulating such insights for oneself and others.

Sharing knowledge of practice

- It is difficult to capture, portray and share knowledge of practice.



- Teachers' professional knowledge is 'built up from practice' valuing it depends on its applicability in the work of other teachers.
- Teachers have a special knowledge that informs their teaching of particular content (PCK).

Representing PCK through a concrete example

- Understanding the *content*: through the research process this became a Content Representation (CoRe)

- Understanding the *pedagogy*: through the research process led to the development of Pedagogical and Professional-experience Repertoires (PaP-eRs)

CoRe (Content Representation)

- The CoRe should not be viewed as static or as the only/best/correct representation of that content. It is a necessary but incomplete generalization resulting from work with a particular group of teachers that leads to a generalized view of the big picture ideas of the content/topic. The purpose of the CoRe is to help codify teachers' knowledge in a common way across the content area being examined and through this, to identify important features of the content that science teachers recognize and respond to in their teaching of that content.

CoRe

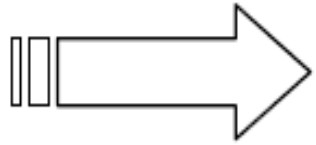
- A CoRe is developed by asking teachers what they consider to be the *big ideas* in teaching a given topic for a particular grade level(s).

- A CoRe does not have a prescribed amount of information or ideas, some boxes may be empty.

- A CoRe is of itself not PCK, it is one element.

This Core is designed for students in Lower	IMPORTANT SCIENCE			IDEAS/CONCEPTS			
	A: Matter is made up of	B: There is empty space	C: Particles are in constant	D: Particles of	E: There are different	F: Atom particles don't	G: Models are used in science to

This Core is designed for students in Lower Secondary School, i.e., Years 7 – 9.	**IMPORTANT SCIENCE**		
	A: Matter is made up of small bits that are called particles.	**B: There is empty space between particles.**	**C: Particles are in constant motion.**
Teaching procedures (and particular reasons for using these to engage with this idea).	**Probes of student understanding:** e.g., students draw a flask containing air, then re-draw the same flask with some of the air removed. Probes promote student thinking ...	**POE (Predict-Observe-Explain:** e.g., squashing syringe of air (ask students to predict the outcome based on different models of matter ...	**Translation activities:** e.g., role-play, modelling, drawing. For example, my life as a Carbon Atom; or, write about what you would see if you were inside a particle of water ...
Specific ways of ascertaining students' understanding or confusion around this idea (include likely range of responses)	.... Explaining thinking and defending views. Making predictions about new situations. Tracking one's own learning, e.g., "I used to think …" Asking questions such as, "What is something that has been bothering you from yesterday's lesson?" ...		



PaP-eRs (Pedagogical and Professional-experience Repertoire)

- A PaP-eR is a narrative account that highlights a particular piece, or aspect, of science content to be taught. It is designed to purposefully unpack a teacher's thinking about a particular aspect of PCK and to represent the teacher's reasoning, thinking and actions in teaching specific aspects of science content.
- PaP-eRs elaborate and give insight into the interacting elements of the teacher's PCK and to foster reflection in the reader.
- The 'voice' of a PaP-eR varies depending on that which is being portrayed.
- PaP-eRs bring the CoRe to life and offer one way of capturing the holistic nature and complexity of PCK.

PaP-eRs

- A PaP-eR is meant to elaborate and give insight into teaching in meaningful ways to the reader.
- PaP-eRs maybe from a student's perspective, or that of the teacher, some are an interview, others a classroom observation or teachers' reflections on practice.
- A PaP-eR is one of many designed to link to the CoRe around that topic.
- A CoRe and its PaP-eRs form a Resource Folio designed to provoke thinking and help teachers see their existing practice in new ways.

Science teachers & PCK

- Becoming familiar with the conceptualization of CoRes and PaP-eRs can help in the development and sharing of knowledge of practice.

- PCK offers a way of considering what quality in science teaching and learning might entail.

- The CoRe and PaP-eRs approach helps to make PCK more accessible and useable for teachers.

Teaching Science for understanding

- CoRe and PaP-eRs help teachers' think about the big ideas in science teaching rather than just content knowledge.
- CoRes offer a structure for teaching for understanding.

- PaP-eRs provide fine-grained insights into teaching.

- Resource Folios (CoRes & PaP-eRs together) as a curriculum approach offer the potential for promoting new ways of approaching structuring science teaching.

An approach to professional learning

- Thinking about science teaching through the lens of PCK fosters a vision for professional learning and development.
- By being sensitized to PCK offers a way to see into learning about science teaching and better aligning content with pedagogy.
- Clearly if teachers develop deeper understandings of science teaching it will impact students' learning.

Conclusion

- PCK is important, CoRe and PaP-eRs help to ‘concretize’ it in the work of teachers.
- Resource Folios help to make PCK useful and they highlight the value of thinking about professional knowledge of practice in constructive and meaningful ways that can help to shape quality in science teaching and learning.
- Research has illustrated that Resource Folios (CoRe and PaP-eRs) enhance learning to teach science (student teachers and in-service) and is viewed as both helpful and valuable.