Critiquing Collaborative CoRe Design as an Effective Professional Development Intervention for Developing Teachers' PCK for Teaching Science

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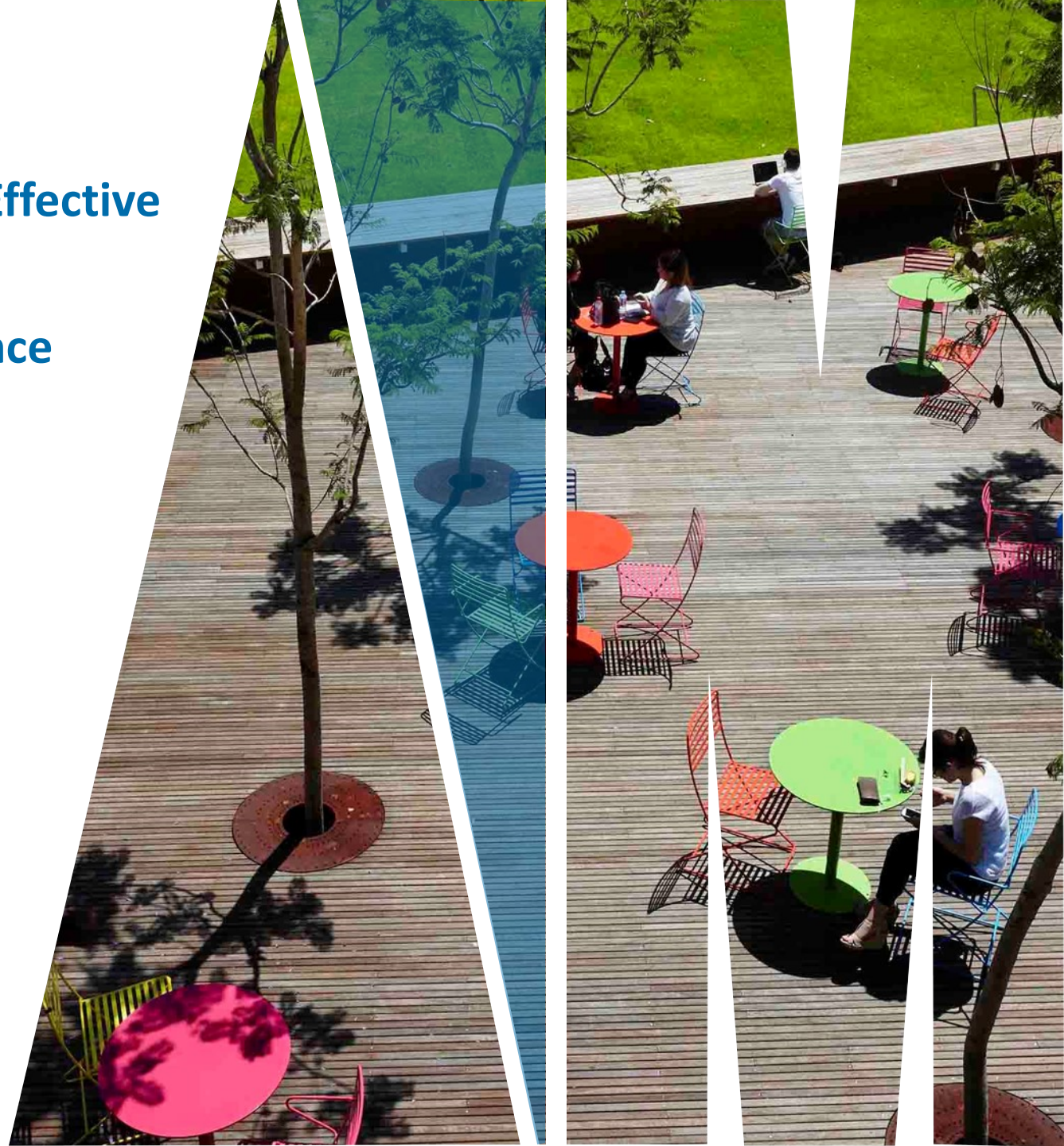


Introduction and Background

- Investigation involved the use of collaborative content representation (CoRe) design as a professional learning and development (PLD) opportunity to enhance teachers' pedagogical content knowledge (PCK) for teaching electricity and magnetism.

- Key aspects from the literature that informed this study include:
  - CoRe design (Loughran, Berry, & Mulhall, 2006).
  - Models of PCK and others' research about PCK development (e.g., Carlson et al., 2019; Hume & Berry, 2011, 2013; Lee, Brown, Luft, & Roehrig, 2007; Magnusson, Krajcik, & Borko, 1999).
  - Considerations for effective PLD interventions (e.g., Desimone, 2009; Desimone & Pak, 2017).

Research Questions

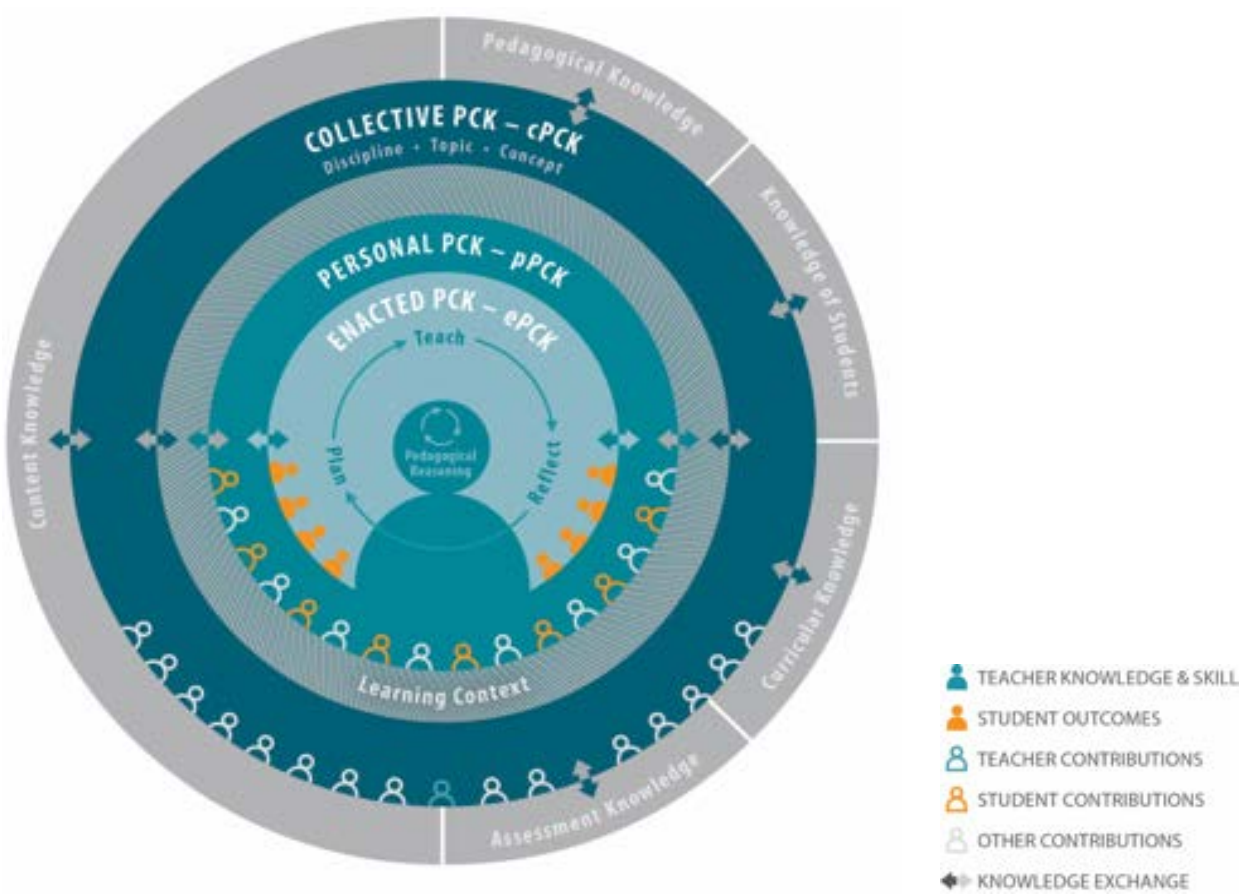
- What impact does collaborative content representation (CoRe) design have teachers' pedagogical content knowledge (PCK) for teaching science?

- When used as a professional learning and development opportunity, how does collaborative CoRe design align with research about effective PLD?

Collaborative CoRe Design

Year Level and Science Topic	Important Science Ideas/Concepts		
	Big Idea “A”	Big Idea “B”	Big Idea “C”
What do you intend students to learn about this idea			
Why is it important for students to know this			
What else you know about this idea (that you do not intend students to know yet)			
Difficulties and/or limitations connected with teaching this idea			
Knowledge about students’ thinking which influences your teaching of this idea			
Other factors that influence your teaching of this idea			
Teaching procedures (and particular reasons for using these to engage with this idea)			
Specific ways of ascertaining students’ understanding or confusion around this idea (include like range of responses)			

Enhancing Pedagogical Content Knowledge

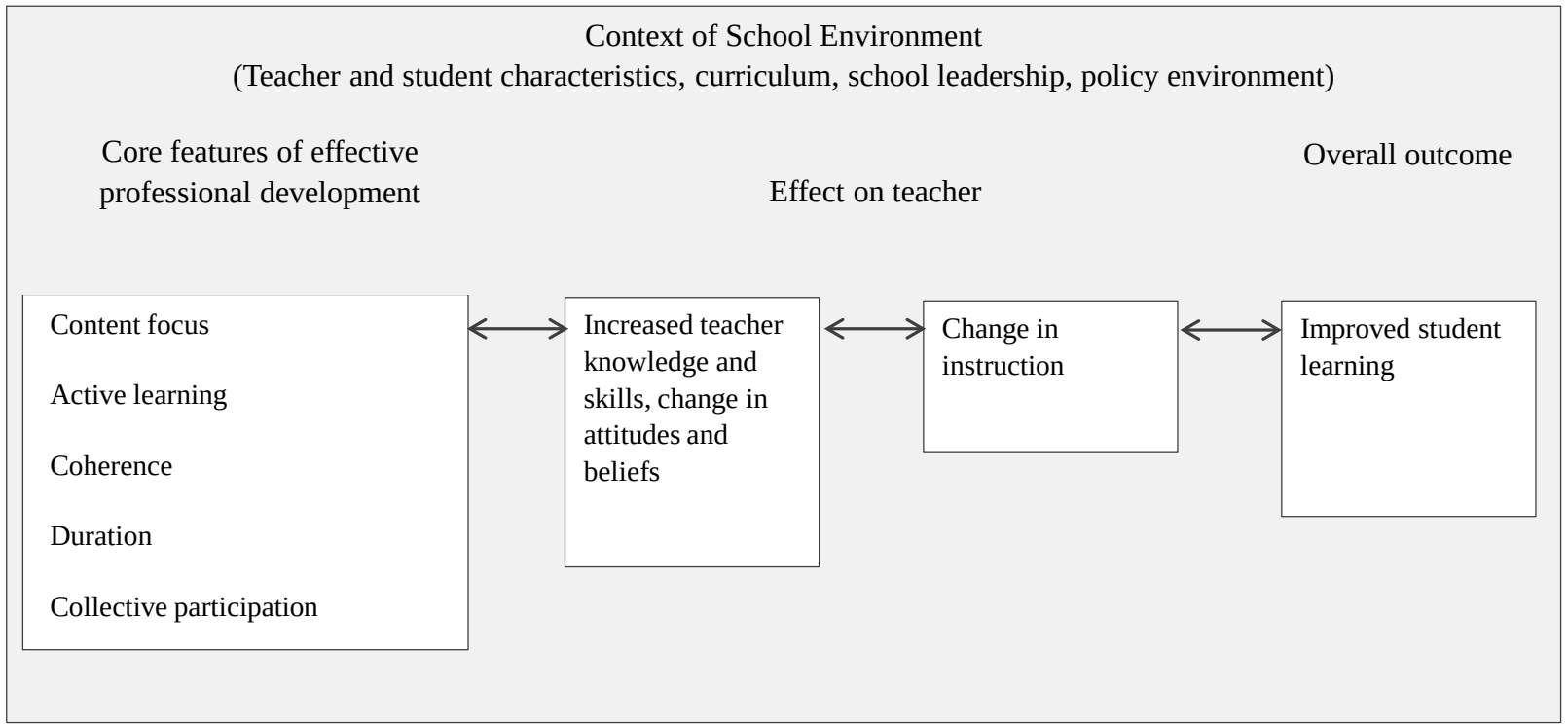


(Carlson et al., 2019, p. 83)

Effective Professional Learning and Development

- Five characteristics for effective PLD (e.g., Desimone, 2009; Desimone & Pak, 2017; Garet, Porter, Desimone, Birman, & Yoon, 2001; Griffith, Ruan, Stepp, & Kimmel, 2014; Tallerico, 2014; van Driel, Meirink, van Veen, & Zwart, 2012):
  - *Content Focus*
  - *Active Learning*
  - *Coherence*
  - *Collective Participation*
  - *Duration*

Effective Professional Learning and Development



(Desimone, 2009, p. 185)

Participants

Nine teachers from the same school, organised into three groups:

- Group One – Teaching physics out-of-field. These teachers were the primary focus of the research.
- Group Two – Also out-of-field teachers, but experienced teaching this topic and not teaching the unit during the study.
- Group Three – Experienced physics teachers.

Research Design

Pre-CoRe Design	Semi-structured individual interviews Lesson observations (video recorded)
CoRe Design Workshop	All participants took part in a collaborative CoRe design workshop about teaching *Electricity and Magnetism* Discussions were recorded and field notes taken
Post-CoRe Design	Semi-structured individual interviews and focus group discussions Lesson observations (video recorded)

Data Analysis

- Data was analysed thematically using a deductive lens.

- When exploring teachers' pPCK and ePCK, and possible developments, the analysis was primarily guided by the RCM (Carlson et al., 2019) and the Magnusson et al. (1999) model, along with influences from other PCK researchers. Included for this analysis was an observational protocol that featured a scoring rubric (see Carpendale & Hume, 2019).

- When comparing the collaborative CoRe design process to aspects of effective professional development, the analysis was guided by five key considerations, as depicted in the diagram by Desimone (2009).

PCK Enhancements

- Three main components of PCK were used for the deductive analysis of Group One teachers' interview and observational data:
  - Content knowledge
  - Knowledge of students' understanding and learning
  - Knowledge of instructional strategies

- Teachers reported developments to their PCK during interviews, and developments were also seen during lesson observations.

PCK Enhancements – Content Knowledge

	1		2		3	
Indicator	Int	Obs	Int	Obs	Int	Obs
Accuracy	↑	↑	↑	-	-	-
Concept links	↑	↑	↑	↑	↑	-

PCK Enhancements – Knowledge of Students

	1		2		3	
Indicator	Int	Obs	Int	Obs	Int	Obs
Prior Knowledge	-	↑	↑	↑	↑	↑
Variations in Understanding	↑	↑	↑	↑	↑	↑

PCK Enhancements – Knowledge of Instructional Strategies

	1		2		3	
Indicator	Int	Obs	Int	Obs	Int	Obs
Sequencing of Concepts	-	↑	↑	↑	↑	↑
Examples and Representations	↑	↑	↑	↑	↑	↑
Metacognitive Strategies	-	↑	-	-	-	↑

Collaborative CoRe design as Effective PLD

- Participants reported positive experiences and perceived CoRe design to be an effective means of PLD.
- Group One participants described their own PCK developments, while the others saw potential in the process.
- The process enabled teachers to share aspects of the PCK and the prompts invited teachers to reflect on, and critique, their practice.
- Time was reported as being a limitation. Although, participants felt the benefits outweighed that limitation.
- Participants were interesting in taking part in more collaborative CoRe design work in the future, including making the process an ongoing endeavour.

Research Question One

To what extent does collaborative content representation (CoRe) design affect teachers' pedagogical content knowledge (PCK) for teaching science?

- While there was overlap in development between the three components (content knowledge, knowledge of students' understanding and learning, and knowledge of instructional strategies), the effect on each teacher's PCK was unique.

- Greatest effects were seen in two of the the three PCK components under study i.e., teachers' knowledge of students' understanding and learning and knowledge of instructional strategies:
  - Eliciting students' knowledge and using that information to inform their teaching
  - Sequencing concepts
  - Using representations and examples when teaching

Research Question Two

When used as a professional learning and development opportunity, how does collaborative CoRe design align with research about effective PLD?

- Content Focus and Collective Participation

  The nature of the CoRe design workshop meant the focus of discussions centred on what students should be learning about for this particular unit of work. Similarly, the facilitation encouraged participants to work together, collaborate, and share knowledge.

- Active Learning

  The CoRe prompts encouraged teachers to dynamically participate and critique their own practice.

- Coherence

  As a component of effective PLD, coherence was seen with the case study teachers as they were current teaching this unit, resulting in seeing change in their knowledge and practice. However, for the others, it the level of coherence was not as high.

- Duration

  The workshop lasted three hours. While participants talked about knowledge development from this workshop, it was seen as a single event. Participants suggested ways of making the process ongoing and were interested in taking part in future work.

Conclusion

- This research signals that when undertaken in collaboration, CoRe design can enhance out-of-field teachers' PCK for a particular topic.

- The pedagogical prompts elicit discussions that require teachers to reflect on, and critique, their knowledge and practice.

- Collaborative CoRe design embodied three key features of effective PLD: content focus, collective participation, and active learning.

- Further consideration needs to be given to coherence and duration.

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