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UNDERSTANDING THE INTERACTIONS BETWEEN PRE-SERVICE SCIENCE TEACHERS WITHIN A LEARNING COMMUNITY FOCUSED ON ENHANCING SCIENTIFIC INQUIRY ORIENTATIONS

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SMEC 2016

Overview of Presentation

- Brief Introduction
- Research Question
- Some Relevant Literature
- Methodology
- Some Key Findings
- Conclusion

Brief Introduction- Rationale for Study

- The achievement levels of Irish students are generally regressing with more students failing and less students achieving well in science (State Examinations Commission 2014).
- <30% of students find school science interesting (Mathews 2007).
- Students' experiences at post-primary level can influence their decision to progress with science as a career (Mathews 2007).

Brief Introduction- Rationale for Study

- Research on inquiry predominantly shows that teaching through inquiry aids students learning and motivation towards science (Wilson *et al* 2010; Asay and Orgill 2010; Palmer 2010).
- Pre-service teachers and their professional knowledge (pedagogical content knowledge) are at the heart of the change process (Price and Villi 2005).
- Interactions within a professional learning community (PLC) can facilitate in the social construction of meaning (McRel 2003)i.e. developing an understanding of scientific inquiry.

Research Question

- Can engaging in a professional learning community (PLC) using pedagogical content knowledge (PCK) as the theoretical lens facilitate the developing inquiry orientations of pre-service science teachers?

Review of Some Key Literature

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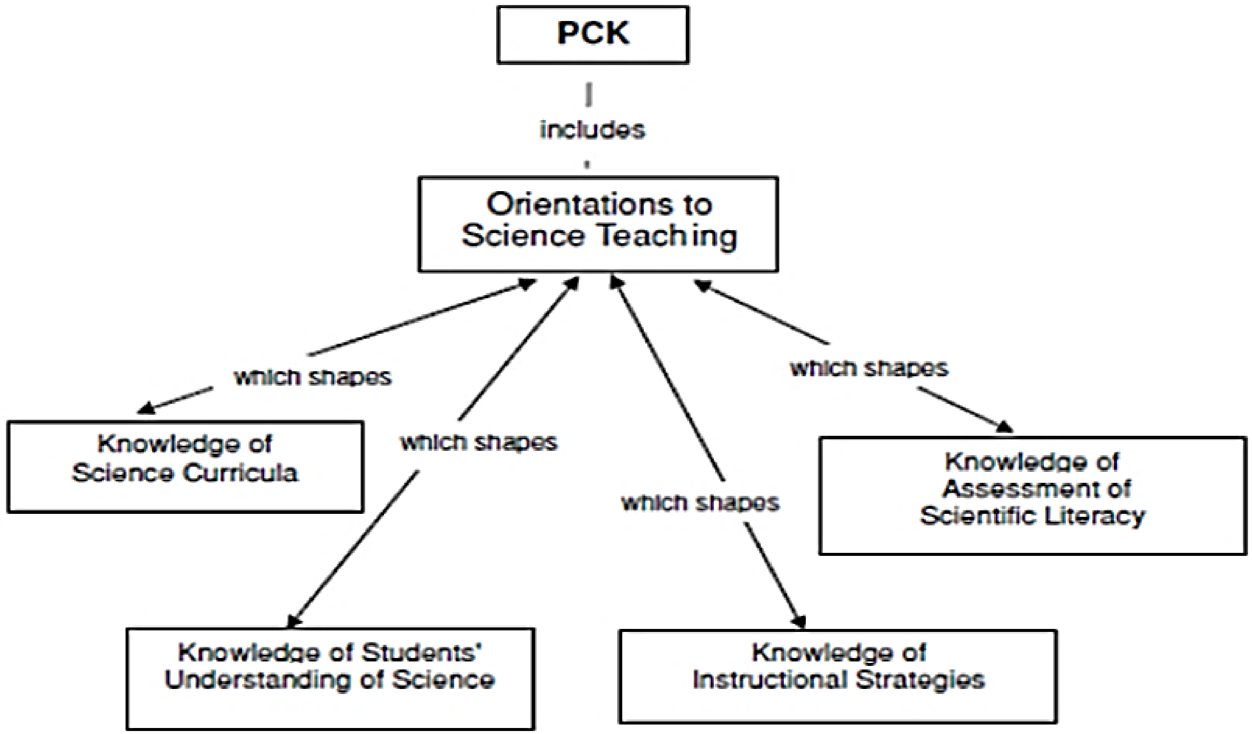
1. Pedagogical Content Knowledge (PCK)

- Knowledge of content and how to teach that particular content (Loughran *et al* 2006).
- Originally considered by Shulman (1986) and was defined as

" for the most regularly taught topics in one's subject area, the most useful forms of representation of those ideas, the most powerful analogies, illustrations, examples, explanations, and demonstrations- in a word, the ways of representing and formulating the subject that make it comprehensible to others"

(Shulman 1986, p. 9)

Conceptualisation of PCK



Model of PCK developed by Magnusson *et al.* (1999)

Conceptualising PCK- The Content Representation (CoRe)Tool

Topic: Year level:	BIG SCIENCE IDEAS/CONCEPTS		
	A	B	C
What you intend the students to learn about this idea.			
Why it is important for students to know this.			
What else you might know about this idea that you do not intend students to know yet			
Difficulties/Limitations connected with teaching this idea.			
Knowledge about students' thinking…			
Other factors that influence your teaching of this idea.			
Teaching procedures (and reasons for using these to engage with this idea.)			
Specific ways of ascertaining students' understanding/ confusion			

(Loughran *et al* 2006)

The CoRe

- Captures and develops the PCK of teachers
- Can be developed in groups (Hume and Berry 2013) or individually (Bertram 2010)
- Allows teachers to understand the complexities of teacher knowledge (Loughran *et al* 2006)
- Topic-specific PCK
- Can allow for group exploration of knowledge
- Social construction of meaning

Review of Some Key Literature

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2. Scientific Inquiry

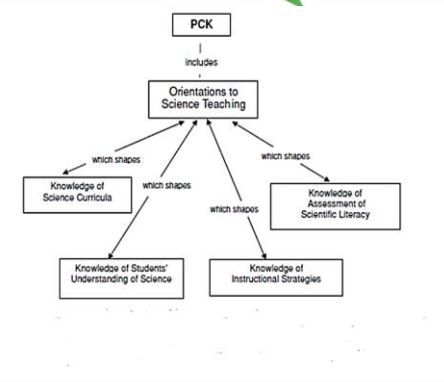
An inductive approach to the teaching of science which is problem based in nature with the importance given to the experimental approach to solving the problem (Rocard Report 2007): mirrors the practice of a scientist.

Students:

- Pose questions
- Plan investigation
- Make observations
- Use tools to gather, analyse and interpret data
- Propose answers
- Communicate results

(The National Science Education Standards Research Council 2006)

Studies associating PCK and Scientific Inquiry



- Making material comprehensible to others (Shulman 1986 Johnston 2008)
- Magnusson's PCK model shows association
- Other researchers have worked with this association (Jorda Spang 2008; Espinosa-Bueno *et al* 2011; Davis and Krajcik 2005; Park *et al* 2010; De Jong and Van Der Valk 2007).
- Low levels of PCK are attributed to low confidence (efficacy) levels which therefore lead to more restricted and controlled forms of teaching (Varley *et al* 2008a).
- Engaging in a PLC can facilitate developing self-efficacy (Mintzes *et al* 2013) and in turn develop PCK (Bausmith and Barry 2011) and scientific inquiry practices (Lewis *et al* 2014).

Methodology

- Social Constructionism Paradigm
- Symbolic Interactionism
- 2 year Longitudinal, Case Study
- Pre-service science teachers (n=12)
- Reporting on phase two of the study
- CoRes constructed in groups of 5,4 and 3
- CoRe altered slightly to include a greater inquiry focus (seventh pedagogical prompt) in light of phase one findings
- Discourse analysis
- Interviews for triangulation

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Participants

- Pre-service science teachers- Recruited year 2 of their initial teacher education (ITE) programme
- University of Limerick, Ireland
- Concurrent model of teacher education
- Voluntary participation

CoRe Topics Phase Two

Group 1(n=5)	Respiration The Nervous System The Immune System
Group 2 (n=4)	Respiration Chemical Reactions
Group 3 (n=3)	Modern Physics Heat Mechanics

Some key findings from phase two- extracts from dialogue: Initial struggles

- *"I don't know, I can't think of an activity though"* (Sandra).
- *""They could form their own ideas and their own opinions but then you give them the answer they can see their mistakes"* (Kate).
- "I would fly through this section" (Sandra).
- *"Obviously you do it* [the experiment] *after you've gone through what happens in the lungs"* (Rebecca).

Some key findings- extracts from dialogue: Initial struggles (Group 3)

- **Edel**- *"I'd say if they went to find the scientists themselves it would be more inquiry based."*
- ***Sean***- *"…ya"*

Extract from the Modern Physics CoRe dialogue

- **Edel**- *"But in terms of the class and if you want a timeline for variety".*
- **Sean**- *"Ya I suppose you'd nearly have to give it to them".*
- **Edel**- *"Or like say "find someone by tomorrow" and "who do you have" "ok well you can't do him, find someone else"*
- **Sean**- *"Ya that's logical".*

Some key findings- extracts from dialogue: Evidence of collaboration (Group 3)

- **Sean-** *"They could have a ramp and there is a car and it is attached to a Ticker tape, you just like let it go, how do you..?"*
- **Edel** *"You show that the dots, the ticker tape timer it punches the..."*
- **Sean-** *"Like every 0.2 of a second."*
- **Edel-** *"Ya like 0.2 of a second put you see that like slowly, the gaps between dots gets bigger because the tape is moving faster cause the tape is attached to the car"*
- **Sean-** *"So like if you pushed it, you could show its accelerating because in the beginning they were only like a centimetre apart but now they're two centimetres apart".*
- **Edel** *"You get them to do it and figure it out themselves".*

Extract from the Mechanics CoRe dialogue

Some key findings- extracts from dialogue: Evidence of collaboration (Group 1)

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- **Grace-** *"Like just throw out the question".*
- **Anne-** *"Or just give them a bowl of hot water, something like that, stick their hand in that, and they say it's hot and you say how do you know…but ah…I don't know, do you know the way… I'd just give them a bowl… I don't know".*
- **Sandra-** *"If he/she moved their hand, you'd say… why did you do that? And ask the class... why do you think he moved his hand and they might say it's hot miss and why do you think it's hot or why do you…"*
- **Clare-** *"How do you know it's hot".*
- **Sandra-** *"Ya".*
- **Clare-** *"Get the students to figure it out for themselves".*

Extract from the Nervous System CoRe

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Key Findings: phase two- examples of scientific inquiry orientations

Respiration	1	**Conducting investigation and drawing conclusions**- Bell jar of the lungs. One person breathing in through it and then someone else can go around and say what's happening here now? Ask them to explain it.
Chemical Reactions	5	**Conducting investigations**- Use oil and water to show a mixture. Get students to do it themselves. **Conducting investigations**- Determining if something is an acid or a base. Give them litmus paper and have them identify unknown samples. **Drawing conclusions and generating new questions**- If you got them to try and think right we've done this one way, how do you think you would be able to show a direction, show a change in direction? **Designing investigations, conducting investigations and drawing conclusions**- Acid base titration using universal indicator showing colour change. Get them to formulate what to do. Then probe them with questions. Give them a comparison between acids and bases and water and bases. Get groups to present their findings. **Designing investigations, conducting investigations and drawing conclusions**- Thermo Flask experiment- get them to figure it out. Compare against water. Thermometer in a flask and stop watch. Get them to see what happens in a reaction, is heat given in or taken off: does the thermometer reading increase or decrease. Then get them to do their own report

Experiences reported by the pre-service teachers

*"Well the first thing I realised was, **don't teach how you were taught** and don't stick to the syllabus. … Use other ways - like use inquiry [be]cause even when we're thinking about how you'd use inquiry, I suppose we're kind of **inquiring ourselves**, getting creative! And … **I remember so much more from these workshops** than I would from a lecture, something like that. And just when you **talk about it**, it's kind of like, you know, that the effects of that type of teaching will be much better than the didactic… we have a better knowledge"*

(Clare)

Conclusion

- Engaging in active, purposeful dialogue can allow for a culture of professional collaboration to nurture.
- The results do indicate a growing awareness of scientific inquiry- social construction of meaning of inquiry.
- Developing a professional dialogue takes time- careful scaffolding needed: e.g. using the CoRe can facilitate this.

Thank you for Listening