Leading education and social research
Institute of Education
University of London

Effective Continuous Professional Development in Science Education

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The lecture

- CPD – what does it mean?
- Twenty years of science education research.
- CPD models and their value.

CPD – what does it mean?

- Professional development
- Professional learning
- Professional growth

Professional learning or professional development?

- ‘teachers’ professional learning can be taken to represent the processes that ....result in specific changes in professional knowledge, skills, attitudes, beliefs or actions of teachers.
- Teachers’ professional development, on the other hand, is taken to refer to the broader changes that may take place over a longer period of time resulting in qualitative shifts in aspects of teachers’ professionalism’
- Fraser, C. et al. (2007) p156-7

Professional growth

- ‘teachers as active learners shaping their own professional growth through reflective participation in professional development programs and practice’ p948
- ‘teacher growth is constituted through the evolving practices of the teacher, which are iteratively refined through a process of enaction and reflection’ p 955.
- Clarke & Hollingsworth (2002)

Teacher learning: two perspectives

- Cognitive – in terms of individual knowledge growth, e.g pedagogical content knowledge (Shulman 1986,87)
- Situated – in terms of teacher growth as practiced within the social system (Borko 2004).

- teacher learning is a complex combination of the individual teacher's knowledge growth, the professional teacher practicing in a particular setting and the social teacher working collaboratively with others in that setting.

Bringing about change

- Different materials
- New approaches
- Alteration in beliefs

- Fullan (1982) The Meaning of Educational Change

Twenty years of CPD

- Open-ended Work in Science, Inquiry (1988)
  - Paul Black , Alister Jones, Rod Watson
- Argumentation (1999, 2008)
  - Jonathan Osborne, Sibel Erduran, Katherine Richardson
- Video-based CPD (2011)
  - Paul Davies, Jill Trevethan

Open Ended Work in Science

- Open-ended work in science is concerned with activities which give the initiative to students for finding solutions to problems. These activities place an emphasis on autonomy in making decisions and on the integration of knowledge and skills from a variety of sources and contexts.
- Explorations, investigations, projects
- Inquiry based learning

Find the best carpet

- An investigation in the existing scheme was called *Find the best carpet for the library corner*. This activity was very open, and the outcomes depended on the way in which the students defined the investigation.
- The teacher wanted the students to define this task using ideas about friction and to formulate investigations using this concept. However the students did not do this, they performed a variety of 'unscientific' activities involving aesthetic qualities such as colour.

From everyday to science

- The teacher was asked to clarify what skills, strategies, knowledge and understanding he wanted the children to learn through doing the open activity.
- He wanted to develop quantification and control of variables, and concepts relating to force and friction. It was therefore suggested that the activity should be changed to one in which the students could focus on the idea of friction, so that relevant variables could be identified.
- A new activity was developed called *Factors affecting the slippiness of winter shoes*

Winter Shoes – the introduction

- The first lesson was introduced in terms of an everyday context to engage the students and encourage them to formulate their own investigations from group discussions.
- The teacher discussed in very general terms the different types of shoes you might need in the winter and some of the reasons why you might wear different shoes in the winter than in the summer. The students, in groups of six, then 'brain-stormed' a list of factors they thought would affect the slippiness of shoes.

Winter shoes – what varies?

- Boot or shoe
- Trainer or shoe
- Area of the sole
- The thickness of the tread
- The pattern of the sole
- Support of the shoe
- Type of sole; for example, leather, rubber.

Winter shoes – what can I ask?

- Which variable I think is the most important
- Why I think that this is important
- I am going to test my ideas by doing this….
- Here is a diagram of my experiment
- I will make my test fair by….
- What happened during my experiment
- What I have found out is….
- What else I would like to find out about winter shoes?

- This table shows what I will keep the same and what I will change

Carpet type	**Size of shoe**	**Mass of shoe**	**Type of sole**	**Force** (N)
Smooth	7	1000g	Smooth	
Smooth	7	1000g	Rough	
Smooth	7	1000g	Ridged grip	
Smooth	7	1000g	Deep tread	
Smooth	7	1000g	Medium	

Type of shoe	Surface	Weight	Moving of shoe	Sole	Grip
Gold shoe	Carpet	1 kg	5 newtons	leather	—
Soft shoe	Carpet	1 kg	4 newtons	rubber	lumpy
Court shoe	Carpet	1 kg	5 newtons	plastic	—
Trainer	Carpet	1 kg	10 newtons	rubber	chunky
beach shoe	Carpet	1 kg	15 newtons	foam	wavy
Stiletto	Carpet	1 kg	5 newtons	plastic	—
Flat shoe	Carpet	1 kg	4 newtons	plastic	—

Variable table – a good strategy?

- The teacher found that he could see clearly what the students were attempting to do in the investigation and could respond immediately to the needs of the students. The tables were also a quick way of carrying out formative and summative assessment of students' ability to control and manipulate relevant variables.

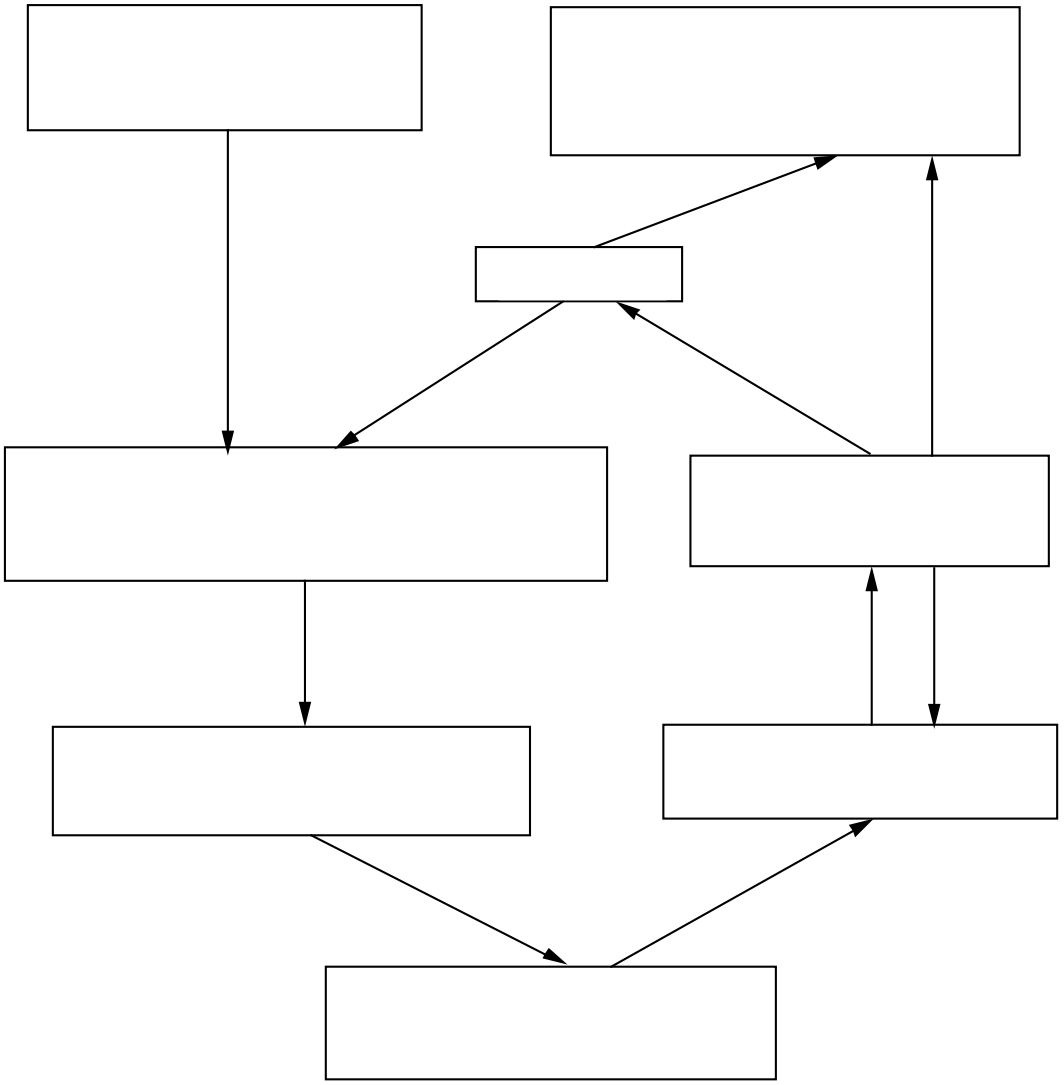
- The teacher's comments reflect the value of the variable table as a means of guiding and interacting with the students.

- *In terms of assessment they helped me identify what the students where trying to investigate and whether or not they were carrying out the right procedures.*

Jones, A. & Simon, S. et al (1992) Open Work in Science

- Exploring the existing situation
- Negotiate the starting point
- Negotiate the kind of intervention
- Development work begins
- Putting development into practice
- Reflection and evaluation
- Re-negotiation
- Output

The process of negotiated intervention



Bell and Gilbert

- Social development
- Professional development
- Personal development

- Bell, B. & Gilbert, J. (1996) Teacher Development: A Model from Science Education

Two argumentation projects

- Enhancing the Quality of Argumentation in School Science (1999-2002)
  - 12 individual teachers from different schools
- Talking to Learn, Learning to Talk in Science (2008-2011)
  - 4 science departments

Argument in learning science

- Learning science involves becoming socialized into the languages and practices of the scientific community.
- Through taking part in activities that require them to argue the basis on which knowledge claims are made, students also begin to gain an insight into the epistemological foundations of science.

Developing a pedagogy of argumentation

- Argument is a form of discourse that needs to be appropriated by children and *explicitly taught* (Khun 1991) through suitable instruction, task structuring and modelling.
- Just giving students scientific or controversial socio-scientific issues to discuss will not prove sufficient to ensure the practice of valid argument.

Argumentation activities

- A Classification Activity
- Competing Theories
- Concept Cartoons
- Predict, Observe and Explain (POE)
- Analysing and Interpreting Data
- Discussion of an Instance
- A Concept Map
- A Diagnostic Test Item

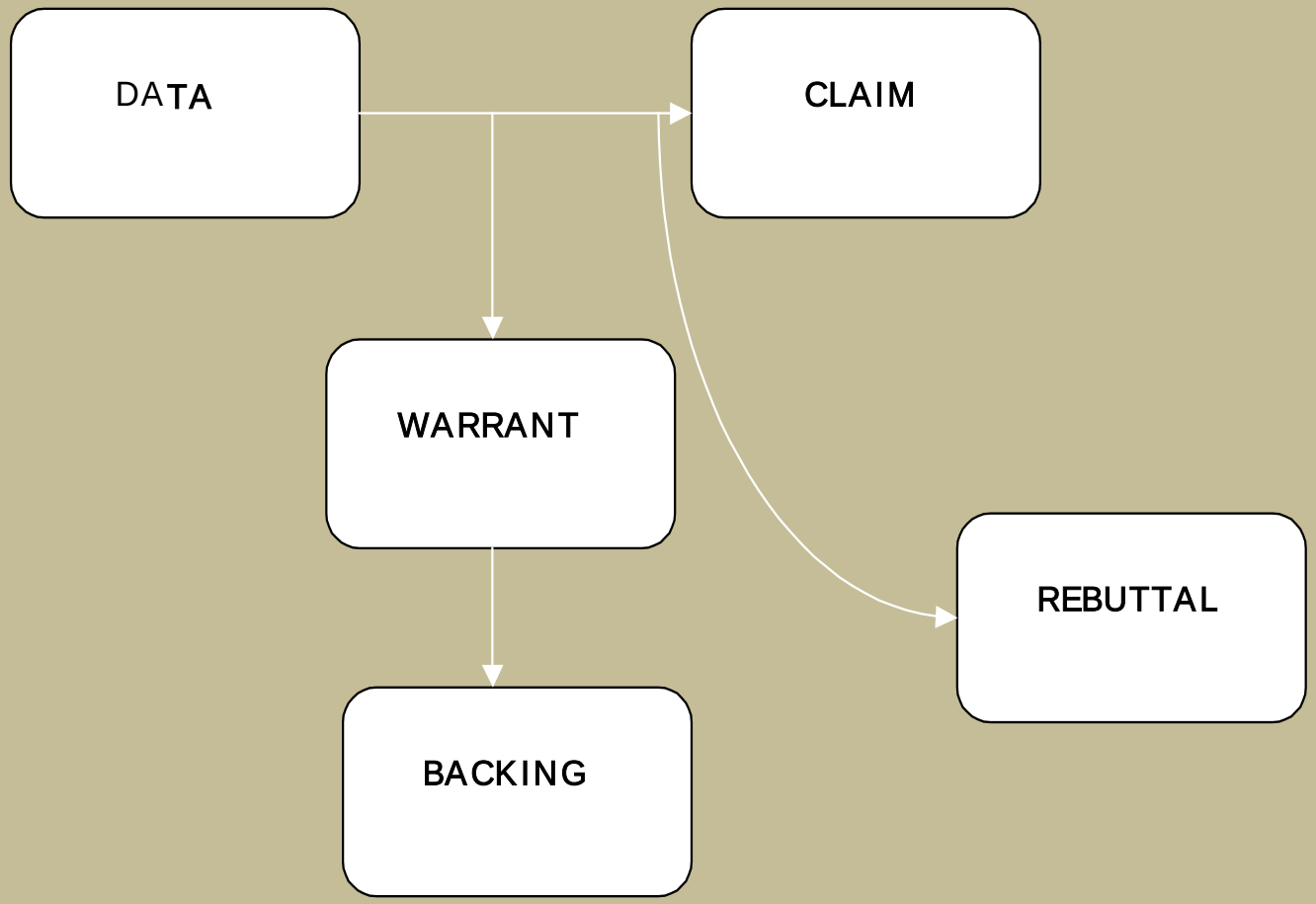
Concept Cartoon

Handout 2.2

Arguing prompts

- Why do you think that?
- What is your reason for that?
- Can you think of another argument for your view?
- Can you think of an argument against your view?
- How do you know?
- What is your evidence?
- Is there another argument for what you believe?

TOULMIN'S ARGUMENT PATTERN



The snowman with the coat

- Claim: The snowman will take longer to melt.
- Data: Because he is wearing a coat
- Warrant: The coat and the hat that he is wearing helps to insulate him.
- Backing: The coat is an insulator so it stops the heat energy getting to the snowman quickly.
- Rebuttal: The coat will make no difference as it will warm up just as quickly in the Sun.

Analytical frameworks become development strategies

- Identification of arguments
  - Toulmin's argument pattern
- Lesson structure and features of teacher talk
  - Critical talk focusing on processes of argument

Facilitating argumentation

- Encourage discussion and listening
- Define and exemplify argument
- Encourage positioning, value different positions
- Check evidence, provide evidence
- Prompt justification, encourage further justification
- Encourage evaluation, evaluate arguments
- Encourage anticipating counter-argument
- Encourage reflection on argument

What is the challenge for teachers?

- A pedagogy where students listen to each other and consider alternative viewpoints is not the most familiar or comfortable for many science teachers, and can pose a significant challenge to their teaching of science.
- Transformations in pedagogy require teachers to rethink their values and be prepared to take risks.

IDEAS.

DVD based in-service training materials for training teachers to teach ideas, evidence and argument in KS3 science classrooms. The pack is intended for KS3 science teachers, consultants, advanced skill teachers, head-teachers, university teacher educators.

In-Service Training Pack

Session 1: Introduction Argument
Session 2: Small Group Discussions
Session 3: Teaching Argument
Session 4: Resources for Argument
Session 5: Evaluating Argument
Session 6: Modelling Argument

Resources Manual – Lesson activities

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Dr Sibel Erduran, King's College London
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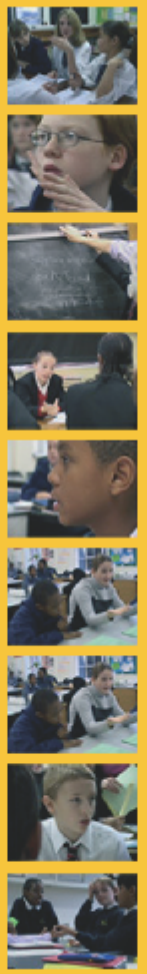
Ideas, Evidence and Argument CD & DVD



IDEAS!
Ideas, Evidence and Argument in Science (IDEAS) Project

KING'S College LONDON

IDEAS resources

- Booklet of 15 argument lessons
- DVD of lesson video clips that relate to the sessions

IDEAS training sessions

- Introducing argument
- Managing Small Group Discussions
- Teaching Argument
- Resources for Argumentation
- Evaluating Argument
- Modelling Argument

Reflection and Sharing

- In their analysis of teacher learning in communities of practice, Shulman and Shulman (2004) note the crucial role of shared metacognitive reflection, where teachers critically discuss their work with each other, and reflection is the central component of their model of teacher learning and development.

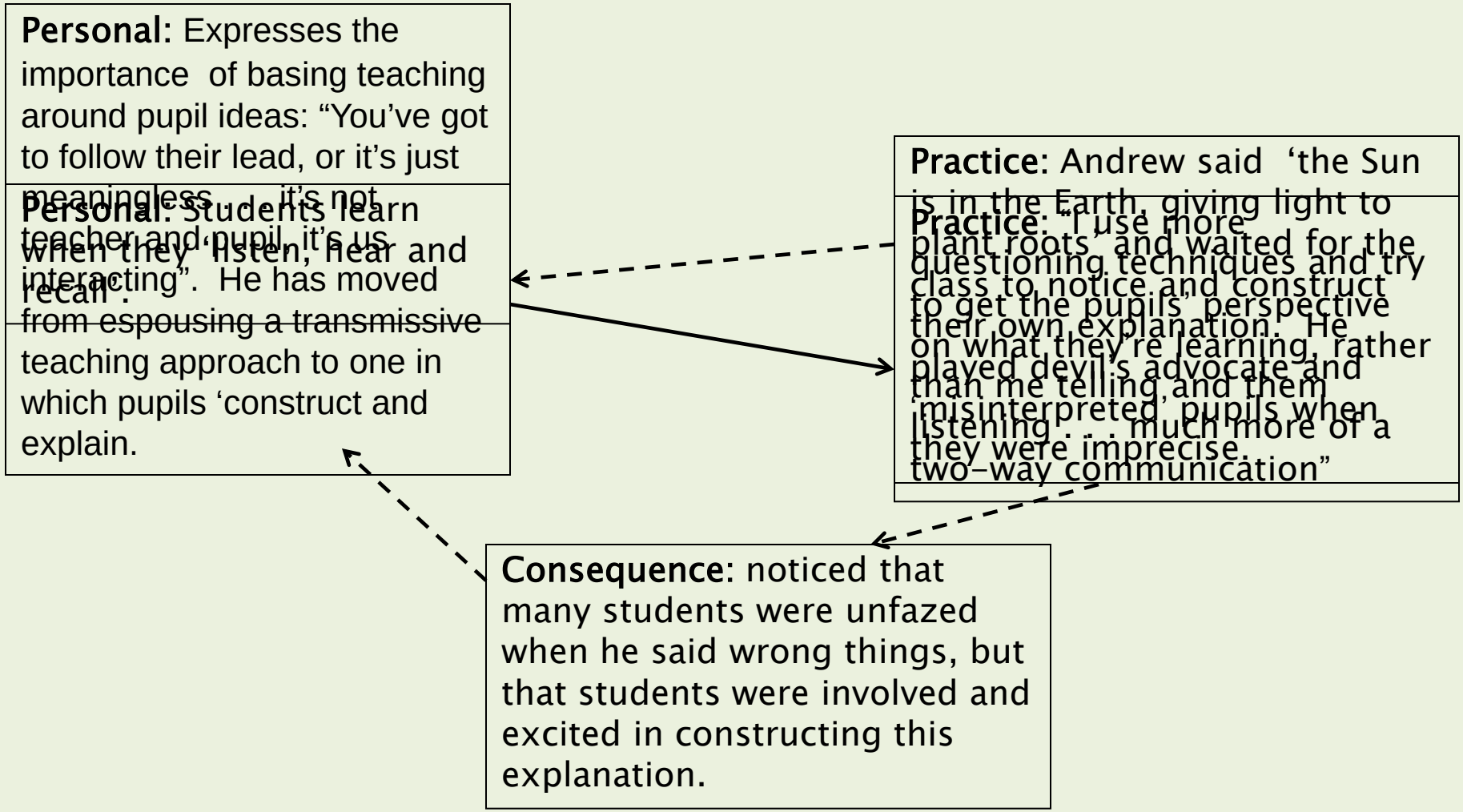
Talking to Learn Project

- Can science departments engage in a cycle of collaborative reflective professional learning, based on the use of argumentation activities, that enables teachers to develop their practice in teaching argumentation?

Professional Development

- The main aim of the professional development aspect of the project was to provide lead teachers with ideas for argumentation pedagogy and guidance for collaborative reflection on progress.
- In this way intervention by the research team was minimal, professional development was reliant on leadership exercised by the two teachers nominated by each school.

Classroom communication: from transmission to tentative dialogue



Argumentation pedagogy

- There are three key aspects of teaching that would benefit from tasks and video material that can support teachers in professional development. These are:
  - The planning and organisation of groupwork.
  - The teacher's role and interactional strategies in introducing argumentation, sustaining small group discussion and conducting a plenary.
  - The design and interpretation of resources within the curriculum.
- For professional development to be effective these practices need to be reflected upon analytically and shared between colleagues working together collaboratively.

New Project: AZSTT

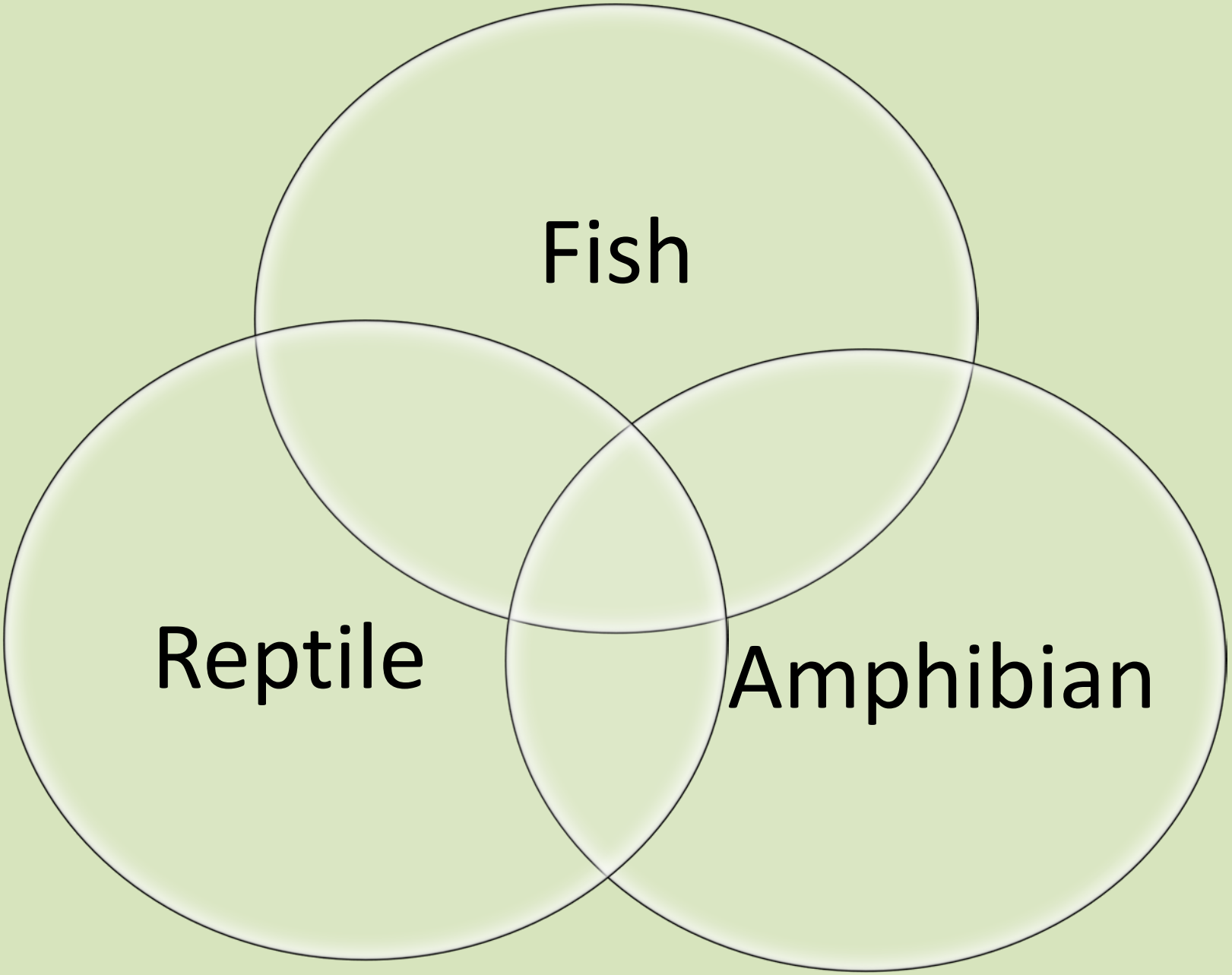
- Produce good quality video material (post IDEAS) that will be accessible via a website and that will be supported by specific professional development tasks.
- Plan three web-based CPD units.

Developing groupwork strategies

- Approach to developing group work strategies (listening triads, envoys, jigsaws)
- Example of *Verbal tennis*:

  Introducing

  In action (*Encourage discussion and listening*)


Fish
Reptile
Amphibian

Facilitating and sustaining argumentation

- The axolotl activity

1. *Encourage discussion and listening*
2. *Prompt justification, encourage further justification*
3. *Encourage anticipating counter-argument*

Designing argumentation activities

- Analysing activities for learning goals, skills and knowledge needed, organisation, outcomes, assessment, evaluation.
- Comparing lesson plans for the same activity
- Designing a lesson plan for a given resource

Professional Learning System Hoban 2002

- Conceptions of teaching
- Reflection
- Purpose
- Time-frame
- Community
- Action
- Conceptual inputs
- Student feedback

Effective CPD in the science department

- Departmental culture for trying new ideas
- Formal and informal opportunities for reflection and sharing
- Collaboration: strategies for working together
- Peer observation: time for observation and feedback

- School culture for CPD – what are the priorities?

My learning about effective CPD

- Developing researcher/teacher partnerships.
- Identifying strategies that work for specific practices that can be resourced and shared more widely (evidence based CPD).
- Understanding the process of professional learning through using models to analyse change.

Teacher change

- Unless teachers really want to change, or value how a particular change can make their and their students' experience more worthwhile, they will not alter how they perceive themselves as science teachers or radically change their practice.

Thank You

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