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THE PALAVA PROJECT – A METHOD OF ASSESSING MODELLING CAPABILITY

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Abstract
Assessment of particle modelling in a practical way is described in this article. The work analysed here was carried out with graduate science teacher education students at an English university. The effectiveness of the cartoon story board methodology was checked. Some surprising results about the ability of student teachers to explain using particles, especially Biologists, were discovered.

Members of project
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Introduction
Gilbert and Boulter (2000) have provided an extensive review of the role of models in science education. Their review provides the background to research on modelling, a typology of models within the field of biology, and a variety of historical and other studies of modelling. What does not seem to have been addressed is a practical hierarchy to characterise modelling capability. This paper describes a preliminary investigation to assess whether a reliable and useful method can be created based on the type of story boards used in cartoons. This method was chosen since it requires the modellers to provide both pictorial and textual explanations, two significant media. The context is the theme of particles since this theme is fundamental to explanations in chemistry.

Previous material on modelling progression
Snir and Smith (1995) provide a framework of three levels of understanding in science (p54-55):

Level 1
Models are thought of as either toys or as simple copies of reality.
Level 2
The student now realizes there is a specific, explicit purpose that mediates the way the model is constructed.
Level 3
Modellers actively now constructed in the service of the development and testing of ideas, rather than serving as a copy of reality itself, and test the models against reality.

In this hierarchy of models, the relation to the purpose is mentioned but not elaborated. It is this function of modelling that is the least well developed aspect of models in chemistry.

Research questions
1. Can storyboards be used to assess particle-modelling capability in the classroom?
2. What explanations do student teachers use for simple particle processes?

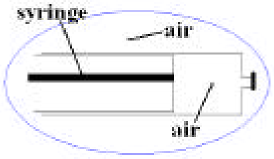
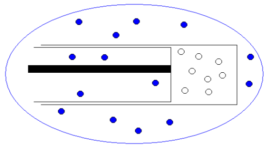
This paper describes one part of the project that concerned a group of post-graduate science student teachers in a university in England.

The sample
- One year post-graduate pre-service science student teachers
- Age range 21-52
- 22 Biologists
- 6 Chemists
- 7 Physicists

Some of the experiments
- Boyle (two parts)

Boyle experiments
Boyle noticed the springiness of air was similar to the springiness of metals. We relate pressure to large numbers of collisions on walls and other objects.
Experiment 1: Trap half a syringe of air and block the end. Push in the plunger and let go.
Experiment 2: Trap half a syringe of air and block the end. Pull out the plunger and let go.

Story boarding
One story board has a set of three frames - phenomenon; visualisation; script to link visualisation and phenomenon. A sequence of story boards is used for dynamic processes. Story boards can promote explicit links between visualisation and phenomenon

Phenomenon	Diagram (cartoon)	Script
		The syringe has air particles inside and outside the syringe. As the syringe is pulled out, the pressure inside is decreased. The differential pressure inside and outside the syringe means that the syringe is pushed back in, **until the pressures equalise when the syringe stops.** At a sub-microscopic level, when the syringe is pulled out, there will be fewer air particle collisions pushing on the inside of the syringe compared with the outside. The resultant force will push the plunger in until the forces balance again**.**

Analysis of explanations

Boyle experiments

- Almost all the diagrams showed sub-microscopic particles - three exceptions were Biologists who drew macroscopic representations only.
- The diagrams had particles inside and outside the syringe (B: 7/22 C: 3/6 P: 7/7)
- The great majority of diagrams showed particle conservation – this was not required
- Most text gave explanations at macroscopic levels as the major explanation (B: 18/22 C: 5/6 P: 2/7)
- Most text did not extend the diagram explanations (B: 17/22 C: 5/6 P: 5/7)
- The highest explanation involving differential collisions at sub-microscopic level was relatively rare (B: 3/22 C: 1/6 P: 5/7)

Balloon

- Almost all diagrams show particles - two exceptions were Biologists
- Diagrams - particles inside and outside (B: 19/22 C: 5/6 P: 7/7)
- Great majority of diagrams showed particle conservation – this was not required
- Diagrams - variation in showing movement of particles
- Minority of text gave explanations at macroscopic levels as major explanation (B: 12/22 C: 5/6 P: 2/7)
- Most text did not extend the diagram explanations (B: 17/22 C: 3/6 P: 6/7)
- The highest explanation involving differential collisions at sub-microscopic level was relatively rare (B: 3/22 C: 2/6 P: 4/7)

Marshmallow

- Almost all diagrams show particles - two exceptions Biologist & Physicist
- Diagrams - particles inside and outside (B: 18/22 C: 4/6 P: 6/7)
- Great majority of diagrams showed particle conservation
- Diagrams - variation in showing movement of particles

- Minority of text gave explanations at macroscopic levels as major explanation (B: 13/22 C: 4/6 P: 2/7)
- Most text did not extend the diagram explanations (B: 18/22 C: 4/6 P: 7/7)
- The highest explanation involving differential collisions at sub-microscopic level was relatively rare (B: 2/22 C: 2/6 P: 1/7)

Overall

- Particles are only drawn when they are enclosed in a space e.g. inside a syringe. Particles in an open space are frequently left out.
- Despite the requirement to draw and explain when using particles, most students show only a limited understanding of the relation between macroscopic properties and sub-microscopic explanations.
- Few students seem to understand at the sub-microscopic level, especially the Biologists.
- Story boards show use of sub-microscopic particles in the cartoon section
- Story boards are an effective way of exploring modelling capability

Implications

- There is a need to emphasise the presence of air outside confined spaces
- The relationship between particle collisions and macroscopic pressure needs to be developed for Biologists and some Physical Sciences
- Story boards could be used for development of student teachers' modelling capability

Further research

- Students could be asked to compare prepared story boards to develop their capabilities
- Further experiments should be devised to assess particle modelling capability
- The range of students should be extended to cover the range from 11+

References

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