Tracking disciplinary learning in interdisciplinary projects

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Tracking disciplinary learning in interdisciplinary projects: A case study in arts and science and use of the SLRC Classroom

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Our study aimed to identify learning outcomes in and across these subject areas when students engaged with two interdisciplinary arts/science projects, incorporating use of the SLRC classroom.
Overview of Presentation

1. Broad methodological challenges and assumptions
2. Methodological assumptions in researching in the SLRC classroom
3. Overview of two cases studies
4. Some early data and ongoing challenges
Case Study One: Arts and Science Year 10 Presentation College

Year 10 students visited Melbourne Zoo to research one of 15 Victorian endangered species in preparation for National Threatened Species day on Sept 7th.

The Melbourne zoo staff design brief was for the students to find a way to "help Victorians fall in love with these animals" as part of their “love your locals" program.

Students came to the SLRC classroom for a 90 minute lesson (August 1st) and in groups of 2-3 started to create a trash puppet of their selected species and to develop a "story in a suitcase". The students had to identify the spine of their species from a range of un-annotated photocopies, and consider how skeletal structure influenced their animal’s behaviour, movement, and endangered status. The puppet creation was completed at Presentation College, with study of puppet styles and methods of puppet movement part of the program.

The students returned to the zoo on Sept 7th (with their suitcase of puppet(s), props) and presented their story to zoo visitors including primary students.
Research Methodological Challenges

1. What should count as disciplinary or interdisciplinary learning processes and outcomes, and why (lack of consensus in research community about similarities/differences in purposes and methods in sciences and the arts)

2. What should count as collaborative creative reasoning (inventive problem-solving) within and across each subject, and why?

3. What methods should be used to construct relevant data as a basis for claim-making and why?

4. How can the affordances of the SLRC classroom be used to support this research?
Theoretical Alignments between Science and the Arts

Both aim to create new realities rather than capture pre-existing ones, by constructing representations of the properties, processes, and interactions of materials, phenomena and human agents.

Neither area aims to copy nature. Scientists make claims about how nature works. Artists makes claims about our learnt perceptions of nature: how our physiology registers our experience of the world (Latour, 2014).
“I create animations that reconstruct what we know about cells but cannot see.”

Drew Berry, biomedical animator
(The Age, 18/11/2017)
Differences between the Arts and Sciences

Scientists and artists can differ in epistemological commitments, in how they view ambiguity, uncertainty, paradox, lived abstraction, experimental verification, assessment and measurement of success, and the value or role of peer or other reviews.

They can also differ about the purpose of their work, what their theories explain, or intend to explain, and what are appropriate foci and tools for inquiry.

If a key focus in the arts is aesthetics (and/or resisting conventional aesthetics), and a key focus in the sciences is model-based reasoning then there are interesting overlaps and divergences.....
Aesthetics in the Arts and Sciences

Aesthetics in the Arts

making the familiar strange and mysterious, transgression, playfulness, unruliness, relinquishing conscious control, practice before theory, realizing concepts through objects, disruption, novelty, repurposing of throwaway materials, pattern-spotting and pattern-making, ephemerality, assemblage, shock, pleasure in distortion, mesmerizing through the beautiful, inscrutability, ineffability, wonder, realism

Aesthetics in the Sciences

Parsimony and elegance of expression/theory, trust in the instruments, search for pattern, anxiety about bias, subjectivity, distortion, inaccuracy and implausibility, appreciation of precision, wonder, beauty, realism (Daston, 2007)
“There are no well-founded doubts about Leonardo’s responsibility for the picture.” “This is not just a matter of judgment by eye, but based on technical examination, and ineffable signs of Leonardo’s ‘science of art’, most notably optics, which none of his followers understood.”

Martin Kemp (2017)
One Drop of Blood, Dan Elborn. The artist has made 20,000 pebble-sized porcelain white blood cells, which viewers are invited to take as a representation of the falling white blood cell count of cancer patients undergoing chemotherapy. Image: Dan Tupos
Model-based Reasoning

Model-based reasoning in Science

Probing models, phenomenological models, computational models, developmental models, explanatory models, impoverished models, testing models, idealized models, theoretical models, scale models, heuristic models, caricature models, didactic models, fantasy models, toy models, imaginary models, mathematical models, substitute models, iconic models, formal models, analogue models and instrumental models (Frigg & Hartman, 2017)

Model-based reasoning in the Arts

Fiction, science fiction, scale models, and see above re realism, photorealism, surrealism, fantasy
Relation of Arts to Sciences

So can art be science and science be art? A work of art always remains open for interpretation, drawing the spectator into the shape of the artist's visualization, but without being able to exert fixed control over the feelings it induces. There is always room for the beholder's share. Scientists may wish to engage the reader or spectator in a wonderful journey of imaginative visualization, but in the final analysis they wish to communicate an interpretation that embodies testable content in an unambiguous way. But behind these diverging streams of intention runs a turbulent river of shared intuitions about the order and disorder of things.

(Kemp, 2005)
Methodological Assumptions

1. Science and the arts, although overlapping, are distinguishable as disciplinary practices and forms of knowledge.

2. Student learning in both subjects can be enhanced through designed interdisciplinary experiences (potential value of arts methods and aesthetic, expressive, affective input into scientific problem-solving and communication, and value of scientific knowledge in shaping new arts research foci and expression).

3. These learning processes can be tracked over time through multiple data sources including microgenetic study (focus on moment-by-moment genesis of ideas/decision-making) in inquiry episodes in the SLRC classroom.

4. These learning processes will entail student creative/critical reasoning.

5. Need for multiple sites (school, uni, zoo) and multiple and multimodal data sources (video capture, researcher observations, discourse and artefact analysis, and analyses of student and teacher presentations and interviews, assessment).
Methodological Assumptions in using SLRC classroom

1. Need to optimise likelihood of purposeful motivated interactions between students in this classroom, with videotaped lesson part of much larger before and after engaging learning sequence and data collection.

2. Likelihood that learners have not considered relation of arts and science before or experienced this kind of project, but interviews can function as Socratic dialogue that prompts reflection and learning.

3. Need for mix of whole class and intensive subgroup semiotic focus.

4. Expectation of high levels of variation in student actions on open-ended tasks, and therefore need for extended sampling of decision-making episodes across sub-groups.
Methodological challenges in using microgenetic research in the SLRC classroom

• If creative reasoning processes are not always evident in explicit “visible” or “audible” signs, how should this be dealt with in this approach?

• What is an appropriate sampling rate for study of this learning?

• What should count as significant events within this learning sequence and why?

• What kind of sequence of analysis is appropriate within this approach?

• How should high variability in moment-by-moment tracking of student groups tackling an open-ended task be dealt with?

• What is the assumed rate of change in student learning, and how does this relate to the sampling frequency?

• Does length of observation suit tracking of proposed learning changes?

(Brock & Taber, 2017)
Theorising the Processes and Value of This Learning

Sociocultural view of learning as purposeful participation in collective discursive practices through interplay of body, mind, feelings, environment, and representational tools

Embodied cognition” (Barsalou, 2008; Glenberg, 2004; Wilson, 2008)

“Manipulative abduction”, (Magnani, 2015)

Distributed cognition (Kirsh, 2010; Latour, 2005)

Activity and creativity (Oppezzo & Schwartz, 2014)

Role of affect in reasoning and judgment (Damasio, 2008; Lemke, 2017)

Interplay of values, aesthetics, feelings in science learning (Jacobson & Wickman, 2008).

Learning through drawing in science (Ainsworth, Prain & Tytler, 2011)

Learning as “messy” and “unstable” over time (Taber, 2013)
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What could be learnt from this project?

• Disciplinary topic knowledge in science on adaptation
• Procedural knowledge about addressing Zoo brief, including design and creation of puppetry, engineering applications
• Dispositional learning about the topic
• Creative reasoning practised in completing brief and explaining topic to younger students
• Student Identity work in learning science
• Student understanding of relation of science and arts
Student interview responses at completion of the project

Value of Art in Learning Science

“It was amazing to combine creative work with all our science research.”

“I think it went for a long time, but it was a relaxing class with hands on, not writing.”

“You need to learn how to work it out. It was nice to, not take a break, but do something creative with your hands.”

“Whether the art helps depends on your animal. Our animal didn’t move much.”

“The art process was useful for learning and communicating science and showing habitat.”

“The art was useful because making it in person was good because it’s life-size and an engaging way to communicate.”

“It made it a lot more interesting and fun in creating something.”

“It challenged our creativity, it was a good relief from everyday schoolwork, learning the science behind how a frog leaps. (but the project) lagged a bit.”
Student interview responses at completion of the project

Applying Engineering in Puppetry

“We learnt a lot about how the movement of the puppet works. I’m also doing physics at the moment and it was interesting to look at the biomechanics of how the puppet worked.”

“I enjoyed the engineering side of it, how the puppet moves.”

“The movement of the puppet relates to engineering and physics.”

Value of Art in Communicating Science

“They say you really know something when you teach it to others.”

“Communicating science can be done for any age group because science is about making sense of something.”

(There is value) “when you touch and hold things for learning concepts”.
Teacher Comments

“I think the girls really needed to learn some of the techniques for actually constructing puppets, that it was really an engineering project. Some of them might have thought it was an art and craft project. But they had to learn that engineering was involved in making joints. I had to teach them how to make an axle to make a joint move”.

“I had to emphasize to them what part might move, how can you make it move. I think we needed something prior (to the trash puppet-making), to look at techniques. How do joints move? And they needed to practise the techniques.”

“I got them to think about what was underneath, the structure. It would have been good to have a bit more about adaptation, exaggerate the part that has helped the animal survive, such as huge eyes on the possum. It would have been good for them to focus on that.”
Year 9 students were studying the topic of the properties of light in term 4 2017. As part of this unit they had a 90 minute class in the SLRC classroom where in groups they were invited to use a range of provided props (mirrors, figurines, fake eyeball, golf ball, bubble-making facilities) and cameras, including infrared cameras to create an intriguing “artistic” photo. They were expected to draw partly on their knowledge of the properties of light, and to give their photo a title that encapsulated its meaning.

The students had follow-up lessons at school, and were interviewed about the SLRC process and their sense of the purpose and value of this interdisciplinary experience.
The illusion is how the flashlight reflects on the surface of the water as well as on the bottom of the jug. Also how the light allows for there to be a clear film surrounding the eye. We used a fake eye, a flashlight, jug of water and a glass prism with animals inside it.
WE TRIED TO CAPTURE THE DIFFERENT COLOURS IN THE BUBBLES AS WELL AS THE DIFFERENT PATTERNS.

The white light bounces off the edges of the bubbles which separates the colours.
Taliah, Sophia, Gizelle

We tried to create an image of 2 eyes. We used the water to make the bottom of the eyeball appear bigger. We use the mirror to create the effect that there was 2 eyeballs. The mirror on the base of the glass reflects onto the other mirror and glass and shows some reflection of light. The mirror behind the glass looks bent. This is because of the shape of the glass with water. It bends the image behind.
GOLF

- The first photo we chose we named golf. In this photo we utilised the mirrors to create a repeating effect with the mannequin. The golf ball was lit with a flash light that gave the photo life.
MOON

- The second photo we chose we decided to call moon. The light gave the golf ball a moon effect. The mirror made the cup seem longer or that there was two separate cups. Chloe’s hair made this particular picture have an artistic look. The angle of the camera makes you think about what is going on.
In this photo I put my handprint on the table so it would make a warm print when we used the infra red camera. The body temperature of my hand left an imprint which is the hand print in the photo.
Student comments

“I liked it, but we didn’t really learn much from art. All we did was take photos.”

“Both the art and the science were pretty much the same thing.”

“(learning from art) Just the way we see things ... photos helped us see things.”

“(learning science) How angles change what we see.”

“We were given objects and had more freedom. It’s a good way to learn.”

“You can use science aspects to create really abstract concepts.”

“Whether you learn science through art depends on what science you are learning.”

“Science made the photo artistic.”

“Science can be seen as art. Science is beautiful and everything can be seen as art.”

“You do it (take the photo) and you see the science behind it.”

“You want to know the science in order to make a cool picture.”

“You can learn science from art. You learn how white light is reflected through the prism. The art aspect is using different colours and ways to capture it.”

“The science was what we put in the photo, and the art was the result.”

(What did you learn?).”Surprises, how bubbles bounce, pop in different ways, and are bendable.”
This was a very creative way to look at light, and it is something that next time I teach it I will use. This is a much more interesting everyday way to introduce it. It opens it up a lot more.

In terms of a task it was a useful to go through this for revision. (Relooking at your photos) Now what do you understand that you didn’t before?

(Can arts be combined with science?) Being able to articulate science is important. So at different times we get the students to make story books to demonstrate what they know. Visual organisers help them to understand the work better.
Further thoughts and what next?

What are generative reciprocal processes between micro, meso and macro analyses?

Are there risks in trying to itemise/essentialise disciplinary creative processes/strategies?

In what ways does a focus on model-based reasoning in science promote student disciplinary inventiveness (Lehrer & Schauble, 2006)?

What would be key features of methodological relational agency (Edwards, 2005)?

How well do our methods serve our intentions?