Methodological challenges in researching aesthetic responses and intentions in science education

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CAR Conference, Deakin University 7-8, November 2019

Renewed Interest in Aesthetics in Science Education

The key role of feelings and affect in learning (Lemke, 2015)

Potential new aesthetic effects when science is combined with other subjects, such as the arts.

The persistent engagement problem in science and STEM (Hobbs, Jakab, Millar, Prain, Redman, Speldewinde, Tytler & Van Driel (2017)

Extensive current collaboration between scientists and artists in conceptualizing and representing research (CERN, 2019).

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, appreciation of objects and methods of science, precision, wonder, beauty, realism (Chandrasekhar, 1987)

Anxiety about bias, subjectivity, distortion, inaccuracy and implausibility (Daston, 2007)

Differences between Science and the Arts

"Art expresses meanings, whereas science states them. A statement gives us directions for obtaining an experience, but does not supply us with experience. If science expressed the inner nature of things it would be in competition with art, but it does not. Aesthetic art, by contrast to science, constitutes an experience". (Leddy, 2019)

While agreeing that art and science are not indistinguishable from one another (in terms of the range of each field's purposes and success criteria), this account sets up unproductive binaries between meaning and experience, and between the inner and outer nature of things.

Case Study Arts and Science Year 9

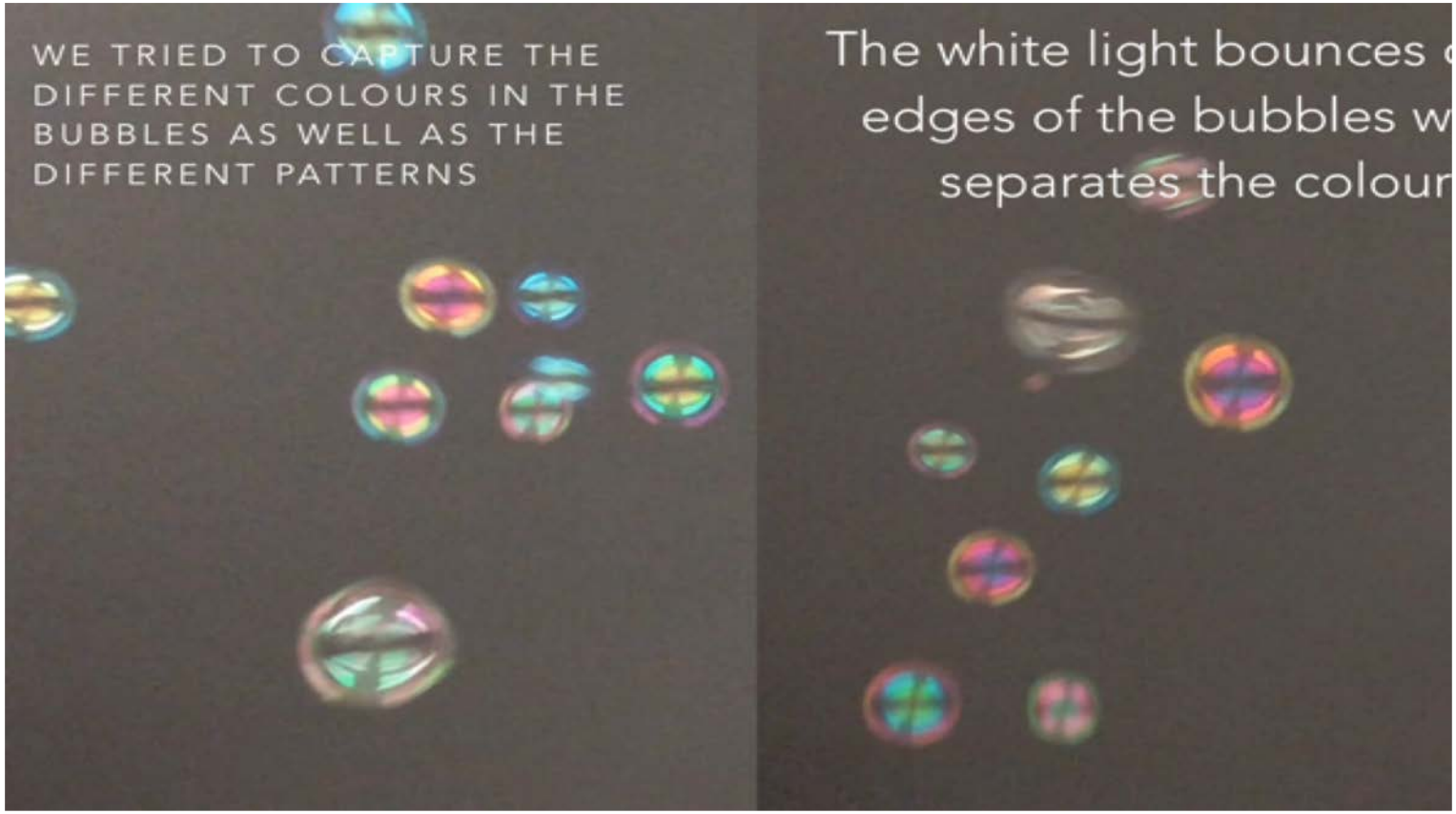
Year 9 students studying the topic of the properties of light.

As part of this unit they had a 90 minute class in the SLRC classroom where they were invited to use a range of provided props (mirrors, figurines, fake eyeball, golf ball, bubble-making facilities) and cameras to create an intriguing “artistic” photo for an exhibition.

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.

Another example



Creating Aesthetic Effects in Science Classrooms

DEAKIN UNIVERSITY

Research Questions

1. To what extent did a focus on students representing aesthetic responses influence what and how students learnt in the topic of light?

2. What were the teacher's perceptions of the value and challenges of this approach?

3. What are implications for future integration of science and arts content and methods?

Hannigan, Tytler & Prain (under review)

Methodological Assumptions and Challenges include:

We assume we can name and explain adequately the object of inquiry (aesthetic feelings/intentions).

However, in this case, the challenges include:

Achieving definitional clarity about the object of study generally, and in science education in particular.

Naming/explaining Influences on aesthetic responses/production over short- and long-term on teacher/student taste for science.

Addressing “transduction” challenges in representing (making claims about) aesthetic responses and their impact.

Transduction

“Transduction” (Volkwyn, Airey, Gregorcic, & Heijkenskjöld, 2016) is the imaginative process whereby learners remake the meaning of a sign in one mode into a sign in a different mode.

”Most feelings are unique to the moment they occur, to the state of the body and its interactivity in/with the surroundings. They are “too specific for words”. It is only when we represent them to ourselves in the terms of verbal language, or classify them as belonging to some class of culturally familiar, if not nameable, feelings that we get the sorts of feeling-types that are commonly referred to (and culturally-specific). (Lemke, 2015, p. 603)

Verbalised aesthetic feelings include awe, wonder, absorption (flow), disappointment, delight, surprise, anticipation, frustration, effortfulness, dismay, pleasure, puzzlement.

This has led to a vocabulary for extended aesthetic experiences, or a subject aesthetic of learnt feelings, including a passion, liking or taste for a subject, for pleasurable “habits”.

Research Methods

Aesthetics has two meanings: intended design/creative effects, and responses to phenomena in terms of these effects (Wickman, 2006)

Practical epistemology of perceptions grounded in experiences (Wickman, 2006)

Focus on how students' perceptions and action are transformed over time;

Treat aesthetic feelings and judgments as contextual facts that shape student actions and intentions.

Focus on how aesthetic judgments promoted by teachers and activity become part of doing science.

Feelings of anticipation, uncertainty, irritation, distaste, disappointment, and success are seen as part of the rhythm of learning sequences, and entail a shift from everyday aesthetics to a disciplinary taste for science.

Further 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.

Methodological challenges in using microgenetic research in the SLRC classroom

If aesthetic responses 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?

(Brock & Taber, 2017)

So what are we studying and why?

Aesthetic responses from a socio-semiotic perspective are feelings where "feeling/meaning is a single material embodied active/interactive process" (Lemke, 2015, p.589).

"Feelings are highly specific, indexing as they do the condition of a very complex, multicomponent, multilevel, interacting system-in-a-surround" (608)

Aesthetic feelings/meanings are always "evaluative" (Lemke, 2015, p. 610)

Like meaning-making, "feeling making" is "situated, context-dependent, active, and culture-specific". (589)

Aesthetic responses are learnt habits of feeling (Peirce, 1931-58)

Why study this in science education? The "feeling-making" divide for learners.

Data Analyses

We analysed samples of student work, and interviewed the teacher and 6 students to identify students' representational meaning-making practices.

Micro-ethnographic analysis entailed using the video record to examine students' and teachers' actions and dialogue representing aesthetic judgments as multi-modal signs and how these related to tasks.

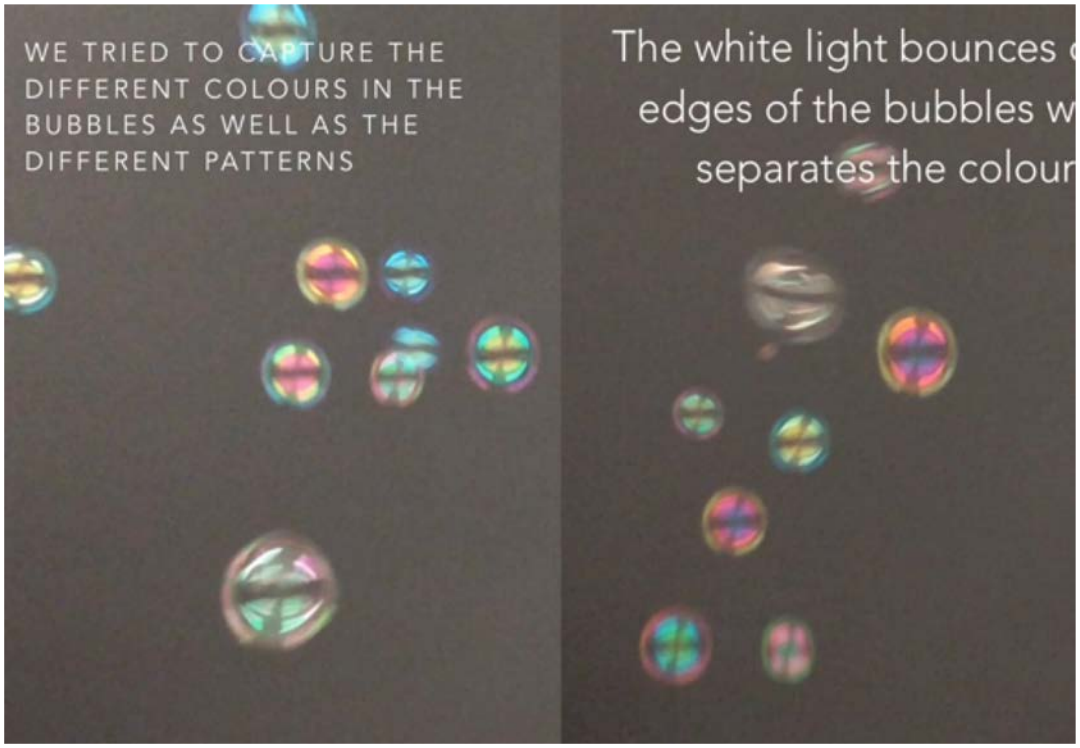
Methodological challenge included characterising and making claims about students' initial and ongoing aesthetic responses and intentions. Reliance on participant self-report entails a double transposition, where students first have to verbalise a non-linguistic response that is then re-interpreted by us.

To address this challenge, we have analysed student actions and dialogue in constructing their art works, including discussions with the teacher, and artefact analyses.

Sample Findings: Student Responses

"In this photo we utilized the mirrors to create a repeating effect with the mannequin", and in a subsequent interview explained: "the reflections in the mirror give a virtual image and you can't work out where the real mannequin ends and the virtual image begins". Their account also makes clear their aesthetic intentions, which were to play with the ambiguity of image and reality, and to utilise lighting strategically: "The golf ball was lit with a flashlight that gave the photo life" and "it's pretty cool". The teacher, in interview, described her surprise at how engaged this particular pair of students were, compared to their normal response to science.

Sample Findings



After discussion with the teacher the students interpreted the science as: “The white light bounces off the edges of the bubbles which separates the colours”

Teacher Response

"This was a very creative way to look at light, and I will use this approach when I teach this topic next time. Too often we present information and do activities such as using mirrors and prisms, but this was a much more interesting way to introduce it. It opened up the topic far more".

"This also led to worthwhile revision. By bringing back the photos and seeing what they had done, it was interesting to find out what the students now understood about the science by looking at them."

"Students need to have visual organizers in science, and it is good for them to have to articulate ideas to show their understanding."

"This was a good way to jog the memory, best to revise with visual stuff, and more fun."

"Hopefully if they look at other images they will consider what is going on."

"The bubble images were the most effective, particularly in colour, but also in black and white. Amazing you can still see the shadows with something so transparent. They are beautiful."

Ongoing Methodological Challenges

1. What should count as enablers and markers of short-term and long-term influences on student taste for this subject?

2. What do we mean by “habits” (routines, orientations, enacted values, scripted procedures or routine-breaking approaches?)

3. What particular topics are generative for linking science and the arts, and why?

4. How adequate was our multi-data, verbal transposition method?

5. How do we support science teachers to value and engage in in-situ aesthetic responses (their own and their students’)?