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Interdisciplinary aesthetics when science and drama are linked

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There is a strong tradition of viewing these two school subjects as mutually enhancing, but aesthetic aspects of this interplay are less studied. In this paper we define disciplinary aesthetics as appreciation and enjoyment of the what and how of learning within and across both subjects. Drawing on Peirce's semiotic theory of signs, we claim that meaning-making from, with and through signs and sign systems (a) is fundamental to learning in both subjects and (b) constitutes a key feature of valuing and contributing to an aesthetic taste for both subjects. We illustrate these claims through examples drawn from secondary and tertiary learning.

KEYWORDS

science, drama, aesthetics, learning, interdisciplinary

Introduction

Science and drama in school have long been viewed as mutually enhancing for student learning in each subject (Aubusson et al., 1997), but the role of disciplinary aesthetics in this learning is less studied. We define these aesthetics as an appreciation and enjoyment of the goals, meaning-seeking and meaning-making processes, resources, procedures, actions, identities and values entailed in learning within and across both subjects (Wickman et al., 2022). This can be felt as a sense of the beauty and pleasure of what is learnt in the moment and over time in each discipline as well as ongoing enjoyment in and valuing of the process. We consider that these spontaneous and learnt responses to what students are expected to notice, use, do, value and share in each subject shape disciplinary aesthetics and deeply influence learning.

We put a case that this shaping of disciplinary aesthetics depends on learning to use and enjoy the sign systems through which meanings are created, reasoned about, enacted and communicated in each subject. We further claim that each subject's sign system, while distinctive, has flexible overlap to support learning in both subjects. In putting this case, we draw on Peirce's (1913) semiotic theory of meaning-making to elucidate this complementarity. We point to emerging research findings about the value of the aesthetic dimension of using sign systems in learning science (Lehrer and Schauble, 2012) and how an expanded range of sign systems can enrich this learning (Tytler et al., 2020). To further illustrate our general case we draw on examples from secondary and tertiary contexts in which two science topics were enriched by drama approaches, and where disciplinary aesthetics overlapped to enhance student learning.

Meaning-making in science and drama

Both Science and drama entail the invention of models/representations (Heathcote, 1984; Lehrer and Schauble, 2006; Nersessian, 2008) that create new accounts of phenomena

(Gooding, 2004), and both disciplines use old and new sign systems to make and share new meanings and critique alternatives. Following Peirce (1913), we claim that meanings are made in both subjects through creating and reasoning through sign systems. In Peirce's theory of meaning-making, meaning is created when signs are interpreted as standing in for referents or other signs. Thus semiosis, or meaning-making, is a recursive, material-conceptual process involving systems of signs in different modes.

Science and drama exist as cultural practices with elaborate material and symbolic resources (sign systems) for seeking and making meanings through representing possible, speculative and modeled experiences and worlds. Scientists integrate linguistic, mathematical, visual and embodied/actional modes in tandem with material manipulation to make warranted claims. In drama, multimodal resources are used to explore, critique, and represent felt experiences and worlds through integrating linguistic, actional/interactional, gestural, visual, aural, temporal, and spatial signs. The inherent multi-modal nature of sign functions in drama intensifies the scope for memorable meaning-making. Both disciplines overlap in their necessary integration of modes, but drama's aesthetic particularly invites personal felt embodied engagement in the meaning-making, whether as participant, spectator or reviewer of a shared experience. We claim that ongoing student engagement with both disciplinary aesthetics can enhance learning by broadening the range of ways that students can make, interpret, review and consolidate meanings through a richer repertoire of signs.

Feelings, aesthetics, and meaning

In Peirce's (1913) semiotics, initial meaning-making in general, and by implication meaning-making in school science and drama, always entails evaluative feelings towards what is being experienced. These feelings also influence the ongoing process of interest in or detachment from this schooling experience, explaining why students may end up liking or disliking these subjects. Lemke (2015), drawing on Peirce, regarded these feelings as inseparable from meaning-making, entailing aesthetic processes that are "distributed, situated, context-dependent, active and culture-specific" (p. 602). Gallagher (2005) claimed that aesthetics in drama brings together the cognitive and affective, as participants collectively come to know a shared imagined world and their sensuous responses to it. Disciplinary aesthetics entails developing positive feelings towards the specific objects, purposes and outcomes associated with disciplinary practices, whether these are material objects [such as a worm in science (Bloom, 1992) or props in a roleplay or production], experiences (such as fieldwork in environmental inquiry, or taking part in a drama improvisation), conceptual constructs (such as the elegance or power of theories) or practices (such as designated roles in particular drama genres, such as mantle of the expert).

Aesthetics of sign-making in science and drama

Aesthetic values and choices inform the work of scientists and professional theatre-makers. These values and choices also infuse school drama, whether improvised or more formal, and school

science. Wickman (2004) demonstrated the aesthetic commitments of scientists in developing new knowledge, and of students negotiating understanding and developing interest in scientific ways of looking at the world (Anderhag et al., 2015). Jakobson and Wickman (2008) demonstrated that teachers' aesthetic focus enticed students into grappling with conceptual learning. Ferguson et al. (2022) described how the process of learning data modeling processes entailed students shifting from an "art" aesthetic of visual attractiveness to a disciplinary aesthetic of appreciation of a data set that could be explored productively through mathematical concepts such as central tendency and distribution.

In advocating a broader repertoire of representations in school science, we noted gains in student learning above expectations (Tytler et al., 2013). Other studies indicate how students' aesthetic responses productively influence science learning (Jakobson and Wickman, 2015; de Mesa, 2018; Tytler et al., 2020). Interdisciplinary art-science learning sequences show the distinct but overlapping and mutually reinforcing disciplinary aesthetics (Tytler et al., 2020; Hannigan et al., 2021).

In drama, this aesthetic occurs as participants work together to move in and out of imagined worlds. Heathcote (1984) noted the importance of drama's sign systems, the "sign of the person, in action, using all objects, significant space, pause, silences, and vocal power" (p. 162). Abbs (1989) explained how such non-discursive symbols of art (drama) are powerful in creating and formulating meaning and value, as they bring "sentience, emotion, feeling, aspiration to consciousness by artistically embodying them in such a way that they are understood" (p. 36). McLean (1996) proposed an aesthetic framework for drama where three conditions enable a drama aesthetic to occur: the importance of dialogue; experiential learning and teacher/students working as co-artists; and critical reflection. We illustrate these aesthetic effects in the following two interdisciplinary vignettes, where we argue that intermingling the two subjects enriches the aesthetics of both.

Vignette: trash puppets

This vignette, drawing on Hannigan et al. (2021) and Hannigan and Ferguson (2021) describes research into the aesthetic entailments of science-art activities, and the use of drama to enrich learning about endangered species. The setting was a school-based art-science project, culminating in a performance at the local zoo. Students investigated an assigned endangered animal, then constructed puppets of these animals for a theatre presentation. They worked in groups to build their puppet from recycled materials (e.g., wire, bubble wrap, fabric off-cuts, plastic bags and bottles, twine and plant material). They then produced a script and a backdrop for a portable "theatre in a suitcase" for an audience of pre-school children and their parents at the zoo. This was part of the zoo's endangered species campaign. We draw on quotations from the published research, using Wickman's (2004) practical epistemological analysis to interpret video capture of student and teacher interactions.

One group of students created a Baw Baw frog, endangered through habitat loss and a fungal disease. These frogs are unusual for their high altitude habitat, and are inactive during the snow season. Students were challenged to create a drama aesthetic of persuasive representation that served twin purposes of representing the physical

and behavioural features of the frog pertinent to its endangered status (a science aesthetic of explanatory accuracy) that would enable its appropriate manipulation in the theatre, and also have empathetic appeal (a drama aesthetic related to production values and persuasive representation through character creation).

Hannigan and Ferguson (p. 167) point out that the material nature of doing science and performing art/drama potentially enables student reorientation in relation to the more than human, and the human worlds. Students performing the Baw Baw frog were impressed with its general inaction in the investigation of its status (Hannigan et al., 2021, p. 9):

S1: Yeah, the Baw Baw frog does not use its legs for anything [laughing]. That's why they are dying out – they are too bloody lazy.

In the drama performance, they conveyed this metaphor of laziness through representing the frog on a couch:

Student 3: Yeah 'cause that's one of its main traits so we just wanted to emphasise that and play on that—because it's pretty relatable.

Researcher: And were you considering your audience when you...

Student 4: Yeah, we made it more of a relatable frog because if we just said it laid on its back people would not pay as much attention, so we made it a couch potato who likes to play footy and watch it (Hannigan and Ferguson, 2021, p. 171).

The puppets as models thus acted metaphorically, with students connecting with the animals through knowledge of their physiology's nature and function and complicity in their endangered status. Two aesthetics are at work: enjoyment in the science aesthetic of articulating structure and function relations with environmental changes as an explanatory narrative: and the drama aesthetics of preparing the puppets and performing them as a metaphor and empathetic model for the animal's plight (See Figure 1).

This attention to shaping metaphor to the audience is part of the sign system of drama. Students acknowledged the power of what they were doing to engage the younger students with learning the science:

Student: It's an engaging way to kind of communicate what we have learnt with the students and stuff because obviously seeing a puppet they are interested and want to learn more about it.

Hannigan and Ferguson refer to Mello's (2016, p. 49–50) proposition that the puppeteer-puppet are performing between themselves a trans-embodied dialogue of new meanings. Material embodied engagement is part of a dramatic sign system that opens up possible new insights and feelings for both actors and audience.

There was evidence of the audience relating to this metaphorical device. In the case of the helmeted honey eater (Figure 2):

Adult audience member 1: Ah that's cool! So, you can actually, move its head around and make its arms flap at different rates....: It's really good. It's got personality too, it's amazing how much personality they all have! (Hannigan and Ferguson, 2021, p. 174).

The aesthetic dimensions of drama work to create a convincing and empathetic subject as intended by the students.

The science related to endangerment (structure and function, ecology, and socio-ecological changes) was made meaningful at a personal and performative level through understanding and appreciating drama's sign systems. The animal could not be presented directly as a convincing subject for understanding and empathy through these science concepts, but is transformed into a metaphor in a narrative setting, eliciting audience attention and appreciation.

Vignette: stem-cell drama

This learning sequence, a two-hour drama workshop for preservice secondary science teachers, was designed to support topic learning as well as how to address controversial issues in science, a part of the senior secondary science curriculum (Raphael and White, 2021; White and Raphael, 2023). Complex issues around the proliferation of stem-cell therapies were explored. Here process drama strategies were applied to learning, with no intended product or performance for an external audience, but rather the participants (students and teacher) were at times both actors and audience. We draw on data previously reported from field notes in the published research above. The workshop began with purposeful theme-connected warm-up activities, including using bodies to create still images to interpret and represent stem-cell news headlines. These strategies facilitate learning sign-systems of co-creating worlds through drama, providing a gradual entry point for less experienced drama participants.

In a final role-play, having identified stakeholders in stem cell therapies (patients, therapists, researchers, medical experts, family members, ethics and government officials, company representatives and investors) small groups were allocated a category (e.g., patients) to research. They held a preparatory discussion to refine and ensure there were diverse viewpoints represented within each category. With students-in-role as the stakeholders, and teacher-in-role as the host of a television current affairs forum a whole-class improvised role-play began. The space was arranged, the scene set and performers were "live on air".

Through dramatic conventions that bring to life key features of stakeholders' (imagined) lived experience, participants have fleshed out the complexity of this scientific issue of stem-cell research and development. For a time, we have lived it. We now comprehend it differently, we appreciate the diverse perspectives, and we can begin to critically reflect on what might be done. We have created a safe space in which to experiment with controversial and even dangerous ideas. Participants have been enticed into an imagined world through linguistic and other signs relevant to creating each of the participant roles. There is tone and rhythm in voice, volume and silences. Physical signs include posture, gestures and the arrangement space as a television studio, with roles positioning emblematic characters in relationship to each other in a state of dramatic tension. The orchestration of these signs rendered the imagined world of the "live" television program authentic, satisfying to the senses, emotions, and intellect. The co-creation of dramatic space created aesthetic engagement, and what Greene (1977) terms a "wide-awakeness". We were our own audience, but if there had been an invited audience,



FIGURE 1
The Baw Baw frog “coming to life” on a couch, in the “theatre in a suitcase”.



FIGURE 2
The endangered helmeted honey-eater being manipulated in the theatre in a suitcase.

they too would have engaged and learned something about this complex socio-scientific issue.

Discussion points

The vignettes demonstrate both the role of sign systems in disciplinary aesthetics in learning in each subject, and the different ways these sign systems can interact, enriching what is learnt and what is felt about this learning. In the Baw Baw frog example, students learnt through attending to, and valuing both (a) the interactions between structure and function of the frog and its changing ecological conditions, realised through the material sign systems of the puppet construction and the endangerment narrative and (b) appreciation of the metaphorical sign systems embedded in their dramatization. In the stem-cell drama example, student understanding of the complexity

of the science-society interactions of stem-cell research and development was enriched through immersion in the sign systems of a TV talk show, and through narrative creation representing stakeholders' perspectives. In both cases the science context opened up opportunities to appreciate the particular dramatic conventions/sign systems that breathe life into these science concepts and their societal settings. Engaging with these sign systems is fundamental to the aesthetics of enjoying, appreciating and valuing the meaning-making in each case. However, as with any pedagogical work, the science and drama links need to be strategically planned to be mutually supportive.

Rather than these cases opening up an interdisciplinary aesthetic that has a meta-character, we argue that the interplay of disciplinary aesthetics that span the science-drama boundary enriches the aesthetic appreciation of each. However, over time this kind of interplay will potentially alter what students experience and enjoy as the aesthetics of each subject. In terms of enabling this interplay, the sign systems in each subject are sufficiently overlapping and flexible to mediate richer meaning-making, valuing and learning in both disciplines. Science has become more human, less abstract, and drama can enable and enact important insights into scientific practices and their effects. The aesthetics dimensions of science opened up by these drama activities are well-represented in scientists' practices within the fields of ecology, and stem-cell R&D processes.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by the Deakin University Human Research Ethics Committee. The studies were conducted in accordance with the local legislation and institutional

requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin. Written informed consent was obtained from the individual(s), and minor(s)' legal guardian/next of kin, for the publication of any potentially identifiable images or data included in this article.

Author contributions

VP: Conceptualization, Writing – original draft, Writing – review & editing. RT: Conceptualization, Writing – original draft, Writing – review & editing. JR: Conceptualization, Writing – original draft, Writing – review & editing.

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References

- Abbs, P. (1989). *A is for aesthetic: essays on creative and aesthetic education*. Barcombe, Sussex: The Falmer Press.
- Anderhag, P., Hamza, K. M., and Wickman, P.-O. (2015). What can a teacher do to support students' interest in science? A study of the constitution of taste in a science classroom. *Res. Sci. Educ.* 45, 749–784. doi: 10.1007/s11165-014-9448-4
- Aubusson, P., Fogwill, S., Barr, R., and Perkovic, L. (1997). What happens when students do simulation-role-play in science? *Res. Sci. Educ.* 27, 565–579. doi: 10.1007/BF02461481
- Bloom, J. D. (1992). The development of scientific knowledge in elementary school children: a context of meaning perspective. *Sci. Educ.* 76, 399–413. doi: 10.1002/sci.3730760405
- de Mesa, J. A. L. (2018). Peirce and aesthetic education. *J. Philos. Educ.* 52, 246–261. doi: 10.1111/1467-9752.12296
- Ferguson, J., Tytler, R., and White, P. (2022). The role of aesthetics in the teaching and learning of data modelling. *Int. J. Sci. Edu.* 44, 753–774.
- Gallagher, K. (2005). The aesthetics of representation: dramatic texts and dramatic engagement. *J. Aest. Educ.* 39, 82–94. doi: 10.1353/jae.2005.0038
- Gooding, D. (2004). "Visualization, inference and explanation in the sciences" in *Studies in Multidisciplinarity*. ed. G. Malcolm, vol. 2 (Amsterdam, The Netherlands: Elsevier), 1–25.
- Greene, M. (1977). Toward wide-Awakeness: an argument for the arts and humanities in education. *Teach. Coll. Rec.* 79, 119–125. doi: 10.1177/016146817707900105
- Hannigan, S., and Ferguson, J. (2021). Art-Science Education in the Anthropocene: Embodied Metaphor with Puppets and Performance, In: *Science and Drama: Contemporary and Creative Approaches to Teaching and Learning*. eds. P. J. White, J. Raphael and K. van Cuylenburg. Cham: Springer. 163–178. doi: 10.1007/978-3-030-84401-1_10
- Hannigan, S., Wickman, P.-O., Ferguson, J., Prain, V., and Tytler, R. (2021). The role of aesthetics in learning science in an art-science lesson. *Int. J. Sci. Educ.* 44, 797–814. doi: 10.1080/09500693.2021.1909773
- Heathcote, D. (1984). "Signs and portents" in *Dorothy Heathcote: collected writings on education and Drama*. eds. L. Johnsons and C. O'Neill (London: Hutchinson), 160–169.
- Jakobson, B., and Wickman, P.-O. (2008). The roles of aesthetic experience in elementary school science. *Res. Sci. Educ.* 38, 45–65. doi: 10.1007/s11165-007-9039-8
- Jakobson, B., and Wickman, P.-O. (2015). What difference does art make in science? A comparative study of meaning-making at elementary school. *Interchange* 46, 323–343. doi: 10.1007/s10780-015-9262-6
- Lehrer, R., and Schauble, L. (2006). "Cultivating model-based reasoning in science education" in *Cambridge handbook of the learning sciences*. ed. K. Sawyer (Cambridge, MA: Cambridge University Press), 371–388.
- Lehrer, R., and Schauble, L. (2012). Seeding evolutionary thinking by engaging children in modeling its foundations. *Sci. Educ.* 96, 701–724. doi: 10.1002/sci.20475
- Lemke, J. (2015). "Feeling and meaning: a unitary bio-semiotic account" in *International handbook of semiotics*. ed. P. P. Trifonas (Dordrecht: Springer), 589–616.
- McLean, J. (1996). An aesthetic framework in Drama: issues and implications. *NADIE Research Monograph Series No. 2:NADIE*.
- Mello, A. (2016). Trans-embodiment. *Perform. Res.* 21, 49–58.
- Nersessian, N. (2008). "Model-based reasoning in scientific practice" in *Teaching scientific inquiry: recommendations for research and implementation*. eds. R. Duschl and R. Grandy (Rotterdam: Sense Publishers), 57–79.
- Peirce, C. S. (1907/1998). Pragmatism. In N. Houser, TienneA. De, J. R. Eller, C. L. Clark, A. C. Lewis and D. B. Davis (Eds.), *The essential Peirce – selected philosophical writings – 2* (1913) (pp. 398–433). Bloomington IN: Indiana University Press.
- Raphael, J., and White, P. J. (2021). "Transdisciplinarity: science and Drama education developing teachers for the future, Ch. 9" in *Science and drama: contemporary and creative approaches to teaching and learning*. eds. P. J. White, J. Raphael and K. van Cuylenburg (New York: Springer)
- Tytler, R., Prain, V., and Hannigan, S. (2020). Expanding the languages of science and how they are learnt. *Res. Sci. Educ.* 52, 379–392. doi: 10.1007/s11165-020-09952-8
- Tytler, R., Prain, V., Hubber, P., and Waldrip, B. (Eds.). (2013). *Constructing representations to learn in science*. Rotterdam, The Netherlands: Sense Publishers.
- White, P. J., and Raphael, J. (2023). "Drama for teaching controversial issues in science" in *Learning science through Drama. Contributions from science education research*. eds. D. McGregor and D. Anderson, vol. 11 (Cham: Springer)
- Wickman, P.-O. (2004). The practical epistemologies of the classroom: a study of laboratory work. *Sci. Educ.* 88, 325–344. doi: 10.1002/sci.10129
- Wickman, P.-O., Prain, V., and Tytler, R. (2022). Aesthetics, affect, and making meaning in science education: an introduction. *Int. J. Sci. Educ.* 44, 717–734. doi: 10.1080/09500693.2021.1912434

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