

Open Pedagogy and Transdisciplinary Thinking: Making Connections Through a Visual Artifact Self- Study

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Abstract

The examination of teacher educators' own practices through self-study research has been well established and self-study aligns with the growing interest in open educational resources (OER) and open pedagogy. This research used a self-study method of a Science, Technology, Engineering, Art, and Mathematics (STEAM) OER project, Form and Function(s): Sustainable Design meets Computational Thinking. Two research questions were pursued: How do open pedagogy attributes contribute to a transdisciplinary STEAM OER pedagogical stance? And how can one apply visual artifact self-study as intentional critical friends to examine professional value and to enhance pedagogical self-understanding? The researcher analyzed visual artifacts of created and documented images that supported the process of her interrogations of transdisciplinary curriculum development and open pedagogy. The sites and modalities of the artifacts were questioned and answers recorded using a critical visual methodology. Klein's (2008, 2018) transdisciplinary thinking and the eight attributes of Hegarty's (2015) open pedagogy frame the interrogation of the images and the connections made to curriculum theorizing. The self-study provides conclusions to the role of visual artifacts when conceptualizing the gestalt of complex ideas and relations. The self-study provides warranted assertions for open educators and researchers interested in the practices of transdisciplinary, open curricular and pedagogical processes alongside the eight attributes of open pedagogy, and the role of critical self-reflection.



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Introduction

Openness in education involves practices, pedagogical tools, and the philosophical approach that can potentially cause a shift in teaching and learning. Although it is difficult to state that at one particular moment openness in education emerged (Bozkurt, 2019), it is clear the intertwining of digital technologies alongside social and cultural practices have affected the affordances of teaching and learning. The focus of this study is exploring what open educational resources (OER) are and how OER were made, but concomitant to such inquiry is the examination of transdisciplinary thinking and its relationship to OER, open pedagogy, and open practices. Using visual artifacts as a tool of self-study inquiry, I employ pragmatics and conceptualizing inherent to the OER produced as part of contributing to a meta-perspective relating open pedagogy and transdisciplinary thinking.

Background

In the spring of 2020, an interdisciplinary faculty assemblage from Athabasca University began the Science, Technology, Engineering, Art and Mathematics (STEAM) OER project, *Form and Function(s): Sustainable Design Meets Computational Thinking* (Blomgren, 2021). The term interdisciplinary in this context is defined as the integration of the concepts, methods, and theories from two or more disciplines as a pathway to solve complex problems (Biox-Mansilla, 2017). Through brainstorming and collaborating, this project brought together concepts from high school Biology, Math, Art, and Computing. With an overall consultancy membership of 13 faculty from Architecture, Biology, Mathematics, Computing, and Education and a smaller design team of five, we collectively created flexible and open learning assets. The partner and funder was Callysto, a Canadian digital portal that supports the teaching of youth with free online tools for learning data analysis, visualization, coding, and computational thinking. The funding through Callysto paid for animation expertise and two research assistants, one developing Jupyter notebook coding assignments and the other supporting pedagogical decisions based in the multi-disciplinary faculty content suggestions. By the end of the project, the OER design plans included teaching and learning activities, Jupyter coding activities, and an eight-minute animation.

The brainstorming for the project originated with transdisciplinary thinking. When architecture, the natural sciences, mathematics and computing intermingle something beautiful and purposeful may occur. The project genesis aimed to challenge high school students to think computationally by considering the notion of “design” through three perspectives on form and function. Firstly, this OER endeavour challenged students to consider a structure’s architectural form in the context of its function within the ecology in which it belongs. Secondly, through the natural sciences students explore nature’s designs created through natural selection. Finally, abstracting form and function through a mathematical and computational perspective focuses on how modelling and coding can emulate natural selection’s form and function. The learning and the three perspectives coalesce when students apply, model, and code evolutionary algorithms to design better buildings, individually and collectively, within a natural environment.

The design team applied a backward design process (Wiggins et al., 2005) focusing on STEAM essential questions framing the learning pathways and introducing different perspectives of form and function in sustainable design. The OER assets, including the animations, have flexibility as granular items or can be stacked and used as an interdisciplinary unit. We aimed for students to recognize that computational thinking does not necessarily equate to mathematics and

computing; rather, mathematics and computing are tools that facilitate computational thinking. The interdisciplinary team's draft OER received peer review feedback from high school teachers, asynchronously as part of an OER Sprint concept, with participation numbers were affected by the global pandemic. The refinement and iterative co-design of the learning materials furthered the practical aspects of teaching computational thinking through three perspectives on "design". By using CC BY licenses, these open assets were shared on the OER Commons platform (e.g., an OER digital library), the Callysto website, and the Callysto YouTube channel, supporting the ability for students to share, revise, remix, or redistribute.

The design team included the roles listed below. In total, more than twenty people had some degree of input and involvement with this project, representing six disciplinary areas (Mathematics, Computing, Biology, Architecture, Art, and Pedagogy).

- A Math lead
- A Computing lead
- An Architectural lead
- A Pedagogy lead
- Two research assistants (one for coding, one for pedagogy)
- Nine additional faculty to support math, computing and architecture content development
- Two studio contracted animators
- Two staff from the partner Callysto
- Volunteer high school teachers (involvement varied due to COVID-19 influences)

Research Questions

This self-study research (Hamilton & Pinnegar, 2013; Hauge, 2021; Samaras, 2009) applies a visual methodology using images found or created during the project (Rose, 2016) to reflect upon the challenges and realities from an educator fluent in understanding curriculum theory, OER, and open pedagogy yet limited in her knowledge of STEAM education. Insights gained relate to the importance of understanding (a) reflection-upon-action (Schon, 1983) and transdisciplinary mental models (Senge, 2006); (b) the challenges of OER co-design with discipline experts and teachers; and (c) the importance of the eight attributes of Open Pedagogy (Hegarty, 2015) to support the co-design processes of STEAM OER. My curiosity centred on the following questions:

1. How do open pedagogy attributes contribute to a transdisciplinary STEAM OER pedagogical stance?
2. How can one apply visual artifact self-study as intentional "critical friends" to examine professional value and to enhance pedagogical self-understanding?

Conceptual Framework

To strengthen self-study research efforts a clear conceptual framing is essential ((Vanassche & Kelchtermans, 2015). Pragmatism, open pedagogy, and transdisciplinarity nest together to inform the theoretical and conceptual of this inquiry and provide structure to the visual interrogations.

Pragmatism

The self-study design of the Form and Function(s) OER project sits comfortably with pragmatism, with its open education and transdisciplinary flavour and long history with

educational research. Fluidity was a secondary flavour to the project through involving a wide variety of people and disciplines, learning activities, and final outputs. Accordingly,

pragmatists believe that reality is not static—it changes at every turn of events. Similarly, the world is also not static—it is in a constant state of becoming. The world is also changed through actions—action is the way to change existence. Actions have the role of an intermediary. Therefore, actions are pivotal in pragmatism. (Kaushik & Walsh, 2019, p. 3)

Additionally, in pragmatism: (a) actions cannot be separated from contexts (e.g., they are relationally embedded); (b) actions have consequences, both of which are subject to change; and (c) actions are based from worldviews which are simultaneously unique yet through social sharing hold points of confluence with others (Kaushik & Walsh, 2019). For John Dewey (Hildebrand, 2018) one of the noted thinkers of pragmatism, human experience is rooted in contexts, emotions, and social connections—inquiry forms one type of human experience. Morgan (2014) summarizes Dewey's inquiry process as: (a) recognizing a problem within a situation; (b) determining the problem's definition after considering several perspectives on it; (c) selecting a pathway of action; (d) assessing potential actions with their possible consequences; (e) taking actions that address the situation's problem. Inquiry marks a process whereby "beliefs that have become problematic are examined and resolved through action. It is a process of making choices by asking and answering questions, in which those questions concern the likely outcomes of applying current beliefs to future action" (Morgan, 2014, p. 1047).

Open Pedagogy

From pragmatism flows the connection to Hegarty's (2015) eight attributes of open pedagogy (see Figure 1). These attributes nest within human experiences of a teaching and learning context, including both emotions and social connections. Participatory Technologies inhere the experiences of participating enabled by digital technologies and energizes the other seven attributes. People, Openness, and Trust come together, coalescing as an attribute larger than the individual parts and signal the importance of both emotions and social connections. Innovation & Creativity infused the Form and Function(s) OER project and the design processes, not only in the process of creating the animation, but also in the coding activities created using a Jupyter notebook for open-source input/output code, text and visualizations. Again, social connections appear in the three attributes of Connected Community, Sharing of Ideas & Resources, and Peer Review. When these experience attributes occur organically, emotions and social connections percolate forth. The seventh attribute, Learner Generated (e.g., content), was included in the initial project design as well as with the affordances of CC BY licensing. Lastly, Reflective Practice informs this visual artifact self-study and enables an inquiry into high school STEAM curriculum and OER beliefs and actions.

Transdisciplinarity

Most scholars are familiar with the term interdisciplinary, as defined earlier using Biox-Mansilla's (2017) framework; however, there is less familiarity with transdisciplinarity (TD) and its movement to transcend disciplines through an "overarching set of axioms associated historically with unity of knowledge and later synthetic paradigms" such as general systems theory, feminist theory, and sustainability (Klein, 2018, p. 11). TD is also connected to "problem-oriented research that generates new conceptual and methodological frameworks and involves stakeholders in society in the research process" (Klein, 2018, p. 11).

Figure 1*Eight Attributes of Open Pedagogy*

Note. Reprinted from [Design Attributes of Open Pedagogy by Bronwyn Hegarty](#), by Michael Paskevicius, 2017. [Licensed CC-BY 4.0](#).

Building upon the more well-known interdisciplinary thinking, and to assist understanding of TD, Klein (2018) created a conceptual TD vocabulary. Her list includes terms such as adaptive and generative learning, collaboration and collaborative learning, integrative learning, mutual learning, reflexivity and reflexive equilibrium, relational thinking, socio-cognitive platforms for communication, transactivity, transformational and deep learning, and transdisciplinary orientation. She provides an historical overview of TD and relates bonds to Dewey among others with an emphasis on experiential learning. There are also TD ties to gestalt psychology (Zwicky, 2019) and Piaget's *cognitive disequilibrium* amended through *metaperspectives* with the end purpose of *advancing knowledge* rather than truth claims (Boix Mansilla, 2017).

As Klein (2008) noted in her literature review of interdisciplinary and transdisciplinary research “the multidisciplinary–interdisciplinary–transdisciplinary environment is not a set of mutually exclusive categories. Research is too complex...” (p. 117). Learning theories for transdisciplinary theories are nascent at best, with interdisciplinary cognitive-epistemological foundations still emerging within the literature. In her discussion of interdisciplinary learning, Boix Mansilla posits a constructionist pragmatic. This orientation holds a

pluralistic epistemology [that] invites the inclusion of other symbol systems (visual, musical, kinesthetic) and ways of knowing such as artistic interpretations or literary fictions. Interdisciplinary understanding can thus be viewed as a ‘*system of thought in reflective equilibrium*’—*embodying insights and tensions across disciplines, representing an improvement over prior beliefs and remaining open for review.* (2017, p. 8, emphasis added)

As part of interdisciplinary projects, four cognitive processes occur: “establishing purpose; weighing disciplinary insights; building leveraging integrations; and, maintaining a critical stance” (Boix Mansilla, 2017, p. 8). Although the Form and Function(s) OER project was a transdisciplinary project, it scaffolds upon what has been previously established from interdisciplinarity, scant as the scholarship on transdisciplinarity may be.

Reflection

From the overview above, one notices the repetition of inquiry (Hildebrand, 2018), reflective practice (Hegarty, 2015), reflexivity (Klein, 2018), and reflective equilibrium (Boix Mansilla, 2017). These themes resound with self-study research. Self-reflective practices date back to various scholars but especially to the work of Schon (1983) and his interest in the reflexivity that professionals have and continue to develop over time as they reflect upon their work. Schon’s concept of *reflection-on-action* informs this research study which requires one to think back upon a problem or situation in order to pull it apart, analyzing and studying to create new understanding of the situation (Meierdirk, 2016). Within faculties of education, self-study research encourages professors to align their teaching intentions with their professional actions (Loughran, 2007). Arising from the 1990s and the growing awareness of the scholarship of teaching and learning within higher education, self-study research holds two aims: (a) the improvement of an individual educator’s practice; and (b) the published exploration of teaching expertise contributing to the broader scholarship of teacher education (Loughran, 2007). These explorations are part of a broader knowledge mobilization aim that shares out the self-study to strengthen and extend the scholarship of pre-service and in-service teacher education (Loughran, 2007; Vanassche & Kelchtermans, 2015). Integral to this form of research is the commitment to show the ways and means in which personal theories of the researcher are challenged beyond the personal alone.

There is no one method ascribed to self-study research (Vanassche & Kelchtermans, 2015). Traditionally, the use of critical friends has been the primary manner to challenge personal theorizing. For this study, instead of inquiring critical friends, the interrogation of the visual artifacts provide an example of extending self-study research into the realm of digital things and post-human inquiry (Adams & Thompson, 2016). Teaching experiences in the forms of interviews, audio/video documentation of teaching, observations, autobiographical reflections, collage, and poetry have been captured as data in self-study research (Samaras, 2009; Vanassche & Kelchtermans, 2015). Critical visual methodology, a relatively new approach, were not captured in a recent systematic literature review of self-study (Vanassche & Kelchtermans, 2015) yet fits within the varied data collection and genres these authors uncovered.

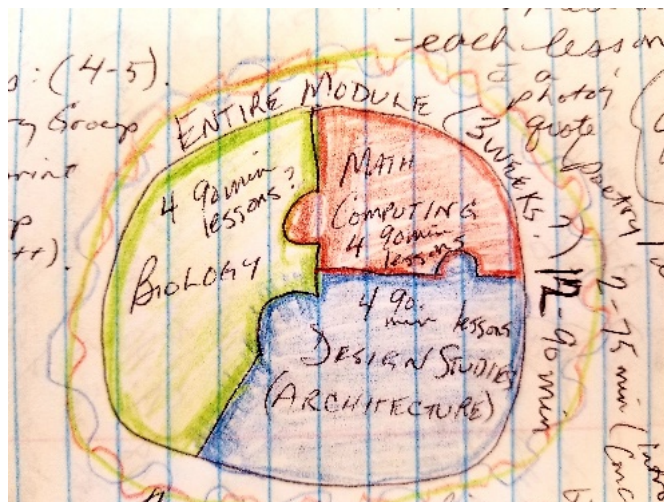
Research Method

To support the reflection process and addressing self-study trustworthiness, integrity, credibility, and authenticity (Vanassche & Kelchtermans, 2015), I applied a critical visual methodology. Critical visual methods have increased in popularity and supply different perspectives on data collection and innovations within research methods (Rose, 2016). Because the Form and Function(s) OER project created an eight-minute animation, a visual methodology seemed highly appropriate. The nature of self-study requires images that have convenient copyright access. This led to artifacts of which I held copyright (see Figure 2) or openly licensed images (see Figures 3, 4, and 5). Additionally, because this project included creating openly licensed learning assets, use of images with creative commons licenses as part of my research decisions reinforced aspects of the eight attributes of open pedagogy. Since the project lasted for nine months, the images correspond to various times within the project’s overall chronology, with the

first image emerging early within the initial stages of the project and the last image occurring in the polished version of the animation.

Figure 2

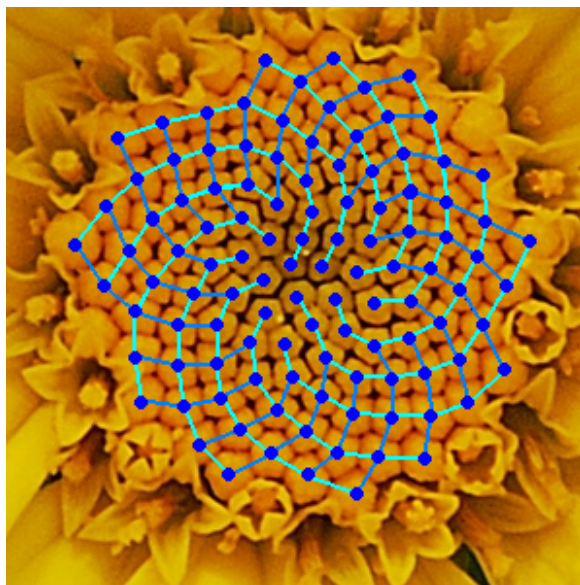
Visual Artifact 1: Initial Sketch



Note. Photo by Connie Blomgren is licensed under [Creative Commons Attribution 4.0 \(CC-BY\) International](https://creativecommons.org/licenses/by/4.0/)

Figure 3

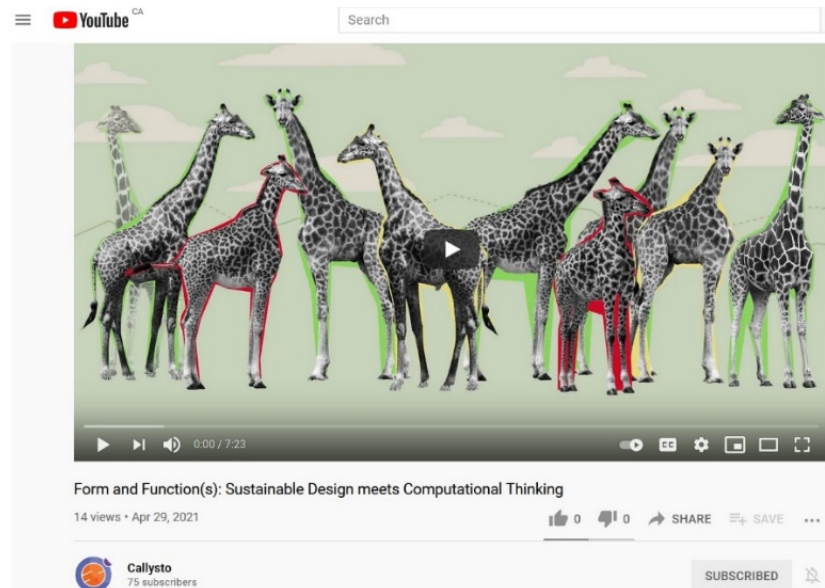
Visual Artifact 2: Fibonacci Chamomile



Note. This image was used in a presentation about the Form and Function(s) OER project for an open education virtual conference. From [FibonacciChamomile](https://commons.wikimedia.org/wiki/File:FibonacciChamomile), by Wikimedia, 2014. [Licensed CC-BY 2.5.](https://creativecommons.org/licenses/by/2.5/)

Figure 4

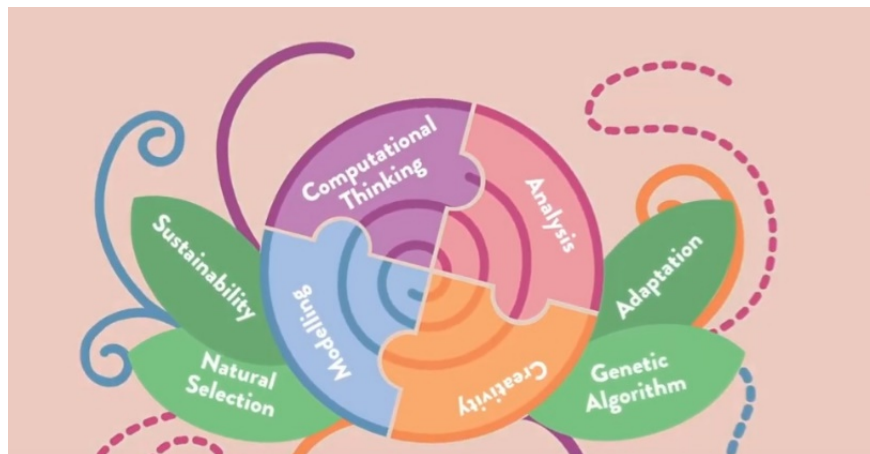
Visual Artifact 3: Giraffe Design



Note. From [Form and Function\(s\): Sustainable Design meets Computational Thinking](#), by Callysto, 2021. [Licensed CC-BY 3.0](#).

Figure 5

Visual Artifact 4: STEAM Form and Function Flower Animation



Note. From [Form and Function\(s\): Sustainable Design meets Computational Thinking](#), by Callysto, 2021. [Licensed CC-BY 3.0](#).

In applying a critical visual methodology, a series of questions were posed of the image artifacts. These questions were nested within the four sites of a critical visual methodology which include: a) the site of production; b) the site of the image itself; c) the site of its circulation; and d) the site of its audiencing. These four sites also have different modalities: the technological, the compositional, and the social (Rose, 2016). The technological modality connotes a “visual technology...[that] can be relevant to how an image is made but also to how it travels [emphasis added] and how it is displayed” (Rose, 2016, p. 25). Technological questions include: how was the image made? How is it displayed? How is it circulated? Composition as a modality refers to the formal visual strategies of content, colour, line, medium. Its interrogative questions include: What is the genre? What is the composition? What is the image relationship to other texts that surround it? Lastly, the social mode encompasses a broad capture of economic, social, and political relations, including the institutional practices that surround an image and through which the image is viewed and may be used. The social modality allows for questions such as: What are the visual meanings? Who(m) organized the circulation of this image? How is it interpreted – by whom and why? (Rose, 2016).

For each image, the sites of production, the image itself, its circulation, and its audiencing were examined through the questions of the three modalities. Using a direct question and answer format, I responded to 15 separate questions to engage in the self-study analysis.

Interrogations of the Visual Artifacts

The framework of the four sites and three modalities for interpreting images allowed for a variety of written responses. The framework questions acted in place of a self-study’s critical friend and were therefore used to frame, explore, and challenge my teaching practice and beliefs regarding co-creating open curricular assets. Through interrogating each of the artifacts, three threads emerged.

Thread One: Conveying Complex Ideas

Through the questions, answers revealed the topic of the complexity of developing transdisciplinary OER high school curriculum and the strength of conveying complex ideas through an image that is, through a gestalt experience (Zwicky, 2019). For Artifact 1, questions of the site of production and its technological modalities produced the following reflections:

I used pen in my scribbler notebook to help conceptualize for myself how the 4 disciplinary areas would be identifiable yet interlocking into the overall “all path way” interdisciplinary/transdisciplinary teaching plans. I used the coloured pencils to help indicate the discipline yet the wavy lines around the circle are braids of the red, green and blue. I was purposeful in selecting the colours too green = life/biology; blue = ideas & concepts/design studies; red = math & computing, like blood coursing through life and ideas. The pieces interlock with each other, the 3 discipline areas interlocking within the braiding, the transdisciplinary, supercircle that encases it all. (Site of production; Technological mode)

Examining the site of production and composition of Artifact 2 delivered this observation:

It falls into explanatory/educational photography as it is a derivative of the original photo Fibonacci Chamomile to which the user Alvesgaspar employed software to draw in the blue dots and their connections. The digital overwriting on the image represents

Fibonacci numbers and their relationship to nature's patterns, such as found in a Chamomile flower (although it looks more like a sunflower to me). Explaining through words (diachronic) may lose someone depending on many factors (e.g. auditory skills, auditory processing, language known, etc.) yet the image with the blue overwriting is a synchronic, gestalt of how Fibonacci numbers "work." (Site of production; Compositional modality)

The screenshot that captured the giraffes depicting hereditary gene selection (AArtifact 3) offers this insight regarding the site of the image and its technological modality:

Visual effects? Yes – there are loads of them within the animation – yet I am only looking at the screenshot. The giraffes are looking in various directions and angles, with different heights...I read this as personalities and the various heights of the animals also speak to diversity (which is a sub-theme throughout the content created). Yet there is similarity in the black and white spots, and their curious faces, looking at the viewer. The use of the coloured outlines provides visual emphasis. So these are subtle design choices that shape the experience of looking at the giraffes. (Site of image itself; Technological modality)

Artifact 4 (interrogations lead to the following reflections:

Who? When? Who for? Why? The hired animators co-created this image from the one I emailed to them in November of 2020. I sent them the image because I felt we needed a graphical advanced organizer to help provide a conceptual map of the discipline areas and major topics covered in the animation. Labelling the parts (as one does in a science illustration) helped to ensure all concepts were acknowledged at the beginning of the animation. Without this conceptual framing, that is returned to at the end through metaphorical book ending, the interlocking pieces may have been lost to STEM entry-level high school students. For teachers it also helps them understand how the animation unfolds (a visual metaphor embedded in the flower opening up). (Site of production; Social modality)

Additionally, Artifact 4 generated imaginative thinking:

How interpreted? By whom? Why? When I first saw this transdisciplinary flower image, I smiled. I imagined myself as a high school viewer, a grade 10 girl having this animation shown to me in math or Science 10 (Biology) class and felt "at home". I could "get" this complex interlocking pieces and even begin to make friends with a high-level concept such as genetic algorithms. I could also imagine myself using this animation as a teacher, and that in watching my students view the animation, the majority of them, would be more engaged than usual – perhaps chuckling at the giraffes necks changing. I imagined that I could see students processing, really thinking about what the animation explains. And maybe even students asking to watch it again, because they got some of it but not all of it and that they wanted to get it all. That the flower image helped them dive into some complex ideas, and that the flower invited them all – male and female, STEM kids and non, to think differently about this very gendered, technical concept of genetic algorithms. (Site of audiencing; Social modality)

Transdisciplinary curriculum content requires the integration of nesting complex ideas into accessible convergences of disciplinary knowledge represented anew. From the interrogations above, the artifacts spoke to the role of gestalt thinking as a means of representing such integration. This first thread flows into the observation of complexity unfolding over the months of the project.

Thread Two: Complexity Processes

The second thread uncovered through the interrogations resonates with the observation that processes to deal with complexity emerge over time (Klein, 2018; Senge, 1994). Artifact 1, which I drew early in the project, speaks to my initial thinking of co-creating transdisciplinary open educational resources:

Who? When? Who for? Why? As the pedagogy lead for the project, I felt it necessary to enable bringing together all of the parts that ordinarily would not be braided together. Perhaps bi-disciplinary, or interdisciplinary but encountering transdisciplinary thinking and then deciphering it to make it intelligible into something unique and beyond the sum of the parts was my intention. In effect, I wanted to share it with the design team to say, “hey – this is somewhat where we are headed”. I felt a bit overwhelmed by the concepts involved (computational thinking especially) yet I knew that sketching out my ideas would help me understand what my colleagues were saying and would be a means to check our understandings. I made this sketch early in the project, late August. I made it firstly for myself, then when it seemed to summarize conceptually (at least in a rudimentary way) the project, I did share it with the design team. (Site of production; Social modality)

Artifact 1 also reveals that this initial sketch lingered in my mind well past its initial creation. This lingering speaks to changes and revisiting initial understandings of transdisciplinary complexity.

Visual effects? I have thought about the image at different times in the project. The concept of the interlocking pieces – whole yet separate. I have also thought about what a big task it was to take these pieces/disciplines/threads and to create something beyond those pieces. About how this task involved hours of work that I did not see or know about through the efforts of my colleague ... and her shepherding the computing aspects. She is a transdisciplinary thinker – and will state gestalt insights. I noticed this early on in the project – a higher octave of how scientific thinking is often generated. (Site of the image; Technological modality).

Artifact 2 has a long and complicated provenance as an openly licensed image first uploaded to Wikimedia. Because of attribution practices, one can trace out who has used this openly licensed image and at the time of my interrogating this image, there were four file usages within the English Wikipedia. For global file usage, 12 different Wikipedia sites (all non-English) attributed using this derived image.

Visual meanings: The technological and social practices conflate here with the following information from the Wikipedia data that documents where and by whom this image has been used. This chain of reuse, revision, and remix speaks to participatory technologies conflating with convergence practices and the open practices of CC licensed images. Unlike a conventional educational image this image has a wild ride of possibilities. The file contributor, Alvesgaspar, likely did not anticipate how [his image](#) would be shared out.

(Site of the image; Social modality)

Additionally, I traced back where this Fibonacci chamomile came from (see Figure 6) as part of the site of the image itself and its compositional modality.

Composition? This is a manipulated digital image. Computer software enables this degree of graphic imaging without having training in the graphic arts and illustration. It is tightly cropped from the original Mother and Daughter image that is shared on the Wikimedia commons site (e.g., a media file repository where the learning objects of photos, images, etc. are held from which Wikipedia draws upon to make its entries). From this tracing back to the [original image](#), one can see that it is a chamomile, not a sunflower. (Site of the image; Compositional modality)

Figure 6

Screenshot of Mother and daughter.jpg



Note. From [Mother and daughter](#) by Wikimedia, 2007. [Licensed CC-BY 2.5](#).

Change over time was a constant element from the genesis of the transdisciplinary idea behind the project. Through sketches, conversations, scripting, storyboarding, and numerous iterations through consultations with the animators, the images proliferated and required modifications. Artifact 3 speaks to these ongoing changes in the site of circulation and compositionality questions.

This [giraffe] image is the iteration of numerous meetings with the animators and the design team. Through the process of content and story refinement this screenshot is a more layered image than the one initially created by Similar to the interlocking circle pieces this image still has its roots in its original inception. (Site of circulation; Compositional mode)

As part of the final product, Artifact 4 indicates the provenance of visual changes over time. Although at the end, the image circles back to the initial stages of the project.

Organized by who or what? Why? The animators took my sketch, our comments through the iterative feedback processes and applied them to create this graphic organizer. Like an aerial view, this image provides waypoints for understanding how these different disciplines relate to each other for the purposes of our project. Again, this image is part of the animation on the Callysto YouTube channel. (Site of circulation; Social modality)

How changed? From a sketch, to a digital file, to a email attachment, to a download, to upload into graphic software, then used in animation software that was then exported to Youtube. (along with several uploads to animation sharing/viewing for design team review). (Site of circulation; Compositional modality)

How circulated? During the creation stages, the image was circulated within our small group of users. Even the larger, consulting faculty were not included as it would have slowed the process down and potentially derailed the project. Once finalized this is when the image has a larger circulation. I selected it for the image to accompany the BOLT blog post as I thought it summarized the transdisciplinary nature of the project in an accessible and visually attractive manner. (Site of circulation; Technological modality)

Through the questions and answers, these four visual artifacts trace out the layers of changes that were part of the processes of handling complexity and complex curriculum ideas. The artifacts indicate personal changes, changes within our design team, and how complex changes reach out into the interconnected, digital, and global provenance of an openly licensed image.

Thread Three: Open Pedagogy

The third theme of the artifact interrogation resonates with co-designing transdisciplinary content integrated with attributes of open pedagogy (Hegarty, 2015; Klein, 2018), especially the roles of people, openness and trust; creativity and innovation; participatory technologies; and reflective practice. The interrogation of the Artifact 1 artifact communicates the following:

Organized by who or what? Why? I drew the image in my notebook. Took a photo of it on my cell phone, emailed it to my work email account. Then I save it on my laptop. I then distributed it to the design team for checking of what I was thinking was correct, and that it roughly conceptualized the concept for the project, as well as indicating pragmatics with the time allotments for study. As a project group, we had no experience working together, and didn't really know each other. In sharing the image by email I wanted to check understanding, so I could support pedagogical aspects related to my role. Additionally, I wanted to model my trust in their ability to correct me if I was wrong – which was also an act of vulnerability on my side. Earlier in the project, the initial project manager quit the project because he took offense to my adding content to his powerpoint. From my lived experiences of collaboration, making changes is part of the process, however for this individual with a math/computing and strong military background he took offense to my suggestions (I actually thought he wanted feedback). I felt that I needed to not have that occur again – we never really talked through this change in personnel, and ... stepped forward to fill the gap. I am glad she did. Later, in late 2020 I emailed it to ..., the animators. I felt that they were also struggling a bit with the dense content and how to bring together these disciplines. As artists, math didn't

seem like their natural sweet spot. I also emailed it to them because I thought it might help them understand conceptually (gestalt) what the diachronic, discipline-based content that dominated the storyboards was all about. Essentially a map of how the pieces interlocked into a broader, more abstract story. My email to them was around this very kind of thinking. I was surprised how they took this initial diagram and changed it. (Site of circulation; Technological modality)

Artifact 2 interrogations revolve around the role of creativity and innovation.

How interpreted? By whom? Why? This image is interpreted in various ways. I can only speak to my own self-study position. I interpreted it as a means to point to some of the complex relationships between mathematical and theoretical biology as I was searching the Internet for more information about the relationship between math modelling and biology when I discovered this image. It reminded me of my sunflowers that I love to grow for the birds. It also spoke to beauty within math, and biology – part of STEAM. (Site of audiencing; Social modality)

Viewing positions offered? Relation to other texts? This image was not a major part of our overall project but it does reinforce the manner in which meaning-making through images can be enhanced by “writing over” – which is of course what illustrations are all about. (Site of audiencing; Compositional modality)

How displayed? Where? It was displayed firstly on the Wikipedia page(s), the entry and then when you go to download another location. It was inserted as an image file into the google slides that I created for the panel presentation, which the recording is now on the ... website. So a chain of reuse happening, with different audiences and therefore different audiencing occurring. (Site of audiencing; Technological modality)

These responses to the revised and remixed image (Artifact 2) highlights the string of creative choices over time that an openly licensed and shared image may provide. These choices change with each user and need.

Artifact 3 also speaks to creativity and the possibilities of participatory technologies adding to the provenance of an OER:

Although the animation is on YouTube the pedagogical and transdisciplinary purposes point to several other digital sites, and then also to individual classrooms. With the licenses further reuse and revision, and even remixing is possible – yet difficult to determine. The producers (us) designed with the hope of reuse, etc. but with the dense content involved, revision may be the first forms of converging OEP with the content. (Site of audiencing; Technological modality)

Artifact 4 also generated responses of participation and creative extensions spring boarding from the animation, especially through the genetic algorithm flower:

Audiences developing other meanings by producing their own materials, from what they see (makes me think of the work of Jenkins and Rose, 2016, p. 41) Potentially, I can see students using this flower image to make notes about the animation – so reworking it into a mindmap of sorts. I can see teachers printing it off as a poster within a high school

computer lab – to provide visual interest but to also highlight how transdisciplinary thinking is part of computational understanding. With the CC licenses, teachers and students are able to make numerous revisions and remixes to this OER. (Site of audiencing – Technological modality)

Taken together, the four artifacts and the application of the critical visual framework provides a process for directed and comprehensive self-reflection, one of the attributes of open pedagogy. The questions interrogate, probe, and provide different points of examination as a stand-in for critical friends.

Discussion

The act of reflective practice and self-study research through the interrogation of visual artifacts has fostered a different form of reflection beyond what purposeful questions answered through the diachronic processes of typing answers would have produced. The critical visual framework with its sites and modes guided this self-study research to carefully consider the role of the visual within the transdisciplinary development of the Form and Function(s) OER project and its open assets.

Complex ideas require a means of communicating these ideas. Because of their time-sequenced, diachronic format, words, whether spoken or written, have a telegraphic aspect to them (McLuhan & McLuhan, 1992). In contrast, an image is synchronic and holistic. Visual thinking involves the gestalt rather than the analytic mind associated with modern Western and scientific epistemological thinking (Zwicky, 2019). Visual thinking is part of gestalt comprehension which “involves the spontaneous perception of structure: not analytic order – one brick stacked on another – but what might be called resonant internal relations” (Zwicky, 2019, p. 19). Additionally, in the age of digital images and open licenses, the lineage of an image becomes slippery and easily bifurcates (e.g., digital modifications). As demonstrated through the interrogations, the four artifacts each hold a gestalt and such thinking was part of the Form and Function(s) OER project from inception to its final upload. These gestalts resonate with internal relations and, as the modalities indicated, numerous technological, compositional, and social external relations. In sum, gestalt thinking of various reverberations highlighted and informed STEAM processes and the culminating OER.

In symbiotic relationship with the synchronic comprehension ran the processes to deal with both the complexity of the curriculum content and of the manifestation of the OER. These processes emerged over time with co-operation evolving into collaboration. Co-operation enabled ebbs and flows of collaboration which “assumes a high degree of joint attention, communication, interaction, mutual engagement, and co-elaboration of knowledge” (Klein, 2018, p. 15). From the artifacts and questions regarding the social modality, one can notice collective learning occurring (McMurtry, 2013). From the sketch (Artifact 1) to the final animation flower (Artifact 4) one can see the exchange of ideas and the changes over time, format, and medium. The interaction and mutual engagement in the aim to make complex transdisciplinary ideas accessible involved a steady investment of co-elaborating disciplinary knowledge into something more, something transdisciplinary. Such collective learning is one experiential outcome of this transdisciplinary and STEAM project.

The eight attributes of open pedagogy were clearly discernible through the artifact interrogations with them overlapping or reinforcing each other. As the responses to the sites and modalities showed, these attributes work together, articulate from, and are energized by participatory

technologies. These layers of experiences hold different characteristics and even educators aware of OER may not fully recognize how their choices and practices correspond to these attributes.

As with all self-study research, there are limitations of relevance and rigour. To this end, a clear theoretical positioning within emerging OER transdisciplinary co-creation projects has been applied, as this lack has been identified as a weakness by Vanassche and Kelchtermans (2015). To support research thoroughness, the critical visual methodology of interrogating artifacts is repeatable and would be further strengthened with dialogue among typical critical friends. Through the questionings, a deeper understanding of transdisciplinary thinking and open pedagogy evolved which will inform my teaching of graduate students, and readers of this research may note similarities of experiences or learn from my exploration. If so, this fits with the aim of self-study research: to share insights gained from reflective practices. Although this purpose was first stated in the early 2000s (Loughran, 2004), it now resonates with the growth of open pedagogy, demonstrates a linkage to the roots of openness (Bozkurt, 2019), and expands educational research. Through the use of this self-study other open or transdisciplinary methods, educators may recognize and examine their own pedagogical possibilities.

Recommendations for Future Research

Due to the short timeline of the project, the effects of the COVID-19 pandemic upon all levels of education, and the trust required for collaborative self-study, visual artifacts were solely interrogated as things that can be interviewed and that speak (Adams & Thompson, 2016). To further the extension of this visual document analysis would be to include members of the Form and Function(s) OER project design team in a larger self-study research project. Now that the level of trust has been established among primarily quantitative researchers, a qualitative and more intimate inquiry is possible and would contribute further to the understanding of what necessitates transdisciplinary OER development.

Conclusion

This small study contributes toward Dewey's "warranted assertions" rather than "knowledge" claims (Morgan, 2014). Additionally, it builds understanding that involves

a series of delicate adjustments by which new insights are weighed against one another. A conclusion is deemed acceptable...through a host of sources of evidence (much of which may not precisely 'match up' but paint a telling picture) which include findings, statements and observations. (Boix Mansilla, 2017, p. 8)

Visual artifacts as part of an educator's self-study trajectory enabled this research to explore aspects of TD as part of co-created OER and open pedagogy. Through the interrogations and the visual artifacts, a telling and complex picture of reasonable assertions have been sketched out for those who pursue comparable transdisciplinary OER and open pedagogy projects.

Author's Contributions

Connie Blomgren completed all of the data collection, analysis, and writing in this piece of original research as part of the Form and Function(s) OER project.

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An ethics review was not applicable.

Conflict of Interest

The author does not declare any conflict of interest.

Data Availability Statement

The encrypted data resides with the author. Access to the data is possible through an email request.

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