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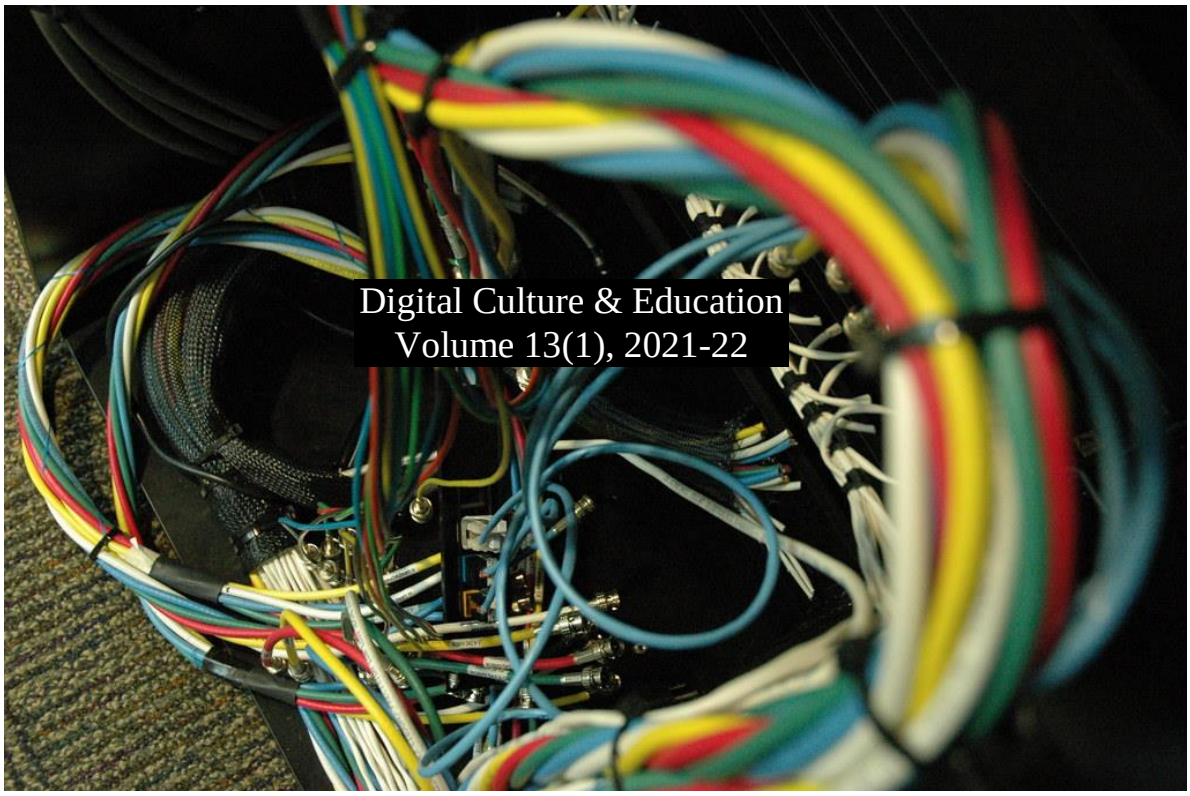

Emerging Artificial Intelligence, Art and Pedagogy: Exploring Discussions of Creative Algorithms and Machines for Art Education

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EMERGING ARTIFICIAL INTELLIGENCE, ART AND PEDAGOGY: EXPLORING DISCUSSIONS OF CREATIVE ALGORITHMS AND MACHINES FOR ART EDUCATION

Nicholas Leonard

Abstract: *The continued development and emergence of creative machines and computational creativity provokes certain questions that audit ontological and epistemological assumptions. Creative artificial intelligence challenges computer scientists, digital artists, and art educators to clarify or reconceptualize their notions of cognition and creativity. The article starts by addressing the increase in AI algorithms in both daily life and formal education settings to begin highlighting the shared investment across domains. The focus is then narrowed down to highlight creative machines and digital artmaking. By exploring the statements and artworks from computer scientists and digital artists, correlations to art education pedagogical approaches are then constructed. This will then lead into a recognition for a need to challenge and examine the ontological and epistemological assumptions present in art education. Finally, a new material theoretical framework for digital art education pedagogy is proposed to reorient discussions to ask new questions regarding increasingly creative machines and the experiences and education of students in the visual arts.*

Keywords: *Art Education, Artificial Intelligence, New Materialism, Creativity, Cognition*

Introduction

In the pursuit to develop creative artificial intelligence (AI), computer scientists are actively investigating the concepts of creativity and cognition. This endeavor has produced many conflicting perspectives of cognition, creativity, and how humans relate to machines (Miller, 2019). Furthermore, prevailing ontological and epistemological assumptions continue to perpetuate entrenched views about the nature of authorship and creativity. These debates almost ironically draw attention to the increasingly blurred boundaries between human and computer relations, provoking a need for other perspectives to ask new questions. This connection between developments in digital technologies and our understanding of ontology, the philosophical study of the nature of being, and epistemology, the philosophical study of knowledge, is clearly stated in media theorist Rushkoff's (2010) comment:

> The industrial age challenged us to rethink the limits of the human body: Where does my body end and the tool begin? The digital age challenges us to rethink the limits of the human mind: What are the boundaries of my cognition? (p.16)

In order to have a meaningful and effective discussion about the impact and significance of creative machines and computational creativity and what this means for art education, there must be both a clarification of terms along with a recognition of the theoretical frameworks that help create such understandings. As this article will make clear, the definition of creativity and cognition is still contested in the fields of artificial intelligence (AI) and digital arts. Furthermore, to discuss the impact of technological events, a historical perspective will be applied to create a foundation to begin addressing the potentialities of what present changes could mean for future digital art education pedagogy.

Addressing the significance of creative machines and computational creativity and what this means for art education, first the rapid increase and development of machine learning and AI algorithms in the daily lived experiences of American students' will be addressed. Secondly, these advances in digital technologies will be explored for their impact and significance within formal educational settings, focusing on art education (Knochel et al., 2020). Thirdly, the controversial topic of creative machines will be addressed to expose the various perspectives surrounding the exploration of AI powered creativity (Miller, 2019). Fourthly, these perspectives within the field of creative machine learning and AI will be connected to dominant digital art education pedagogies. Through these four points, the impact and significance of creative machines on art education will be adequately addressed for what has already occurred, creating a foundation to begin addressing the future potentialities of digital art education pedagogy. Fifthly, creativity and cognition will be readdressed in light of the ongoing developments in machine learning and AI which blurs the boundaries between human and algorithm entities. Finally, the potentialities of an art education pedagogical approach, such as Entanglement Art Education (Leonard, 2020a), which acknowledges the entangled becomeings (Barad, 2007) and blurred boundaries of humans and algorithms within a new materialist framework will be addressed.

Increasing Prevalence of Artificial Intelligence

Current visual culture inspired art education curricula focuses on the everyday lived experiences of students (Freedman, 2003) recognizing both formal and informal learning experiences that can occur online (Freedman et al., 2013). Since present art education seeks to address the significant aspects of daily experiences, a growing aspect which must be acknowledged in the increasing presence and complexity of digital technologies and algorithms. In 2009, researchers Kitchen and Dodge were already claiming that "It is fair to say that code now conditions existence in the West-code is routinely embedded into everyday objects, infrastructures, and systems" (p. 260). Building on this point, Cathy O'Neil (2016) has investigated how algorithms using big data greatly influence college admissions, online advertising, social justice issues, applying for jobs, and receiving credit or insurance. Other notable investigations of algorithms by Pariser (2011) and Meredith Broussard (2019) have explored how AI both misunderstands and influences the world. This fascination on the influence of algorithms in culture is not limited to fringe scholars as demonstrated by Netflix's documentary *The Social Dilemma* which explores how algorithms curate online experiences to influence an individual's thinking and behavior. These acknowledgements clearly indicate that algorithms have become an influential and significant aspect of American culture.

Regarding the developments of algorithms and AI, Kelly (2017) predicts that AI will continue improving and "become an increasingly ingrained part of our everyday life" (p. 40) since parallel computation has become cheaper, data has gotten bigger, and algorithms have grown more complex. This focus on the functioning and development of more complex algorithms in software, through machine learning and AI, continues the discussion started by Rushkoff (2010) who claimed "the underlying capability of the computer era is actually programming-which almost none of us know how to do" (p.13). While this can be a potential concern creating a blackbox phenomenon where humans do not understand how variables are being used in machine learning (O'Neil, 2016), the ability for computers to process data differently can also produce new and surprising results. This aspect of machine learning highlights the need to help teach and inform students about the computational aspects of their digital technologies since "at the center of every significant change in our lives today is a technology of some sort" (Kelly, 2017, p. 6) which is increasingly relying on machine learning and AI.

Formal educational settings have been and are continually exploring the pedagogical implications of new media as they emerge. In the early 1990s, Postman (1992) comments on digital technologies noting that "we need to know in what ways it is altering our conception of learning, and how, in conjunction with television, it undermines the old idea of school" (p. 19). This question is weighted with various assumptions such as what is learning, what justifies change, and what criteria is needed to state that a change is either positive or negative. For instance, educators who aligned with a banking pedagogy, which Paulo Freire (1970/2015) described as an approach to teaching in "which the students are the depositories and the teacher is the depositor" (p. 72), was directly challenged with the technological development of the Internet. This struggle was articulated by Atherton (2018) asking "if the teacher's role is no longer the keeper of the gates of knowledge, then what are teachers for" (p. xiii)? Rather than viewing this as a negative aspect of digital technologies, I view it as a frequent and recurring audit of teaching theories and practice which can help further develop the field.

As more digital programs continue to emerge in the classroom, educators are claiming that "technical skills and knowledge, while necessary, are not sufficient, in and of themselves" (Mishra and Henriksen, 2018, p. 2). Rather, the technology and activities must be addressed through educational theories, which have including but are not limited to instructivism, individual and social constructivism, and more situative theories such as activity theory and communities of practice (Beetham and Sharpe, 2013). Similar approaches can be seen in my own development as an art educator when I relied on critical social theories to address digital technologies in the art classroom (Leonard, 2018a, 2018b). While publications regarding digital technologies have increasingly addressed the hidden curriculum which may be conveyed in a program's code, I argue that there is a growing need to go farther and address machine learning and AI.

The body of work that addresses AI in education is referred to as AIed. The earliest landmarks of AI in education include the *International Journal of Artificial Intelligence in Education* which first published in 1989, and the formation of the International AI in Education Society (IAIED) in 1993 (Williamson and Eynon, 2020). Early work in AIed recognized that AI has a shared endeavor with education, specifically the focus on "getting machines to read, to reason, to express themselves, to make generalizations, and to learn" (Schank and Edelson, 1989, p.3). Schank and Edelson projected that AIed would inevitably change the way teaching and learning were understood and practiced. Similar remarks about the implications and significance of AIed to "offer new goals and practices for teaching and learning" (McArthur et al., 2005) have continued to be made up to the present day (Knox et al., 2020).

The developments in AIed alongside new understandings regarding cognition and consciousness have raised questions on contested reductionist understandings of human learning (Perrotta and Selwyn, 2020), and possible racial discriminatory designs (Dixon-Roman et al., 2020). This is because the data and corresponding variables provided to algorithms risk reproducing prejudice which feminist scholars have invesitated and challenged (D'Ignazio and Klein, 2020). The work of female scholars of color have highlighted the need to address racism in data (Benjamin, 2019a, 2019b, 2019c), search engines (Noble, 2018), digital practices and marketing (Sobande, 2021), and the online experiences of Black trans women (Bailey, 2015). Furthermore, researchers have addressed the need to decolonize the developments, practices, and trends in artificial intelligence (Mohamed et al., 2020).

When addressing AIed in the realm of visual arts education, there is very limited published research. This should be a cause for concern since trends in AI in daily life and AIed in general education fields

show no indication of slowing down. When addressing the use of AI for educational purposes in art education, Kong (2020) develops a theoretical argument for what could be possible and pursued through AI. While these ideas can be beneficial, such as AI's ability to develop highly personalized content, these concepts are theoretical and provide limited empirical evidence for AI personalization compared to personalized human instruction.

While not directly addressing AI in art education, Sean Justice (2016, 2020) has explored the influence of materials in education with a focus on digital technologies. In his earlier work, Justice (2016) investigated materials in art education following "qualitative, sociomaterial research traditions" (p. xvi). In his more recent work, Justice (2020) has argued for interface pedagogy which he claims "interweave tools and materials in unexpected ways, leading to unexpected challenges, frustrations, and questions" (p. 63). Elaborating on his concept of interface pedagogy, Justice references the work of Garoian to explore how art education can "go beyond representationalism" where "materially and socially co-constructed agents that build interdependent systems of meaning, together" (p. 68). This focus on emerging relations to define ways of knowing and being with digital technologies has been hinted at by other digital art educators stating that programmable objects "as boundary shifters have significant potential for impacting learning by inviting complex relationships and offering models for challenging thought" (Knochel and Patton, 2015). While these explorations into digital technologies in art education are beneficial, they fail to directly address the computational creation and use of variables to create content, which machine learning brings to AI technologies.

Recognizing this hole in art education literature, I published an article challenging the field of art education to address AI stating: "despite the massive advances in artificial intelligence alongside the saturation of digital technologies in society, the domain of art education has experienced little change to account for the fact that humans are not the only content creators" (Leonard, 2020a). To support this argument, a commonly used feature in Adobe Photoshop, Content-Aware Fill, was provided as empirical evidence of how AI is already a part of common digital art education experiences. Recognizing the expanding prevalence of AI in artmaking endeavors, it becomes clear that the impact of these AI algorithms are only beginning to be addressed in art education. To address the significance of these developments, I proposed the exploration of posthuman theoretical frameworks through Entanglement Art Education (EAE) to readdress the ontological and epistemological assumptions in dominant art education pedagogies.

Since the domain of art education has generally lacked substantial research endeavors regarding AI, other domains with a more developed history of artmaking and AI research can provide insights to help outline the hole in art education research. Researchers of creative AI, such as Miller (2019), have documented the developments of AI powered creativity and computational creativity to state that the future is "not one to fear, but one to look forward to with anticipation, in which machines work together with us to enrich our lives with new forms of art" (p. 309). Applying a level of caution to emerging technologies (Postman, 1992), multiple perspectives of creative AI will be addressed. Furthermore, since digital art educators already acknowledge that our entangled future with technologies will impact our "pedagogical discussions" (Knochel et al., 2020, p. 1), the following comments by creative AI researchers could offer a new lens to explore how computational creativity influence pedagogical concepts.

Perspectives on Creative AI from Artists and Computer Scientists

In the introduction if Miller's 2019 publication *The Artist In the Machine: The World of AI-Powered*

Creativity, he dedicates nearly an entire page to sharing conflicting quotes regarding if computers can be creative from various AI artists, professors, and computer scientists (pp. xxii - xxiii). Further elaborating on this point, Miller is careful to detail the perspectives of each of the artists, computer scientists, and professors he includes in the book. Despite the common theme of AI and creativity, it may be surprising to discover that there are a wide range of conflicting perspectives on if computers are, or will ever be, creative. By addressing these various perspectives of computational creativity and AI artmaking by significant names in the field, conflicting assumptions and theoretical frameworks regarding creativity can be identified.

One artist referenced by Miller is Patrick Tresset, the creator of sketching robots which are collectively referred to as Paul (See Figures 1 & 2). These drawing machines used a robotic arm to manipulate a drawing utensil on paper to doodle information received by a camera. As a result, Paul has drawn self portraits of people willing to participate as a live model. Pushing this concept even further, Tresset has further developed Paul to doodle based on activity levels sensed in a room by a camera so there can be high and low levels of doodling performance. Despite having a successful art career, complete with multiple gallery showings of Paul, Tresset claims that machines cannot be creative and that real art is done by humans (Miller, 2019). This perspective suggests a hard binary between what humans and computers are capable of achieving.

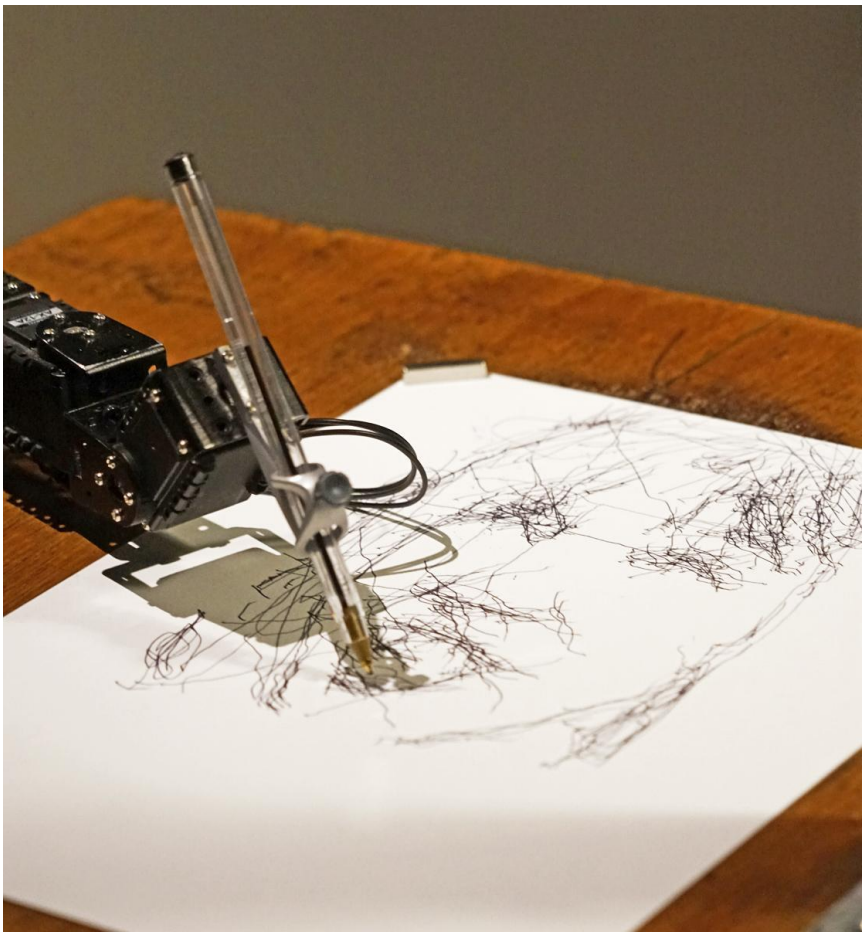

Figure 1: *Etudes humaines de Patrick Tresset (Festival EXIT, Créteil) by Jean-Pierre Dalbéra [Accessed from: https://www.flickr.com/photos/dalbera/25904887983/in/photolist-FsWM3o-oCiQNP-oAhkBp-oMTsin-Ft8jFH-oMTsdc-p5okwZ-oMTDVm-p5mjPh-p5845g-JB6vAd-eLm8mw/]*

Figure 2: *5 robots named Paul / Patrick Tresset (FR/UK) by Ars Electronica [Accessed from: https://www.flickr.com/photos/arselectronica/14850723843/in/photolist-FsWM3o-oCiQNP-oAhkBp-oMTsin-Ft8jFH-oMTsdc-p5oknZ-oMTDVm-p5mjPh-p5845g-JB6vAd-eLm8mw/]*

Another perspective of creative machines comes from the French art collective, Obvious. Obvious is best known for the Generative Adversarial Network (GAN) created image titled *Edmond de Belmy* (See Figure 3) which became the first AI artwork to be sold at Christie's art auction for nearly half a million dollars. This artwork is part of a larger collection called *La Famille de Belamy* (See Figures 4 & 5) which is a tribute to Ian Goodfellow, the creator of GANs. Miller (2019) notes that the members of Obvious "compare AI with the camera, which appeared to be a scientific instrument when it was first invented in the nineteenth century and only gradually revealed its artistic potential" (p. 120). This statement alone could suggest that AI and GAN algorithms are tools which can be used for human creative

intentions. In other interviews such as one with the *New York Times*, Obvious emphasizes that they try to have as minimal human input as possible and that "creativity isn't just for humans" (Nugent, 2018). From this perspective machines can be creative co-producers of art as others have argued that "In this brave new world, machines take on a role in the creative process itself-partners to humans as it were" (Mishra and Henriksen, 2018, p. 75).

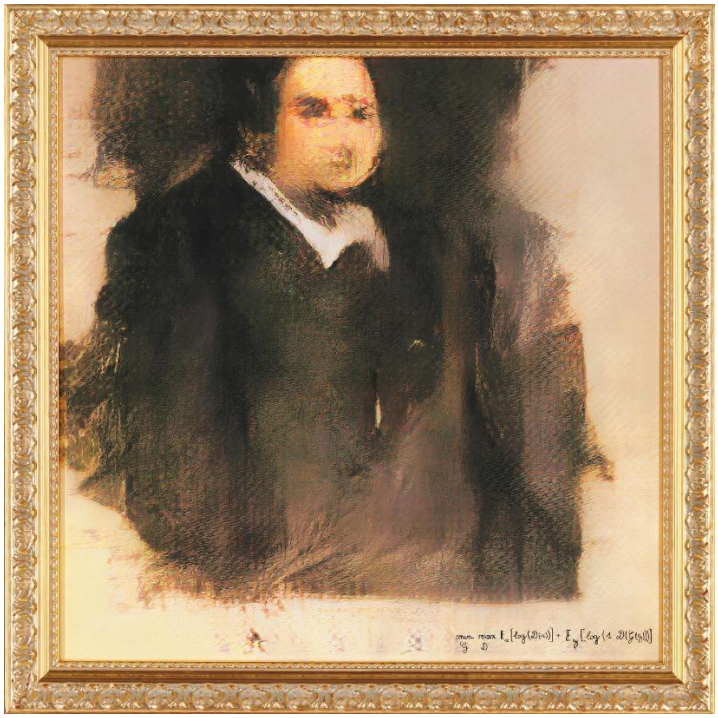

Figure 3: *Edmond de Belmy generously provided by Obvious*

Figure 4: *Comtesse de Belamy generously provided by Obvious*

Figure 5: *Madame de Belamy generously provided by Obvious*

Further expanding the possible perspectives of digital technologies is Simon Colton, creator of The Painting Fool (Miller, 2019). The Painting Fool is an AI program that is "an inspiring painter" which seeks to be "taken seriously - one day - as a creative artist in my own right" ("The Painting Fool," n.d.). The goal of The Painting Fool is to explore philosophical questions of nonhuman emotion and intentionality in artmaking. For this reason, Simon Colton is critical of algorithms that are fed large amounts of data to create their art arguing that it is less imaginative thought. It is for this reason that the machine learning and AI algorithms are designed for skillful, appreciative, and imaginative behaviors, as described on The Painting Fool's website. Here, Colton argues that the ability for The Painting Fool to be provided limited data, search for content and concepts, create novel images, and make judgements on the produced work which he has addressed aspects of in numerous papers (Colton, 2008; Krzeczkowska et al., 2010; Pease and Colton, 2011). Furthermore, Colton believes that it is irrelevant to compare computer art to human art and that humans will grow their own values and understanding of creativity when they view computational creativity (Miller, 2019). This perspective can blur the lines between human and computational creativity and where computers are creative in their own right.

Finally, there are perspectives that computers can be just as creative as humans. One example of this perspective comes from Ahmed Elgammal, developer of Creative Adversarial Networks (CAN). The CAN is a version of a GAN which allows for AI to train itself on various historical art styles and movements and adjust parameters of established styles to create novel images. According to Miller (2019), Elgammal believes that machines are not currently creative since they must be able to eventually judge their own work. Meanwhile, others involved in cognitive robotics, like Murray Shanahan, believe that "computers can do anything the brain can do" (Miller, 2019, p. xxiii). According to these understanding, computers are clearly able to be creative in their own right.

Despite these conflicting views on computational creativity, Miller summarizes his book on AI creativity identifying "the connection between creativity and consciousness" and suggesting "that in the future machines will be fully creative and may even surpass us" (2019, p. 311). One clear take away from Miller's collection of AI art examples and interviews is the connection between theoretical understandings of creativity guiding the practice of developing creative AI algorithms. Since Schank and Edelson (1989) identified the development of AI as a shared endeavor with the domain of education, how might the developments in AI align with art education pedagogies? Furthermore, since art educators explore how contemporary artworks can influence art education to think differently about pedagogy (O'Donoghue, 2015), how may the contradictions in computational artworks produce contradicting pedagogical approaches in art education?

Aligning Creative AI Perspectives with Art Education Pedagogies

While the field of art education has had limited publications directly investigating the impact and significance of AI (Kong, 2020; Leonard, 2020), similar theoretical frameworks applied in the areas of computational creativity and creative machines can be identified in art education pedagogies. These theoretical frameworks provide a basis for understanding ontology and epistemology with a focus on cognition and creativity. By briefly exploring how digital art education pedagogies have developed alongside algorithms, a foundation for addressing the changes in computational creativity may influence art education.

When digital technologies first became commonplace in the art classroom, researchers began addressing the computer as a tool for educational instruction and art making (Freedman, 1989, 1991; Greh, 1986, 1990; Hubbard, 1985; White, 1985; Wohlwill and Willis, 1987). These studies focused on how the tool (program) was constructed and the resulting functioning as a tool may influence artistic making practices. While technological developments continued, the pedagogical framework that digital technologies are similar to any other artistic medium persisted within a Discipline Based Art Education (DBAE) framework. The DBAE approach strongly reflects the traditional understandings of art education dating back to the Renaissance and earlier (Efland, 1990) where materials were passive, students were receptacles for depositing information, and creativity was treated as an individual gift. This resulted in educators emphasizing the need to uphold human traits and values when using digital media (McCullough, 1998).

When discussing early AI, Hubert and Stuart Dreyfus (1986) commented that "tools enlarge our capacities and provide us with a range of abilities we could not otherwise claim. But computers are more than tools" (p. xix). This idea that digital technologies go "beyond instrumentalism" (Knochel et al., 2020, p. 2) as a result of the complex algorithms becoming increasingly common within programs. During this time, approaches to art education were heavily influenced by the work of critical theorists like Paulo Freire (1970). As a result of applying a critical theory lens, digital technologies were observed as entities with agency that can influence both student learning and artmaking (Leonard, 2018b). For example, researchers have identified students' relations to digital applications for artmaking as either app-enabled or app-dependent (Gardner and Davis, 2013). This critical pedagogical approach to digital technologies is now one of the most influential in the field, as demonstrated by the recent international edited collection of digital art education writings titled *Critical Digital Making in Art Education* (Knochel et al.,2020).

While early critical digital art theories clearly addressed the human and the computer or program as

separate competing entities, more recent pedagogical approaches are beginning to blur boundaries of where agency lies in the process of digital artmaking. An example of this pedagogical approach can be observed in Knochel's (2016) research of Adobe Photoshop using Actor-Network Theory. In the actor-network theory, entities are separate but connected through their various relations to produce new possibilities. The findings of Knochel's study suggest that the pedagogy of Photoshop functions like a hidden curriculum that influences users. Similar work in human and nonhuman digital assemblages for artmaking have also been explored by Keifer-Boyd, Knochel, Patton and Sweeny (2018) with a focus on mobile devices. In this way, similar aspects in technological determinism and AI blackbox phenomena discussions could be addressed with an educational focus to explore how entities relate to and influence each other. Emerging assemblage based digital art education pedagogies could provide new approaches to understanding how to relate to entities and how these relations influence epistemology.

Regarding computer scientist theological frameworks which claim computers are already creative (Miller, 2019), there are very limited art education pedagogical frameworks which directly address this aspect of artificial intelligence. Due to limited research in this area, pre-service art educators have been noted to conceptualize digital artmaking as a machine following a program which neglects creative thinking by the individual (Lu, 2005). While Kong (2020) has provided some hypothetical applications of AI, I propose that more must be done in regards to developing art education pedagogy to account for creative AI developments (Leonard, 2020a).

Reviewing the impact of digital technologies in the development digital art education pedagogies, there are some clear correlations. Specifically, the early perspectives held by creative AI computer scientists, artists, and scholars were that creative machines are either tools or creative partners to some degree. These perspectives have been acknowledged in both DBAE and critical digital artmaking pedagogies. In order to better address how present AI developments may impact future art education pedagogy, the current issues of computational cognition and creativity must be addressed in art education. A reconceptualization of creative AI, through new ontological and epistemological perspectives, allows for new engagements with creative machines which can also help influence art education pedagogies. An important aspect of this ontological shift is not to resolve the debate of creative AI, but rather challenge the debate itself by opening up new possibilities.

Readdressing the Blurred Boundaries of Creativity and Cognition

Art educator Tillander (2011) has emphasized that art educators need a "renewed examination of creative expressions in art education, especially how their understanding of creativity, technology, and pedagogy informs one another" (p. 46). Furthermore, the rapid growth and development of AI algorithms have caused those in the field to state "In this day and age, we are going to have to rethink what we mean by thinking and what we mean by creativity" (Miller, 2019, p. xxii). It is in this overlap of attempting to understand cognition and creativity that the fields of art education and computational creativity can produce a rich cross-disciplinary discussion on ontology and epistemology. After briefly addressing the perceived binary philosophical assumptions that have framed questions as dichotomous regarding creativity and cognition in art education, the challenges presented by creative AI will be presented to address new questions which may have a significant influence in art education pedagogy.

Initially, concepts of creativity and cognition were assumed to be an individual affair. In art education,

the seminal work of Victor Lowenfeld (1949) expressed creativity as an individual quality of a student which develops in stages. This resulted in the development of tests to measure student creativity (Clark and Zimmerman, 2001, 2004; Wallach and Kogan, 1965). In the 1950s, around the same time that Victor Lowenfeld was exploring concepts of creativity, the domain of the cognitive sciences was emerging inspired by the works of Miller (1956) and Chomsky (1959). The cognitive sciences began to study cognition as complex mental stages involving information, process, and feedback (Neisser, 2014). These approaches to creativity and cognition make the ontological assumption that entities exist separately and have their own qualities which produce certain ways of knowing.

Later, during the renewed global interest in creativity in the 1990s (Craft, 2005), critical and social theories were developing new understandings of creativity and cognition. Largely influenced by the work of social psychologist Csikszentmihalyi (1997), creativity was understood to have social and environmental influences. Furthermore, seminal publications by Efland (2002) and Eisner (2002) studied cognitive processes in the visual arts. The findings produced a theoretical argument for the cognitive contributions of the arts where cognitive concessions were made to aesthetics and the senses and experiences of materials (Efland, 2002). The expansion of cognition and consciousness also grew to incorporate nonhumans and algorithms in the environment (Hayles, 2017). When addressing the ontological and epistemological assumptions of this time, the processes of creativity and cognition were seen to be greater than the self and addressed the assemblage of separate entities acting together with their own qualities.

The philosophical assumptions applied to both the individual and social understandings of creativity and cognition have produced a stress point in the discussion regarding creative AI. Since both perspectives seek to apply reflective thought (Haraway, 1997) to describe and interpret the qualities of entities, they go on producing more of the same, mirroring fixed positions. These reductionist views continually perpetuate dichotomous understandings, pinning the qualities of humans against computers. This binary issue can be seen in John Searle's Chinese Room thought experiment where an individual who does not understand the Chinese language, could receive a Chinese character through one door, follow a provided process regarding Chinese symbols, and submit a response though a second door. Here, the argument is made that, thanks to the process being followed, it may appear that the individual understands Chinese, when in actuality the individual has no understanding of the Chinese language. By switching the context of the thought experiment from manipulating the Chinese language to image creation, it becomes clear how arguments can be made regarding creative AI. What complicates this argument is what Haraway (1997) described as reflective thought which applies a reflective perspective to describe what is happening rather than focusing on the potentialities of what is emerging. For example, there is a transcendent ontological assumption of entities such as the individual in the room and instructions interacting with another entity outside of the room. Instead of perpetuating these transcendent binary assumptions, individuals in the field of creative AI are becoming increasingly interested with what becomes possible rather than describing what has occurred.

This positioning away from relying on reflective thought to exploring what might become possible with creative AI can be seen as an emerging trend. The founding executive editor of *Wired* magazine, Kevin Kelly (2017), addressed the future of AI. In his book, he starts by addressing what will become possible using the term becoming. His very next chapter is a focus on cognition, once again avoiding reflective issues to instead identify what becomes possible with cognitive machines that "will think different" (p. 42). Furthermore, leaders in Google's AI program like Blaise Agüera y Arcas are arguing that "When we do art with machines I don't think there is a very strict boundary between what is

human and what is machine" (as cited in Miller, 2019, p. xxiii).

The trend in these developments is that this issue is no longer trying to define the author, creativity, or cognition, rather, the focus is on what differences are being made. This is an ontological and epistemological shift influenced by the development of creative AI. Similar shifts can be seen in the arguments that have been made by Gunkel (2016) regarding remix. Underlying binary philosophical assumptions for addressing originality, authorship, and creativity had created contested debates regarding remix as an artform and if AI can create art through remix. Rather than succumbing to these transcendent understandings, Gunkel proposes Žižek's (2006) concept of the "short circuit" (p. ix) as an alternative to Platonic dichotomies. Here, a short circuit can be understood as an occurrence that interrupts the smooth functioning of expectations, and there is no language to adequately address what has occurred due to its unfamiliarity. Gunkel introduces the concept of the short circuit to address the ontological and epistemological assumptions regarding the question of remix itself since "as long as we continue to leave these basic principles untouched, unchallenged, and unexamined, very little progress will be made in our thinking" (Gunkel, 2016, p. 177).

To contextualize the significance of this ontological and epistemological issue within the visual arts, I will briefly discuss a recent artmaking endeavor involving a GAN algorithm, an artist Mads Huisingh, and Pokémon. As an art educator interested in digital technologies and creativity (Leonard, 2018a, 2018b, 2020a), I was fascinated in merging my readings from the field of art education with developments in computational creativity. Working with GANs in approachable platforms, such as RunwayML, I explored artmaking processes to directly challenge reductionist binary understandings of both the artmaking process and product. Using hundreds of Pokémon images as a dataset, the GAN algorithm produced many visuals of new Pokémon (See Figure 6). I then selected some of these images produced by the GAN and commissioned artist Mads Huisingh to create an illustration of the new Pokémon designed by the algorithm (See Figure 7). Through this project, multiple questions could be raised such as: What is art? Is the Pokémon remix by the GAN algorithm creative? Who is the author? All of these questions reflect back on parallel ontological and epistemological assumptions and will do little to progress our thinking in the visual arts and artmaking in a world of algorithms. Instead, previous assumptions must be audited to explore what differences in the world emerge when presented with algorithms to address what the world is becoming.

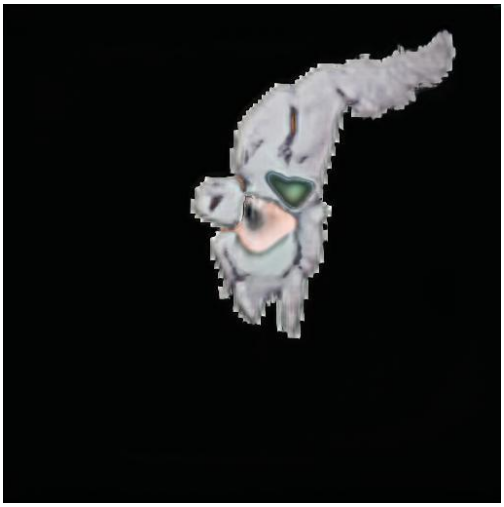

Figure 6: *New Pokémon 2.1 by RunwayML GAN Algorithm*

Figure 7: *Ghost Type by Mads Huisingh 2020*

These developments in creative AI illuminate and stress longstanding ontological and epistemological assumptions applied to understanding creativity and cognition. Furthermore, researchers in AIed are directly highlighting these issues stating that AIed "embodies particular sets of values and entails new distributions of power in educational research to data science experts with particular ontological and epistemological commitments" (Williamson and Eynon, 2020). It is becoming increasingly clear that new theoretical frameworks need to be explored which can appropriately address these challenges.

Since AI development has a shared endeavor with education (Schank and Edelson, 1989) and it has been argued that "we humans are slowly and imperceptibly merging with machines" (Miller, 2019, p. xxvi), how may discussions in computer science and creative AI produce new perspectives and questions for art education pedagogy?

New Materialism and Potentialities for Art Education Pedagogy

Since the introduction of the computer as a commonplace technology in classrooms, educators were asking "How does the relationship between children and computers affect learning" (Papert, 1993, p. x)? Furthermore, since ontological and epistemological challenges have been raised in the development of creative AI, it is encouraged that "we need to rethink creativity, rethink schooling, and rethink technology in schools." (Mishra and Henriksen, 2018, p. viii). To address these concerns, a branch of feminist materialism, known as new materialism (Barad, 2007; Braidotti, 2019), will be introduced as a potential theoretical framework to begin exploring new approaches to art education pedagogy. By exploring a new materialist framework, the dichotomizing of bodies, objects, and actions which becomes trapped in questions of intentionality are averted by "focusing on the indeterminacy of relationships between various types of human and non-human agents" (De Freitas and Sinclair, 2014, p. 3).

It should also be noted that New Materialism (Barad, 2007; Braidotti, 2019; Bennett, 2010) has emerged from postmodern feminist materialism whose theoretical linage generally include the works of Barunch Spinoza (1677/2005), John Dewey (1925/2018; 1934/2005), Whitehead (1929/2010) Michael Polanyi (1978/2009), Nelson Goodman (1978), Gilles Deleuze (1994), Gilles Deleuze and Félix Guattari (1988), and others. Since these concepts were developed prior to the surge of smart device and artificial intelligence, there are limited seminal writers (Haraway, 1994; Hayles, 2017) that directly address digital technologies. Notably absent from the citations of many publications engaging with New Materialist concepts is the work of Indiginous scholars. For this reason it is also crucial to acknowledge that "Indigenous thinkers and scholars developed ideas about non-human agency thousands of years earlier than contemporary philosophers of science" (Rosiek et al. 2020, p. 2). To this point, Rosiek, Snyder, and Pratt (2020) have also noted that multiple Indigenous scholars (De Line 2016; Higgins 2017; le Grange 2018; Martin 2017; Todd 2016; Tuck and McKenzie 2015; Watts 2013) have published comparisons between Indigenous scholarship and emerging posthuman scholarship. This work is significant since Indigenous scholars have already moved beyond attempts to justify nonhuman agency to focusing on the implications of such understandings (Coulthard 2014; Coulthard and Simpson 2016; Deloria 1988, 1999a, 1999b; Martin 2017; Simpson 2017; Todd 2014; Watts 2013). Since Tillander (2011) has already stated that new understandings of creativity may confront historical Western understandings, future research should respectfully engage various perspectives of creativity.

In Karen Barad's (2007) theory of Agential Realism, the concepts of agency and causality are reworked

in relation to new discoveries in quantum physics while expanding on postmodern and deconstriction concepts. In this understanding, agency is not a power or force that any entity has which is then applied against other entities, rather, agency is the intra-action that occurs between matter. This intra-action between matter temporarily collapses many potentialities into one momentary actualization. This actualization then allows for a temporary subjectivity among dynamic matter which is always in the process of becoming. Barad calls this blurring of being and knowing "Onto-epistem-ology" (p. 185) which the then defines as "the study and practice of knowing in being-is probably a better way to think about the kind of understanding that we need to come to terms with how specific interactions matter" (p. 185).

The work of Karen Barad is significant to developing future digital art education pedagogy since an onto-epistemology approach means that matter and meaning are mutually created. Barad (2007) declares this aspect in clear terms when she states that "neither is articulated or articulable in the absence of the other; matter and meaning are mutually articulated" (p. 152). This approach avoids the binary arguments of what a computer or algorithm is doing and describing what it means (Miller, 2019), allowing an opening up to alternative ways of knowing. Alternative ways of knowing are particularly significant for digital art education pedagogy since it allows new questions to be asked about digital artmaking which were previously incomprehensible. As this article suggests, alternative ways of knowing which challenge dominant ontological and epistemological assumptions in digital art education become less concerned with placing creative agency in a particular entity in favor of being sensitive to engatelments for creative potentialities (Atkinson, 2018; Leonard, 2020a).

Art educators like Sweeny (2010) has challenged art digital educators to investigate the dynamic becomings of artmaking which "blur the binaries upon which much of the Modernist core of art education is based" (p. x), thus an onto-epistemology approach for exploring pedagogical assumptions could be fruitful in this endeavor. Since Cutler and MacKenzie (2011) have questioned if "perhaps the challenge is to treat learning as an ontological rather than epistemological problem" (p. 63)? To this end, Barad's (2007) theory of Agential Realism provides helpful concepts which merge ontology and epistemology where "neither discursive practices nor material phenomena are ontologically or epistemologically prior" (p. 152). In a digital art education context, this could imply that art educators need to be attentive to the potentialities that emerge in the classroom. For this reason, Atkinson's (2018) Pedagogy of Immanence becomes a helpful conceptual tool to bridge Barad's theories inspired from quantum physics into the social sciences.

Recognizing that learning begins to take on a Deleuzian sense of difference, Atkinson (2019) states that "effective learning encounters involve trying to connect with the virtual potential arising from relations with the actual content of the encounter" (p. 134). Thus, "a learning event is a problematic process constituted by a virtual domain of potentialities and a domain of actualizations that produce something new, a new relation" (p. 139). It is important to note here that there is no new matter produced, rather it is a new relation between matter, what Karen Barad (2007) would refer to as an "agential cut" (p. 348). Art educators, who are experts in exploring materials and knowledge, may see a similarity regarding that tacit knowledge (Polanyi, 1978) that develops when engaging artworks. The main difference between a postmodern understanding and a new material approach through Atkinson's (2018) Pedagogy of Immanence is the "ontological and epistemological displacement" (p. 80). Specifically in a digital art education context, rather than conceptualizing the teacher as a resource for teaching students how to follow certain procedures of a computer program, the focus transitions to a recognition of emerging entanglements and acting to emphasize new relations and potentialites. In my own art teaching practice, I am consistently working with students to see how they perceive

various digital technologies and attempt to create situations that challenge their preconceived notions so that new options become possible in regards to their digital artmaking (Leonard, 2020a).

Tillander (2011) comments on the difficulty of incorporating new theories in digital art education stating that "These ideas—that people can create in tandem with computers—confront historical Western constructs of creativity and originality, and in having no precedents we need inquiry on how thinking and knowing are impacted when creating in tandem" (2011 p .42). The ontological and epistemological shifts that occur in new material theories would certainly create some challenges since it changes "how and why we choose to see, hear, and think about the work of children in art classrooms and the ways in which we approach and represent this work as teachers and researchers" (Schulte, 2019 p. 99). While this pedagogical approach may also benefit education in general, the focus on art education aligns with Penn's (2018) perspective that "art educators, in their understanding of art and practice with material encounters, are positioned to lead the way for such a pedagogy in schools" (p.117). It is for this reason that I have proposed alternative ways for engaging art (Leonard, 2020b) and an Entanglement Art Education approach(Leonard, 2020a) to explore how digital art education discussion may continue to explore and engage the material and ontological turns in both theory and practice.

Conclusion

The continued development and emergence of creative machines and computational creativity provokes certain questions which audit many ontological and epistemological assumptions. These questions in the domain of computer science have an entangled and parallel relationship with those in art education since they seek to identify and support cognitive and creative behaviors. This article has addressed the increase in AI algorithms in both daily life and formal education settings to then narrow the focus on creative machines and digital artmaking. By exploring the statements and artworks from computer scientists and digital artists, correlations to art education pedagogical approaches were constructed. This led into a recognition of a need to challenge and examine the ontological and epistemological assumptions in art education. In conclusion, if art educators want to effectively enhance student learning with new technologies, then new pedagogical understandings should be explored that are sensitive to the increasing blurring boundaries of students, digital technologies, and artificial intelligence algorithms.

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