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Visualizing the Collective Learner through Decentralized Networks

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Abstract

Understandings of decentralized networks are increasingly used to describe a way to structure curriculum and pedagogy. It is often understood as a structural model to organize pedagogical and curricular relationships in which there is no center. While this is important it also bears introducing into the discourse that decentralized networks are also *dynamic*. These dynamics have been observed in nature, social behavior, and are now coded into the algorithms of social media. As art educators utilize social media to support teaching, it is important to consider the dynamics of decentralized networks and how they can influence attention and learning of a collective learner. This paper presents a method for visualizing ideation and attention drawn from an empirical study of social networking with teens in an art classroom. The visualizing of these dynamics provides art educators a method of reflecting on teaching and learning to better challenge assumptions, observe trends, and respond to the individual and the collective learner.

Introduction

Online practices such as viewing webpages, clicking on links, and posting content like photographs and video are becoming a ubiquitous part of a teenager's daily life in North America. Every time teens go online they create a traceable pattern of their activity. Not only do they create a data record online, they also "teach" the algorithms that govern social media and search software. Search engines such as Google and social networks like Facebook have algorithms designed to adapt to our activity and present information based off our browsing history. There are characteristic decentralized network dynamics at work in these algorithms (Barabási, 2003; Pariser, 2011).

As art educators move to interweave social media into their curricula it is important to know that not only do learners have the ability to share creative works in a decentralized fashion; teachers can look to the dynamic patterns of a decentralized network to visualize attention and learning of a collective. The coupling of social interactions with online contexts creates the conditions for the amplified dynamics of decentralized networks. It is imperative to carefully consider these dynamics when teaching online. In this paper I present a method for visualizing decentralized ideation and learning online through activity such as image view counts and responses to creative works by participants in a recent study. The purpose of this paper is to discuss how decentralized networks are *dynamic* phenomena embedded in social behaviour and computer code and the rationale for critically incorporating these tools in teaching and learning art online. Additionally, by visualizing these dynamics art educators and research can gain an image of collective learning. This is particularly useful for not only art education researchers but also classroom art teachers who incorporate social media into the art curriculum.

Networks

Over the past decade there have been increasing calls for a restructuring of art curricula and pedagogy to become *decentralized.* Whether it is a rhizomatic structuring of art curricula (Wilson, 2003), a bottom-up self-organizing classroom (Sweeny, 2008), or a pedagogical structure in which the teacher is not the center of power (May, 2011), decentralization offers a way of thinking about generative relationships of learning between teachers, students, and curricula. In other words, a decentralized art education is called for to address oppressive pedagogy by essentially creating a space for open reciprocal relationships between learners, teachers, and content. However, decentralization, especially when it involves the Internet, does not promise a more democratic classroom.

Much of the substance of these calls have focused on the structuring relationship between elements such as students and teachers. I have argued elsewhere (Castro, 2010) that decentralized networks are also useful in describing the dynamics of attention and learning of

a collective. Recent research into the dynamic of decentralized networks offers more compelling insight into the dynamics of these morphologies.

Decentralized networks are the morphology of complex systems such as the human brain, beehives, and ecosystems. Complex systems are nested phenomena. An example would be the complex interplay between the cellular, biological, cultural/political, and ecological scales. The dynamic interrelationships of cellular systems give rise to bodily systems, which give rise to human consciousness, which give rise to social groups, which give rise to cultural groups, which give rise to species, which give rise to a biosphere. Pollution and carbon emissions, social, cultural and political actions affect the relationships of each scale, from cellular to biosphere. When addressing a classroom, it is often treated as collection of individual learners. Complexity challenges educators to think of the group of individuals as a *learner* (Davis & Sumara, 2006). Thinking about the collective as a learner enables educators to attend to the influences where representations of individual inquiry and interaction online form systems of interrelations that feed back into the collective of individuals.

Networks and Power

Foucault (1994) describes power not as an organ of oppression, meaning that power does not reside in things. Power resides in action. It moves through network structures. Castells' (1996) research delineated a theory of societal and economic activity as a networked society. For Castells, technology is not the determining factor in pronounced network behavior; rather, it is co-specified by social and economic activity. Technology does not determine a networked society, but it enables the possibility of these types of activities and interpretive frames to emerge. Castells' theories surrounding networked societies tended toward conclusions in which he placed the space and flows of networks in a timeless and non-existent space. For him, this creates a view in which the desire of people to be rooted in a place is dissolved. As a result, globally networked economies that find meaning not in place but in power and production become systems of oppression. Global capitalism has ravaged local economies and exploited untold amounts of workers and ecosystems; however, the use of networks to describe resistance to this phenomenon is missing from his work. Networks are not inherently good or bad; they are the structures in which power flows. One counter-example to Castells is the World Trade Organization protests in 1999. These were described as a leaderless movement (Johnson, 2001). This movement was a network of smaller groups, such as anti-Nike protesters, radical environmentalists, labor unions, and so forth. For the most part they operated independently, coming together occasionally to share information and coordinate action. By having a decentralized system of resistance, they were collectively able to consistently hold together a more sustained protest than if they had been following one leader or leadership hierarchy. This movement was also enabled by networked new and social media

technologies (for example, mobile phones, chat rooms, and Web sites) to coordinate local action.

Though power and systems of oppression do flow through network structures, networks are not inherently democratic or undemocratic, oppressive or liberating; rather, it is the interpretation of the dynamics of networked relations that describes our own cultural values we impose on them. Those who are in power might see their actions as the functioning of government, while those who are subjected through the power in networks might experience it as inherently oppressive. These kinds of power relationships and the perspectives of the participants involved are important because they have implications for teachers and students in art classrooms modeled on a decentralized network structure.

Network Structures

A variety of structures can be referenced to describe the morphology of networks (Barney, 2004). There are three common network forms: distributed, centralized, and decentralized. Making up these network forms are *nodes* and *links*, which connect nodes. The number and quality of links define the characteristics of nodes.

Nodes can be described as a bounded system. Nodes are elements of a system, such as the vital organs of an organism, or the distinct components of an idea. In this study I use the idea of nodes to represent participants, their ideas, their images, and ideas of the collective. Nodes can be connection points or terminuses. Cell phones and computers are nodes; in pre-Web 2.0, computers acted more as terminuses whereas now they act more and more like communication channels.

Links also describe the associations between nodes. In this study, they are considered to be the associations and relations between participants and their ideas. Links have distances between nodes and the closer or shorter the links between nodes, the stronger the association between them. Links can also be thought of as a relation or interconnection between any two elements.

Distributed networks have a structure that has few, if any, hubs in its architecture. This was the architecture for the U.S. Army communication network, ARPANET, one of the precursors to the Internet (Leiner, Cerf, Clark, Kahn, Kleinrock, Lynch, Postel, Roberts, Wolff, 2000). Distributed networks are comprised of nodes that have a fairly even distribution of links. The reason the U.S. Army was interested in this design was because of its ability to distribute information even if multiple nodes (cities) were taken out in a nuclear attack. Its advantage is that it is very resistant to failure in communication, although it can also be very inefficient in terms of the time taken for information to make all the jumps from one node to another.

A centralized network has many nodes all linking to one central hub. This type of network architecture is very efficient and effective at communicating and distributing information. Centralized networks do not enable communication between nodes, other than through the centralized hub, which makes for inefficient communication between elements in the network. It is also much more vulnerable to breakdown if the centralized hub is removed or unable to communicate effectively.

Key to understanding the dynamics of decentralized networks are hubs. Hubs are nodes that have proportionately more links or ties than do other nodes in a network. Examples include major airports like London-Heathrow or Frankfurt: fly anywhere in Europe from North America and you are likely to go through one of those two airports. They act as hubs because many smaller airports associate with them through their links, or flights, to and from there. Ideas can act as hubs: for example, sustainability is becoming a hub in which all sorts of areas of inquiry are associating, such as education, design, architecture, and economics. All decentralized networks have multiple hubs, that is, nodes with a much larger proportion of links.

Albert-László Barabási's (2003) research has shown that in the terms of how the World Wide Web has grown, it is no longer the distributed network it was when it began but has become a decentralized network with certain Web sites acting as hubs. Additionally, Clay Shirky (2008) reflected that the blogosphere was for many years considered a democratic publishing space, where anyone had an equal chance to have their work seen. However, the Web evolved into a much more uneven distribution of attention. Barabási's (2003) research showed that links beget links and views beget views according to a dynamic of preferential attachment. In the beginning of blogs, like LiveJournal in 1999, the distribution of readers was spread fairly equally (Shirky, 2008). However, as the blogosphere grew, as certain influential readers and blogs began linking with one another, and as recommendations and reviews began to orient readers towards certain Weblogs, the dynamic of preferential attachment kicked in. The result: there are a few heavily read blogs and a disproportionate amount of blogs that are read by far fewer readers. Decentralized networks are not just structures with out a defining center, they are also dynamic flows of power that if left unchecked can become hegemonic.

The dynamics of preferential attachment, in which ideas or people receive proportionately more associations, are based on the associations they already have (Watts, 2003). This understanding offers an image of a shape and dynamics that can describe learning through social media. As more art educators use social media to support instruction it becomes more imperative to consider these dynamics as they exist in social interactions and are coded into the algorithms of social media.

Youth learn from each other by looking at each other's art. Hagaman (1990) uses the Philosophy for Children's program, which is based off of Vygotsky's (1978) sociocognitive theory of learning, to make the argument for developing communities of inquiry to support student learning. James' (1996) study of a sculpture studio class described social influences as an important component of student learning, along with the teacher and studio environment. And Wilson (1976, 2004) has long argued that youth learn from looking at each other's work and popular culture. The medium of a social network enables a tracing of activity that is qualitatively different from what is possible in physical spaces. It is now possible to visualize attention and ideation for the shape and dynamics that might be at play in learning art through engaging with others online. Specifically, it is possible to visually map viewing trends, attention, and influence that illustrate the characteristics of a collective learner's activity. What is presented here is one picture of a collective learner.

Description of Study

The following data visualizations of collective learning come from a study of the use of social media with a group of art teachers and their students (Castro, 2012; 2014). The study used a Design-based research (DBR) methodology (Collins, Joseph, & Bielaczyc, 2004), which is similar action research, except that it is oriented towards designed learning interventions (e.g. curriculum, technological interfaces, software, etc…). Researchers who use DBR seek to design more meaningful learning conditions in classrooms, while also theorizing new understanding of learning (Wang & Hannafin, 2005). As a part of the research methodology used in this study, data visualization was a key component to understanding the viewing and thematic relationships between learners online.

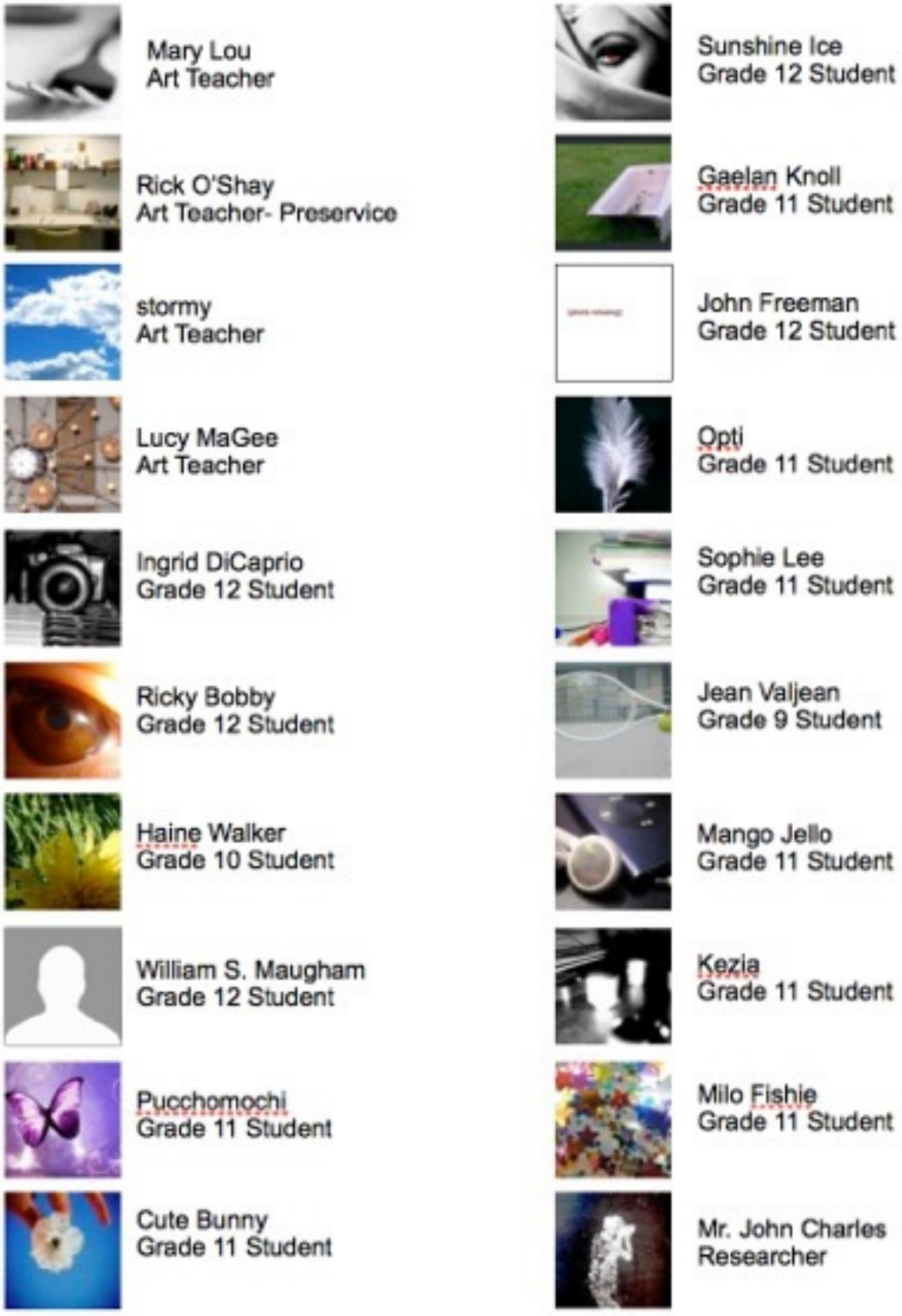

Figure 1. Pseudonyms and self-portrait icons of participants.

In this study there were 15 student participants and 4 teacher participants from a secondary art program (Figure 1). They came from Grades 9 through 12 and was open to any student who was interested at the public school they attended. For this study I custom designed a password protected social network where participants could post digital photographs and videos, post blogs, send messages, chat and initiate discussions with each other. It was designed to resemble many of the social network interfaces that participants were familiar with at the time, such as Facebook or deviantART (www.deviantART.com). This was to ensure that the online social network interface would feel familiar and be easy to use.

The curriculum was designed by the researcher and divided into two major phases. The first consisted of responding with images and text to the themes presented in the film *Euphoria* (http://theeuphoriaproject.com*).* The purpose of responding to the film was to engage participants in thinking about, and creatively responding to, issues of happiness and culture. Students responded to weekly prompts that would ask them to create a visual response in any media they wanted and then upload digital images to the social network in response to the prompt. Examples of prompts included: What makes you happy? What does advertising tell you about being happy? Who in your life is so engaged in something that they make their own happieness? The second phase consisted of a series of prompts and questions that were designed to engage participants with each other's creative productions. For example, in Week 5 participants were asked to select an image that was previously posted by another participant and then create a new work of art in response to either the ideas or form of the original work. They would then upload their work in digital form and reference the image they responded to. All work was uploaded to the social network and all interaction occurred through the posting of images and comments. By the second phase of the project there were over 200 images and posts by participants creating a robust history of activity and production from which participants could respond to in the Week 5 prompt. In Week 6, participants were asked to create their own prompt or question for the other participants (teachers, students, and researcher) to respond to and then respond to someone else's. The purpose of this prompt was to use the rich history of images and ideas created by the collective of participants as the source for the next iteration of inquiry. These two prompts and the participant's responses are visualized in the method described in this paper.

The medium of our social network was shaped by our activity, from posting comments to viewing images. This made it possible to trace a history of interactions, and to make visualizations of the relationships in our social network. For example, views were tracked with images and activity. The more views an image received, the more it would be seen. An image that received a comment would show up in the Recent Activity section of the Main Page. The actions of many individuals clicking, scrolling, looking, posting images, and commenting, taught the social search algorithm what was significant. In turn, home page results delivered the most viewed images resulting in a compounding effect of views. Though

it could be suggested that viewers could deliberately skew the results, none of the participants in this study stated this as a strategy on our social network site.

Because participant's activity, specifically view counts, on the social network could be recorded as data, it provided a valuable source of information in which to craft visualizations of attention. Regarding the value of tracing association between actors, which includes objects and people, Latour (2005) remarked, "...information technologies allow us to trace the associations in a way that was impossible before" (p. 207). Encounters with images create associations that in many cases are as significant as those with the social (Mitchell, 2005). The relationship between images and viewers was noted as a significant learning activity for participants in this study (Castro, 2012). Ellsworth (2005) put particular emphasis on the dynamic and active relationship between the learner and encounters with media as an "interval for you to fall outside of what we already know" (p.162). And social media create new traceable associations of the kinds of encounters with *difference* (Massumi, 2002) that constitute event potentials (Ellsworth, 2005). Learning, as defined within complexity and network theory, can never have a singular or linear cause. Instead it is a reciprocal relationship between many internal experiences and external conditions (Davis & Sumara, 2006; Maturana & Varela, 1992). It is a reciprocal relationship between an individual learner and collective learner. The claim here is not that the activity of looking at images online was a singular cause of learning in individuals, instead the act of viewing and the tracing of viewing activity is a significant addition to how art education researchers account for a learner's experience (see Castro, 2012). In this paper, the visualization method used and described here offers a qualitatively different way of understanding the collective learner.

Data Visualization Method

Data Visualization

Data visualizations are visual representations of information. Examples include subway and road maps, street signs, lists, bar charts, organization charts, weather graphics, and so on. They can be sophisticated depictions of statistical studies, or more abstract and playful interpretations of content. Newspapers and magazines like *USA Today* and *Time* use colorful visualizations to visualize complex ideas and data (Tufte, 1997). With more and more numerical data collected and available, there is an increasing need to be able to understand data with visuals. Data visualizations also tell compelling stories (Yau, 2011). They reveal patterns of activity and quantities that are not readily available from viewing a spreadsheet. In educational research, data visualization is used to understand the collective histories of knowledge building in wiki's (Rowe, 2009). Data Visualization programs are emerging from a variety of disciplines such as fine art and design (The Maryland Institute College of Art - http://goo.gl/VC4D2); media studies (MIT Media Lab - http://goo.gl/Htfdo); and journalism (Stanford - http://goo.gl/s5Jc8).

Every year since 2004, artist Jess Bachman has taken the United States' annual budget and created a data visualization entitled *Death and Taxes* (http://www.wallstats.com). Bachman's method for creating this visualization involves adding up the total budget and then, using simple calculation, creating percentages for each department and budget line. With these percentages he creates a proportional representation of what is spent where in relation to the other departments. Size relationships create the meaning in works like *Death and Taxes*. The body is critical in understanding information, as relationships between things, such as large and small quantities, create meaning. In data visualization, meaning arises in the size, relationships, and proportions of visual forms and what they represent. Networks have been used to describe how individuals come to create meaning and understanding (Lakoff & Johnson, 1999). Meaning and understanding are never self- evident; rather, they exist in relation (Cilliers, 1998). It is the relationship between viewer and visualization in which meaning and significance arise (Merleau-Ponty, 1962). The viewer's body is implicated and referenced in this relationship. The body's prior experience of space, movement and size give meaning to the proportional relationship between visualized data. In data visualization meaning arises from the proportional relationships between quantities and frequency.

Figure 2. Word cloud of this manuscript's text.

This visualization technique is also incorporated in software applications that create word clouds. Word clouds are visualizations of word frequency: the number of times a word appears in a text. The greater the occurrence of a word, the larger and darker the word is represented in proportion to the total amount of words. This provides an opportunity to "see" a text visually through spatial and color-tone relationships. Using Daniel Steinbock's online software, TagCrowd (www.tagcrowd.com), I created a tag cloud of this manuscript's text (Figure 2). Common words like 'that,' 'the,' and 'a' are excluded from tag clouds to represent those words that are most descriptive of a text.

Epistemology

Epistemology is a theory that addresses characteristics and qualities of knowledge. Instead of understanding knowledge as subjective, objective, or inter-subjective interpretive frames, I employ a complexity thinking (Davis & Sumara, 2006) understanding that represents the following data visualizations as inter-objective. This is an attitude enacted in research that "is not just about the object, not just about the student, and not just about social agreement. It is about holding all of these dynamic, co-specifying, conversational relationships while locating them in a grander, more than human context" (Davis & Sumara, 2006, p. 15). It is considered to be a kind of hybrid of intersubjectivity and objectivity (Davis & Sumara, 2006). In an inter-objectivity epistemology, there is no such thing as knowledge "out there," or knower-independent knowledge. There are no observer-less observations, or measurements without a measurer. Our descriptions of ourselves as researchers, of ourselves in the world, and of the world itself operate in a linguistic domain that is also a part of our world. Maturana and Varela (1992) stated:

> the linguistic domain becomes part of the environment in which linguistic coordinations take place, and language appears to an observer as a domain of descriptions of descriptions. But what an observer does is precisely this: he makes linguistic distinctions of linguistic distinctions, or what another observer would say are ontogenically generated descriptions of descriptions. (p. 211)

As humans, we do not exist outside of language and the language of our distinctions, because perceived phenomena and our knowledge of those phenomena shape the phenomena as our descriptions of our distinctions change. Simply, our descriptions are a part of the world and they change the world while shaping our perceptions (Davis, 2004). Varela (1999) stated "local situations will constantly change as a result of the perceiver's activity" (p. 12). This places the descriptions of the perceiver as shaping a perceived: not as an act of describing and recovering a world already out there, but as dynamically implicated in the dynamics of a world. As a result I am implicated in the visual forms presented in this essay. This is especially apparent when approaching the second set of data visualizations that illustrate the themes explored by the collective. Here another form of verification is critical in that a data stream based solely on frequency is inherently problematic (Fine, Weis, Weseen, & Wong, 2003). As a result excerpts from interviews, with participants, and field notes accompany data visualizations, interpretation, and analysis to better understand the dynamics between learner and collective.

Process

Visualizations were used in this study to analyze the collection of view counts, images, and themes. The series of visualizations presented in this paper are stylized to suggest metaphors of the *shape* of attention and learning as a decentralized network of the collective. There two

sets of visualizations that were used in this study. The first set illustrates relationships between individual participants by visualizing view counts, idea link associations, and who received the most responses in Weeks 5 and 6 (Figures 3, 4, & 5). The second examines the collective ideas and proportions of idea occurrences in relationship to each other throughout the project (Figures 6 through 9). A series of topologies to illustrate the often overlapping, dynamic, and sometimes contradicting qualities of networks.

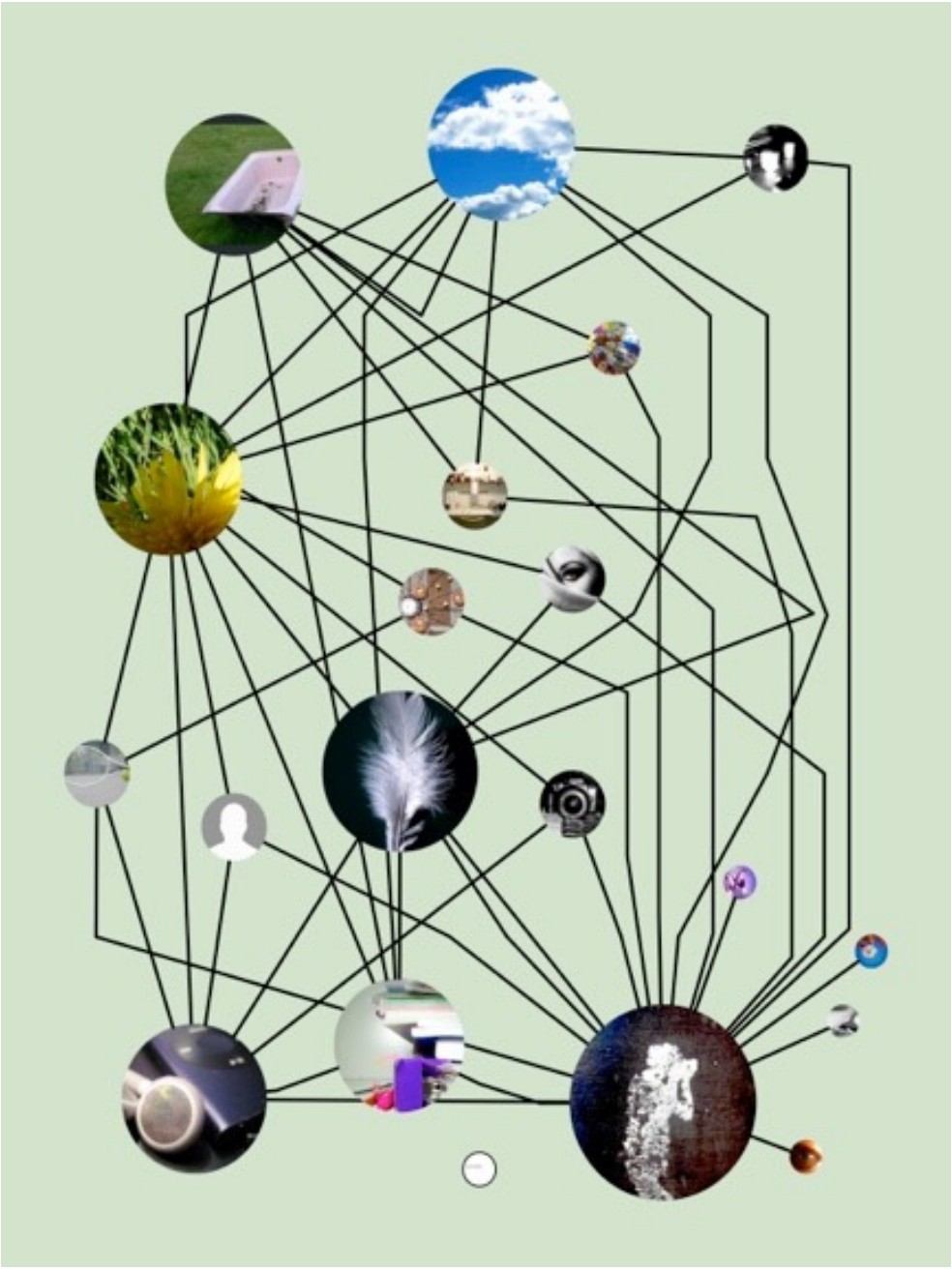

Figure 3. Network map of idea links.

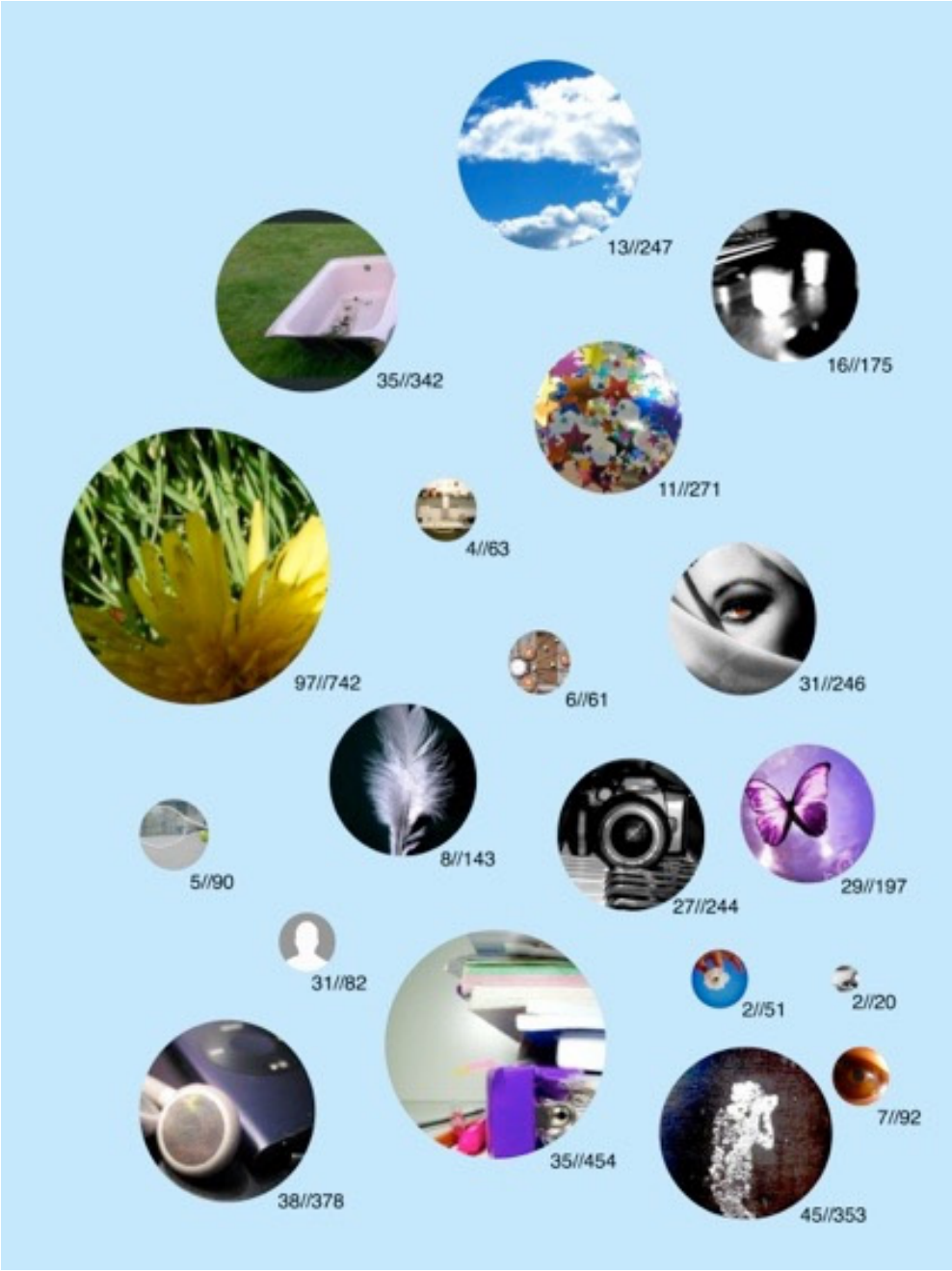

Figure 4. Image views per participant. Accompanying each profile image is a number that represents total images posted and total image views.

Galloway and Thacker (2007) suggested that there are many topologies of networks at play, each operating at different scales, yet each interrelated, co-specifying, and sometimes conflicting online. Different selections of data yielded different interpretations. For example, in Figure 3 the idea-link network shows a high number of links to the researcher, as I was the

designer of the weekly projects. However, in Figure 4, which illustrates the total views each participant received, I am not the participant with the most image views; in fact I am not even the second- or third-most views. During the course of the study I always considered myself to be influential to the shape of the collective's learning. These illustrate the varying and almost conflicting coexistence of differing visual interpretations present in decentralized networks. These visualizations examine some of the relationships between stated links and participants, who received the most page views, and what themes were represented in the images posted.

The process for determining sizes and proportions for nodes was relatively straightforward. For example, in Figure 3 the total views a participant's images received were totaled. Then each participant was assigned a percentage according to how many views their images received out of the total of views. An 8- by 10-in. (20.3 cm by 25.4 cm) canvas size was created in a graphic design program. The canvas equaled 80 $in.^2$ (516.128 cm^2). Participants' profile images were then sized to a diameter proportionately equivalent to the percentage of the total area of the canvas. Each circle then was arranged, and all the circles resized simultaneously, to fit the canvas in a way that reflected their proportional relationship of views received. In Figure 2, links were added between participants when one named another participant or responded to them positively as an association in their idea development. In Figure 3, links were not added because it could not be determined who was viewing whom. In the thematic sets of data visualizations (Figures 6 through 9), links were added. For Weeks 1 and 4 the thickness of links were generic, but in Week 8 the links were altered to represent link strength. Link strength (as represented by thickness) was determined by the overlapping idea relationship. Images were often coded with more than one idea: for example, an image could be coded by the terms *sustainability*, *place*, and *macro photography*.

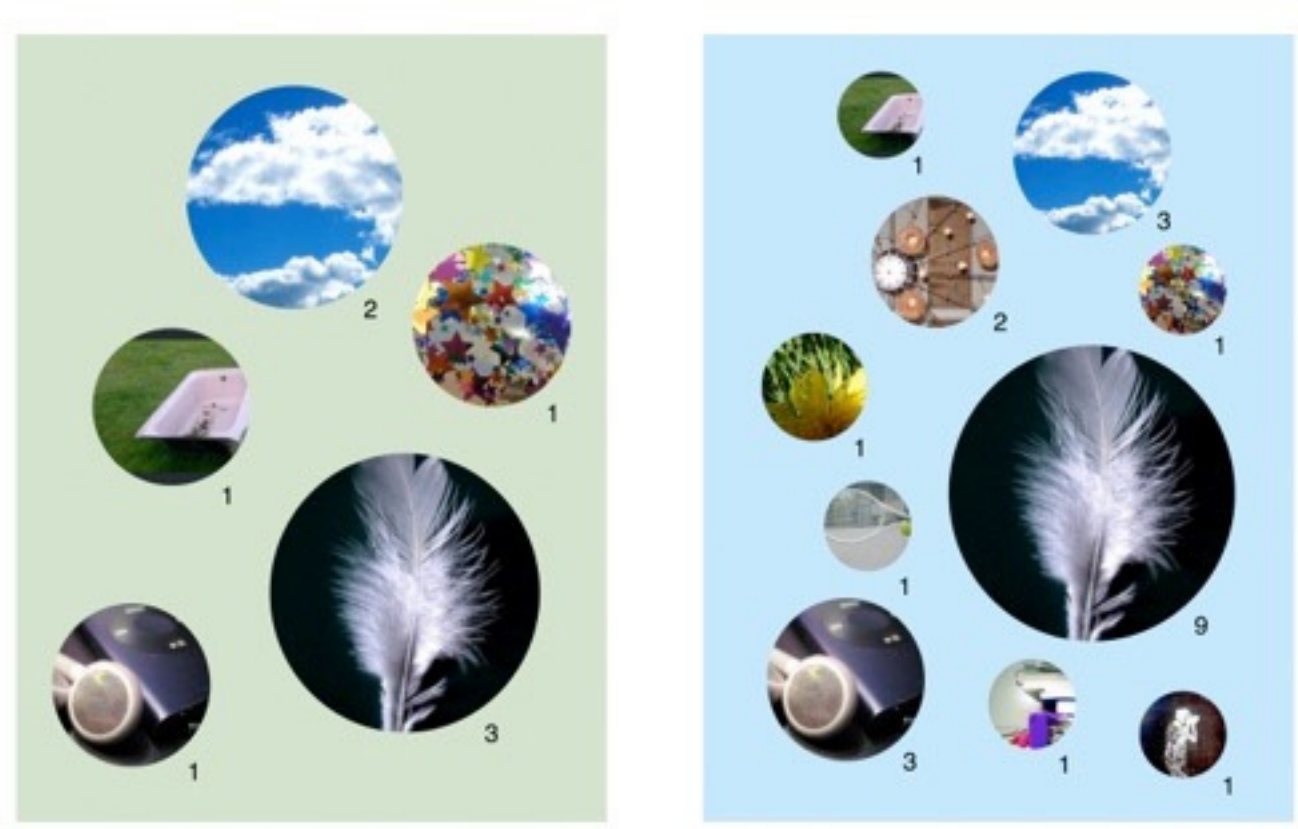

Figure 5. Weeks 5 and 6. Week 5 is on the left and Week 6 is on the right. Accompanying each profile image is the number of responses the participant received during each week to their images or prompt.

The first set of visualizations illustrates the viewing relationships between participants (see Figures 3, 4, & 5). Figure 3 is a network map of the idea-links between participants. Every time a participant in an interview mentioned another participant specifically as inspiration, or responded to their artwork in either of the Week 5 or 6 projects, a link was established. I was given the highest number of links (18) due to participants' responding to the posted weekly projects. One participant did not respond to any of the weekly responses, nor was he mentioned, he was not assigned any links. The proportion of links determines the size of the participants' profile image. Figure 4 displays size proportionate to the total amount of image views a participant received throughout the project. The total number of images posted, and image views, accompanies each profile image. Figure 5 shows a similar design to Figure 4, illustrating the number of responses each participant received to his or her images or prompts from Weeks 5 and 6.

Results

Mapping the Influential: Idea Links, Views, and Responses

In this set of visualizations (Figures 3, 4, & 5), which illustrate participants' viewing and ideation relationships, I interpreted two themes. The first is a difference between stated and observed idea links and associations and who was receiving the most views in Figures 4 and 5. The second is the number of associations and responses that Opti's ideas and images received from Week 5 to 6. The differences in Figures 5 and 6 illustrate a possible interpretation of some of the characteristics of learning through our social network. Figure 3, illustrates the many idea links that participants described throughout the curriculum. Idea links are important in that they map the influences between learners and how they might influence the collective.

Figure 6. Network map of Weeks 1 and 4 ideas. Week 1 is on the left and Week 2 is on the right. In Week 1, the green and orange dots act as placeholders for sustainability, people, and relationships. Their instances were so small that they could not be represented on the map accurately.

Decentralization does not mean I, as the teacher, am removed, because there are a high number of links to myself. Rather, decentralization describes there were many centers, or hubs, that were influencing learning on our social network. In Figure 4, this dynamic becomes more pronounced as Haine Walker, Sophie Lee, and Mango Jello became the most viewed participants on the site. Even participants like Opti and stormy, who posted a relatively small number of images, were receiving a high proportion number of views per image. Because Haine Walker, Sophie Lee, and Mango Jello were all personally interested in macro photography and propagated the site with images that looked closely at things, other's and I interpreted the visual qualities of many of the participant's images to take on these qualities (Figure 6). The collective learner in this sense emerged as one with a distinct visual style influenced by a number of the influential participants. Yet, participants like Sophie Lee did not seem to realize the influence she was having on the group.

Another characteristic of decentralized networks is suggested in Figure 5. In Weeks 5 and 6, participants were asked to choose another participant's image or prompt and respond to it through artistic inquiry. In Week 5, I noticed that, for not posting many images, Opti was receiving the most attention in terms of his images being the starting point for artistic inquiry. This was later confirmed through the process of visualizing the responses to Opti (see Figure 5). In Week 6, participants were asked to post a question or prompt for fellow participants to respond to through art. Again, Opti's ideas in that week received three times the amount of attention as he had received in the prior week. It is impossible to say mathematically if Opti was becoming a hub in the power law sense, but what can be seen is that for relatively few images, his ideas were attracting a significant amount of attention.

Thematically, Opti was asking other participants to reflect on their privileged situation and how sustainable it was to maintain their quality of living. Opti's question, which built off of earlier questions around sustainability, crystallized the broad thematic qualities observed in the collective learner. Opti's questions and images acted as a hub that amplified many of the already present ideas in the collective.

Understanding Influence Online

Many participants already came into this study with a tacit understanding of the dynamics involved in gaining attention online. For example, image views affected how images and ideas circulated on the social network site. For example, Jean Valjean viewed content almost exclusively based on the rating system of others. A video posted on YouTube that gets a large number of views will continue to get more views and is more likely to be ranked. Videos that are highly ranked will not always catch the attention of users like Jean Valjean. They also have to have a high number of views in order to be featured on YouTube's home page. Student participant Haine Walker intuitively understood this ranking system and its

implications, especially for those who do not receive many views. He stated,

> Normally when I search for stuff, I look at all the popular stuff first, I also look at the ones that get less views, some of the ones that get less views are really good and like maybe it is traditional and maybe the color is not so good. I do give feedback and say, maybe color lighter or something. I don't get that many views either so why should I not look at other peoples because they don't get that many views, right?

Haine Walker understood that view ranking excludes content on the site deviantArt, and took an active position to seek out art and ideas not being looked at because he is able to empathize with not getting as many page views. In effect, Haine understands that views begets views. In addition to viewing the most popularly ranked content, he seeks out those images that have not received many views or comments in an effort to distribute the amount of attention any one idea receives. Similarly, Gaelan Knoll looked to leave comments for those artworks on our social network that had no comments. When asked why he would respond to an image or not he stated,

> Well some of them they really stand out. They are like really nice and you just want to pull something and some of them are nice but nobody has responded to them and you want to say something because you know they are nice and you just want to let the person know, yeah that they're nice, especially if there are no comments.

Yet, when it came to Opti's images and prompt receiving so many responses he was at a loss for an explanation or even an initial desire to influence the collective. When asked why he thought fellow participants paid attention to him. He stated

> ...well I don't know why people choose mine but it kind of makes me feel good.

Beyond the personal affective response, Opti tacitly stumbled upon a way of representing ideas that resonated with the collective, as did Sophie Lee. One way of interpreting this phenomenon of influence is through the decentralized dynamics in search software. How students learn online is influenced by what is brought to their attention through the algorithms that govern the Internet and social media.

Search software ranks images and videos based on ranking and views. Yet, this is only one way of how an influential "hub" is constructed online. There is also the factor of who posts and how influential they are and the number of comments posted. For example, Google uses a ranking algorithm that measures how many links are made to a particular URL. Though this helps determine the rank a page receives, the software also ranks the page that is linking to the

one being ranked. If, out of a scale from one to 10, the web page being ranked has 10 links from pages with a rank of three, its rank is less. Being influential online means that a web page has links to it and the ranking of those links are highly ranked.

In this study, certain ideas and associations were brought into our social network. It was not a blank slate, waiting to be filled with responses to my questions and prompts. At the beginning of the study many participants posted their own images before responding to the designed curriculum. As seen in the visualizations (Figure 6), our social network was very early on shaped with ideas and images that were not prompted by me or the curriculum; this persisted through the study. Watts (2003) stated: “the set of contexts in which each of us participates is an extremely important determinant of the network structure that we subsequently create” (p.115). The ideas and themes that learners come with to an online or offline space are important because they shape the initial themes and interests of the collective. This can become influential to the individual's learning and ideation. In this particular instance the collective learner adapted to the concerns of the individual and became crystallized throughout the course of the study to become primarily concerned with a visual stylistic approach of macro photography and a thematic interest around sustainability. As each individual learner is different so too is each collective learner. If this study were to be enacted again a different thematic and visual focus would develop because the learner's contributions would be different.

Mapping Collective Ideation

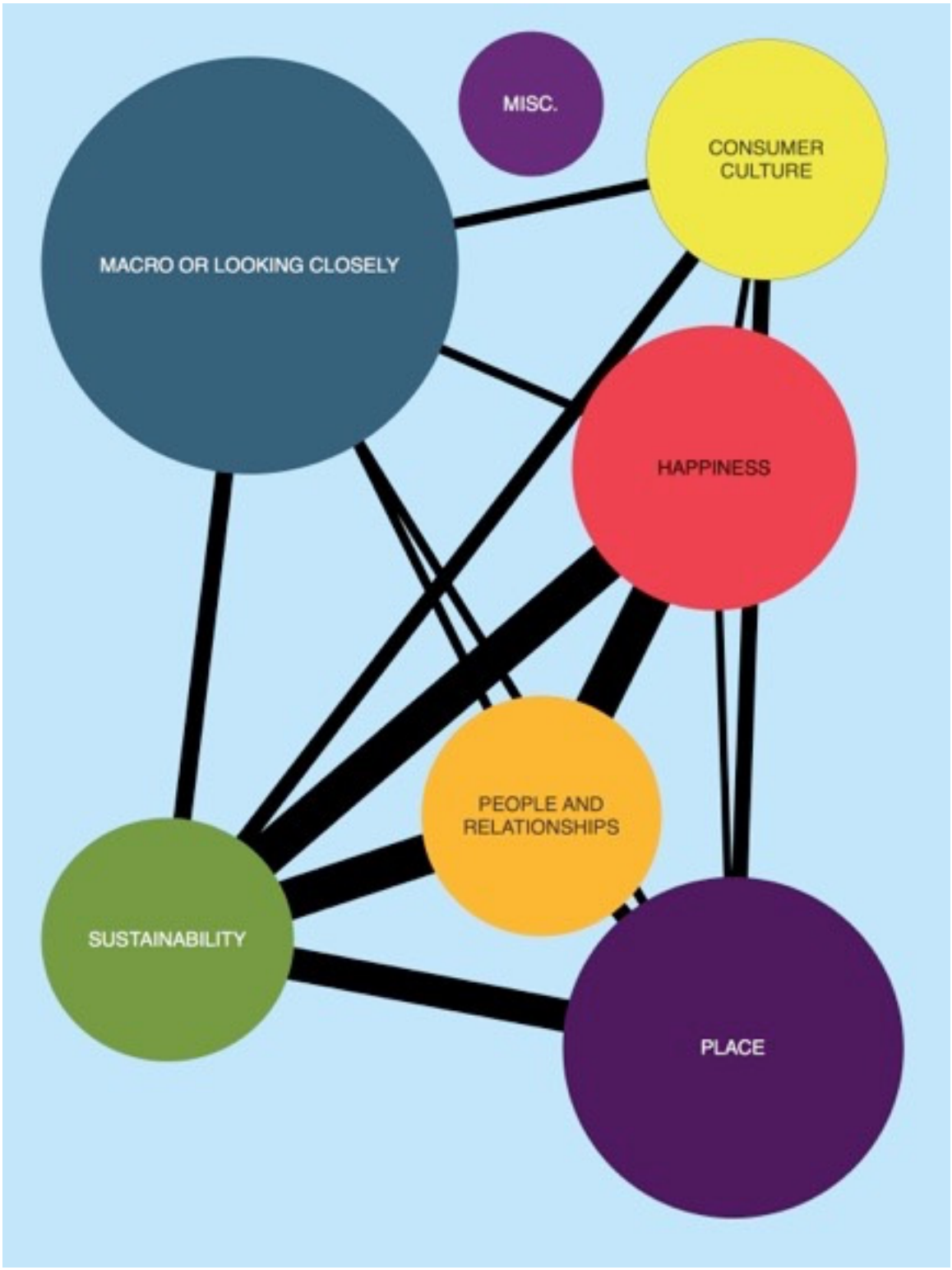

Figure 7. Network map of ideas, Week 8.

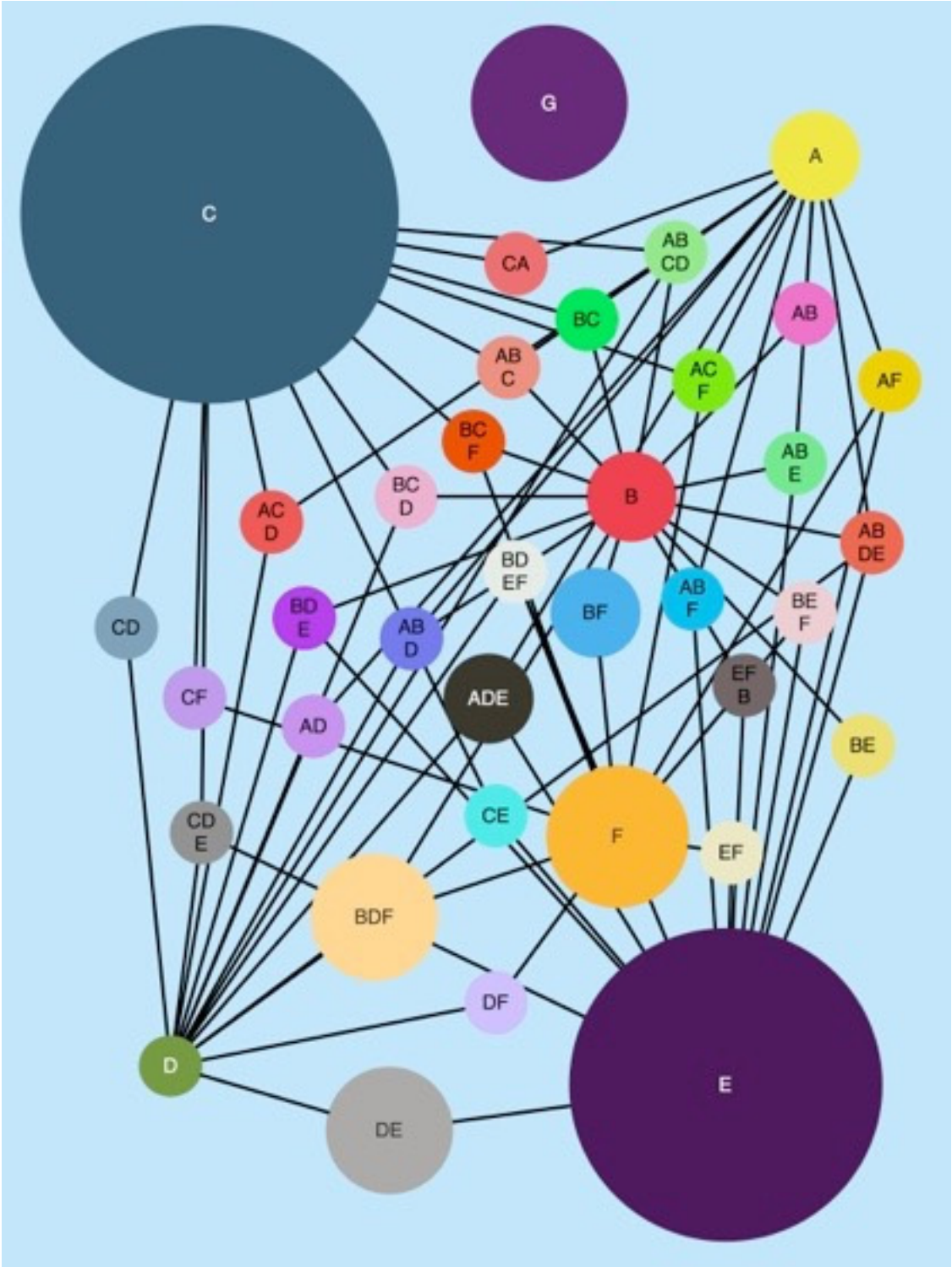

Figure 8. Network map of total idea combinations. Refer to Table 1 for thematic codes.

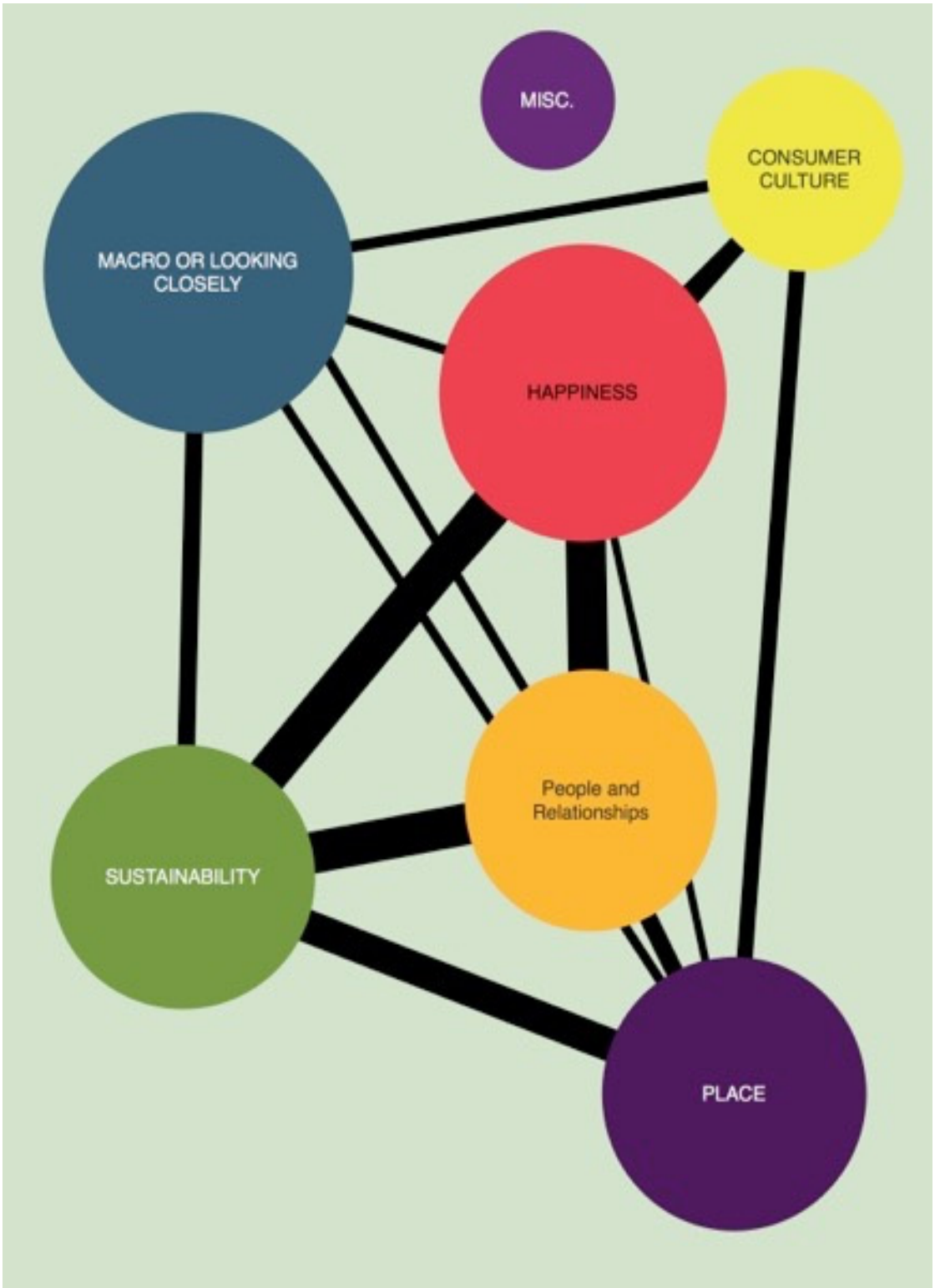

Figure 9. Network map of total views each idea received.

Data visualization not only can be used to identify which participants form hubs of attention and thus influence learning but also which themes form hubs of attention. The second set of visualizations illustrated the relations between ideas in the collective that is the network of ideas and themes present in the artworks posted. Figure 6 is network maps of the ideas in Weeks 1 and 4. The links are placeholders. Not until Figure 7, which represents the collective theme relationships at the end of the project, do the link thicknesses represent the strength of links between ideas. There are seven general ideas represented in Figures 6 and 7. Each image posted could be assigned more than one idea coding if appropriate, and there were a total of 38 idea combinations represented. Figures 6 and 7 were attributed every instance of their code in any of the idea combinations. For example, if an image was coded ABE, where there was interpreted Consumer Culture, Happiness, and Place, then each general category would receive one count. Figure 8 represents all 38 idea combinations. Each image posted could be assigned more than one thematic coding if appropriate. Figure 9 represents the view count proportion for each idea, using the seven general categories.

Idea Categories

Table 1. Idea categories.

Code	Category
A	Consumer Culture
B	Happiness
C	Macro or Looking Closely
D	Sustainability or Environmental Issues
E	Place
F	People or Relationships
G	Miscellaneous

I chose idea categories based on number of factors: how participants described their own images in the posted description accompanying the image or from interviews, and how other participants described the ideas and themes they perceived, either through posted comments or interviews (Table 1). I closely analyzed how the participants described the ideas they observed in the posted images.

From participant interviews I chose seven thematic categories that accounted for all of the stated ideas: (a) consumer culture, (b) happiness, (c) macro or looking closely, (d)

sustainability or environmental issues, (e) place, (f) people or relationships, and (g) miscellaneous. I chose consumer culture as a number of participants in the first few weeks mentioned this in discussions and image comments and descriptions. Of course, given the nature of the first four weekly prompts in response to the film Euphoria, happiness was a category. I would not consider macro, a term in photography that is either a setting or a lens that enables the ability for a camera focus closely, an idea category in and of itself; rather, the term looking closely is more appropriate. However, the fact that participants used the term so frequently to describe what an image was about justified its inclusion. I coupled sustainability with issues of the environment due to how it was invoked to both describe euphoria and then how it was used more to counter notions of happiness prescribed through consumer culture. Place was established due to the high number of images and interviews that described a place or space. People and relationships, like place, were noted as the subject of many images and this was directly related to the Week 3 project prompt. Miscellaneous images fell outside of the established categories, and did not show up enough to warrant the creation of a new category. In many instances, I assigned multiple idea codes to a single image, thereby creating a number of sub-categories such as sustainability and place, or consumer culture and place.

In the second set of visualizations I interpret two features. First is the relative meta-stability of the idea growth throughout the curriculum. Second is how early propagation of the social network with images about looking closely and place established these ideas and maintained their growth throughout the study. The identity of a complex system is a patterned coherence through time (Juarerro, 2002). Though decentralized networks are dynamic they do embody their history of structural changes (Davis and Sumara, 2006). Figures 6 and 7 illustrate this dynamic, in that we can see a relatively stable growth through the curriculum. The ideas of sustainability, happiness, and consumer culture grew as our inquiry through the designed curriculum progressed. However, macro/looking closely and place continued to grow as well, in proportion to the other ideas. Granted, some of the idea categories overlap, and who is to say what is the difference between a photograph that can be characterized as looking closely and place? This is where Figure 8 is helpful in illustrating the fine-grained qualities of overlapping and intersecting themes. Additionally, Figure 9 offers another illustration of where the attention was oriented throughout the curriculum. Like the illustrations showing the difference between idea links and participants' views, Figures 7 and 9 present a different picture of which themes were getting the most views. Though there were a significantly higher proportion of macro/looking closely and place, the number of views distributes as the other ideas become more prominent and begin to overlap.

This set of visualizations illustrates how the histories of interactions and relationships participants brought with them, their ideas, and their social links shaped our collective. Early on in the curriculum in Week 1, participants began propagating the social network with images that had nothing to do with the prompts or questions. This was not requested nor

barred; it was a behavior that seemed part of each individual participant's identity construction and performance. These individual acts, such as Haine Walker's posting of close to 90 images early on, Sophie Lee's and Mango Jello's posting of their portfolios of mostly macro photography, and Gaelan Knoll's posting of images of places, all contributed to the forming of a decentralized network of ideas and inquiry. We can see the difference the curriculum made from Week 1 to Week 4, yet it did not diminish these other ways of inquiry that participants brought with them. Their ideas and activities shaped the curriculum as much as the curriculum shaped them. Together, they gave rise to a collection of ideas that was dynamic yet meta-stable. These ideas, themes and visual approaches shaped the learning of individuals participating, and yet the collective also learned in the sense it was shaped by the contributions of each individual. This is where the dynamics of decentralized networks come into play as a reciprocal relationship. The individual shapes the collective as the collective shapes the individual.

Control

These interpretations raise the issue of control. Who controls the network, what causes learning, and who is responsible? In networked relations, there is no "one" controller. Rather, it is the topology of the network that causally influences participants in a network. The topology of our network of collective ideas is illustrated by this set of visualizations. In it are observable causal influences, but not a centralized control, as the topology forms through the weekly projects. Galloway and Thacker (1997), stated that the "two-fold dynamic of network control—distributing agency while instantiating rigid rules—implies that subjects acting in distributed networks materialize and create protocols through their exercise of local agency" (p. 41). In their local knowledge and contributions, participants shaped the collective—which dynamically looped back into our individual inquiry, further shaping it by confirming previous forms of inquiry and pointing to new possibilities for inquiry.

Summary

One of the advantages of learning and teaching art through social media are the traces that can be drawn from the patterns of activity online. This manuscript presented a series of creative interpretations of data collected through the social network in the form of visualizations. Visualizations, made through human interpretation and computer software, are a way to understand large amounts of data in meaningful ways. One of the most common methods is through proportion and distribution to create meaningful relationships from the data. These relationships implicitly reference the body's ability to judge size, quantity, and distance. From these visualizations, I offered a series of interpretations through the illustrations. In the first set of visualizations, I interpreted a difference in stated idea links and image views, meaning that even though I had designed and enacted a curriculum, it did not mean that all eyes were watching me. Learners are looking to each other for ideas and cues in the art classroom. These

visualizations give one possible interpretation of the shape and dynamics of who is viewing whom online.

The second set of visualizations represented another interpretation of the ideas in the collective. What I interpreted in this set was a relatively meta-stable collective identity that was established early on in the study. The shape of the network was determined not only by the designed curriculum, but also by the participants' history of artistic inquiry. This history was enacted in the social network by posting previously made images or images of personal inquiry. What is also interpreted is that control in these kinds of networks is two-fold: individual local action shapes the collective's network topology, which loops back into individual local action.

Decentralized Networks and Democratic Art Education?

Democratic pedagogy should not be equated with the understanding of decentralized networks presented in this paper. Decentralized networks are not inherently democratic and egalitarian, a claim that has been made many times about the Internet. What research about decentralized networks has shown is that their dynamics can evolve to be quite hegemonic. Many of the calls for democratic participation in the art room embody qualities of "sharing through expressive media" (Fredriksen, 2010, p. 392). Democratic classrooms are ones where power is seen to be distributed amongst students and the teacher (Aitken, Fraser, & Price, 2007). This coupled with the touted democratic potentials of social media (Delacruz, 2008) make the image of a decentralized classroom as a democratic one attractive. However, as explored in this paper art educators need to proceed with caution in spaces where students are allowed and encouraged share to their opinions, ideas, and beliefs. I suggest that art educators consider the dynamics involved in the decentralized models of democratic art education.

Since ideas and systems can grow exponentially should give us pause, as educators, to consider both our responsibility and the ease with which certain ideas, trends, styles, and themes may spread and take hold when learning and teaching art through social media. This insight asks us to consider who and what are the hubs, those ideas and personalities that are associated and linked to in greater proportion. It also asks us to consider who and what ideas the collective is marginalizing for lack of attention. The hubs of a dynamic decentralized network offer a representation for understanding the organization and structure of how attention and learning happens not only among individuals, but also as a collective.

The role of the art teacher in a decentralized network is still a hub, one of many centers in a network of relations, active at making and building associations between students, teachers, and ideas. It is to function as a consciousness of the collective (Davis, 2005), pointing toward possibilities in the landscape while also being aware of those ideas and participants that are

gaining links and growing in significance. What if, for instance, the idea of macro and looking closely was something far more damaging, like classifying a race or culture in harmful ways? What if this were a hub in which participants were organizing their thinking around? Or what if, through our examples and histories of art that are used in our curricula, we create an idea-hub that artists are only male and of white European descent? Being aware of those ideas which our students structure their thinking around, and associate with, seems to be of utmost importance. Teaching democratically with social media is not just about dismantling hegemonic ideas, liberating our students, and getting out of the way, but also about enacting constraints (Castro, 2007) that ask for a reexamination, reevaluation, and a building of new links and associations with those marginalized ideas, beliefs, cultures, genders, and so on. Embodied in the collective is a depth of possibilities waiting for the occasion to be realized. Teachers can create those occasions.

The advantages of teaching art through social media is that it offers opportunities to trace those associations of ideas and relations that affect learning and artistic inquiry at multiple scales. As art teachers move towards incorporating social media into their curriculum and as technology progresses it will be possible to visualize in real-time the activity of the collective. This paper has illustrated some possibilities for visualizing how the collective's ideas form and evolve. It also offers a new method for understanding how learners influence and are influenced by collective activity online.

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