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Collaborative Creativity in STEAM: Narratives of Art Education Students' Experiences in Transdisciplinary Spaces

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Abstract

Current efforts to promote STEAM (STEM + Arts) education focus predominantly on how partnering with the arts provides a range of benefits to STEM students. Here we take a different

approach and focus on what art and art education students stand to gain from collaborating with STEM students. Drawing on a variety of student field texts, we present three visual-verbal, constructed narratives of art education students who, in the context of a transdisciplinary design studio, were challenged to experiment with collaborative forms of creative thinking. Their stories point to STEAM as an opportunity for art students to question the notion of the 'lone artist,' reflect upon the tension between product and process, and expand disciplinary-based understandings of creative thinking. These potential benefits align with contemporary visual arts practices that strive to move beyond the individual and embrace dialogue, collaborative action, and interdisciplinarity as vital aspects of the creative process.[1]

I like the idea of collaboration…because it pushes you…
It's a richer experience….
Frank Gehry (2008)[2]

As an art educator, I[3] am relentlessly intrigued by the idea of creativity. Both engaging in artmaking and watching others create over the years has impelled me to consider how individuals conceive of creativity, how they see themselves as creative beings and, perhaps most importantly from my perspective as an educator, the facets of what and how we teach as supporting students' creative development. During the fall of 2012, I was afforded the opportunity to teach, along with co-author Nicki Sochacka, a STEAM (an acronym for Science, Technology, Engineering, Art, and Mathematics)-inspired course referred to as the Transdisciplinary Design Studio at a research university in the southeastern United States. It was in the context of this formative experience that I, as both a teacher and researcher with an interest in visual-verbal methods of analysis, became attuned to the notion of *collaborative creativity*—how individuals' creative processes enmesh and collide as they endeavor to reach new and shared understandings. In particular, when the semester ended and I began to analyze the students' field texts as part of my dissertation research, I was provoked by the way the creative process, often characterized and understood as an individual pursuit, was described

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[1] An earlier version of this paper was presented at the 2014 American Educational Research Association Annual Meeting in Philadelphia, PA:
Guyotte, K. (2014, April). Considering the Creative Self: A Visual-Verbal Narrative Inquiry.
Paper presented at the American Educational Research Association Annual Meeting. Philadelphia, Pennsylvania.

[2] http://www.ted.com/talks/frank_gehry_asks_then_what/transcript?language=en

[3] In this paper, the use of "I" refers to the first author's (Kelly Guyotte's) voice as this paper draws from her dissertation work. The dissertation was situated within a grant funded by the National Science Foundation under which Kelly was a research assistant. Therefore, this paper represents both Kelly's inquiries into collaborative creativity ("I") and the research team's interest and collaboration ("we") with regard to student learning and experiences in the Transdisciplinary Design Studio.

by many of the students as a collective action that emerged as they explored design challenges within interdisciplinary groups. Perhaps it is unsurprising that this notion was not immediately visible to Nicki and me while we taught the design studio. As Eisner (1960) pointed out, it is difficult to see the creative process "qua process" (p. 28). Instead, he wrote: "We must infer the nature of the process from what we can observe" (*ibid.*). In line with Eisner, it was through a post factum visual-verbal analysis of a collection of the students' visual-verbal artifacts from the course that Nicki and I were able to observe the students' narratives of creativity and the creative process. These narratives painted a unique and unexpected picture of STEAM as a space that cultivated a collaborative approach to creativity.

In this article, my co-authors and I draw on a variety of student field texts to present three visual-verbal, constructed narratives of art education students who, in the context of the Transdisciplinary Design Studio, were challenged to experiment with collaborative forms of creative thinking. This unique visual-verbal methodological approach (Guyotte, 2013) afforded us the opportunity to consider how students told stories of their interdisciplinary collaborative experiences and how those experiences impacted their perceptions of creativity. Their stories have important implications for art educators, proponents of STEAM education and, more broadly, for society where the need to find collaborative and creative solutions to complex challenges is becoming increasingly critical.

Collaborative Creativity

The belief that learning is a sociocultural and co-constructed activity (Vygotsky, 1978) is often cited as the impetus for fostering collaboration in the classroom. Through such collaboration, students bring together varied life experiences, knowledge, and approaches to meaning making in the shared pursuit of a learning goal often put forth by the instructor. While the notion of collaboration is not new in educational contexts, it does stand in contrast to many traditional perceptions of the visual arts in higher education. In these disciplinary experiences, students often speak of autonomy in their studio courses—retelling the longstanding narrative of the lone artist, physically or mentally isolated, deeply engaged in her/his own creative process (Thomas & Chan, 2013). This perception may be rooted deeply in the American psyche as a recent study found a bias towards single-artist works of art when compared to collaborative works (Smith & Newman, 2014). This study found that the same work of art presented by researchers as a single artist-creation was evaluated as higher quality than if it were presented as a group undertaking. Interestingly, these perspectives juxtapose contemporary visual arts practices that strive to move beyond the individual and embrace dialogue, collaborative action (Bourriaud, 2002), and interdisciplinarity (Sandell, 2011) as vital aspects of the creative process. In other words, contemporary visual arts are becoming a space where the possibilities in learning and creating move beyond the "I" of creation, and towards the "we" (Glăveanu, 2011).

In this paper, we draw upon a sociocultural perspective where collaborative creativity is understood as inherently social, existing between the individual and 'the other' (Glăveanu, 2011). Csikszentmihalyi (1990) was an early proponent of creativity as functioning within a system, which encompasses the individual as well as other external, social structures including the field and the domain. Arising from interactions with structures such as these, the study of collaborative creativity seeks to explore creativity as situated across individuals who are engaged in a collective pursuit (Sawyer & DeZutter, 2009). Hargrove (1997) described collaborative creativity as:

> an act of shared creation and/or shared discovery: two or more individuals with complementary skills interacting to create a shared understanding that none had previously possessed or could have come to on their own. Collaboration creates a shared meaning about a process, a product, or an event. (p. 4)

This perception builds upon similar approaches to collaborative learning, examining creativity as intersubjective (Glăveanu, 2011) where individual experiences, knowledge, and creative process merge and contribute to a holistic and collective creative effort.

In addition to being intersubjective, collaborative creativity emphasizes creativity as process. Littleton and Miell (2004) explained, "inherent in contemporary approaches to collaborative creativity is an emphasis on studying the processes involved rather than a sole focus on examining the quality of the product of creative endeavors" (p. 1). This process focus was reinforced in the curriculum of the Transdisciplinary Design Studio as Nicki and I made a conscious effort to withhold the students from solution-finding (further explained in the design challenges below) and instead encouraged them to embrace the exploratory nature of problem finding—"the way problems are envisaged, posed, formulated, [and] created" (Getzels & Csikszentmihalyi, 1976, p. 5). Through engagement in the creative process, problem finding is often discussed as a preparatory, yet recursive activity (Runco & Nemiro, 1994) as well as involving divergent thinking (Runco & Okuda, 1988). Nicki and I found that asking the students to engage deeply and thoughtfully with the early stages of the creative process cultivated a space where they had permission to explore, consider multiple and conflicting viewpoints, and come to understand the collective nature of the group design challenges.

Unlike the visual arts, literature on collaborative creativity is prevalent within the performing arts (e.g. Burnard & Dragovic, 2014; Kenny, 2014; Sawyer & DeZutter, 2009). Jazz ensembles, theatrical productions, dance, and other improvisational performances rely upon artists to engage in a joint creative process through which individuals are mindful to both their own actions and the ways in which their actions function within a larger system (Chappell, Craft, Rolfe, & Jobbins, 2012). In this way, collaborative creativity might be likened to an assemblage, where seemingly disparate objects are thoughtfully brought together to comprise

a conceptually or aesthetically harmonious whole. Extending the assemblage analogy, this article seeks to explore how art education students discussed their experiences in moving beyond their distinct (individual and disciplinary-based) creative processes as they worked together through interdisciplinary group design challenges towards a co-constructed and harmonious whole.

The Transdisciplinary Design Studio

From August to December 2012, the Transdisciplinary Design Studio brought together eleven undergraduate and graduate students from the seemingly disparate disciplines of environmental and civil engineering, landscape architecture, and art education into an assembly of unique perspectives and processes. Funded by a grant from the National Science Foundation's Engineering Education and Centers Program (EEC)[4] the goal of the overarching project within which I conducted my graduate research was to investigate the notion of 'synergistic learning' or, how students make connections between disparate aspects of their educational experience. With the view to bringing these disparate aspects of the students' experiences to the fore, the curriculum was inspired by the notion of STEAM[5] (Science, Technology, Engineering, Arts, Mathematics), which emphasizes the need for STEM professionals to develop creative problem solving skills in interdisciplinary settings. Given the multidisciplinary and multilevel enrollment, Nicki and I strove to cultivate a space that reflected a type of *interdisciplinary understanding* as presented by Boix Mansilla, Miller, and Gardner (2000) where: "…disciplines are not simply juxtaposed. Rather, they are purposefully intertwined. Concepts and modes of thinking in one discipline enrich students' understanding in another discipline" (p. 29).

The concept of purposeful intertwining relates to the transdisciplinary nature of the studio where content is not simply incorporated but thoughtfully and deeply integrated.[6] Along these lines, transdisciplinarity is conceived as a type of interdisciplinarity Lattuca (2001) described as: "the application of theories, concepts, or methods across disciplines with the intent of developing an overarching synthesis" (p. 83). It is distinct from other interdisciplinary

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[4] Partial support for this study was provided by the National Science Foundation's Course, Curriculum, and Laboratory Improvement (CCLI) program under Award No. 0837173, the Engineering Education and Centers' (EEC) program under Award No. 1160350, and the University of Georgia's Office of STEM Education. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation or the University of Georgia.

[5] While the "A" in STEAM encompasses all forms of the arts, the Transdisciplinary Design Studio focused on the visual arts.

[6] The notion of purposeful intertwining the Transdisciplinary Design Studio has also been discussed in Sochacka, Guyotte, Walther, Kellam, and Costantino (2013).

approaches as it engages individuals in inquiries that *transcend* disciplinary boundaries with the goal of applying new understandings to their home discipline (Holley, 2009). Nicki and I were particularly sensitized to the importance of this holistic approach to interdisciplinary learning in light of recent concerns that STEAM education might be conceptualized in a way that benefits the STEM fields without developing a reciprocal benefit among all the disciplines (Bequette & Bequette, 2012; Sochacka, Guyotte & Walther, in press; Sochacka, Guyotte, Walther, Kellam, & Costantino, 2013). In this way, the design studio curriculum and pedagogy was driven by the need for reciprocity through a purposeful intertwining of course content.

In line with the vision of STEAM education as a way to promote creativity and creative thinking across disciplines (Wynn & Harris, 2012), creativity was brought forth as an explicit component of the curriculum of the studio. In support of this learning goal, one of the two required readings for the course was *Sparks of Genius: The Thirteen Thinking Tools of the World's Most Creative People* written by Robert and Michèle Root-Bernstein (1999). Akin to the spirit of collaboration underpinning STEAM-inspired learning, the authors of this book presented creativity as transdisciplinary, arguing the perception of creativity as fragmented and often situated within a particular discipline is unnecessarily limiting. The Root-Bernsteins' explained, "it is obvious that education based solely on separate disciplines and public languages leaves out huge chunks of the creative process" (p. 13). Restructuring the perspective of creative capacities, the Root-Bernsteins discussed thirteen thinking tools they asserted are "at the heart of creative understanding" (p. 25), some of which include: observing, forming patterns, analogizing, body thinking, empathizing, playing, and synthesizing. Through studying highly creative individuals throughout history and across disciplines, the Root-Bernsteins shifted their focus from the differences among these creative individuals and their creative processes to the underlying universalities in how they create. In this way, the text played an important role in situating creativity as transcending disciplinary lines rather than as relegated to the arts, furthering the notion of STEAM education as an integrated and purposeful intertwining.

Reflecting the notions of transdisciplinarity and purposeful intertwining, students spent much of the semester in collaborative teams engaging in two distinct "design challenges." These design challenges engaged students in explorations of environmental sustainability, specifically focused on exploring the topics of waste reduction (Introductory Design Challenge) and a water ethic (Final Design Challenge) as having local and global implications. Through these ill-structured problems (Jonassen, Strobel, & Chwee Beng, 2006), the students were divided into interdisciplinary teams and were charged with finding and framing a problem nestled within each broad and emerging topic. Their explorations were visually represented through the creation of artworks (mostly sculptural), which were

displayed in a gallery setting in the university's School of Art (Figure 1). In addition, the Final Design Challenge entreated students to implement an initiative focused on inspiring a water ethic in the local community and document this community interaction through a second gallery exhibit.

Figure 1. Gallery exhibit from the Final Design Challenge. Visual exploration of water ethic focused on increased demand (left) and documentation of community initiative (right).

It was through engaging in these two design challenges that the students, across all three of the disciplines, reflected deeply on their experiences, and themselves as creative beings as they were both awakened and released to consider their perceptions of creativity, process, and self. Throughout the semester, the students engaged in focus groups and kept visual journals—a hybrid between the writer's reflective journal, artist's sketchbook or engineer's design notebook—blending image and text into one expressive space. It was through both image and text that the art education students, in particular, told stories of collaborative creativity, inspiring Nicki and me, and our colleagues, to take a fresh look at STEAM with a particular focus on what the arts might stand to gain from STEAM-inspired learning.

Theoretical Framework: Embarking Upon a Collaborative Search

Theoretically, I grounded my dissertation and this work in the writings of educational philosopher, Maxine Greene. Greene wrote passionately of educational reform and the benefits of aesthetic education asserting that it cultivates "imagining, thinking, feeling, perceiving, and active beings" (2001, p. 56). For Greene, education was not a means to an end but rather an ongoing process, a quest, through which individuals learn to reflect, express, and construct meanings based on their lived experiences. Through visual journaling and other opportunities for reflection in the Transdisciplinary Design Studio, students were gently nudged towards an active and wide-awake educational experience that encompassed exploration and expression in visual and verbal modes. More broadly, the goals of the course paralleled the ideas put forth by Greene (1995) as Nicki and I strove for a constructivist pedagogy where both "teachers and learners [found] themselves conducting a kind of collaborative search, each from her or his lived situation" (p. 23).[7]

As a practitioner researcher, I was acutely aware of the collaborative search of which Greene spoke and the critical nature through which learners view the world and construct meaning. It was not until after the course, however, when I began to more deeply engage with the students' texts, that I realized the collaborative nature of the search extended beyond teacher and student interactions—it brought the students together in this quest. In a similar way, psychologists Dudek and Coté (1994) described the entire creative process "from start to finish is characterized by an urgent and relentless search" (p. 147). In this spirit, it is the constructivist underpinnings of Greene's writings, the quest for learning and creativity as a relentless search, which theoretically inform both the curriculum of the course and the narrative methodology of this study.

Methods

This exploration of collaborative creativity emerged out of an ongoing conversation between Nicki and me regarding the potential of STEAM to enrich the educational experience of both STEM *and* Arts students (Guyotte, Sochacka, Costantino, Walther, & Kellam, 2014; Sochacka et al., in press; Sochacka et al., 2013). As I describe above, it was not until I was deeply in the process of constructing the following narratives that Nicki and I began to

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[7] More about the design studio as fostering a constructivist and collaborative inquiry within the instructors can be read in the following conference proceedings: Sochacka, N., Guyotte, K., Walther, J., Kellam, N., & Costantino, T. (2013, June). Faculty reflections on a STEAM-inspired interdisciplinary studio course. Paper presented at the American Society for Engineering Education Annual Conference and Exposition. Atlanta, GA.

appreciate the depth and significance of some of the art education students' struggles with working in a collaborative space.

In my dissertation research, I adopted an intrinsic case study design (Stake, 1995) in which I was interested in the specific and unique case of the Transdisciplinary Design Studio. As I was a co-instructor for the studio, this study is also considered practitioner research where the teaching space became the site for inquiry (Cochran-Smith & Lytle, 2009). Through a practitioner lens, I was most concerned with addressing both narratives of lived experiences and conceptions of creativity in the course, which led to the use of a narrative inquiry methodology (Clandinin & Connelly, 2000). As Clandinin and Caine (2008) described, "narrative inquiry is first and foremost a way of understanding experience" (p. 542), valuing stories of human experience "as a source of important knowledge and understanding" (Clandinin, 2013, p. 16). For me, as a teacher and now researcher, student narratives are a compelling yet inherently multivoiced vehicle through which experiences are told and meaning is made. Listening to the voices in student narratives provides insight into curriculum, pedagogy, and how students make connections among these educative spaces as they intersect with their own lives. This is why practitioner research is compelling to me, and why focusing on student narratives drove this inquiry. Both becoming wide-awake to and giving voice to the experiences of students in the Transdisciplinary Design Studio was driven by a focus on developing a deepened understanding of creativity in this interdisciplinary and complex social space through holistically preserved (rather than parsed) accounts of experience (Josselson, 2011; Riessman, 2008).

Data Sources

This study included the analysis of three different types of field texts[8]: focus groups, personal visual journals, and a final reflective paper. Focus groups are a form of data collection which resemble group interviews or collective dialogue (Kamberelis & Dimitriadis, 2005) and emphasizes group interaction (Morgan, 1996). The semi-structured focus groups (Roulston, 2010) were conducted twice during the course, were led by members of the NSF research team, and were not attended by the course instructors. On each occasion, the students were divided into three groups that met in distinct locations with their respective facilitator. The focus group protocol was designed to elicit critical incident accounts of students' experiences (Flanagan, 1954; Walther, Kellam, Radcliffe, & Boonchai, 2009; Walther & Radcliffe, 2007). Prompts based on the use of emotional indicators (Walther, Sochacka, & Kellam, 2011), for

[8] This aligns with Clandinin and Connelly (2000) who use the term field texts rather than data to signify the perspective that "they are created, neither found nor discovered, by participants and researchers in order to represent aspects of field experience" (p. 92).

example, "What was the most exciting/the most frustrating moment in the first few weeks of this class?", were used to draw the students' attention to impactful learning experiences.

A required component in the course, visual journals were kept by the students throughout the semester. Visual journals are documents in which individuals create representations of their learning using various modes of communication, including verbal and visual expression. As indicated above, visual journals are also closely related to the engineer's design notebook. The visual journaling process was integrated into the course design as a means of engaging students deeply in the course content; permitting a space for critical reflection, exploration of ideas, and documenting the creative process. LaJevic and Springgay (2008) explained visual journaling as establishing "an opening of inquiry for students to document their reflections, questions, and beliefs" (p. 82). This inquiry was essential for both students and researchers as it opened the students to explore and construct meaning while providing a space where narratives of experience and conceptions of creativity could emerge. Student visual journals were scanned and submitted electronically by students at specific checkpoints during the semester while physical journals were collected for review at the semester's end.

Visual-Verbal Narrative Analysis

In this study, I employed a visual-verbal narrative method of analysis (Guyotte, 2013). Situated within narrative inquiry and drawing heavily from visual narrative analysis, this method "pushes the boundaries of narrative and narrative analysis" (Riessman, 2008, p. 145) where multiple layers of meaning contribute to understanding lived experience (Bach, 2008). Visual-verbal narrative analysis acknowledges the limitations of relying solely on verbal data (Keats, 2009; Riessman, 2008) and embraces the complexities of narrative as it is revealed and generated through the various modalities through which humans communicate and construct meaning. Similarly, it aligns with Eisner's (2002) assertion that expression through an artistic medium affords the creator a visual language, conveying qualities inexpressible through words.

The term for this method, visual-verbal narrative analysis, is borrowed from Greer Cavallaro Johnson (2001; 2004) who situated her research in the space between text and visual as she investigated visual-verbal narratives of student teacher's experiences. Johnson (2004) explained, "The combined visual–verbal narrative genre itself positions storytellers to question the 'truthfulness' of the stories they are telling: to tell tales in different voices" (p. 425). Inspired by Johnson, the goal of this visual-verbal narrative analysis was to place an equitable focus on both visual image and written text as both voices were essential to understanding the holistic narrative.

The analytic process began with an initial reading of the various texts documenting "initial and more global impressions of such aspects as unusual features, metaphorical representations, reflexive comments, focused attention, or other aspects of a researcher's interest" (Keats, 2009, p. 189) in a Word document memo. Concurrently, field texts were organized into an Excel spreadsheet, which permitted a more "hands-on" and holistic approach to data organization that complemented the groundings in visual-verbal method and narrative methodology. Successive readings moved between the visual and verbal in a recursive manner fostering a more holistic exploration of these expressive modes and these relationships between them. The Excel format permitted easy movement between the concepts of creativity intertextually (across students' field texts) and intratextually (with one individual's field texts) (Keats, 2009).

The findings were represented through emplotted narratives (Polkinghorne, 1995) that focused on creativity and were constructed with attentiveness towards Clandinin and Connelly's (2000) three narrative dimensions—temporality, sociality, and place (click here to see how Christy's narratives were constructed from the different data sources). Images were incorporated into the verbal narratives to correspond with the text but also allow the reader to engage in the meaning making process alongside the researcher—contributing to a multilayered (co)construction. This process might also be thought to mirror the assemblage as the constituent parts of the narrative were pieced together into a coherent and harmonious whole (Polkinghorne, 1995). Below, we present three narratives focused on collaborative creativity that emerged from this visual-verbal analysis.

Findings: Three Visual-Verbal Narratives

Creativity represented an explicit facet of the Transdisciplinary Design Studio curriculum and was therefore a prominent topic in many of the students' narratives. In this findings section, we focus on three of the four art education students enrolled in the course, two undergraduates and one graduate student, and their narratives of creativity in a collaborative space. These three students were selected for several reasons. First, their narratives thoughtfully and holistically unpacked their experiences in the course, particularly surrounding the group design challenges. Second, and perhaps most importantly, we focus on these three students as they were in each in different groups for both of the design challenges and they provide insight into these three distinct group experiences. Finally, we felt three narratives would be more manageable for the readers in this space. Using the visual-verbal narrative analysis method, the narratives are assembled together from the various field texts where italicized text represents verbatim text while non-italicized portions represented additions and narrative smoothing (Spence, 1986), which contributed to clarity and cohesiveness. The images contained within each narrative derive from the particular students' visual journal and are explained through a brief caption.

The narratives begin with Christy, a nontraditional doctoral student who spent a decade as a professional artist and studio professor prior to returning to school to work on her doctoral degree. This story focuses on the tensions that emerged as she attempted to reconcile her professional identity and creative process as encompassed in her new role as a student and group member. Next, undergraduate Sara's story reveals how she sought to overcome a tremendous challenge in the Introductory Design Challenge with regard to interdisciplinary communication and differences in creative processes. Finally, Amy's narrative reveals her experiences within her design challenge groups. She recounts how she developed understandings about the assignment through creative collaboration and how empathy contributed to her group's success.

Christy's Narrative[9]: "The problem was it wasn't mine. It was ours."

> *When they first handed out the assignment, I was the person who jumped into the solution immediately, by myself, without my group. I was doing research, collecting images, writing a proposal. I was ready to go. By our second group meeting, I had three fully fleshed out ideas ready for the group and I was ready to do it. My poor group just looked at me like I was insane and I really needed more to do in my life than to work on this project, but I didn't get it at first, I didn't get the working backwards idea. I could not stop myself from jumping to the solution method and what I needed to do is to stop and define the problem—to find the heart of the problem.*

[9] Christy's narrative also appears in the first author's doctoral dissertation (Guyotte, 2014).

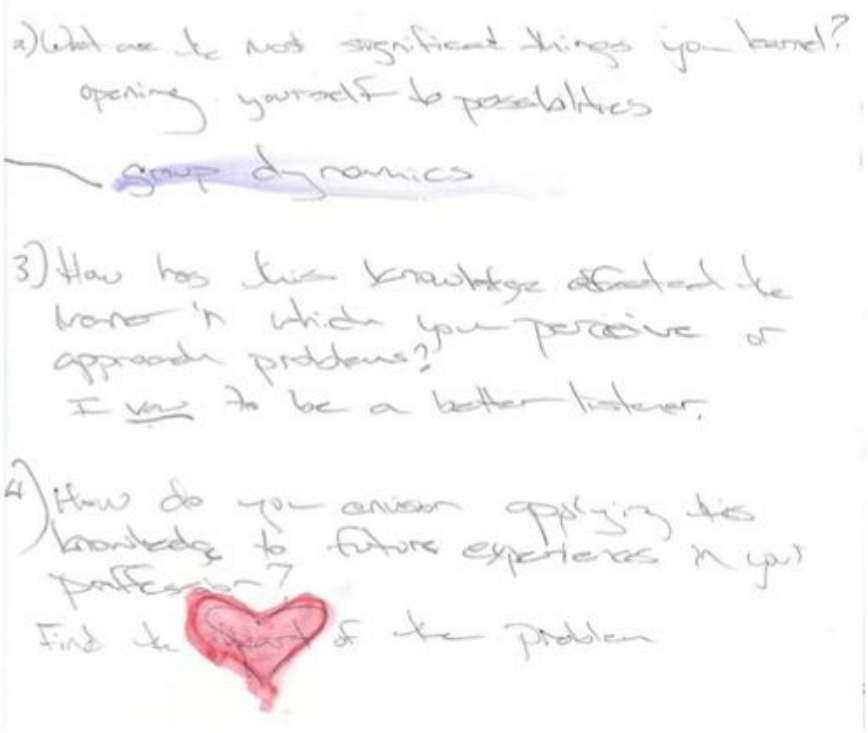

Figure 2. 2) *What are the most significant things you learned?* Opening yourself to possibilities; group dynamics. 3) *How has this knowledge affected the manner in which you perceive or approach problems?* I vow to be a better listener. 4) *How do you envision applying this knowledge to future experiences in your proffession [sic]?* Find the heart of the problem.

> *In my work, often times I will go to a site and sit and let sounds, smells, and things direct and inspire ideas.* For the Introductory Design Challenge, *I went downtown and sat and there's an excitement, there's twinkle lights. There are all kinds of things that are happening downtown. That is what I responded to and so my first ideas were about performance, live performance downtown. Projecting images, sound of glass breaking. I wasn't at all bothered by the open-endedness of the question, that's sort of what I do. I deal in metaphor all the time. I was very comfortable taking that huge open question* of waste *and making it my own. The problem was, it wasn't mine. It was ours. That's where I had the most difficulty.*

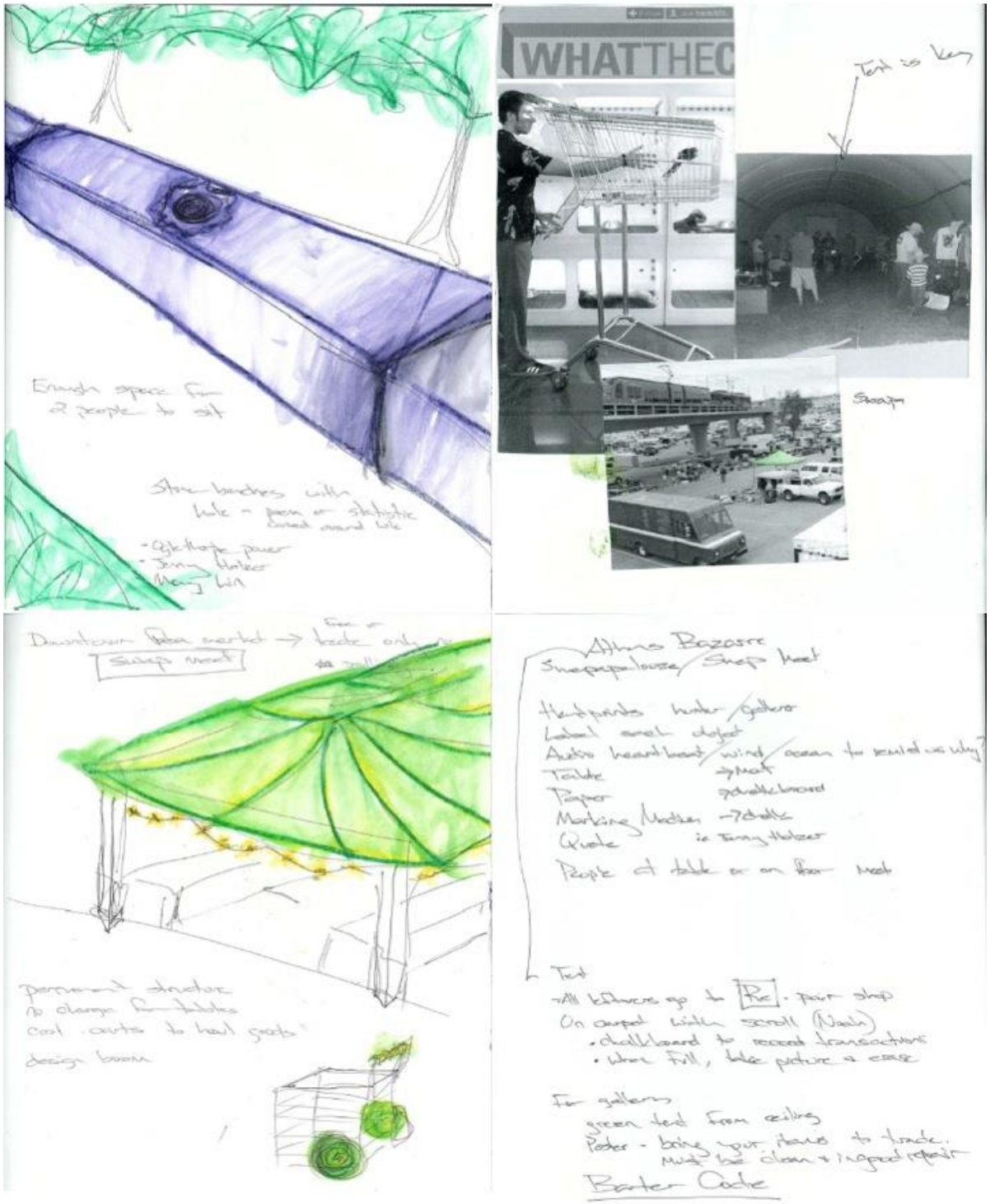

Figure 3. Sketches from Christy's visual journal illustrating her initial ideas for the Introductory Design Challenge.

> *I was the only art major in my group, but I'm also a professional artist so I jumped. I'm a pretty careful reader. I really thought I had this* assignment *figured out. It is not at all what I thought it was. It was an undergraduate environmental engineering student,* Ellie, *who was just a very generous, comforting individual in the group, she said to me, "Chill out." It wasn't in front of the other group members; she said it under her breath. She said, "We do this, don't worry about it. We do this all the time, just chill out." I was like, "Okay." I was shocked. Because you know, I'm 40 years old and I've been a professional artist and teacher, and she's maybe 22-23. And I'm like, "You're the smartest person I've ever met." She was very calm, and I responded to that calmness. I was sitting over here bursting with ideas, not nervous but anxious energy, and she was calm and she was listening and she was letting the process unfold. I didn't get that the instructors were consciously putting these, what I thought were obstacles in our way when they were actually… They were speed bumps to keep you from moving to a solution too quickly.*

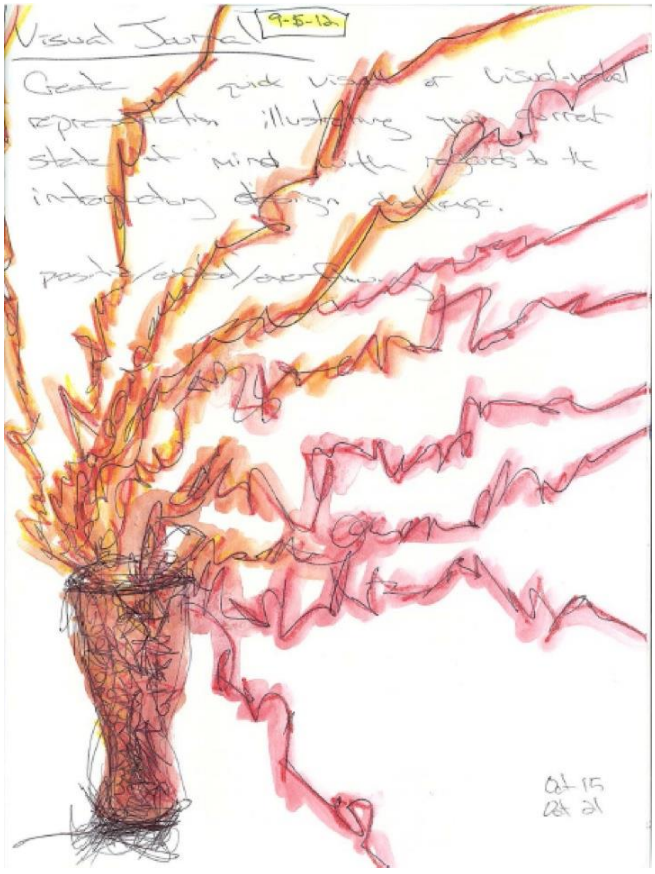

Figure 4. Visual depiction of Christy's state of mind with regard to the Introductory Design Challenge with text which reads: "positive/ excited/ overflowing"

> *Working collaboratively is always a challenge. Different egos operate in different ways. I definitely will take away from this to pay more attention to the group, not necessarily their ideas—I mean their ideas are good—but their behavior and their mood. I think gauging that earlier will be more helpful. It's difficult to gauge emotional temperature in the beginning. My first instinct is to react when I hear a bad idea. At one point, someone brought up an idea and very loudly, I said, "No." That did not work out very well. Everyone sort of got a shocked look on their face and it just kind of disrupted what we were doing. I tried to make a joke about it, but afterwards I thought, "That was really inappropriate." I didn't mean it the way that it sounded. It taught me that sometimes it's more important to keep your mouth shut rather than disturb the group dynamic and to use the activity as a learning experience. The group member's solution would not have been my solution but, by listening to him I have a better understanding of working in groups.*
>
> *I think that as professional artists we are kind of insular, but we do have critiques and we get feedback and we have of course reviews and things like that. I think that what I would take away from this that would help me in my own work is… the slowing down. The reason that I have to slow down is I have to give myself time to absorb other people's opinions. It is important to open yourself up to possibilities, whether the solution is mine or part of a group's. I don't know that I will ever go into group work or collaborative work as a profession, but in either case, I think that listening is really important. I vow to be a better listener. When I reflect back on this class, I will remember my experience as a member of a group. An MFA trains you to work independently. I had never been dependent on other people before completion of a project or its success and I can't say it was fun but it was beneficial. I learned patience, perseverance, and empathy. Empathy is still the most useful tool for me. I am using it every day in so many ways. These qualities are invaluable especially in that patience was not one of my strong suits.*

Discussion of Christy's Narrative

Christy's story traces her experience beginning with the Introductory Design Challenge and concluding with her perspectives as articulated in her final visual journal entry. As Christy engaged in the first design challenge, she became aware of the incompatibility of her own creative process with the process of her group—explaining her extensive experiences in the MFA (Master of Fine Arts) and post-MFA world dictated how she viewed and approached creative problems. In her narrative, Christy discussed a realization that required a slowing down and holding back as opposed to her initial instinct of jumping to solutions and defining and tackling the problem herself. Moran and John-Steiner (2004) indicated that patience is essential to creative collaboration, which Christy admitted in a visual journal reflection was

not "one of [her] strong suits" (Visual Journal Check #2, p. 43). Initially, Christy struggled with a sustained engagement in the early stages of the creative process but she attributed her effort to slow down and embrace process to her group mate and engineering counterpart, Ellie, and her gentle suggestion to "chill out." As Christy began to realize the importance of process—taking the time to define the problem, rather than jumping immediately to the solution—she worked hard to hold herself back. In this spirit, Christy (re)envisioned the perceived obstacles in the curriculum as speed bumps and began to open herself up to the possibilities of creativity and understanding that lie in a collective approach to design, rather than an individual one.

It was also through the context of collaboration, that Christy began to perceive the notion of empathy as both meaningful and essential. Root-Bernstein and Root-Bernstein (1999) presented empathizing as one of their thirteen creative thinking tools, explaining: "the key to empathizing is learning to perceive the world through someone else's mind and body" (p. 186). These authors grounded empathy in the imagination where an individual immerses oneself completely into the subject in order to authentically engage with the world as if s/he was that subject—developing not a *feeling-for* but a *feeling-with* the other (Noddings[10], 2010; 2012). This perception of empathy parallels Greene's (1995) proclamation that: "imagination is what, above all, makes empathy possible. It is what enables us to cross the empty spaces between ourselves and those we teachers have called 'other' over the years" (p. 3).

Christy pointed out that learning to empathize did not come without challenge as, according to her, the collaborative experiences were not all enjoyable. She explained that it was a struggle for her to negotiate the group work as her previous education and professional experience in the visual arts had fostered creative autonomy (Thomas & Chan, 2013; Thornton, 2013). Though she did not necessarily envision collaboration in her future after the design course, she did state that the most useful tool that emerged from her experiences was that of empathy as she was using it "everyday in so many ways" (Visual Journal Check #2, p. 38). Despite her struggles with collaboration, Christy found empathizing a necessary and beneficial creative thinking tool that she employed both inside and outside the transdisciplinary context.

Sara's Narrative: "…not every person thinks the same way I do"

> *I hold firm to the theory that every person is capable of creative thought and processing. Creativity is like a muscle – it needs exercise to function at its optimum*

[10] While Noddings (2012) notes her hesitancy to adopt the term "empathy," the way in which she described her ethic of caring closely aligns with the Root-Bernstein's conceptualization of this thinking tool, particularly with regard to the notion of *feeling-with*.

level. I have found that, like the first trip to the gym, the first dive into creative exploration is quite intimidating. Individuals who do not engage in creative exercise frequently are timid, shy, and oftentimes afraid of failure. Within the design challenges, I was discouraged to see many people feel this way. The engineers in the class labeled themselves as "not creative" and would readily let the art majors do the "artsy stuff". It was not until after engaging in the activities described in Sparks of Genius that I saw my fellow students taking small risks to practice creativity. It was through low-risk activities and a little bit of creative freedom that we all became comfortable enough to stretch our creative muscles.

As we practiced creativity, we encountered challenges since our processes were not always compatible. For the first design challenge in the Studio, *I was in a group; I was the only art* education *major in a group of engineers. My issue* was that *the group* wanted *to go straight to product. They just* blazed *past the process. I can understand why they thought that way because that's how assignments are usually set up, and that's what we want. They're used to knowing, "This is what I have to design. I have to get it done in two weeks. This is what I'm allowed to do. This is what I'm not allowed to do." You see, I had this wild idea about half way to the project that it was not at all about our product. That the purpose of the project was to get us to think differently, to challenge people to think differently. I got really hung up on that* and thought, *"Okay, well...My group is not thinking differently. We're still going straight to product." I kept trying to ask my group members, "Hey, what is the problem that we're trying solve?"* I told them*, "we can't change the issue of waste without changing how people look at it. Because people are not going to care about waste if, they don't even look at it. If they don't see the problem, we can't make them fix the problem." I thought my group members* understood what I was saying, but I came into class *one day and they were just gung ho on, "This is our solution. This is our solution. This is our solution." I was* speechless. I thought to myself, *"I can't... I don't know what else to do."*

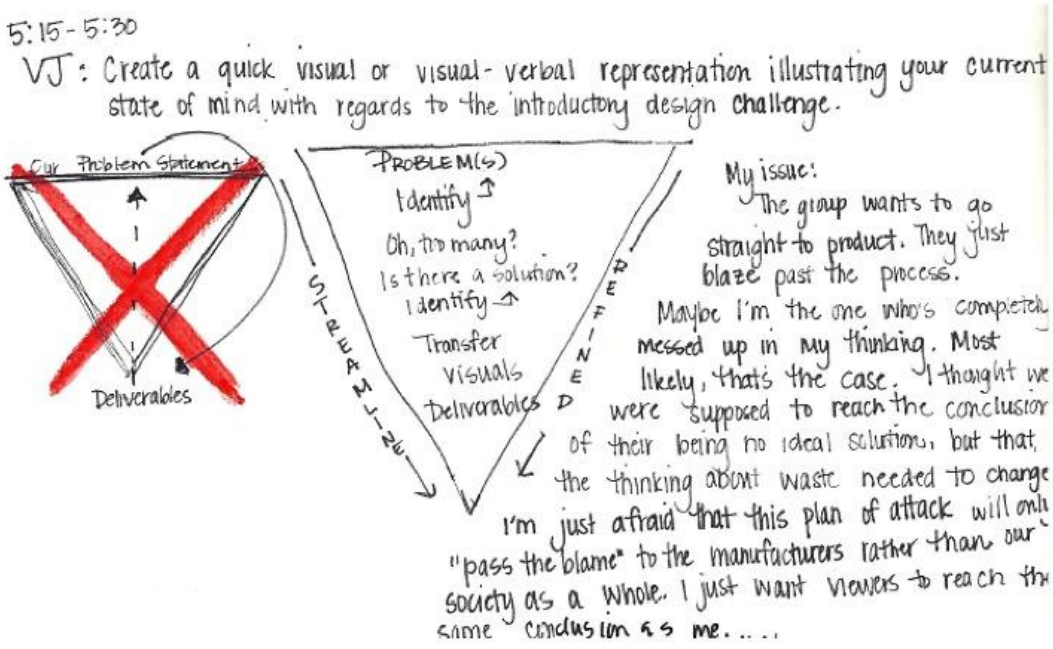

Figure 5. "My issue: The group wants to go straight to product. They just blaze past the process."

> *Maybe I'm the one who* was *completely messed up in my thinking. Most likely, that's the case. I thought we were supposed to reach the conclusion of* there *being no ideal solution, but that the thinking about waste needed to change.* In my mind, *our, "solution"* needed *to not necessarily be a fix, but something that makes viewers aware. I think that's where the purpose of the art project came in—to make viewers aware of the situation and I understood that. I guess maybe they were just... Maybe they just sat there and pretended to understand, because they were tired of listening to the art major ramble on about* these *big lofty ideas.* Ultimately, *I made the connection with this assignment that it's designed to be open-ended to stimulate the thought process, and that was fine. I understood that* pedagogy *as an art education major, but I felt that other members of my group wanted to jump straight to final product. It's that balance between, "Hey, do we want to just sit here and do deep thinking all day long?" Or, "Hey, we got a project due in a week and half. It's* crunch time *let's make something, who cares if it actually make sense or not."* At that point I felt that *I might as well just go ahead, give up on* my *idea, just learn what I can from the situation, and try again next time.*

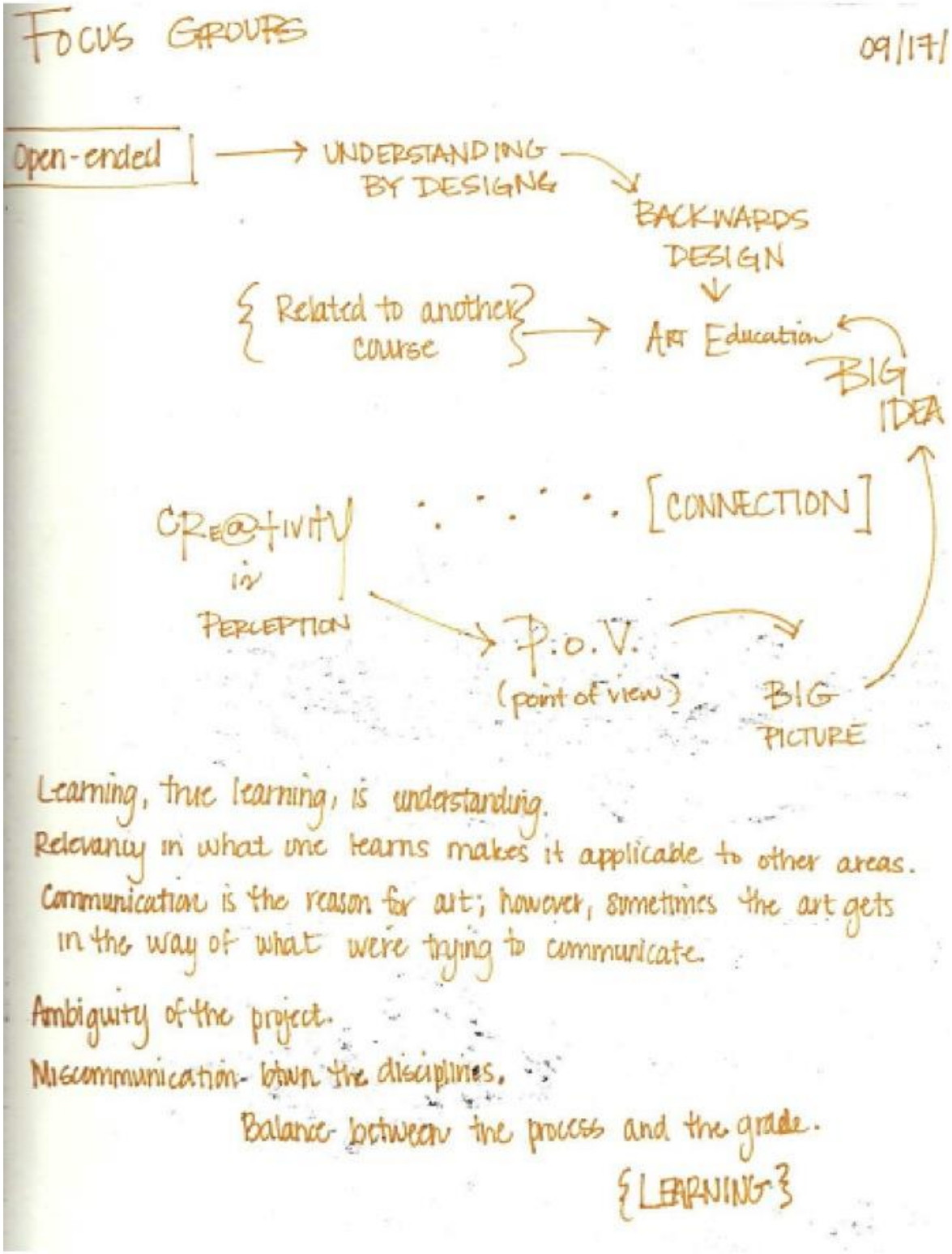

Figure 6. "Cre@tivity is Perception"

Through my group experiences, *it became necessary for me early on to employ the use of empathy and analogy in my communication efforts. By taking on the perspective of my classmates, I was able to momentarily break down and recombine concepts in a way similar to their own methods. Miscommunication runs rampant between disciplines, which I have experienced firsthand. The design challenges within the* Transdisciplinary *Design Studio showed me that not every person thinks the same way I do. By taking on the perspective of my classmates, I was able to momentarily break down and recombine concepts in a way similar to their own methods. Specifically, I remember my classmate* and teammate in the second design challenge, Marissa, *explaining an engineering concept to me through a visual analogy. She drew a picture of a blueberry pie and tried her best to instruct me on integrals. I never did understand what an integral was, but her efforts to communicate with me and the mutual willingness established a foundation of trust and mutual respect. In a matter of days following this communication, our group was working collaboratively on our water design challenge and making fast progress.*

By taking this Studio, *I have been challenged, pushed, and grown in such a way that, like a rubber band, I cannot return to my original state. It is interesting that as* a *B.F.A. student,* like my engineering peers, *a majority of my* studio experiences have also *been focused on PRODUCT. Learn it as fast as I can and then crank out as much as I can in as little time as possible. But playing…Playing is hardly allowed. So I want to play more with the materials. Explore. Experiment. Do it for FUN. And then just play. Because that's how my students will learn.* Learning things like this *will help me in my future career as an art teacher; the best teachers never stop learning. Through this interdisciplinary studio and its influence on my other classes and extra-curricular activities, I have become more aware of my own creative processes and my thinking patterns. I have learned how I specifically learn, and I believe that knowledge will positively influence my abilities in synthetic thinking for the rest of my life.*

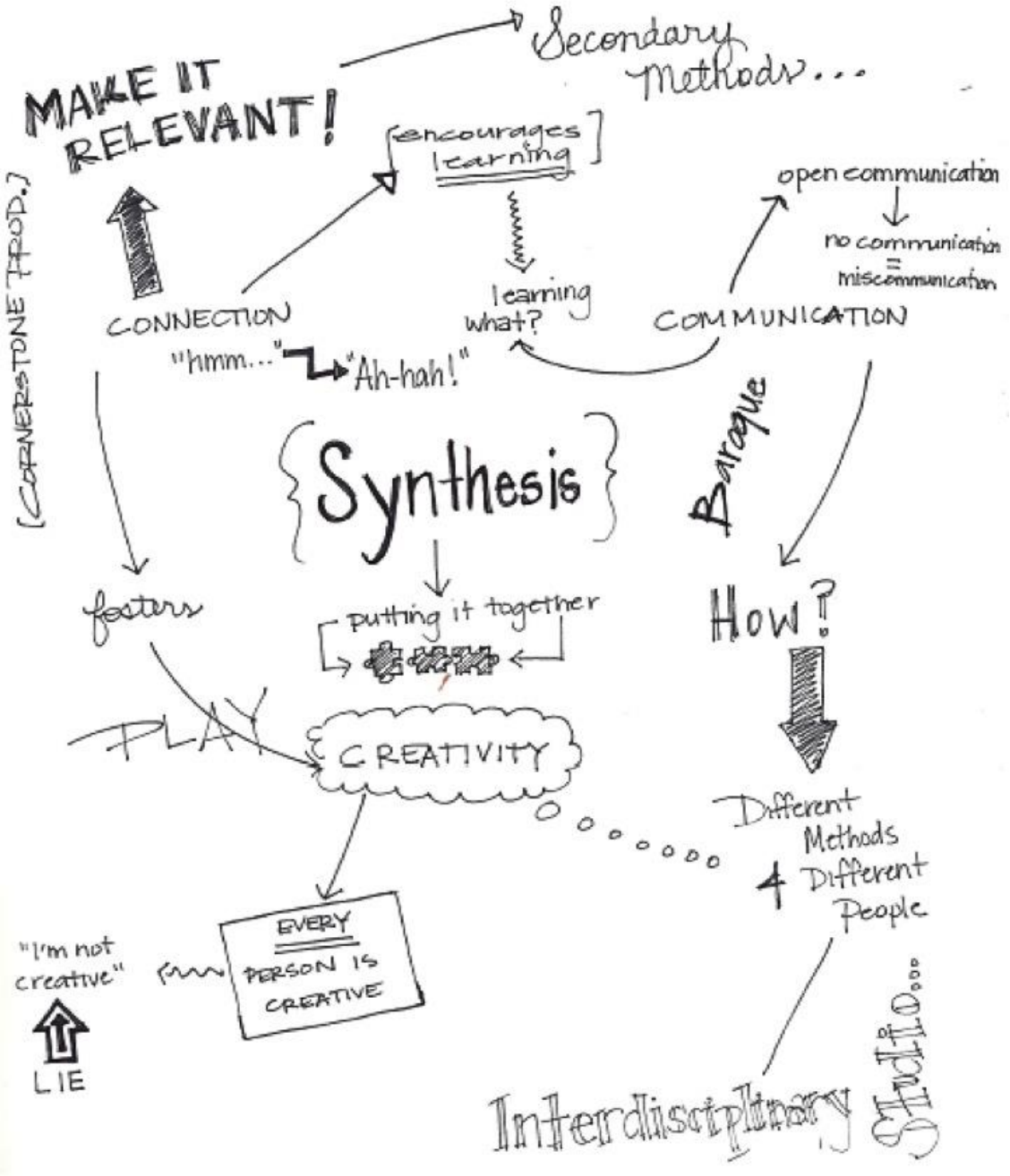

Figure 7. Synthesizing concept map submitted with Sara's final reflective paper.

Discussion of Sara's Narrative

Similar to Christy, Sara's creative process differed greatly from her two engineering peers in the Introductory Design Challenge. She described encountering a problem which stood in contrast to Christy's in that Sara's group wanted to jump to a solution while she, through empathizing, attempted to hold them back, to play, explore, and experiment in the early stages of the creative process. Pink (2005) identified empathy and play as two of six senses (alongside design, story, symphony, and meaning) necessary to thrive in what he terms the "Conceptual Age," where "artists, inventors, designers, storytellers… and] big picture thinkers...will…reap society's richest rewards" (p. 1). Searle (2004) addressed the notion of distinctive creative processes in collaboration asserting, "team processes are an important factor in promoting or inhibiting creativity and innovation" (p. 178). While Christy's and Sara's experiences were similar with respect to the conflict of process, the difference emerged when Sara noticed her group's unwillingness to hold back whereas Christy *was* willing to adjust her process for the good of her group. In this way, Sara's group struggled with the give-and-take aspect of collaboration (Sawyer, 2000). Eventually, Sara and her group resigned to the fact that they needed to put something together for the sake of the project deadline which speaks to the pervasive issue of *process* versus *product* when such open-ended and ill-structured problems (Dym, Wessner & Winner, 2003) are posed. Sara's group experience indicated the inherent challenges of interdisciplinary collaboration with regard to interdisciplinary communication and a curriculum that promoted a deep engagement with process.

Emphasizing the importance of empathy to group communication, Sara's narrative described her attempts to cultivate the notion of feeling-with (Noddings, 2012). She explained that assuming her peers' perspective allowed her to disassemble her own ideas and reassemble them in a way that reflected their collective perspectives and processes. Continuing on, Sara discussed a specific class activity where students were asked to practice the thinking tool of analogizing with a disciplinary other. She revealed even the attempt to relay concepts across disciplines resulted in more effective communication in her group as they navigated through the final design challenge. Through both the positive experiences with Marissa and the difficulties faced in the first design challenge, Sara brought forth empathy as a tool vital to effective communication—particularly in interdisciplinary contexts where differences in process and thinking prevail.

Amy's Narrative: "We were all separately confused, but as we all got together, we understood collectively"

> *I signed up for this class because I was interested in learning more about the creative thinking process as well as finding new ways to synthesize the seemingly contrasting*

subjects taught in public schools. However, to be completely honest, I also *needed to take one extra studio class to be able to graduate in the spring, but I could not stand to take another drawing class.*

When we were first handed the first design *project, I didn't know what we were supposed to do. I was just like, "I don't get it. I don't know what the problem is. What exactly* is *the final product they want?" And just from my background, I haven't encountered any of this* waste *stuff, so everything's new, and* there was *a lot of information. A lot of* the *time* the engineering-based information *just* went *over my head, and I* didn't *really understand* it *all. And so I just stopped listening after a certain point, and then I* couldn't *focus on anything. I know* the instructors are giving us *helpful information, but I* couldn't *process it.*

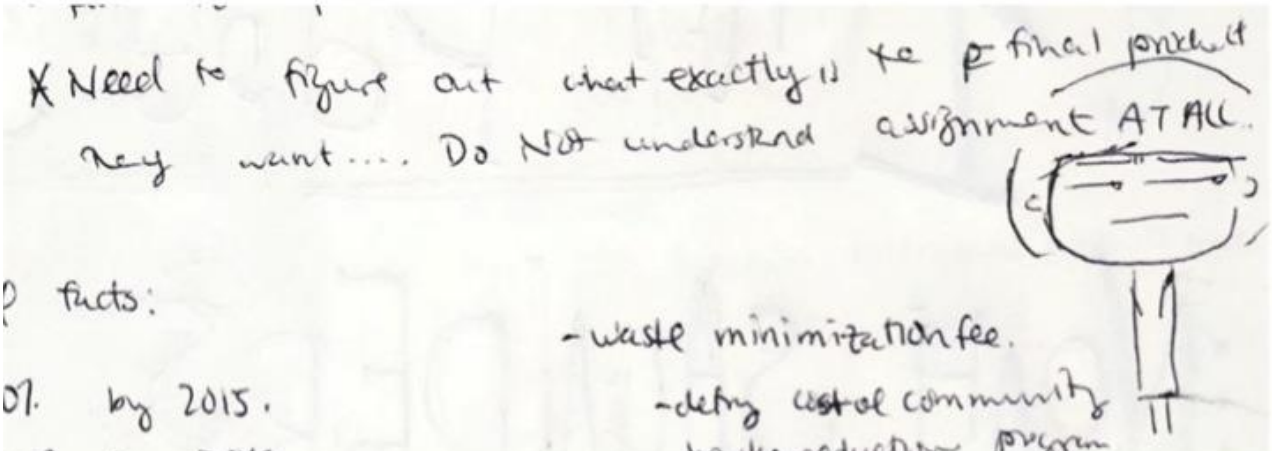

Figure 8. Need to figure out what exactly is the final product they want...Do Not understand assignment AT ALL"

It was not *until we got together in our groups; we had a group with all three different disciplines. Then we were like, "oh!" When we got together, we talked it over, and we were like, "okay, then let's do this and this," and everything just fell in place after that. And it was so much easier than when we were just given it and by ourselves. I don't know,* we were *lost, I guess. We were all separately confused, but as we all got together, we understood collectively. Everyone had their own ideas,* we meshed *together really well.*

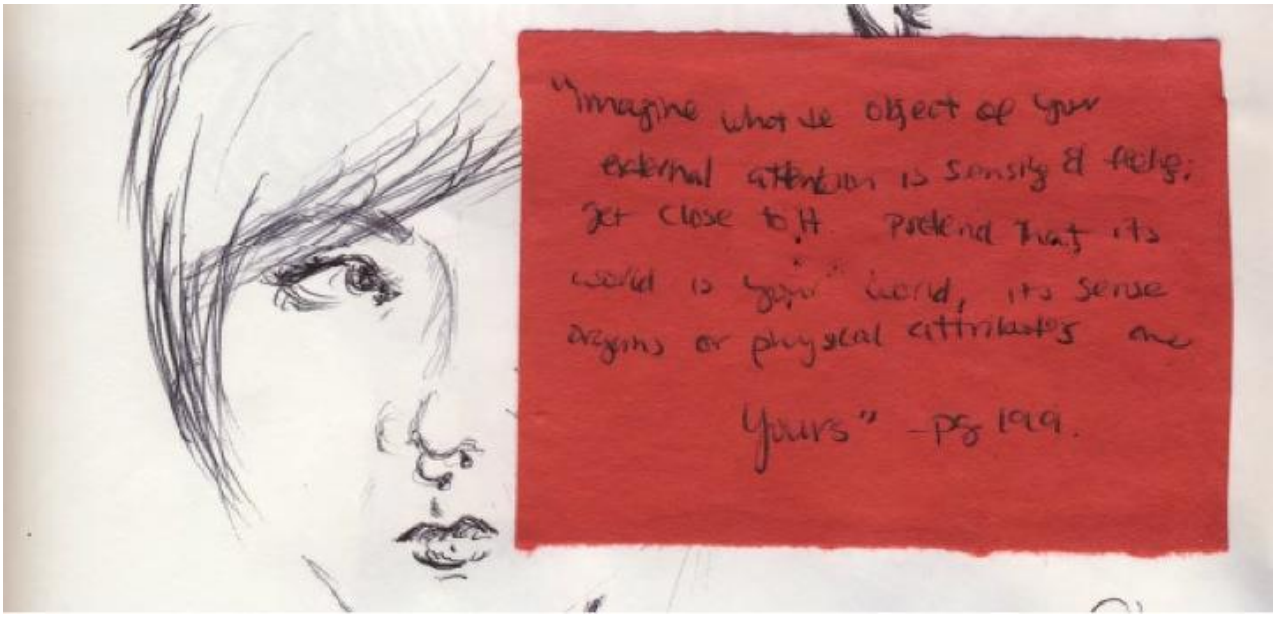

Figure 9. "'Imagine what the object of your external attention is sensing and feeling; get close to it. Pretend that its world is your world, its sense origins or physical attributes are yours.' p. 199 [Sparks of Genius]"

> *Our final design project was the perfect example of how everything we were exposed to in class, especially the idea of empathy, came together to create something truly wonderful and amazing. When it came time to select an actual form, I was surprised at how everyone was able to choose one that related to our project. I felt that everyone tried to stand back from what they aesthetically liked, and stepped into the skins of the people viewing the piece on game day in north campus. Furthermore, I believe that each one of us had to step into each other's skins to try and work together cohesively. I had to let myself feel and understand the design project as the other members in my groups felt and understood it. I had to think in their shoes; I had to loosen up and let a part of my rigid way of thinking go.*

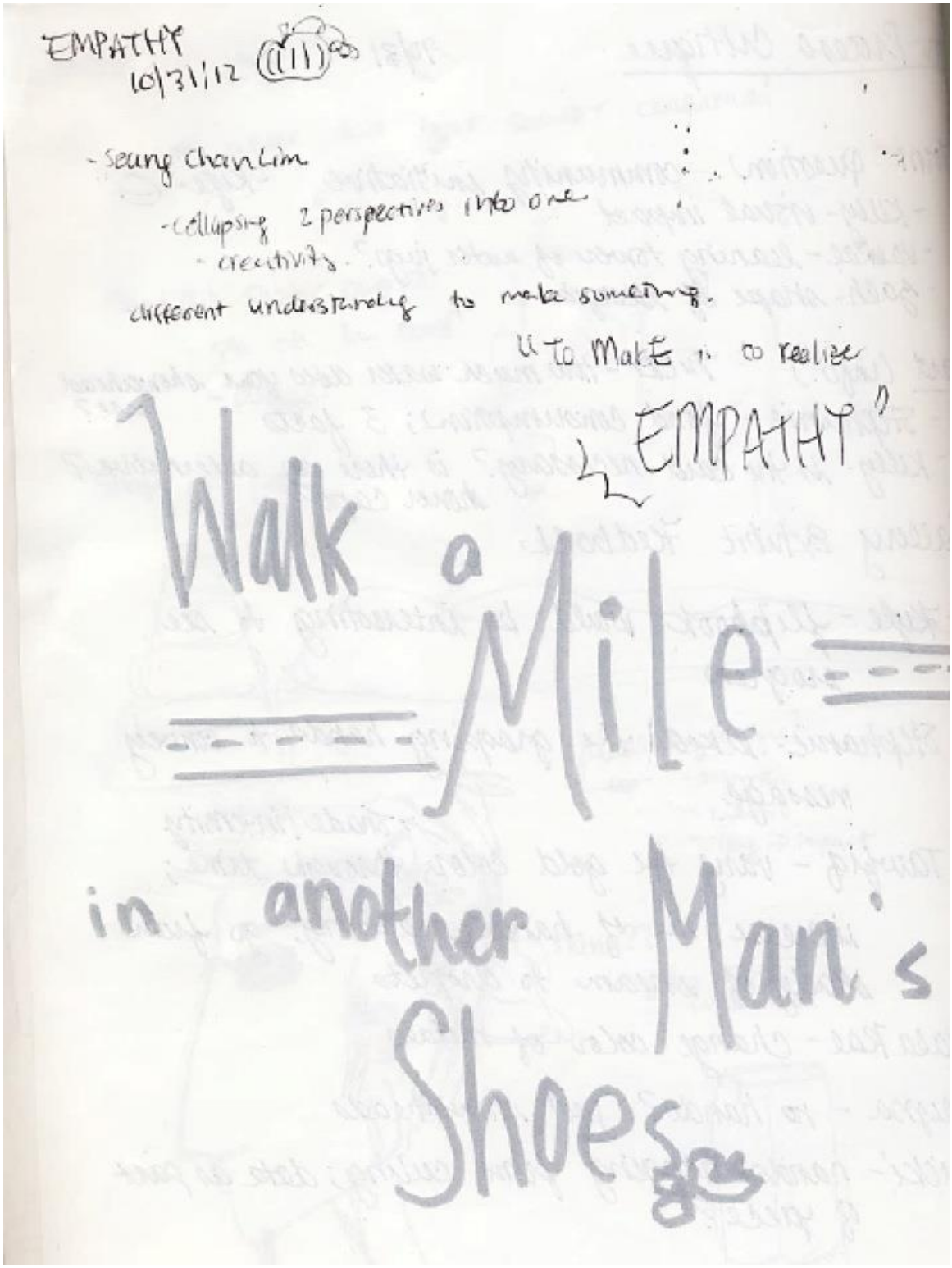

Figure 10. "'To make is to realize EMPATHY.' Walk a mile in another man's shoes."

Designers and engineers have to consider their stakeholders, the people who are buying their products, as they are designing. Similar to designers and engineers, artists, architects, and authors have to consider who their audiences are. The question remains: *who are they creating their art for? To be able to successfully fulfill their goals, they must consider the stakeholders and empathize with them. Acquiring the ability to empathize with someone will better equip us to interpret others' attitudes, experiences, and ways of thinking that are completely different from our own. Since the final design project required a lot more detail and finesse than our first one, as a group we had to work closer together than my first group did. We had to consciously recognize how to empathize with each other to be able to work together cohesively and design a well thought out final exhibit. This ability to empathize with one another helped us to put together two exhibits for the gallery space that resulted in a very successful final critique.*

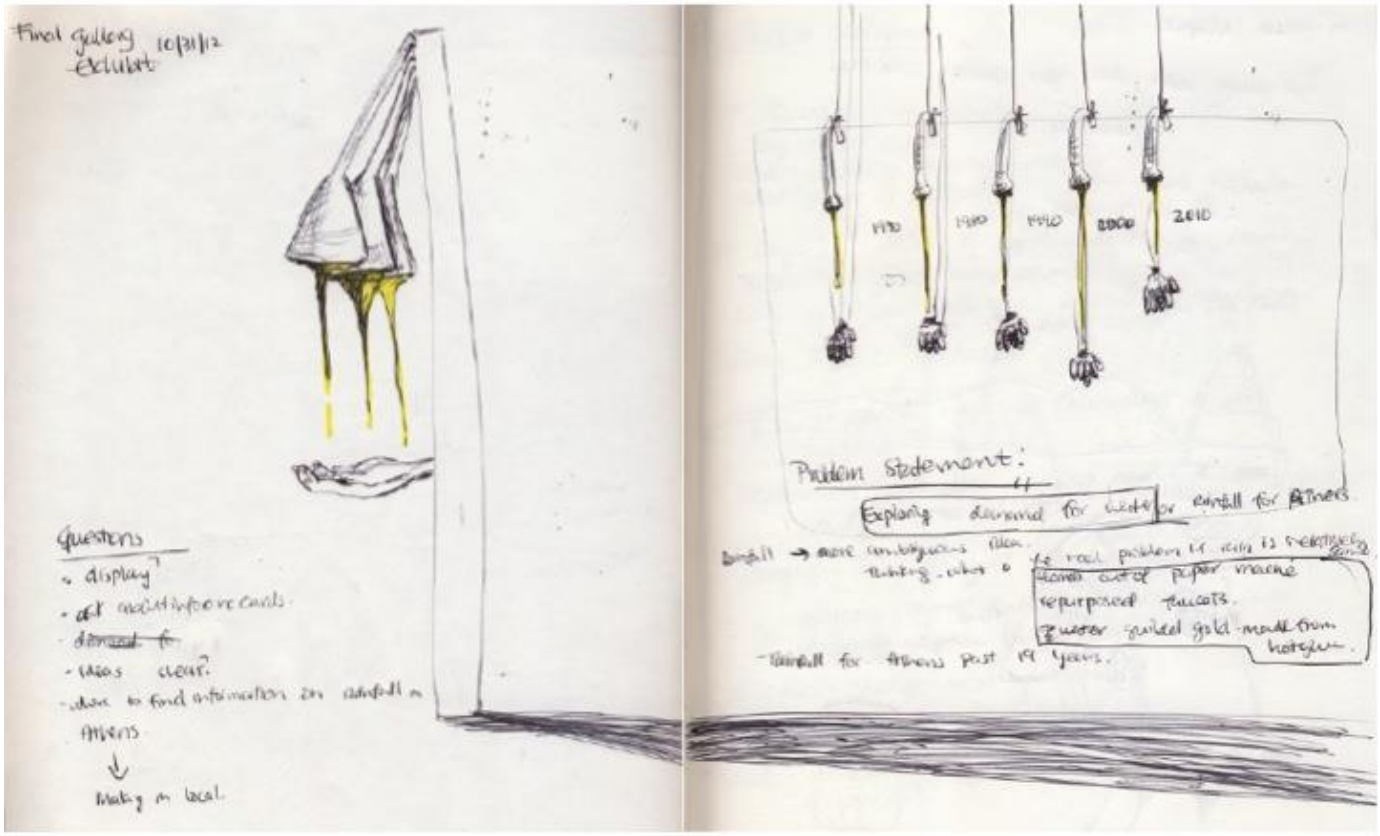

Figure 11. Amy's sketches of the final design challenge exhibit

> *Working with two other disciplines in the group proved to be a rewarding challenge. We were all different people who come with different experiences and view things in different lenses. Although I was the art education member in my group, I have a very calculating and logical way of thinking. I quickly dismiss things that I do not see as practical, and I am very product oriented. Even* in *studio classes, it's just, like, "this is my painting; this is what I have." And then* in *art ed.* it *is like, "oh, this is my lesson plan," and that's it. You're not really doing anything with groups or anything like that.* In my other classes *it's definitely a different process, because you're given your assignment, and then you just produce whatever it* is *that you need to get an A. As I've spent more time working* with *students from other disciplines, I've realized that everyone works differently.*
>
> Despite my initial frustrations, *this interdisciplinary course has taught me so much more than I first anticipated. I learned more than synthesizing different disciplines in a classroom setting; I actively participated in a class where I had to work with students from other disciplines and at different levels of education. I observed, firsthand, how people from different disciplines can interact together and solve problems*, like those in the design challenges.

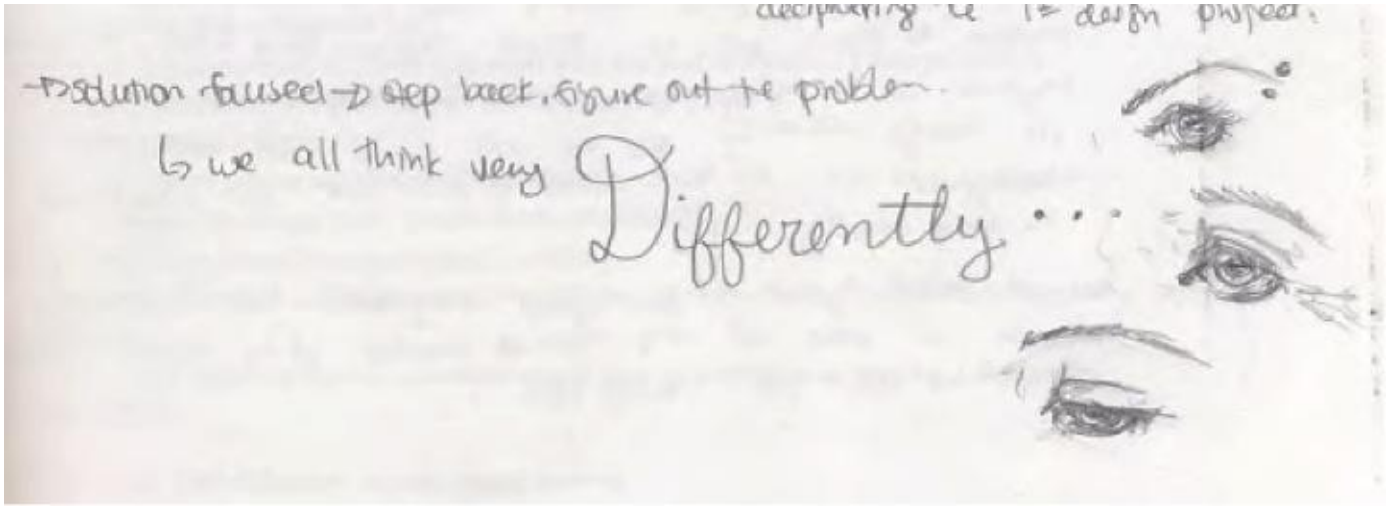

Figure 12. "We all think very differently"

Discussion of Amy's Narrative

In Amy's narrative, she cited the importance of diversity in disciplinary knowledge and creative processes as her interdisciplinary group came "with different experiences and [viewed] things [with] different lenses" (Final Reflective Paper, lines 28-29). While these disciplinary differences were perceived as obstacles inhibiting Sara's group's performance in the Introductory Design Challenge, Amy's experiences indicated that they were vital to the

success of her group despite the open and ill-structured nature of the problems. In their study, Jonassen et al. (2006) cited two prominent themes in their research on ill-structured problems in engineering curricula which focused on the importance of distributed knowledge among the collaborators as well as the nature of most engineering problems as requiring collaboration.

While the notion of distributed cognition is often discussed within the context of group collaboration, others focus on a more specific concept with regard to creativity termed distributed creativity (Sawyer & DeZutter, 2009). Amy's discussion of her group members being separately confused yet coming together to develop a collective understanding alludes to distributed creativity where the goal was the generation of a shared, yet unpredictable creative product. Similar to Amy's collaboration, Sawyer and DeZutter cited the equitable sharing of responsibility amongst the group members as an important facet of the creative process in these group contexts, which they call collaborative emergence. Collaborative emergence reflects the unpredictable and improvisational quality of the group work and nicely complements the ill-structured nature of the design challenges and Amy's experience with collaborative creativity.

Amy's description of learning to think in the shoes of her group members required her to "loosen up and let a part of [her] rigid way of thinking go" (Final Reflective Paper, line 35). Amy's selfless act of letting go is reminiscent of Noddings' (2012) concept of the caring relation through which an attentiveness on the part of the carer leads him or her to *feel-with* the cared for in an act where "her motive energy is directed (temporarily) away from those of her own projects and towards those of the cared-for" (p. 53). In other words, Amy's acknowledgement that her thinking approach was not working for her group led her to become more empathetic towards the other and (re)consider her own processes through the caring relation.

In addition to Amy's endeavor to adopt empathy with her group members, she discussed how the entire group practiced empathy during the planning of their community initiative. She explained that the group had to "stand back from what they aesthetically liked, and [step] into the skins of the people viewing the piece on game day" (Final Reflective Paper, lines 48-49) while also considering each other's perspective as they worked. Along these lines, Amy brought forth the notion of a collective, or group-level, empathy that increased their group performance (Roberge, 2013). This approach to empathy invoked the group members to also let go of their personal visions in order to embrace a collective vision, not unlike Greene's (1995) concept of the social imagination. It was through this collective empathy that Amy described as the creation of something "wonderful and amazing" (Final Reflective Paper, line 15) for the Final Design Challenge.

Discussion and Implications

As Christy, Sara, and Amy discussed in their narratives, creative collaboration is not often a part of the traditional art education or studio experience in higher education. In many instances, art education students engage in an autonomous creative process and are solely responsible for the creative product. Through the collaborative approach to STEAM implemented in the Transdisciplinary Design Studio, the art education students developed an awareness of their own creative processes and how these processes might be (re)considered and reconciled in group projects and contexts. Facets of collaborative creativity, including empathizing, emerged across these three art education students' narratives and, interestingly, were also discussed amongst the engineering and landscape architects' field texts.

As researchers in this transdisciplinary space, we conclude with three primary implications for this research. First, the collaborative potential embedded in STEAM education is immense, complex, and nebulous as new knowledge and technologies relentlessly emerge. In visual arts, the days of the autonomous artist are existing alongside a contemporary arts practice that embraces notions like participation, relationships, interaction, and collaboration (Bourriaud, 2002) and is increasingly focused on social issues (Bourriaud, 2002; Miner, 2013; O'Donoghue, 2011) such as those encompassed in the design challenges (Guyotte et al., 2014). Further, there are individuals in both engineering education (ABET, 2013; Ford & Riley, 2003; McNair, Newswander, Boden & Borrego, 2011) and art education (Bequette & Bequette, 2012; Marshall, 2014) who advocate for more cross-disciplinary collaborations which might cultivate creative thinking skills and mimic a 'real world' not bound by isolated disciplines. Along these lines, approaches to STEAM which engage students in interdisciplinary explorations of complex social issues might offer a space where collaborative engagements with and through the arts nurtures a more holistic, authentic, and dialogic perspective towards these issues.

Second, a transdisciplinary STEAM curriculum itself has the potential to foster thoughtful reflection on individuals' creative processes. By making creativity an explicit facet of the curriculum, it provided students with a language through which they could articulate their understandings of creativity and discuss their processes across disciplines. Amy explained the Root-Bernsteins' text was helpful as "A lot of times these things go unsaid & therefore useful to know & reflect on" (Visual Journal Check #2, p. 50). As evident in this statement, opportunities for reflection are paramount as students move from the familiar and the ordinary and into realms replete with open-ended inquiry and even dissonance (Greene, 1995). This sentiment complements Gude's (2013) perception of a "New School" of art education by opening up creative possibilities rather than narrowing them "into pre-determined channels" (p. 10). In the design studio, visual journals cultivated a space where students could both document their creative processes and critically reflect on how these processes were

manifested in individual and group pursuits. Additionally, the focus groups represented another avenue through which students could reflect on and articulate their experiences—good, bad, or indifferent—as prompted by interactions with others' in a dialogic space.

Finally, we see the process of visual-verbal narrative analysis as offering a unique lens for exploring student's lived experiences. The use of visual journals in the design studio alongside focus groups and written reflective papers provided multiple layers of experience that could be unpacked and understood. As Johnson (2004) indicated, image and text afford the participants the opportunity to tell narratives in different voices and it permitted us, as practitioner-researchers, insight into creativity as a social and multimodal process. By maintaining a wide-awakeness (Greene, 1995) to the students' voices through relying on their in-vivo text and created images, we were able to gain valuable insight into their experiences in this collaborative, transdisciplinary STEAM space.

The notions of collaborative creativity and empathy provide a unique perspective on STEAM. While many focus on what the arts bring to the STEM conversation, we are also interested in what STEM might bring to the arts. It is our hope that future research on inter- and transdisciplinarity, as well as STEAM education, demonstrates an attentiveness to synergistic (Bequette & Bequette, 2012) and reciprocal benefits between all disciplines, including the arts. We also hope practitioners will thoughtfully develop curricula which inspire creativity and create spaces for student reflection, (re)examining traditional pedagogical practices in order to thoughtfully orchestrate collaborative and creative learning (Hämäläinen & Vähäsantanen, 2011). As the Root-Bernsteins (1999) proclaimed with regard to their conception of a transdisciplinary and synthesizing education, it is not enough to "change *what* we teach" but we need to "change *how* we teach" (p. 316). While STEAM education might not be *the* answer to the incessant call for educational reform, there is much to be gleaned from the experiences of our students in such contexts where inquiry, exploration, collaboration, empathy and creativity are brought to the forefront of the curriculum; and where students are nudged into the vibrant and evocative spaces that lie between themselves and the other.

References

ABET. (2013). Criteria for accrediting engineering programs: Effective for evaluations during the 2014-2015 accreditation cycle.

Bach, H. (2008). Visual narrative inquiry. In L. Given (Ed.), *The SAGE encyclopedia of qualitative research methods.* (pp. 939-941). Thousand Oaks, CA: SAGE Publications, Inc. doi: 10.4135/9781412963909.n490

Bequette, J., & Bequette, M. B. (2012). A place for art and design education in the STEM conversation. *Art Education, 65*(2), 40–47. Retrieved from http://www.arteducators.org/research/art-education

Boix Mansilla, V., Miller, W. C., & Gardner, H. (2000). On disciplinary lenses and interdisciplinary work. In S. Wineburg & P. Grossman (Eds.), *Interdisciplinary curriculum: Challenges of implementation.* (pp. 17-38). New York: Teachers College Press.

Bourriaud, N. (2002). *Relational aesthetics*. Dijon: Les Presses du Réel.

Burnard, P., & Dragovic, T. (2014). Collaborative creativity in instrumental group music

learning as a site for enhancing pupil wellbeing. *Cambridge Journal of Education*, doi: 10.1080/0305764X.2014.934204

Chappell, K., Craft, A. R., Rolfe, L., & Jobbins, V. (2012). Humanizing creativity: Valuing our journeys of becoming. *International Journal of Education & the Arts*, *13*(8). Retrieved [October 3, 2014] from http://www.ijea.org/v13n8/.

Clandinin, D. J. (2013). *Engaging in narrative inquiry*. Walnut Creek, CA: Left Coast Press, Inc.

Clandinin, D., & Caine, V. (2008). Narrative inquiry. In Lisa M. Given (Ed.), *The SAGE Encyclopedia of Qualitative Research Methods*. (pp. 542-545). Thousand Oaks, CA: SAGE Publications, Inc. doi: 10.4135/9781412963909.n275

Clandinin, D. J., & Connelly, F. M. (2000). *Narrative inquiry: Experience and story in qualitative research*. San Francisco: Jossey-Bass Publishers.

Cochran-Smith, M. & Lytle, S. L. (2009). *Inquiry as stance: Practitioner research for the next generation*. New York: Teachers College Press.

Csikszentmihalyi, M. (1990). The domain of creativity. In M. A. Runco & R. S. Albert (Eds.), *Theories of creativity* (pp. 190-212). Newbury Park, CA: SAGE Publications.

Dewey, J. (1934). *Art as experience*. New York, NY: Perigee.

Dudek, S. Z., & Coté, R. (1994). Problem finding revisited. In M. A. Runco (Ed.), *Problem-finding, problem solving, and creativity* (pp. 130-150). Norwood, NJ: Ablex.

Dym, C. L., Wesner, J. W., & Winner, L. (2003). Social dimensions of engineering design: Observations from Mudd Design Workshop III. *Journal of Engineering Education, 92*(1), 105-107.

Eisner, E. (2002). *The arts and the creation of mind.* New Haven, CT: Yale University Press.

Flanagan, J. C. (1954). The critical incident technique. *Psychological Bulletin 51*(4)*:* 327 - 358.

Ford, J. D., & Riley, L. A. (2003). Integrating Communication and Engineering Education: A Look at Curricula, Courses, and Support Systems. Journal of Engineering Education, 92(4), 325-328. doi: 10.1002/j.2168-9830.2003.tb00776.

Getzels, J. W., & Csikszentmihalyi, M. (1976). *The creative vision: A longitudinal study of problem finding in art.* New York: John Wiley & Sons.

Glăveanu, V. P. (2011). How are we creative together? Comparing sociocognitive and sociocultural answers. *Theory and Psychology*, *21*(4), 473-492. doi:10.1177/0959354310372152

Greene, M. (2001). *Variations on a blue guitar: The Lincoln Center Institute lectures on aesthetic education*. New York: Teachers College Press.

Greene, M. (1995). *Releasing the imagination: Essays on education, the arts, and social change*. San Francisco: Jossey-Bass.

Gude, O. (2013). New school art styles: The project of art education. *Art Education, 66*(1), 6-15.

Guyotte, K. W. (2014). *"All the lovely in-between": A visual-verbal narrative inquiry into student lived experiences in a transdisciplinary design studio.* (PhD), The University of Georgia, Unpublished doctoral dissertation.

Guyotte, K. W. (2013). Visual–verbal narrative analysis: Practicalities, possibilities, and challenges in transdisciplinary visual journal research. *SAGE Research Methods Cases*. London, United Kingdom: SAGE. doi: 10.4135/978144627305013512938

Guyotte, K. W., Sochacka, N. W., Costantino, T. E., Walther, J. & Kellam, N. N. (2014). STEAM as social practice: Cultivating creativity in transdisciplinary spaces. *Art Education, 67*(6), 12-19.

Hämäläinen, R., & Vähäsantanen, K. (2011). Theoretical and pedagogical perspectives on orchestrating creativity and collaborative learning. *Educational Research Review, 6,* 169-184. doi:10.1016/j.edurev.2011.08.001

Hargrove, R. A. (1998). *Mastering the art of creative collaboration*. New York: McGraw-Hill.

Holley, K. A. (2009b). Understanding interdisciplinary challenges and opportunities. *ASHE Higher Education Report, 35*(2), 1–131. doi: 10.1002/aehe.3502

Johnson, G. C. (2004). Reconceptualising the visual in narrative inquiry into teaching. *Teaching and Teacher Education, 20,* 423-434. doi:10.1016/j.tate.2004.04.009

Jonassen, D., Strobel, J., & Chwee Beng, L. (2006). Everyday problem solving in engineering: Lessons for engineering educators. *Journal of Engineering Education, 95*(2), 139-151. doi: 10.1002/j.2168-9830.2006.tb00885.x

Josselson, R. (2011). Narrative research: Constructing, deconstructing, and reconstructing story. In F. J. Wertz, K. Charmaz, L. M McMullen, R. Josselson, R. Anderson, & E. McSpadden (Eds.), *Five ways of doing qualitative analysis: Phenomenological psychology, grounded theory, discourse analysis, narrative research, and intuitive inquiry* (pp. 224-242). New York & London: The Guilford Press.

Kamberelis, G., & Dimitriadis, G. (2005). Focus groups. In N. Denzin & Y. S. Lincoln (Eds.), *The SAGE handbook of qualitative research* (3rd ed., pp. 887-908). Thousand Oaks, CA: Sage.

Keats, P. (2009). Multiple text analysis in narrative research: Visual, written, and spoken. *Qualitative Research, 9*(2), 181-195. DOI: 10.1177/1468794108099320

Kenny, A. (2014). 'Collaborative creativity' within a jazz ensemble as a musical and social practice. *Thinking Skills and Creativity, 13,* 1-8. doi: http://dx.doi.org/10.1016/j.tsc.2014.02.002

La Jevic, L. & Springgay, S. (2008). A/r/tography as an ethics of embodiment: Visual journals in preservice education. *Qualitative Inquiry*. *14*(1), 67-89. doi: 10.1177/1077800407304509

Land, M. H. (2013). Full STEAM ahead: The benefits of integrating the Arts into STEM. *Procedia Computer Science, 20,* 547-552. doi: 10.1016/j.procs.2013.09.317

Lattuca, L. R. (2001). *Creating interdisciplinarity*. Nashville, TN: Vanderbilt University Press.

Littleton, K. & Miell, D. (2004). *Collaborative creativity: Contemporary perspectives.* London, UK: Free Association Books.

Maeda, J. (2013). STEM + Art = STEAM. *The STEAM Journal*, 1(1). Article 34. Available at: http://scholarship.claremont.edu/steam/vol1/iss1/34

Marshall, J. (2014). Transdisciplinarity and art integration: Toward a new understanding of art-based learning across the curriculum. *Studies in Art Education, 55*(2), 104-127.

McNair, L. D., Newswander, C., Boden, D., & Borrego, M. (2011). Student and faculty interdisciplinary identities in self-managed teams. *Journal of Engineering Education, 100*(2), 374-396.

Milne, W. M. (2004). The use of reflective artmaking in pre-service education. *Mentoring and Tutoring, 12*(1), 37-52. doi: 10.1080/1361126042000183057

Miner, D. A. T. (2013). Teaching "Art as Social Justice:" Developing prefigurative pedagogies in the (liberal) art studio. *International Journal of Education & the Arts, 14*(2.2). Retrieved March 11, 2014 from http://www.ijea.org/v14si2/

Moran, S., & John-Steiner, V. (2004). How collaboration in creative work impacts identity and motivation. In D. Miell & K. Littleton (Eds.), *Collaborative creativity: Contemporary perspectives* (pp. 11-25). London, UK: Free Association Books.

Morgan, D. L. (1996). Focus groups. *Annual Review of Sociology, 22*(1), 129- 152. doi: 10.1146/annurev.soc.22.1.129

Noddings, N. (2010). Moral education and caring. *Theory and Research in Education, 8*(2), 145-151. doi: 10.1177/1477878510368617

Noddings, N. (2012). The language of care ethics. *Knowledge Quest, 40*(5), 52.

O'Donoghue, D. (2011). Has the art college entry portfolio outlived its usefulness as a method of selecting students in an age of relational, collective and collaborative art practice? *International Journal of Education & the Arts*, *12*(3). Retrieved March 11, 2014 from http://www.ijea.org/v12n3/

Pink, D. (2005). A whole new mind: Why right-brainers will rule the future. New York: Riverhead Books.

Polkinghorne, D. E. (1995). Narrative configuration in qualitative analysis. *International Journal of Qualitative Studies in Education, 8*(1), 5-23.

Riessman, C. K. (2008). *Narrative methods for the human sciences*. Los Angeles: SAGE Publications, Inc.

Roberge, M. (2013). A multi-level conceptualization of empathy to explain how diversity increases group performance. *International Journal of Business & Management, 8*(3), 122-133. doi:10.5539/ijbm.v8n3p122

Root-Bernstein, R. & Root-Bernstein, M. (1999). *Sparks of genius: The thirteen tools of the world's most creative people*. New York: Houghton Mifflin.

Roulston, K. (2010). *Reflective interviewing: A guide to theory and practice*. Thousand Oaks: Sage.

Runco, M.A. & Nemiro, J. (1994). Problem finding, creativity, and giftedness. *Roeper Review, 16*(4), 235-241. doi: 10.1080/-2783199409553588

Runco, M. A., & Okuda, S. M. (1988). Problem-discovery, divergent thinking, and the creative process. *Journal of Youth and Adolescence, 17,* 211-220.

Sandell, R. (2011). Seeing a bigger picture: The visual arts. *Principal Leadership, 11*(7), 48-54.

Sawyer, R. (2003). *Group creativity: Music, theater, collaboration*. Mahwah, New Jersey: Lawrence Erlbaum Associates.

Sawyer, R., & DeZutter, S. (2009). Distributed creativity: How collective creations emerge from collaboration. *Psychology of Aesthetics, Creativity, and the Arts, 3*(2), 81-92. doi:10.1037/a0013282

Searle, R. H. (2004). Creativity and innovation in teams. In D. Miell & K. Littleton (Eds.), *Collaborative creativity: Contemporary perspectives* (pp. 175-188). London, UK: Free Association Books.

Smith, R. K., & Newman, G. E. (2014). When multiple creators are worse than one: The bias toward single authors in the evaluation of art. *Psychology of Aesthetics, Creativity, and the Arts, 8*(3), 303-310. doi: http://dx.doi.org/10.1037/a0036928

Sochacka, N. W., Guyotte, K. W., Walther, J. W. (in press). Learning together: A collaborative autoethnographic exploration of STEAM-inspired education. *International Journal of Engineering Education.*

Sochacka, N., Guyotte, K., Walther, J., Kellam, N., & Costantino, T. (2013, June). Faculty reflections on a STEAM-inspired interdisciplinary studio course. Paper presented at the American Society for Engineering Education Annual Conference and Exposition. Atlanta, GA.

Spence, D. P. (1986). *Narrative truth and historical truth: Meaning and interpretation in psychoanalysis*. New York & London: Norton.

Stake, R. E. (2005). Qualitative case studies. In N. Denzin & Y. S. Lincoln (Eds.), *The SAGE handbook of qualitative research* (3rd ed., pp. 443-466). Thousand Oaks, CA: Sage.

Thomas, K., & Chan, J. (2013). Negotiating the paradox of creative autonomy in the making of artists. *Studies in Art Education, 54*(3), 260-272. Retrieved from: http://www.arteducators.org/research/studies

Thornton, A. (2013). *Artist, researcher, teacher: A study of professional identity art and education*. Chicago, IL: Chicago Press.

Walther, J, Kellam, N. N., Radcliffe, D, & Boonchai, C. (2009, October). Integrating students' learning experiences through deliberate reflective practice. Paper presented at the Frontiers in Education Conference, San Antonio, TX

Walther, J, & Radcliffe, D. (2007). Analysis of the use of an Accidental Competency discourse as a reflexive tool for professional placement students. Paper presented at the Frontiers in Education Conference, Milwaukee, Wisconsin.

Walther, J, Sochacka, N. W., & Kellam, N. N. (2011). Emotional indicators as a way to initiate student reflection in engineering programs. Paper presented at the American Society for Engineering Education (ASEE) Annual Conference and Exposition, Vancouver.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes.* M. Cole, V. John-Steiner, S. Scribner, & E. Souberman (Eds.). Cambridge, MA: Harvard University Press.

Wynn, T., & Harris, J. (2012). Toward a STEM + Arts curriculum: Creating the teacher team. *Art Education, 65*(5), 42-47. Retrieved from http://www.arteducators.org/research/art-education

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