



Faculty Reflections on a STEAM-Inspired Interdisciplinary Studio Course

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Dr. Walther is an assistant professor of engineering education research at the University of Georgia (UGA). He is one of the leaders of the Collaborative Lounge for Understanding Society and Technology through Educational Research (CLUSTER), an interdisciplinary research group with members from engineering, art, educational psychology and social work. He has conducted qualitative educational research in a number of contexts ranging from formation of students' professional identity, the role of reflection in engineering learning, and engineering students' creativity development. He was the first international recipient of the ASEE Educational Research Methods Division's "Apprentice Faculty Award", was selected as a 2010 Frontiers in Education "New Faculty Fellow". In 2011, he received a National Science Foundation CAREER award (#1150668) to investigate and systemize practices and conceptions around research quality in interpretive approaches to engineering education research. His teaching focuses on innovative approaches to introducing systems thinking and creativity into the environmental engineering program at the University of Georgia.

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Dr. Nadia Kellam is an Associate Professor in the College of Engineering at the University of Georgia where she is co-director of the interdisciplinary CLUSTER research group. Dr. Kellam is interested in understanding how engineering students develop their professional identity; her research focuses specifically on creativity, interdisciplinarity, and the role of emotion in cognition. She created the synthesis and design studios in the environmental engineering program and is currently developing the professional and design spines for the upcoming mechanical engineering program. She is also interested in faculty development and recently co-organized the NSF-sponsored PEER workshop for tenure-track engineering education research faculty.

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Abstract

Concerns regarding America's standing as a globally competitive innovator have spurred a growing interest in STEAM (STEM + the Arts) education. Set against this context, this paper uses collaborative autoethnographic techniques to uncover and explore some of the possibilities and pitfalls of STEAM-inspired learning. Data for the study entails an email exchange between the first two authors of this paper, instructors from environmental and art education, respectively, who co-taught a transdisciplinary, split-level, design studio in fall of 2012. In line with the research approach, the emails describe "epiphanies" that were experienced in the process of facilitating the design studio which included students from Art Education, Environmental and Civil Engineering, and Landscape Architecture. Key possibilities and pitfalls identified in the analysis of the emails center around the question of how STEM disciplines and the arts might be thoughtfully integrated in a reciprocal manner. Specifically, the paper highlights potential difficulties associated with current understandings of STEAM education which, almost without exception, focus on the sole objective of calling upon the arts to increase the creativity of STEM majors. Concurrently, it is observed that insufficient attention is presently given to what STEM disciplines might contribute to the arts.

Introduction

Recognition of creativity as "perhaps even *the* essential [...] requirement for sustained competitiveness, leadership, and fulfillment in the age of globalization"^[1] has led an increasing number of educators to explore the potential of integrating the arts (with a capital "A") into STEM education. Referred to as STEAM (STEM + Arts), Robelen^[2] describes how STEAM-inspired initiatives can "help unlock creative thinking and innovation" (p. 8). Ideally, STEAM and other arts integration initiatives are built on the premise that there is a synergistic relationship between the disciplines and that movement across the borders between arts and science offers reciprocal benefits to all those involved^[3]. In practice, however, STEAM initiatives can be challenging to implement. Bequette and Bequette^[3] discuss a number of reasons for this, most notably the risk that STEAM efforts may co-opt the arts as an "entryway to presumably more important STEM topics" (p. 43) rather than appreciate how thinking strategies developed in visual arts classes have cognitive and cultural value in and of themselves. Given the relatively recent emergence of STEAM and the resulting lack of specificity in curricular planning, Bequette and Bequette^[3] also warn against the superficial integration of the arts and sciences where, for example, "students might just be asked to color the bridge they build in a STEM lesson without talking about the choices they made, or might talk about Leonardo da Vinci in an art lesson without actually considering his scientific work" (p. 46).

Set against the context of STEAM education as an emerging area of study and practice, this paper uses faculty reflections on a recently implemented interdisciplinary studio course as a lens through which to examine some of the possibilities and pitfalls of STEAM-inspired learning. Specifically, the paper shares a series of six emails which were written by the first two authors of

this paper as they grappled with issues of STEAM and interdisciplinarity, both in the classroom and in collaboration with each other. Drawing on collaborative autoethnographic techniques, we then examine how the experiences described in the emails stem from different disciplinary cultures and point to broader patterns and possible outcomes of STEAM-inspired, interdisciplinary initiatives

The Interdisciplinary Design Studio

Within the realm of interdisciplinarity scholarship, the design studio described here is best characterized as transdisciplinary^[4]. Transdisciplinarity is an approach which transcends traditional disciplinary boundaries and applies ideas across disciplines with the goal of creating knowledge synthesis. Synthetic thinking, or the piecing together of disparate segments of knowledge, is an important concept which was explored in the course through the writings of Robert and Michele Root-Bernstein^[5]. Transdisciplinarity is unique as it does not simply take ideas from one field of study and apply them in another; rather it seeks to integrate and make ideas relevant to multiple disciplines. Mansilla, Miller, and Gardner^[6] articulate this phenomenon as *interdisciplinary understanding* where, “disciplines are not simply juxtaposed. Rather, they are purposefully intertwined” (p. 29). This concept of purposeful intertwining eloquently outlines our primary goal for the design studio.

Initially, the design studio intended to enroll undergraduate students from two different majors: Art Education and Environmental Engineering. However, as the fall semester approached there was a concern that the course would not meet the minimum enrollment numbers and it was opened to three additional groups who showed interest in the course. Granted access were graduate students from Art Education and Environmental Engineering, as well as students from a third major—master of Landscape Architecture. Final enrollment for the course consisted of eleven students: four from Art Education (two undergraduate, two graduate—one master and one doctoral); five from Engineering (four undergraduate Environmental Engineering, one master of Civil Engineering); and two from the master of Landscape Architecture program.

Traditionally, the acronym “STEAM” refers to the integration of visual arts into the STEM curriculum. As indicated above, the visual arts were represented in this interdisciplinary studio by students from the major of Art Education, rather than students from a purely studio art background. Generally situated within Schools of Art, undergraduate Art Education programs of study require students to successfully complete a variety of lower- and upper-level studio coursework in addition to classes which focus on art education theories and curriculum design. In this way, the interdisciplinary design course described here fulfilled one upper-level studio requirement for the undergraduate Art Education majors. Art Education students possess a unique combination of studio and pedagogical knowledge but also understand the importance of advocating for the visual arts and visual arts programs. The inclusion of Art Education as opposed to studio art majors in this interdisciplinary course thus brought forth a unique perspective through which the authors developed insight into STEAM.

Just as Art Education majors contributed to a unique view of the arts and STEAM, the inclusion of Environmental Engineering students in the studio also allowed for a particular aspect of “STEM” and hence “STEAM” to be explored. Students often choose to study environmental

engineering because they care for the environment and want to “make a difference” and it may well be for these reasons that the field of environmental engineering attracts a gender-balanced workforce. While not explicitly included in the STEAM acronym, it could be argued that the discipline of landscape architecture falls somewhere in between the disciplines of art (education) and environmental engineering, with an appreciation for aesthetics and the complex relationships between people, objects and places on the one hand, and training in sustainable design and natural systems on the other. Given the diversity of fields under the STEM and STEAM umbrellas, it is evident that the course described here constitutes a particular take on STEAM education. We argue that this unique combination of art education, environmental engineering and landscape architecture provided a valuable standpoint from which to generate new insights for the broader STEAM conversation.

On the first day of class, the eleven students from Art Education, Environmental Engineering, and Landscape Architecture were encouraged to break through disciplinary walls and find common ground. Specifically, they were asked to interview a peer from another discipline and then create visual-verbal representations of their new understandings on large pieces of butcher paper. These images sparked dialogue about connections between the three disciplines as students visualized how they might be interconnected. It was a time where questions sparked evocative, and at times passionate, conversations as students grappled with preconceptions, misconceptions, and new understandings of their classmates. This lesson served as an initiation for these students into interdisciplinarity and was our first glimpse into the many facets of a STEAM curriculum.



Figure 1: Students creating visual-verbal representations of the three disciplines on the first day of class

Throughout the semester, the students were divided into three interdisciplinary teams and presented with two open-ended design challenges (see Appendices A and B). These design challenges provided students with the freedom to explore and develop understandings of the socio-technical complexities surrounding waste and water sustainability. Working in interdisciplinary teams cultivated a space where students might consider multiple vantage points and integrate their knowledge in a cohesive and creative manner. As Holley^[7] explains: “...the interdisciplinary curriculum is believed to promote holistic understanding and a greater synthesis of ideas that affect the modern world” (p. 42). Indeed, the two design challenges focused on contemporary issues in our world (waste and water) and also aspired to let students see these issues through the lenses of the three different disciplines.

The first design challenge, entitled “Mission Zero Waste by 2030”, drew inspiration from a local county initiative which seeks to divert 75% of solid waste from landfill by the year 2020. This challenge looked forward an additional 10 years and students were tasked with conceptually and visually exploring a target of zero waste by 2030. The instructor from Environmental Engineering led students through an examination of municipal waste from a national and global perspective while also providing a combination of statistical and qualitative data. Concurrently, the instructor from Art Education engaged students in explorations of nature and waste through the work of visual artist Andy Goldsworthy and also introduced the class to a California family who made it their prerogative to produce zero waste. A local artist was also invited to one class meeting to discuss the inherent value of objects and provoked students to re-conceptualize definitions of waste. These presentations elicited inquiry and dialogue about waste—a starting point through which students could pursue further investigations based on their interests. For the first design challenge, no requirements were set forth in terms of solution-finding rather the focus was on examining and framing problems associated with the zero waste goal. From a visual standpoint students were asked to present their understandings through two representations: 1) an artistic format which visually depicted the group’s explorations, and 2) a second format which would be appropriate for disseminating information to a broader cross-section of the community. Both representations were required to demonstrate a visual and conceptual cohesiveness when displayed collectively.

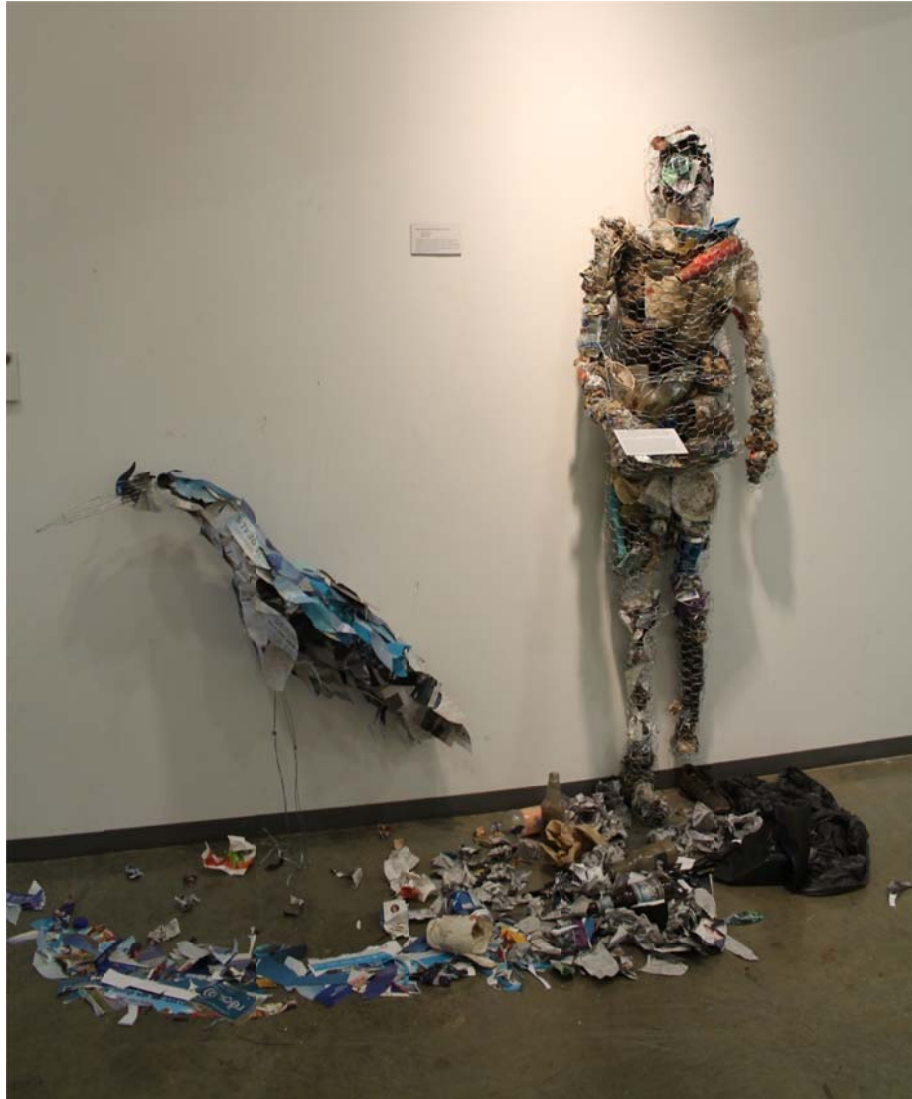


Figure 2: An exploration of waste through visual form as created by one design team for the first design challenge

While the first design challenge focused on waste, the second encouraged students to explore an idea brought forth by Cynthia Barnett^[8] which she termed a “water ethic”. In new interdisciplinary groups, students were asked to create two deliverables that thoughtfully investigated how a water ethic might be inspired in the local community. The deliverables were similar to the first design challenge in that two visual representations were expected. First, and slightly different from the previous challenge, groups were required to conceive and execute a water-inspired initiative in the local community. This initiative sought to inspire citizens to understand their responsibility and connectedness to water and water resources. The community initiatives required some form of documentation (i.e. photographs) which would be available for view in the gallery. The second deliverable again asked students to engage on a deep conceptual level with the idea of water ethic through a visual (artistic) representation. In both design challenges, groups exhibited their work in the art school’s gallery space and were required to provide gallery talks and answer questions about their creative processes.

things as *desired* and things as *perceived*”^[9]. In a lesson on this chapter, students were asked to consider various stakeholders in the local community and their respective perceptions and desires. The main ideas within the text were approached in similar ways as students were encouraged to apply the content in a meaningful way.

The second text, by Root-Bernstein and Root-Bernstein^[5], presented thirteen creative thinking tools that derived from the authors’ research on some of the world’s most prolific individuals representing a variety of disciplines (e.g. Richard Feynman, Barbara McClintock and Pablo Picasso). The authors argue against a discipline-specific perspective of creativity and advocate for a more holistic approach to understanding creativity, where creative thinking tools are viewed as transdisciplinary. Root-Bernstein and Root-Bernstein emphasize that these creative thinking tools are not innate proclivities but require thoughtful practice and cultivation. This idea was reiterated in the class meetings as various lessons engaged students in interactive studio lessons, exercises, and discussions on tools such as Observing, Dimensional Thinking, Empathizing, and Synthesizing. In these activities, the focus was not on creating products but rather allowing the students to think deeply about the creative process, specifically *their own* creative process.

In addition to lessons developed by the instructors, graduate students were also given the opportunity to select a thinking tool which they found particularly relevant to their research or discipline and devise a lesson on that tool. For example, one masters of Landscape Architecture student spent most of his adult life as a professional contemporary dancer in New York. His lesson brought to life the thinking tool dubbed “Body Thinking” and explored it through multiple lenses, encouraging students to think about how movement is an important component in all of the represented disciplines and even in their daily lives. Rather than lecture about Body Thinking, the former-dancer created opportunities for his classmates to push back the chairs and move throughout the space through various activities. This graduate student’s lesson nicely encapsulated the goal for all the thinking tool lessons which was for the students to intimately interact with the tools and to consider how they might permeate through, connect, and even dissolve disciplinary lines.



Figure 4: Exploring Body Thinking in a dance-inspired lesson developed by a graduate student

Methodology

This paper employs collaborative autoethnographic techniques to describe and analyze possibilities and pitfalls of STEAM-inspired learning as they came to light in the process of designing, facilitating and reflecting on the above-described course. Data for the study entails a reflective email exchange between the first two authors of this paper which was started in October 2012, two months into teaching the studio. At the outset, the purpose of the email exchange was to take the time to reflect on non-programmatic aspects of the class that we found personally meaningful and relevant to our development as educators working in an interdisciplinary space (i.e. ‘ah-ha’ moments). As our conversation progressed, we found ourselves exploring issues and asking questions that had implications beyond our own experiences. Motivated to share our reflections with the broader STEAM community, we began to investigate autoethnography^[10] and, subsequently, collaborative autoethnography^[11; 12] as possible research approaches within which to frame the broader insights that emerged from our shared reflective process. The paragraphs below describe this emerging methodological approach and highlight which characteristics of autoethnography we adopted in this work. Following this discussion, we present the first six emails from our ongoing email exchange, after which in the discussion and conclusions section, we consider how our experiences illustrate broader patterns and possible outcomes of STEAM-inspired, interdisciplinary initiatives.

Autoethnography is a research approach that is rapidly gaining attention in the social sciences. In 2010 the Journal of Research Practice published a special issue of ten papers discussing

autoethnography. In the introductory article to the collection, Ngunjiri et al.^[11] describe autoethnography as “a qualitative research method that utilizes data about self and its context to gain an understanding of the connectivity between self and others within the same context” (p. 2). Unlike more traditional forms of research where social scientists are trained to guard against subjectivity, autoethnography recognizes that to “separate self from research activities [...] is an impossible task” (p. 2)^[11]. In other words, autoethnography positions itself as a research endeavor that is self-consciously value-centered rather than pretending to be value free^[13]. By stepping away from “canonical ideas about what research is and how research should be done”, Ellis^[10; 14] describes autoethnography as a way of:

“[...] producing meaningful, accessible, and evocative research grounded in personal experience, research that would sensitize readers to issues of identity politics, to experiences shrouded in silence, and to forms of representation that deepen our capacity to empathize with people who are different from us.”

As a method, autoethnography combines characteristics of *autobiography* and *ethnography*, whereby researchers seek to “describe and systematically analyze (graphy) personal experience (auto) in order to understand cultural experience (ethno)” (p. 1)^[10]. Drawing from autobiography, autoethnographers typically write about “epiphanies”, or remembered moments perceived to have had a transformative effect on their life or thinking^[10]. What distinguishes autoethnography from autobiography is a purposeful focus on examining how these epiphanies “stem from, or are made possible by, being part of a culture and/or by possessing a particular cultural identity” (p. 3)^[10]. In this way, autoethnographers use personal experience as a lens through which to explore broader cultural questions.

Autoethnographies are typically written by individual authors. Increasingly, however, ethnographies written by two or more authors are appearing in publications^[11]. Referred to as collaborative autoethnographies, these studies capitalize on multiple perspectives to promote a dialogue where:

“One researcher’s story stir[s] another researcher’s memory; one’s probing question unsettle[s] another’s assumptions; one’s action demand[s] another’s reaction” (p. 6)^[11].

Collaborative autoethnographers adopt various modes of collaboration. In this study we used what Ngunjiri et al.^[11] refer to as a sequential model, whereby one autoethnographer writes about his/her experience and then passes his/her writing to the next person who adds his/her story to the previous writing. Collaborative autoethnography is thus both process and product, drawing on co-constructed dialogue as the method of inquiry.

The following collection of six emails represents our first attempt at collaborative ethnographic research. In line with the literature, these emails are centered on epiphanies that we experienced while facilitating the design studio. As newcomers to both autoethnographic research and STEAM education, we found the process of writing these reflective emails to be highly valuable in identifying critical questions pertaining to the purpose and practical implementation of STEAM-inspired initiatives. Key questions and themes emerging from the email exchange are further discussed in the final section of the paper. The emails below are presented in their

complete and near-original form. Minor changes were made to respect the privacy of the students involved in the studio and for editorial clarity. We ask readers to judge the quality of this work according to the definitions of reliability, validity and generalizability proposed by Ellis^[10] as they apply to autoethnography (Table 1). Central to these conceptions of quality is the focus on how readers relate to the work and how the work is located within, and relates to, broader cultural processes.

Table 1: Quality considerations for autoethnographic research

Aspect of quality	As applied to autoethnography
<i>Reliability</i>	Questions of reliability refer to the narrator's credibility. Could the narrator have had the experiences described, given available "factual evidence"? ^[10] Anderson ^[15] also describes this as "complete member research (CMR) status" (p. 378).
<i>Validity</i>	For autoethnographers, validity means that a work seeks verisimilitude; it evokes in readers a feeling that the experience described is lifelike, believable, and possible, a feeling that what has been represented could be true. The story is coherent. ^[10] In particular, autoethnographers ask: "How useful is the story?" and "To what uses might the story be put?" ^[16] .
<i>Generalizability</i>	In autoethnography, the focus of generalizability moves from respondents to readers, and is always being tested by readers as they determine if a story speaks to them about their experience or about the lives of others they know; it is determined by whether the (specific) autoethnographer is able to illuminate (general) unfamiliar cultural processes ^[10; 14; 17] .

The Email Exchange

From: sochacka@uga.edu

To: guyotte@uga.edu

Subject: An interesting connection between Environmental Engineering and Art Education

Date: Thursday, October 11, 2012 5:42 PM

Dear Kelly,

I hope you're enjoying this beautiful fall day. As we discussed yesterday, I'm writing to begin our reflective exploration of the studio course, with a particular focus on the emergent transdisciplinary space we're in the process of exploring between Art Education, Environmental Engineering and Landscape Architecture. I'd like to begin by reflecting on an early 'ah-ha' or 'meta-moment' I had in the very first class of this semester.

As you will recall for the introductory class we had the students participate in a 'getting to know you' activity. Specifically, we asked the students to pair up with a student from a different discipline, interview each other, and find out five interesting things about their partner's discipline. After these short interviews we tasked the students with representing the five things they learned from their classmate on sheets of butcher block paper – one sheet for each discipline. After half an hour or so of more or less enthusiastic playing with crayons and colored pencils, we all stood back and asked the students to describe what they had drawn. This process

of reporting back sparked a rich conversation about what it means to be an art educator, environmental engineer or landscape architect. To begin exploring the transdisciplinary space between the three disciplines, we encouraged the students to make connections between the three fields – to highlight what was similar and/or different and what other relationships they could identify.

It was during this ‘making connections’ discussion that an Art Education student drew an interesting parallel between environmental engineering and Art Education (we’ll call this student Kate for now). Specifically, Kate pointed to the “caring” aspect of environmental engineering. She described how the environmental engineer she had interviewed had spoken about environmental engineering as being a discipline that “gives nature a voice”. Kate then described the act of “caring”, in her understanding, as being linked first to noticing that there is something outside of our immediate surrounds to care for and then developing the sensibility to act on that caring impulse. It is these characteristics, Kate went on to explain, that are at the heart of Art Education; that is, the ability to observe and think deeply about the meaning of something and then to explore and represent those thoughts by engaging with materials. Art Education, Kate went on to propose, might therefore be an ideal preparation for future environmental engineers as it may serve to develop the sensibilities required to care for the environment.

So there you have it, a short account of my first ah-ha moment of this semester. You might be wondering why Kate’s comments made such an impression on me, especially as I presume that this perspective on art education is unlikely to be new to you. Well, I think it was because this was the first time that I got a glance at what the vast and varied value of integrating the Arts into STEM might look like. I guess I was also taken aback at just how little I really knew about art education and art in general.

I’d be interested to hear your thoughts on this.

Kind regards,
Nicki

From: guyotte@uga.edu
To: sochacka@uga.edu
Subject: Hybrid spaces
Date: Friday, October 12, 2012 8:47 PM

Dear Nicki,

Your email was thought-provoking and carried me back to the same class meeting. I remember that moment vividly and the comments that Kate made as we all sat together looking at the papers tacked to the back wall of the classroom. Interestingly, this moment was profound for me as well but for a different reason. The empathetic, or caring, nature of art is an idea that I understand from both a theoretical perspective and through my own experiences as a high school educator. What resonated with me was the fact that she drew a connection from this aspect of our discipline to environmental engineering in such a thoughtful and insightful way. One of my favorite things about teaching is the many perspectives that students bring and

that I can learn so much through the things they say and the connections they make. She saw the qualities of care as they are found within art education as related to the way environmental engineers give nature a voice. I had never thought of your profession in such a way and that experience gave me a new understanding of, and appreciation for, what it is that environmental engineers do. Like you, I realized how little I knew about environmental engineering. Rather than cause me anxiety, this realization made me excited to engage in the interdisciplinary journey that is our design studio. When Kate spoke, she so eloquently discussed a meaningful relationship between care in her discipline to the discipline of her peers. She tugged at the thread of this idea in way that caused it to unravel for the two of us, opening both our eyes to this “meta-moment”.

This lesson also brought me back to a reading that I completed during my first semester of graduate school. In the reading, the qualitative research study explored middle school, minority girls and how they navigated through their social identities and their identities in science class. The girls struggled with finding solace in being socially accepted and performing well in science even when societal and cultural norms dictated that “girls don't do science.” What brought me to see this article as relevant is that the researchers discussed a third space, or hybrid space, where the girls could accommodate both of these perceptions. On the first day of class, I began to think of our class as a hybrid space- a place where disciplines might overlap, enmesh, and amalgamate. As I watched students from landscape architecture, environmental engineering, and art education interact, I realized what a unique space we were creating. I think there was, and sometimes still is, a discomfort in the students where they are asked to break free of the constraints that bind them to “the way *we* do things in (engineering/ landscape architecture/ art education).” They struggle when dealing with different ways of knowing but I think this hybrid space has so much potential for the students. I know that during that first class meeting, I realized what a potentially precarious situation we were in. Just like the girls from the research study, we could either turn these students on to this class or unknowingly make this a frustrating experience. I wondered if our students would be able to eventually find their way into the hybrid space and if they might also find solace there.

Thinking back to Kate's words, I find it so interesting that that moment struck us as meaningful but for different reasons. I wonder how many other times we sat listening to student dialogue and had these thoughts, perhaps we will uncover more as we engage in these email reflections. It is interesting that we work so hard to facilitate these synergistic moments within our students yet we are finding these moments in our own practice as instructors. I look forward to unpacking more of these experiences and hope that you enjoy your evening.

Warmly,
Kelly

From: sochacka@uga.edu
To: guyotte@uga.edu
Subject: The goals of STEAM education
Date: Wednesday, October 17, 2012 4:24PM

Dear Kelly,

I am intrigued by the “empathetic, or caring, nature of art” you described in your last email. In particular I am curious as to how this aspect of art and Art Education might contribute to an interdisciplinary context, such as our class, and, more broadly, to STEAM initiatives across the country.

After receiving your email last week, I searched the internet to try and find out if the empathetic and caring aspects of art are part of the mainstream STEAM conversation. I found many websites which describe the need for STEAM education (see for example: <http://steam-notstem.com/about/> and <http://stemtosteam.org/>), as well as numerous newspaper articles (see for example: <http://www.edutopia.org/blog/stem-to-steam-strengthens-economy-john-maeda>, <http://blogs.scientificamerican.com/guest-blog/2012/08/22/from-stem-to-steam-science-and-the-arts-go-hand-in-hand/> and <http://www.pbs.org/newshour/rundown/2012/07/the-movement-to-put-arts-into-stem-education.html>). Surprisingly, however, I read very few comments regarding the contribution the arts could make to STEAM in the sense of fostering a more holistic, empathetic and care-based education. Instead, the focus seems to be almost entirely centered on the understanding that incorporating the arts into STEM will promote creativity, thereby spurring the innovation which will ensure America’s future economic well-being. See for example the following excerpt from <http://steam-notstem.com/about/>:

“The future of the US economy rests on its ability to be a leader in the innovation that will be essential in creating the new industries and jobs that will be the heart of our new economy. Where the US has historically ranked 1st in innovation it now ranks between 3rd and 8th depending on the survey. We have taken steps to reverse this slide by embracing and funding the much needed improvements in STEM (Science, Technology, Engineering and Math) education.

STEM is based on skills generally using the left half of the brain and thus is logic driven. Much research and data shows that activities like Arts, which uses the right side of the brain supports and fosters creativity, which is essential to innovation. Clearly the combination of superior STEM education combined with Arts education (STEAM) should provide us with the education system that offers us the best chance for regaining the innovation leadership essential to the new economy.”

Below is one of the few comments I found which, I feel, at least touches on aspects of care and empathy (see in particular the bolded text):

*“What does it mean to turn STEM to STEAM? The problem-solving, the fearlessness, and the critical thinking and making skills that I see every day in the RISD [Rhode Island School of Design] studios are the same skills that will keep our country innovating, and their development needs to start in the K-12 schools. Design creates the innovative products and solutions that will propel our economy forward, **and artists ask the deep questions about humanity that reveal which way forward actually** is.” <http://www.edutopia.org/blog/stem-to-steam-strengthens-economy-john-maeda>*

Reflecting on these quotes and the underlying purpose of integrating the arts into STEM education led me to another interesting point you raised in your email – the concept of a third, or hybrid space, “a place where disciplines might overlap, enmesh, and amalgamate”. Thinking about this hybrid space took me back to a Wednesday afternoon class in the fourth week of semester, one week before the deadline for the introductory design challenge. During this particular class, one of the three interdisciplinary groups was having difficulties progressing with their gallery exhibits. More specifically, the two engineering students in this team both were of the understanding that they had completed the process of brainstorming and coming up with the two ideas for their exhibits. The Art Education undergraduate student, however, was suggesting that now it was time to “dig deeper” and further engage and explore their two ideas. At this point in the team discussion the engineering students became frustrated and said to the Art Education student something to the effect of “you’re the Art Education major, how about we just build it and you make it pretty”. If you recall, this comment effectively led to a complete breakdown of communication and the group sat in almost total silence for the remaining hour of the class. During the next class meeting, the Art Education student attempted to get the project back on track and led her group in a visual mapping exercise that sought to examine the relationships, connections, and assumptions underlying their ideas. Despite these last minute efforts, it was evident to us both that the group’s two exhibits lacked cohesiveness in the gallery show. While each exhibit posed thought-provoking questions about waste, they did not come together as the group envisioned.

So what does all of this mean for the hybrid space we are currently in the process of both creating and witnessing? At this point I can’t say I’m entirely sure. What I do want to express though is my increasing discomfort with the two apparent front and center goals of STEAM, those being, first, to stimulate creative thinking and therefore innovation to ensure our future economic well-being, and second, to attend to the aesthetics of design (as demonstrated in the account above). Based on our early observations in this class and the struggles our students are experiencing negotiating their own ‘hybrid spaces’, I feel this is an area that *we* need to dig deeper into.

I would be very interested to hear your views on this subject.

Kind regards,
Nicki

From: guyotte@uga.edu
To: sochacka@uga.edu
Subject: Creativity, the arts and hybrid spaces
Date: Friday, October 18, 2012 6:32 PM

Dear Nicki,

It is indeed interesting that STEAM initiatives seem to focus very narrowly on how the arts can contribute to STEM education. I find myself wondering why this narrow perception exists and what circumstances are fostering the pervasive structure of **creativity= arts**. Through *Sparks of Genius*, we have explored thirteen creative thinking tools that have been found in individuals

from a wide variety of disciplines. The problem posed by the authors is that our current educational systems from K-16 and beyond are not cultivating creative minds because of a lack of inter- or transdisciplinarity approaches to curricula. Creativity, then, is not equated with the arts but is something that transcends disciplinary boundaries.

Given this information, it seems as though some STEAM advocates may be misunderstanding the essence of the arts and what the arts may offer to science, technology, engineering, and mathematics. It is this very problem that surfaced in your story about the Art Education student and the engineering students when the engineering student said something to the effect of “you’re the Art Education major, how about we just build it and you make it pretty”. I remember that day as the group sat silent for the last portion of class and the Art Education student stayed after class to discuss her frustration with this experience. If STEAM initiatives are to fulfill their potential, there must be more than a superficial arts *incorporation*—there needs to be a thoughtfully planned arts *integration*. With this in mind, the arts must also visualize what it is that STEM might offer at this deeper level where all five of these disciplines might stand on equal ground.

In reference to your comment about empathy and caring being absent from the STEAM conversation, the authors of *Sparks of Genius* present “empathizing” as one of the thirteen thinking tools of the most creative individuals from *across* disciplines. Recall that we also found that Howard Gardner and Daniel Pink discuss empathy as they envision the necessary minds of the future. Is it that our society (or maybe STEM education) does not value this type of creative thinking? Or is that most people do not think of the ability to empathize *as* a creative thinking tool? Your thoughts?

Finally, I thought that I would readdress this idea of the third, or hybrid, space of which I spoke in my first email. I was thinking back to our class on “Abstraction” on October 1st and an interesting comment I heard one of the environmental engineering students bring forth. Let’s call this student, Ethan. Ethan had just completed his wire sculpture, a simplified abstraction of a buck (male deer). As he stood up at the end of the studio portion of class, he stated that he was not able to add a lot of detail to his wire sculpture as the wire did not permit him to work in this way (my paraphrasing). What Ethan pointed out is a unique quality of Art Education. When students work with a medium, they learn what the medium affords the artist as well as its limitations. Elliot Eisner^[16], eminent scholar of Art Education, discusses that an attention to the constraints and affordances of a medium “requires a sensitivity to nuanced qualities” (p.80) which is a cognitive act. Ethan’s comment struck me as he was thinking like an artist, thinking in qualities. It seemed coincidental that I happened to overhear Ethan make this observation and it made me wonder if other students were beginning to develop such habits of mind—whether they be arts-based, design-based, or something else? This is one of *our* limitations. How will we know about the hybrid space unless students somehow make these realizations known?

I would be interested in hearing your perspective.

Warmly,
Kelly

From: sochacka@uga.edu

To: guyotte@uga.edu

Subject: Creativity, empathy and habits of mind

Date: Friday, October 26, 2012 6:35PM

Dear Kelly,

I like your formulation of “the pervasive structure” of **creativity = arts** and think we could further expand it to include **arts = creativity = innovation = economic growth**. Like you, I feel this line of logic underlying STEAM initiatives misrepresents both the arts, for reasons we have only just begun to touch on, as well as the notion of creativity. I was particularly interested by your reference to the Root-Bernsteins’ work that “Creativity, then, is not equated with the arts but is something that transcends disciplinary boundaries.” Presuming for a moment that this is a valid representation of creativity, then STEM initiatives alone (without the arts) should also promote creative thinking. STEM education is, after all, an interdisciplinary endeavor which combines science, technology, engineering and math. The growing push to add art to STEM, however, seems to suggest that something is missing from STEM. I have to admit that writing this last sentence makes me feel a little foolish. By this I mean that of course there’s something missing from STEM! The arts yes, but other humanities too, like history, politics and philosophy. Unlike the arts though, which seem to have an economically beneficial contribution to make to STEM in the form of creative innovations, I suspect that the meaningful integration of these other disciplines has the potential to muddy our simple formulation bolded above (i.e. **arts = creativity = innovation = economic growth**) and lead to questions concerning difficult issues like social justice and environmental ethics. I don’t mean to be cynical; I guess I am just still trying to get my head around the purpose of STEAM initiatives.

In light of the seemingly one-directional nature of the collaboration between the arts and STEM, I find it an interesting exercise to visualize, as you suggest, what “STEM might offer at this deeper level where all five of these disciplines might stand on equal ground.” In other words, what could STEM offer the arts? While I find this question to be crucially important to our own challenge of how to achieve a “thoughtfully planned arts *integration*”, I have to admit that I am not entirely clear on the answer. What occurs to me at this early stage in my thinking about this issue is some kind of letting go or sharing of the technological and economic power that is associated with STEM fields. STEM fields have a significant impact on society, both beneficially, for example through medical research, and non-beneficially, for instance through the unsustainable use of limited resources. Perhaps placing the arts and STEM on an equal footing might somehow lead to a more equitable division of the power and decision-making associated with technological development – development that affects all of society. I’m not sure how this might manifest in a classroom setting though. This is clearly an area that I/we have to reflect further upon.

In your last email you raised a number of questions relating to empathy. Specifically, whether society/STEM values empathy as a creative thinking tool, or whether most people even think of empathy as a creative thinking tool. My initial reaction to your question was no, empathy is not a term or concept that I have often heard associated with either STEM fields or as a creative thinking tool. My impression though, both from my own experience as an engineer and as a

member of the engineering education community, is that the role of empathy in engineering is gaining steam (sorry, I couldn't resist). Whereas in the past many areas of engineering were relatively people-free, centralized water infrastructures for instance, increasingly people are having to play a more central and active role in engineered systems. In these cases technological know-how can only get engineers so far. Perhaps this is where creative thinking skills, like empathy, will become increasingly needed. If you remember, [the names of two of our colleagues] began exploring the role of empathy in engineering communication last year with a faculty member from social work. I've attached their ASEE paper [reference removed for blind review] on this topic and another by Riley et al.^[18] to give you an idea of the current conversation around concepts of empathy and caring in the engineering education community.

Finally, I wanted to further explore your recollection of Ethan's experience working with the "constraints and affordances" of wire; what you refer to as the development of "habits of mind". I recall earlier in the semester you described eight artist habits of mind: develop craft, engage and persist, envision, express, observe, reflect, stretch and explore, and understand art world. I remember at the time thinking that some of these habits mapped to the Root-Bernsteins' creative thinking tools, such as observation, while others I could relate to from my own teaching experience, the importance of reflection for example. I think I let the others flow over me that day and it wasn't until reading your story about Ethan that I began to think about these habits of mind more deeply. Your questions regarding whether other students are also developing these habits of mind and how we will know unless the students make these realizations known led me to become curious about what the students are thinking when we ask them to engage in art making. To explore this I joined the students this past Wednesday during one of our graduate students' lesson on Dimensional Thinking and sat down and made my own collection of sculptures out of paper. While doing this I noted down my feelings and thoughts with the goal of gaining some insight into what our students, in particular the non-Art Education students, might be experiencing. Below are my notes.

- Excitement at creating something
- A little anxiety too
- Wonder how to transform an idea into a form
- What's more important – the idea or the form?
- Making meaning, before, during and after the fact
- Playing, failing, critiquing – perhaps I could try this...
- Developing patience and precision, cutting straight
- Experimenting
- Relaxing
- Learning about the material – folding, cutting, stretching, scrunching...

Sitting there working on my paper sculptures I overheard and jotted down the following exchange between one Engineering and two Art Education students:

Undergraduate Engineering student: [Holding up a piece of blue card] I guess it's going to go like this.

Graduate Art Education student: Just cut it and see what happens.

Undergraduate Art Education student: And then if it doesn't work – damn! [smiling]

Graduate Art Education student: Then just try again.

My tuning in to habits of mind on Wednesday leads to me think that our students are developing these thinking skills. We could argue, for example, that the environmental engineering student above was being encouraged by his Art Education peers to “stretch and explore”, that is “to explore playfully without a preconceived plan and to embrace the opportunity to learn from mistakes and accidents.” Looking forward, perhaps we need to encourage the students to be more attentive to these habits of mind, or, more generally, to what they are thinking and experiencing when they participate in different class activities. Perhaps in interdisciplinary settings it’s particularly important to be very explicit about what we’re doing, why, and what these experiences might mean for different disciplines. I’d be interested to hear your views.

Kind regards,
Nicki

From: guyotte@uga.edu
To: sochacka@uga.edu
Subject: Creativity, empathy and habits of mind
Date: Friday, November 2, 2012 8:28 PM

Dear Nicki,

Your email raised some thought-provoking ideas that made me both reflect and question over the past week. In particular, I thought heavily on your discussion of the structure: arts = creativity = innovation = economic growth. The current nationwide push towards a STEM focus in K-12 education brings forth the assumption that we can provide students with all the knowledge necessary for success through an academic focus on science, technology, engineering, and mathematics. As obvious as it may seem, I had not really focused on the idea that STEM, and even STEAM, initiatives are inherently exclusionary in which specific disciplines (or subjects) are given more weight than others. With this focus on what STEM/ STEAM might offer, I began to wonder what it is that these initiatives are neglecting and what is being “left behind.” Although I am not an engineer, I do know that there are individuals in your field who believe that the future engineer needs to be creative and embrace a more holistic type of thinking. I remember reading a statement from the National Academy of Engineering^[15] last year:

“We aspire to an engineering profession that will rapidly embrace the potentialities offered by creativity, invention, and cross-disciplinary fertilization to create and accommodate new fields of endeavor, including those that require openness to interdisciplinary efforts with nonengineering disciplines such as science, social science, and business” (p. 50).

I realized that what first drew me to the idea of STEAM was the potential for interdisciplinarity collaboration. It was the idea that both instructors and students from these diverse areas would stand on equal ground and investigate relevant topics together in a dialogic manner. Isn’t that the crux of interdisciplinarity, after all? I wonder, though, if this dialogue is happening and if there is a true reciprocity among all the disciplines. I also wonder if STEM or STEAM will effectively

cultivate the holistic, creative, interdisciplinary engineer as presented above. Finally, I wonder what might be missing if we only focus on these four or five areas for interdisciplinarity. I am not proposing any answers here but merely bringing forth the things that have been on my mind since your last email.

On a slightly different note, I thought your perspective on how the students are developing studio habits of mind was quite interesting. The interaction between the undergraduate engineering student and the graduate Art Education student was such a nice example of what the arts can contribute to STEM and interdisciplinarity in general. I am so glad that you observed this interaction take place and I hope we can be privy to more conversations like this one in next few weeks.

Finally, I wanted to share with you one of my own observations this past week. During our lesson on empathizing, we asked the students to close their eyes and imagine that they were either participants in their group's community initiative or a gallery visitor viewing their exhibit. Afterwards, we allowed them some time to discuss their empathic visualizations with their group members. A graduate landscape architecture student asked a graduate engineering student if he had imagined that he was walking through the entrance towards their community initiative. The engineering student replied yes and the landscape architecture student commented on how busy the environment was and asked if he agreed. He did and they began to talk about whether or not this was a good thing. I thought that this was such an interesting journey into creative thinking. A collaborative type of creativity emerged from this activity where imaging facilitated dialogue and a seemingly altered perception of their group's community initiative.

This made me think of our ongoing discussion of empathy and engineering. As I listened to the three design groups deep in conversation and wondered what other new perspectives this simple activity might have inspired. I also thought about one of our engineering undergraduates who commented earlier that same class that she did not feel that empathy was relevant to her research with air pollution. She even described the frustration directed towards her mother when the student told her to keep her niece indoors on a day with particularly poor air quality. It seems as though this student thought of empathy as being something that others should feel for her research but she was missing the fact that *she* was the empathic one, caring for the health of her family. Was it that she did not see this connection? Or was it that she did not want to see it? It baffled me at the time, but sometimes we have to sit back and let our students come to these new understandings when they are open to them. After all, learning (like creativity) is a process.

I realize that I may not have offered many answers in this email but rather posed more questions for us to consider. I have enjoyed exploring these topics with you and, as always, look forward to hearing your thoughts.

Have a nice weekend and enjoy this beautiful fall weather.

Warmly,
Kelly

Discussion and Conclusions

Our engagement in the above email exchange revealed a number of possibilities and pitfalls of STEAM education. Arguably the most discussed topic addressed in the emails centered on the question of how the disciplines might be thoughtfully integrated in a reciprocal manner. This topic surfaced in the initial correspondence which expanded the environmental engineering instructor's conception of the arts and art education into the realm of caring and empathy. The conversation that followed highlighted potential difficulties with current understandings of STEAM education which, almost without exception, focus on the sole objective of increasing the creativity of STEM majors, with little attention given to what STEM might contribute to the arts. This implicit understanding of the purpose of STEAM became apparent when the environmental engineering instructor admitted that she was "not entirely clear" on what thoughtfully planned arts integration might look like where all five STEAM disciplines stand on equal ground. While this question has been previously raised in the literature^[3], our experiences demonstrate how easy it is to embark on a STEAM initiative without giving adequate forethought and attention to how all parties might contribute to and benefit from the collaboration. In this particular instance the instructors' shared commitment to reflection and co-constructing an emerging conception of STEAM averted serious misunderstandings. It is plausible, however, that other art instructors may not be as willing to engage in STEAM initiatives if they perceive the majority of benefits to be directed towards their STEM counterparts. We urge the STEAM community to explore this issue in more depth to ensure that all involved disciplines derive maximum advantage from STEAM initiatives.

In the process of uncovering this potential pitfall of STEAM education, we became excited at the possibility of expanding current understandings of STEAM education to include broader conceptions of the arts and art education, in particular the commitment to engaging with issues on a deeper level and exploring the relationships and connections between people and materials. There is a growing interest in the engineering education research community of the role of caring and empathy in engineering. Pantazidou and Nair^[19], for example, propose combining the engineering design process with an 'ethic of care'^[20] in order to transform engineering design "from a capitalistic or militaristic-driven process into one focused on care"^[18] (p. 28). Similarly, Walther, Miller and Kellam^[21] argue that empathy, which they understand to entail "both the intuitive emotional, as well as, cognitive aspect of "perspective taking", enables engineering students to develop a nuanced, critical understanding of the multiple perspectives which characterize contemporary engineering problems" (p. 1). We see great potential for STEAM collaborations to help the engineering community to continue to develop in these directions. We are aware, however, that once again this is an engineering-focused discussion of the purpose of STEAM and we invite artists and art educators to contribute to this conversation.

Another issue that arose from the email correspondence focused on disciplinary preconceptions and misconceptions. This was evident among the group that struggled with the first design challenge. The statement of "how about we just build it and you make it pretty" indicated that the engineering students carried specific thoughts about their own discipline and that of art education. Implied here is that engineers build and have the know-how to execute plans while artists deal purely with aesthetics and creativity. Despite many lessons which attempted to break

down disciplinary lines and encouraged students to delve deeper into the nuances of the three disciplines, misconceptions lingered.

A challenge that lies inherent within STEAM is that the compartmentalized disciplinary approach^[7] of traditional education is a pervasive structure. In this context Spelt, Biemans, Tobi, Luning, and Mulder^[12] warn that:

“Interdisciplinary thinking does not occur spontaneously, it can take a considerable amount of time for students to achieve an adequate level of expertise in its practice. In addition, students need help in order to be able to synthesize two or more disciplines” (p. 366).

Our experiences confirm Spelt et al.’s statement and highlight the importance of purposefully seeking to uncover and address preconceptions and misconceptions early on in the an interdisciplinary course and support synthesis processes in later sections. In other words, while interdisciplinarity, and STEAM, may hold tremendous potential for promoting holistic and creative thinking, what became clear to us from engaging in these emails is the myriad of ways in which disciplinary preconceptions persist in students’ minds and the need for a consistent effort to reflect on when and how these understandings might help or hinder student progress.

Closely related to this issue was another idea which emerged in our emails – that of a hybrid, or third space. As illustrated by the examples described in the emails, this space might be thought to contain both possibilities and pitfalls. Specifically, we experienced possibilities when we heard students like Kate make new and interesting connections between disciplines and when students such as Ethan unconsciously began to think in qualities of materials. On the other hand, we also saw the potential pitfalls of how STEAM might serve to consolidate existing understandings as we observed when the art education student struggled to break free of the stereotype of an artist who attends solely to aesthetic qualities.

In the process of exploring these possibilities and pitfalls of STEAM education, we observed and experienced the reflective dialogue portion of collaborative autoethnography as an effective way to uncover deeper questions and understandings. Based on these explorations we offer the following four key questions to the STEAM community: What are the underlying goals of STEAM education? What might STEM fields contribute to the arts? What are ways to confront and work through stereotyping in an interdisciplinary setting? And, what are characteristics of hybrid space learning and ways to foster it?

We look forward to the opportunity to explore these questions in further research.

Acknowledgements

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Appendix A – First Design Challenge

Introductory Design Challenge: “Mission Zero Waste by 2030”

Background:

In November 2010, the Mayor and Commission of Athens passed community wide solid waste diversion goals of:

- 40% by 2015
- 60% by 2018
- 75% by 2020

In order to achieve these progressive goals, the Athens-Clarke County Solid Waste Department has an extensive plan to add several new or improved programs over the next few years. The first program initiated is a Waste Minimization Fee. This fee was passed by the Mayor and Commission in October 2011 and began in January 2012 (see attached information sheet).



Looking to the future, the current Mayor has proposed the goal of “**Mission Zero**” by 2030. This target has resulted in fierce debates across the community. Many stakeholders feel that a zero waste goal is simply not possible. The Mayor is confident that the goal will inspire groundbreaking design and innovation.

Your Team Task:

Your task is to explore what life at UGA and in the local community might look like if Athens-Clarke County were to achieve the Mayor’s 2030 “Mission Zero” target. You are to present your findings in **two different formats**. Both of these will be showcased at a **local gallery exhibition** on September 12th. One is to be designed with the intention of reaching a **broader cross-section of the community** (i.e. for ease of distribution beyond the exhibition).

Our Expectations

Keep a clear record of your discussions in your visual journal (you can make sketches, drawings, bulleted lists, flowcharts, etc). Make sure that an outsider can understand your record. You will be required to turn in your visual journal as part of the assessment for this project.

Your Deliverables

Due Date: September 12, 2012

- A problem statement that clarifies the stakeholder perspectives, aspects and sources of the current difficulties.
- A gallery exhibit and broader community initiative.
- Two x 1-pg information sheets describing your gallery exhibit and broader community initiative (to be presented with your exhibits).
- Visual journal documenting creative design process.

Due Date: September 26, 2012

- A 24” x 36” poster that illustrates and discusses both of your pieces of work.

This team project will count for 25% (undergraduate students)/ 20% (graduate students) of your final grade.

Appendix B – Second Design Challenge

Final Design Challenge: “A water ethic in Athens, GA”

Background:

In her recent book “Blue Revolution: Unmaking America’s Water Crisis”, Cynthia Barnett calls on America citizens to embrace a new ‘water ethic’. Similar to the ‘land ethic’ described by Aldo Leopold in 1949, Barnett argues that a water ethic is needed to help people see their connection to and responsibility for the natural world, in particular our water resources.

Your Team Task:

Your task is to produce two gallery exhibits designed to inspire a water ethic in the local Athens community. One exhibit should draw on the studio techniques, creative thinking skills, and other materials and subject areas we explore during the second part of the semester. This exhibit should involve a sophisticated use of media and a deep conceptual exploration. For the second, we ask you to plan and undertake an activity to inspire a water ethic in the local community. Your exhibit for this activity will entail an innovative documentation of your planning process and execution (e.g. using various media such as photographs and video). Both exhibits, as well as your poster from the Introductory Design Challenge, will be showcased at the end of semester at a public gallery opening.



Our Expectations

We expect you to engage thoughtfully in the task of inspiring a water ethic in Athens, GA. The level of conceptual exploration and creative output should surpass that of the Introductory Design Challenge. We expect that groups will participate in either a newly devised or existing water-based initiative in the local community. Here is your opportunity to bring thought into action. The manner in which the activity is documented should be both informative and innovative. The other exhibition is expected to push the artistic envelope through an advanced use of media and employ an insightful investigation of subject matter. While you are not required to submit a problem statement, we expect you to explore this challenge keeping in mind the ideas expressed in *Are Your Lights On?*.

We expect you to keep a clear record of your discussions in your visual journal (you can make sketches, drawings, bulleted lists, flowcharts, etc). Make sure that an outsider can understand your record.

Your Deliverables

- Two gallery exhibits - one documenting your group’s community action and one work of art.
- A one-page information document describing *each* of your gallery exhibits (to be displayed with your exhibits; in other words, two gallery statements).
- Visual journal documentation of the creative design process.

Due Date: November 28, 2012