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Examining the Confluence of Literature and Mathematics through Art

Sofia Alavosius
University of Rhode Island, salavosius@my.uri.edu

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In the twenty-first century, there is a disparity in the perception of the humanities and sciences. A university student majoring in a scientific field not only receives recognition for his economically and socially valued choice to pursue science, but also his assumed intelligence. Contrarily, society deems a humanities student as wasting his time studying subjects that will not directly lead to much success outside of school. I am interested in societal views of the humanities and sciences. Thus, this paper will attempt to demystify the relationship of literature and mathematics to produce a clearer, less biased view of the fields. In order to do so, it is important to look at this disciplinary relationship both today and in the past.

Stereotypical perceptions of the sciences and humanities are not uncommon and may influence how the study of specific areas are valued or devalued. These stereotypes further the disparity between the humanities and sciences. This is evidenced by some recent proposals to adjust tuition at state universities according to field of study.

Florida Governor Rick Scott is currently proposing to lower tuition at state universities for students who enter science, technology, engineering, and mathematics related majors, commonly referred to as STEM fields. A recent study at the University of Michigan (2012) about raising tuition and enrollment in majors revealed that an increase in tuition results in a decrease in enrollment (tuition.io). A prime example of this correlation is University of Texas at Austin's 9% increase in tuition for engineering students, which led to a decrease in enrollment to the engineering program (tuition.io). Data are not currently available to determine what happens to enrollment choices when tuition is reduced for specific majors. Nevertheless, Florida Governor

Scott has proposed lowering tuition to increase enrollment in certain programs. Florida is the first state to propose lower tuition for STEM students to entice more students to join STEM fields because the governor believes Florida, and the United States in general, is lacking in such "critical skills" (tuition.io). A recent petition quotes Scott's classification of the STEM fields as "high risk, high demand, [and earning] high wages" (tuition.io). This implies that non-STEM fields, in other words, the humanities, are not high risk or high demand, and do not produce high wages, further implying that the humanities are not valued as much as the sciences. Governor Scott was actually quoted saying "we don't need a lot more anthropologists in the state…we don't need them here" (alligator.org). His derogatory statement was supported when, soon after, Florida State University stopped admitting new anthropology students (alligator.org). This shows not only a depreciation of a humanities field by a STEM supporter, but also the possible outcomes. Although this has led to outrage by many in the humanities, Governor Rick Perry is following Scott's precedent and proposing the same tuition cut for STEM in Texas (cnn.com).

The notion that humanities students are wasting their time might originate from concerns about job readiness and employability of non-STEM students. In 2013, The Wall Street Journal published statistics indicating that STEM fields have a 5% unemployment rate, while non-STEM fields are at 11%. Although Governor Scott and Governor Perry claim the unemployment rates in STEM fields are lower than those in the humanities, a study shows that it is not as "black and white" as they portray (cnn.com). For instance, communication majors have lower unemployment rates than mechanical engineers and computer science majors, while architecture has a 13.9% unemployment rate and English has a 9.2% rate (cnn.com). Nevertheless if employability is considered a benchmark of a successful education, then some areas of study will be perceived as more valuable than others.

Decreasing or freezing STEM tuition may result in a relative increase in humanities tuition. Humanities students will "receive a higher tuition rate to make up for the difference experienced by reducing STEM" tuition (alligator.org). As the study in Michigan showed, an increase in tuition correlates with a decrease in enrollment. With two states within the last few months proposing this change, it is reasonable to wonder how many more states will follow suit, and if they do, what will happen to humanities education in the United States. This may not only exacerbate the perceived disparity between the humanities and sciences, but would also be detrimental to the representation of humanities in our society.

This issue was addressed at a recent conference at the University of Rhode Island. During the 2013 Spring Humanities Festival, President David Dooley questions if we are living in a "STEM-centric world," warning any "country that turns [its] back on the liberal arts will be diminished" and less "globally competitive." National Endowment for the Humanities (NEH) chairman James Leach gave the keynote address in which he asserts that the STEM fields and the humanities should be "complementary and not competitive." Furthermore, he claims that neither the STEM areas nor the humanities can ignore the other. Similar to Dooley, he wonders whether we have entered into a job-centric world where society has come to believe STEM fields produce more job-ready students. Leach maintains theses are "misconceptions" or "myths," and that no one can run a business without a liberal arts background, or at least an understanding of history, and that history is taught through literature.

As James Leach postulated in his keynote address, "what better way is there to apply perspective of our times then to study the history of prior times." It is a similar idea that has defined the structure of this paper. I will attempt to deconstruct the perspectives of our modern society regarding the areas of the humanities and sciences, in particular, literature and

mathematics. In order to do so, I will first look at modern scholar C.P Snow's critique of the perceptions and classifications of the sciences and humanities. Next I will examine the relation of literature and mathematics during the Renaissance. Through close analyses of the works of major literary figures of the time, Sir Philip Sidney and Ben Jonson, and a major mathematical figure, John Dee, I will show that literature and mathematics during the Renaissance were not divided and opposing fields of study. Furthermore, to solidify my argument, I will use a piece of Renaissance artwork as an exemplar. The painting I will use as my case study is by well-known Renaissance painter Hans Holbein the Younger. He frequently depicts in his paintings a "tangible, real-seeming world, yet often there is more than meets the eye" (Rynck 164). In 1533 Holbein the Younger was commissioned to paint a portrait of two French ambassadors. The final result is his painting *The Ambassadors*, which includes many aspects from both the humanities and the sciences.

To begin an examination of the relationship of literature and mathematics, let's refer to an important recent statement on the topic. Twentieth century novelist and scientist C. P. Snow identified the divide between the sciences and the humanities as a division of "two cultures." In his 1959 lecture, *The Two Cultures and The Scientific Revolution,* Snow defines the "two cultures" as the divide between two groups, the scientists and the writers. He continues to assert that these two cultures are "comparable in intelligence, identical in race, not grossly different in social origin, earning about the same incomes, who [have] ceased to communicate at all, who in intellectual, and moral and psychological climate [have] so little in common" (2). He named these two cultures the literary intellectuals and the scientists, and argues that between them is a "gulf of incomprehension" (4). Interestingly, Snow does not define any other culture. Thus it is inferred that he thinks the whole of academia is separated into only these two cultures. However,

there seems to exist a visual, and perhaps auditory, culture, not only in our society, but in all societies. Although Snow's classification is important to the scientific versus literary debate, it does not appear to recognize that not all areas of study are scientific or literary.

The decision to call these groups cultures stems from Snow's observation that when in similar situations, the non-scientists, without thinking, respond like other non-scientists; and similarly, scientists respond like other scientists. Snow claims this is the definition of a culture; hence, the non-scientists and scientists form separate and distinct cultures. However, this definition of "culture" did not come about until the late nineteenth century (oed.com). So this classification of the sciences and non-sciences as cultures can only accurately be applied to the nineteenth century to today. For societies of the eighteenth century and earlier, the word culture is derived from the word cultivation. "Cultivation" can mean the study of a subject and the development of the mind and manners through training or education (oed.com). Hence, by this definition, the sciences and non-sciences are each cultures, as they are the study of a specific subject to the extent of developing the mind and manners. However, such definitions do not include the idea of separated or distinct cultures that Snow calls to mind.

Snow develops his claim that the groups are cultures by arguing that the feelings of one culture become the "anti-feelings" of the other (12). This brings about the idea of the two cultures as being polar opposites. An example of the pole-like qualities of the cultures, according to Snow, is what fuels them. The literary culture, according to Snow, is always backwards looking. It continually references and reveres the past, whereas scientific culture "has the future in [its] bones" (11). Snow may not be accurate in this assumption. Are the cultures fully distinct, to the point that they are polar opposite? In fact, history shows us they are not, as we will soon see. Furthermore, today we have to wonder if the cultures are actually opposites, or if our society

just wants them to be. The two cultures exist both today and in our relative past and by using Snow's discourse of the two cultures, the relationship and reciprocal influence of the cultures of English literature and mathematics can begin to unfold.

In his examination of the divide, Snow draws upon the perceptions of each culture to the other. He claims that although both cultures are part of intellectual life, the literary intellectuals have taken to calling themselves "intellectuals," indicating they believe they are the only real intellectuals, and no other group can thus be called so (4). Furthermore, the literary culture tends to think that the scientific culture is comprised of brash and boastful people who are shallowly optimistic. Finally, the non-scientists think the scientists are "unaware of man's condition" (5). The choice to use "optimism" is at first puzzling, but Snow explains that the optimism of scientists resides in the fact that they are "impatient to see if something can be done" (6), but that most go beyond mere impatience. Most scientists think that something can be done until proven otherwise. Another example of their optimism is Snow's belief that scientists are forward looking, whereas non-scientists are backwards looking, and it is more optimistic to look towards the future.

Like literary culture, scientific culture has preconceptions about non-scientists. Scientific culture thinks that the self-proclaimed real intellectuals are actually anti-intellectuals who restrict "art and thought to the existential moment" (6). The scientists also claim that the non-scientists are unconcerned with man in general, as well as lack foresight because of their backwards-thinking inclination (5). Although Snow seems biased towards the sciences as revealed in his belief that all people need to have the optimism that he claims only scientists have, he still thinks that the mutual misinterpretations of the cultures are very dangerous. However, Snow has his own views of both cultures, which are perhaps less misguided since he is of both cultures. He

claims that the scientist is less religious, poorer, and more liberal in his ideas than the literary culture (10-11). This implies that the literary culture is more religious, richer, and more conservative than the scientist. He also recognizes that the scientists use senses of words not recognized by the literary culture (13), furthering the divide between the two. Since Snow is looking at the two cultures within England, the country's universal language is English. Hence, it furthers the cultural divide if the English-speaking scientists use words differently than the English-speaking literary intellectuals because within the same language the cultures cannot communicate. It is interesting that these are the classifications Snow saw in the late 1950s because in the twenty-first century, not all of the classifications would still hold for the same culture.

The literary culture tends to change more slowly than the scientific culture, a fact Snow attributes to the longer "misguided periods" of literature (9). This is an interesting opinion. First and foremost, this is just an opinion. Snow does not define what he classifies as misguided periods. Today we tend to classify the scientific culture as more objective than the literary culture, where objectivity is defined as not being influenced by personal feelings or interpretations, but rather being based in facts (oed.com). According to Snow, the scientific and non-scientific cultures are polar opposites. This then implies that the literary and scientific cultures cannot be both subjective and objective as they would no longer be opposites. In keeping with Snow's polar argument, if the scientific culture is objective then the literary culture is subjective, or rather based on interpretations. Objectivity implies there can exist a right or a wrong answer, as facts are either correct or incorrect, whereas subjectivity blurs these lines because it is personal interpretation. By such reasoning, it would make sense that the literary culture cannot have "misguided periods" since they cannot actually be wrong. However, we

know from history that for almost fifteen hundred years it was a common belief that the Earth was the center of the universe until Copernicus suggested otherwise. By Snow's reasoning this could be an example of a "misguided period." Thus, this is another example of Snow's bias towards the sciences. Nevertheless, Snow exists in both cultures and still asserts that the division of the cultures is a "problem of the entire West" (3) and should be remedied because if the two cultures continue to grow apart, no society that contains them will be able to think with wisdom (53).

In the twenty-first century, Howard Machitello examines the cultures of literature and science in his book *The Machine in the Text: Science and Literature in the Age of Shakespeare and Galileo*. Like Snow, Machitello notes the separation between the two cultures and maintains that the "separation is entirely artificial" (29). Thus Machitello is saying that the separation is not natural, but rather forced by man's unwillingness to allow a bridge between the two cultures. To support his claim of artificiality, Machitello recalls how the literary and scientific cultures of an era are "socially and culturally embedded" in that era (32). He speaks specifically of the early modern period; however, the same holds true for any period. Hence, the debate, and even the division of the cultures itself may be changing depending on the time period, but always in existence in some form. It is the specific society that modifies how the literary and scientific cultures are separated and perceived. Moreover, he notes the relation of how the "literary is always scientific and the scientific, by its nature, is literary" (50). Thus, the scientific and literary cultures cannot be fully separated as some societies over time have tried to do.

In addition, Machitello directly responds to Snow's *Two Cultures*. Machitello questions the "enduring nature" of the two cultures debate (197). As a twenty-first century author, he notices how the two cultures debate "remain[s] pertinent, even fifty years beyond Snow's

Cambridge lecture" (197). He wonders if the cultures are as opposite and polar as Snow claimed in 1959. However, Machitello chooses to not answer his own questions about the enduring quality of the debate, and instead focuses on whether this two culture debate is a modern rendition of the centuries-old nature-versus-art debate.

Now that we have examined the nature of the two cultures debate in our current society, we need to go back in history to examine if the same cultural divide existed then, for as NEH chairman James Leach stated, we cannot understand or critique our societal perspectives without looking to the past. The distinction of the humanities and sciences was also present during the Renaissance. The Renaissance was a period of flux; not only were the conventional ideas of the time uprooted, but also what was taught and how it was taught and regarded changed. These changes appear in the artwork and literary and mathematical texts of the period. The relationship between literature and mathematics can be excavated through close interpretation of textual details. In this regard, I will show that the division and opposition we see today between literature and mathematics was not as evident during the Renaissance.

In order to adequately and appropriately examine the two cultures in the Renaissance, some important terms will need redefinition. For twenty-first century readers of the Renaissance, modern definitions and connotations of words may lead to invalid assumptions because the meanings of many words have changed over time or new meanings have emerged. Sometimes this change is great, and other times it is insignificant. There are some important terms that will be used frequently in this paper that will have differing definitions depending on their application to different historical periods. Although the modern reader may not be able to ignore the modern definitions or connotations, it will be important to keep in mind the older uses of the words.

A prime example of this discrepancy in definitions is the use of "English" in the twenty-first century. In the dictionary, "English" yields results such as characteristic of England, pertaining to, spoken, or written in the English language, or the people of England. However, "English" is also the term given to a field of study. As a discipline at universities, "English" has come to stand for the field of literature, even literature that is not from England. However, this use of "English" as a discipline only began in the nineteenth century (oed.com). Thus, disciplinary English must be redefined to fit with the discourse of the Renaissance.

The term literature as a discipline is more appropriate to the Renaissance than the term English. "Literature" can mean any form of printed material as well as any literary work or production. Furthermore, a literary culture is one that is appreciative of letters and books. "Literature" can also mean humane or polite learning (oed.com); in other words, texts dealing with humanity and civility or resulting in the civility of the reader. Interestingly, "learning" is another entry for "literature" in the dictionary (oed.com). Thus, English literature denotes the field of literature that originates in England or is written in the English language. It is important to note that literature encompasses English literature. Hence, in this paper, "literature" is the term used to describe one side of the two cultures.

The other culture, as Snow defined, is science. "Science" is the "systematic knowledge of the physical or material world gained through observation and experimentation" (dictionary.com). Hence, there are clear parallels between "science" and "learning" since "learning" is knowledge acquired by systematic study. In the twenty-first century, "science" is typically thought of as empirical sciences: biology, chemistry, physics. However, during the Renaissance, the term science did not represent such areas. In fact, "science" was considered to

be “various kinds of knowledge,” stemming from the Latin root, “scientia,” meaning knowledge (oed.com).

During the Renaissance, the seven liberal arts—alternatively the seven sciences—were divided into two groups: the trivium and quadrivium. The “trivium” is the “lower division of the seven liberal arts, comprising grammar, rhetoric, and logic” (oed.com). The remaining four are called the “quadrivium,” the “four mathematical sciences, arithmetic, geometry, astronomy, and music” taught in “European schools and universities” (oed.com). The classifications suggest that the quadrivium is more quantitative whereas the trivium is more aligned with language. Furthermore, the use of “lower” in the definition of the trivium is misleading. To a modern reader this implies a hierarchy among the seven liberal arts. In turn implying the quadrivium is valued more than the trivium. However, this is an incorrect modern reading. The “lower” in the definition is explained by the fact that the trivium is “more elementary” than the quadrivium (oed.com). In other words, the trivium was taught first in schools and universities, and the quadrivium taught after.

During the Renaissance “mathematics” was considered to be the “disciplines of the quadrivium collectively” which were “linked by a concern with number or magnitude, arithmetic dealing with magnitudes as such, geometry with immovable magnitudes, astronomy with magnitudes in motion, and music with the relations of different magnitudes to one another” (oed.com). Although the mathematics of the Renaissance and today are similar, during the Renaissance the field of calculus had yet to be developed. Nevertheless, mathematics such as algebra and geometry did exist. Furthermore, it is clear that mathematics is aligned with scientific culture and credited for its level of exactness, precision, and certainty. Oftentimes, if something is described as mathematical it is not only numerical or geometrical, but also exact

and accurate. For the duration of the paper, "mathematics" will be used to describe the culture opposing the literary culture.

A major figure of the mathematical culture during the Renaissance is English mathematician, philosopher, and occultist John Dee. In 1570, John Dee wrote "The Mathematical Preface" to Euclid's *The Elements*. Dee claims that all things in the universe are in one of three categories: "Supernaturall, Naturall, or, of a third being," the mathematical (sig. ☞.iiij v). He classifies the supernatural as immaterial, simple, indivisible, incorruptible, and unchangeable. He defines natural things to be the opposite: material, compounded, divisible, corruptible, and changeable. Lastly, according to Dee, "*Thynges Mathematicall* [are] betwene thinges supernaturall and naturall" (sig. ☞.iiij v). Thus, *Thynges Mathematicall* are not as "absolute and excellent" as the supernatural, nor as "base and grosse" as the natural (sig. ☞.iiij v). Instead, mathematics is immaterial but able to be denoted by the material.

The purpose of the "Preface" is to present a "frutefull *Mathematicall Tree*" of the "strange Artes" and explain why and how each is part of the "*Artes Mathematicall*" (sig. ☞.iiij v). For instance, Dee discusses "Arithmetike" and "Geometrie," as well as "Musike," "Astrologie," and "Architecture," to name a few. Although Dee devotes the majority of his "Preface" to the areas that can be classified as mathematics, he also addresses, although briefly, the arts unrelated to mathematics. He says that there are "Many other artes…which beautifie the minde of man: but of all other none do more garnishe & beautifie it, then those artes which are called *Mathematicall*" (sig. ☞.iiij r). Beauty is a quality that gives pleasure to the senses, or "which charms the intellectual or moral faculties, through inherent grace, or fitness to a desired end" (oed.com). Hence, Dee suggests that knowledge or competence of other arts leads to moral ends, but that mathematics is the best and most adept way for man to do so.

To stress the importance of numbers, and by extension the *Artes Mathematicall*, Dee refers to philosopher Boethius' claim that all "thinges [are] Formed by the reason of Numbers" because that was how God created the universe (sig. *.i r). This creates an interesting relation because God used numbers to create the universe, and in particular man, and then man uses numbers within the universe. To further the relation between mathematics and God, Dee asserts that arithmetic, "next to *Theologie*... is most diuine, most pure, most ample and generall, most profounde, most subtile, most commodious and most necessary" of all the Sciences (sig. a.j v). Theology is the study of God and divinity. Hence, Dee is saying that mathematics is closely related to theology, implying that mathematics is also a way to study God and divinity. He also separates mathematics from the other sciences when he claims that it is the best way, besides theology, to study God and divinity. Thus, there exists a relation between the mathematician and God and between mathematics and God, implying mathematics is a godly art. Besides stressing the importance of this field, the connection between mathematics and God seems to suggest Dee thinks mathematics heightens the mathematician to a level of divinity and purity that a non-mathematician cannot reach.

Kenneth Knoespel is a modern scholar who looks at the conventional idea of the separation between mathematics of the scientific culture and language in general. In 1987, he wrote the essay, "The Narrative Matter of Mathematics: John Dee's Preface to the Elements of Euclid of Megara (1570)" dealing with the relationship between mathematics and language. In particular, Knoespel uses John Dee's "Mathematical Preface" to Euclid's *The Elements* to emphasize how related the two actually are and in fact how they cannot be separated.

Knoespel claims the "Preface" is a defense of mathematics. The author places modern perceptions of language and mathematics against what can be extracted from the "Preface." In

fact, an advantage of Dee's "Preface" is how it "alerts [readers] to [their] modern assumptions by challenging [them] to think of mathematics from a different vantage point" (30). An example of such a challenge is how modern readers "tend to define mathematics as a symbol system separated from discursive language" (30). In other words, today we think of mathematics as a language of symbols, as almost its own language with its own characters. However, during the Renaissance a set mathematical language had yet to be determined, thus mathematicians relied heavily on "ordinary language"(29) and not on the symbolic representations used today. In particular, mathematics of the time functioned as a narrative form since most problems were actually word problems. Due to this, mathematics and language cannot be separated because the language is the only mode to convey the mathematics of the Renaissance. Furthermore, the narrative helps determine how mathematics is applied to the world. For example, the perception of shapes is based on the descriptions of the shapes defined with language. Hence, interpretation permeates the application of mathematics and thus the application of mathematics is, in a sense, language.

Dee places emphasis on proportional analysis, which not only has to do with mathematics, but also art and literature. Since poetry relies heavily on the right proportion of meter, rhythm, and beat, it clearly incorporates proportional analysis. Knoespel also refers to sixteenth century writer George Puttenham, who noted "harmony could be sought in the skill which brought language and mathematics closest together—prosody" (32). Furthermore, Dee frames his problems in the "Preface" as proportional relationships. His problems do not take the form of formulas, which we would expect today, but of word problems dealing with proportion. Knoespel points out that Dee presents all such problems, scattered throughout the "Preface," without any intention to solve them (34). Proportional analysis, according to Dee, "discovers the

secrets of God's creation" (39). The belief is that proportional analysis connects nature and God because God used numbers to create the universe, then man measures the universe with numbers. It was also a common belief of mathematicians that a "language composed of numbers not letters…reveals the divine structure of the universe" (39). In turn, this brings about the commonality of the assumption that in order for mathematics to have a "privileged epistemological status" (41) language must seem "more imperfect" (41).

Knoespel's argument on the inability to separate mathematics and language is very important to the discussion of the two cultures. However, Knoespel points out how the scientific culture, which he takes to be the mathematical culture, regards language as a less perfect realm of communication. In addition, he notes that mathematics and language challenge one another for their claims "of exacting knowledge" (27). One of Knoespel's most important contributions is that he can bring to light the perspectives of a mathematician during the Renaissance and compare them with modern perspectives.

Through his examination of linguistic discourse, which he calls ordinary language, and mathematical discourse, which he calls artificial language, Knoespel proves that mathematics and language cannot be separated, not in the Renaissance, and not today. Knoespel's choice to use "artificial" and "ordinary" is interesting. Since he is applying these words to both mathematics and language in the Renaissance and today, let's look at what "artificial" and "ordinary" mean for both periods.

The definitions of "artificial" and "ordinary" are similar during the Renaissance and the twenty-first century. During the Renaissance, if something is "ordinary" then it conforms to the normal order of things (oed.com). "Artificial," on the other hand, is opposed to natural, in other words, man made, and especially with the goal to imitate something natural (oed.com).

Additionally, "artificial" could mean "of or relating to art or science" (oed.com). Thus Knoespel is claiming that linguistic discourse is normal, but mathematical discourse is man made, an imitation, or relating to art and science. We saw from the definitions of "art" and "science" that both mathematics and literature are forms of art and science. Thus mathematics can indeed be an artificial language by this definition.

Today we think of "ordinary" as common or usual, and "artificial" as man made or fake. Thus, for linguistic discourse to be ordinary implies that it is common and usual and for the mathematical discourse to be artificial implies it is fake. This classification of mathematical discourse is only really applicable to the modern day if we consider the mathematical language as the created language of symbols. However, even here we cannot ignore the fact that the symbolic language evolved from the narrative of mathematics, which is language. This progression refutes mathematics' artificiality and seems to imply mathematical discourse is ordinary because it is a natural progression from language. However, Knoespel's classification of linguistic discourse as ordinary is more complicated. For example if he is looking at the linguistic discourse within the English language, then the writings and spoken language are all of the same tongue, and thus could be seen as ordinary. However, there exist many different languages, so how could all languages be common and usual.

Knoespel's binaries may not be fully accurate. Perhaps there should not be a distinction at all. Languages can be viewed as human constructs because language has evolved in varying environments and adapted to various communications. Thus language is man made, and so it is artificial. As all languages are artificial to some degree, and as the mathematical discourse began from the linguistic, we see that both linguistic and mathematical discourses are artificial. However, pretentious, feigned, and fictitious are all synonyms for "artificial," both in the

Renaissance and today (oed.com). Such negative connotations are hard to accept as modifying language, either linguistic or mathematical.

Similar to Dee's defense of mathematics, in 1579 Philip Sidney wrote *An Apology for Poetry or The Defence of Poesy*. Posthumously published in 1595, his work is believed to be the first work of literary criticism in English. Thus, Sidney is not only part of the literary culture, but an advocate for the respect for and importance of the culture. Sidney provides a poet's perspective on art, literature, and learning. The reason for Sidney's defense was a growing antipathy to poetry. Sidney wanted to defend poetry's nobility, as he believed it led people to virtuous actions. His literary criticism is important because it defends poesy, a term he defines to mean all literary forms. Poesy, he claims, is the "imitation of art" (101). In addition, he continually emphasizes the power of learning. Sidney thinks that the purpose of learning is to "[teach] and [move] to virtue [and that] none can teach and move thereto so much as poetry" (123). It is interesting that the literary culture, as evidenced in Sidney's defense, believes that poetry is the most direct way to virtue while the scientific, specifically the mathematical culture, as seen in Dee's defense, believes that numbers are the most direct route to divinity. Virtue is moral excellence, goodness, or righteousness. It can also be the "power inherent in a supernatural or divine being" (oed.com). On a similar note, divinity is the quality of being divine. In particular it means to have "divine attributes, ranking below God but above humans" (dictionary.com). Thus, clearly both divinity and virtue are attributes ascribed to people to raise them closer to God. If both the literary and the mathematical heighten the status of man, then by Sidney's logic, both are important and noble.

In his defense Sidney presents the complaints against poetry. His society was under the impression that poetry was a waste of time, the "mother of lies," (123) and the "nurse of abuse"

(123). Furthermore, they thought that since Plato banished it from his imaginary republic, it must be bad. Sidney's method is exact. He presents the above arguments and then provides a counter for each. He claims that the purpose of learning is to achieve virtue and that poetry is the best way to learn, thus it is not a waste of time. He then addresses the attack that poetry is untruthful by asserting poetry does not claim to be truth, so it cannot present a lie, unlike history and philosophy. He claims that the poets are the "least liars" (123), enforcing his claim of poetry's veracity, as well as affirming that he, as a poet, is truthful in his accounts. According to Sidney, poetry should not be blamed for the abuses wrought upon it by bad poets. Finally he argues that Plato banished the abuse but not the thing, thus honoring poetry by showing he recognizes its power.

Sidney also addresses other modes of learning besides poetry. He claims that different "inclinations of man" bring men to their respective fields (104). He describes the reasons one would choose to study astronomy, philosophy, music, and finally mathematics. According to Sidney, it is the "certainty of demonstration" that entices people to mathematics (104). In this section of the defense, Sidney respectfully addresses each subject and those who are drawn to them. Finally, he categorizes astronomy, philosophy, music, and mathematics as "serving sciences, which, as they have each a private end in themselves" they are all "directed to the highest end of the mistress-knowledge" (104). In other words, the purpose of the serving sciences is not only to gain knowledge, but to reach an "end of well-doing" also (104). Thus, when Sidney says that the reason for learning is to reach virtue, and that poetry is the best way to learn, he is not saying that the other areas are not capable of such virtuous ends. Sidney shows his bias for poesy here; although he can recognize that the other areas lead to virtuous actions as well, he still asserts that it is poetry that does it best.

Sidney employs religion to help show the reader that poetry is the best way to reach virtue. Most of the Bible and many philosophical writings are written in verse. He claims that this shows the virtuous and noble nature of poetry. He also argues that poets "draw the mind more effectually than any other art doth" (115), implying that poetry can bring the best and most out of anyone who comes into contact with it. However, besides his biases, his choice of words makes it difficult to separate his literary culture from other cultures. Both Sidney and Dee make the claim that during the Renaissance, the belief was that a language revealed the divinity in the universe. However, Sidney claims this language is literature, and Dee claims the language is mathematics. Thus, from Sidney's defense, it appears that literature is a very important, and actually virtuous culture, but it cannot be seen as more important or more virtuous than its opposing culture. As both cultures have made claims to the same level of divinity, the only conclusion that can be made is that the two cultures are at least equal in their level virtue and significance.

Ben Jonson was also a member of the literary culture. Published posthumously in 1641, *Timber: Or Discoveries* is a collection of Jonson's experiences throughout his life. He presents a coherent mix of his thoughts on topics as varying as fortune, art, nationalism, opinion, and speech. Similar to Sidney, Jonson gives emphasis to learning, and not just to literary learning.

Jonson noticed society's condescension to his craft. Jonson recalls how a man is "upbraidingly called a poet as if it were a most contemptible nickname" (383). From this utterance, the reader sees that society does not value poetry, or the literary culture. Jonson seems distressed by the societal opinion and calls for the redemption of art (378), which would include not only poetry, but also the entire literary culture. Throughout *Timber*, he gives emphasis to art. Art is the "skill of doing something… as the result of knowledge or practice" (oed.com).

Furthermore, especially during the Renaissance, art meant knowledge, learning or "the seven subjects of the trivium and quadrivium considered collectively" (oed.com). Although the modern reader will initially think Jonson is discussing artwork, such as painting or sculptures, it is important to remember art can mean more than just artwork. Thus, when Jonson discusses the need to redeem art, he is not just talking about artwork. Instead his claims suggest he sees a need to redeem knowledge and learning. As he does not specify the type of knowledge, it can be inferred that he means all modes of learning. Thus, Jonson's desire to redeem art can be extended not only to artwork, but also to literature, mathematics, and other areas of study. Furthermore, Jonson uses terms such as eloquence, elegance, and wisdom, which apply to mathematics, literature, and artwork.

Jonson also discusses science. This is a point where the modern reader needs to remember to set aside their modern definitions, and apply the appropriate definition for the time period. When Jonson talks about science, he undoubtedly means knowledge. Thus, when Jonson says, "science is not every man's mistress" (380) he does not mean the field of science is not for everyone. Instead he means that not everyone is knowledgeable or scholarly. He also promotes the idea of "science mixed" (385) to mean the inclusion of more areas of knowledge available to people. So, although he is biased towards literary culture, this statement seems to promote all areas of both cultures. Furthermore, he spends some time discussing wisdom. Note that wisdom is knowledge of what is right or wrong. Thus, clearly wisdom is aligned with virtue. Jonson discusses how "wisdom without honesty is mere craft" (377), essentially saying that without honesty, wisdom is very little. So again there exists the idea that the end result of learning is to become honest, wise, and virtuous. Both Jonson and Sidney think that the way to reach such an

end is through the literary culture. But again, as with Sidney, this cannot be placed above the mathematical culture since both assert the exact same claims.

The concepts of analysis and synthesis are common to literary writing, rhetoric, and mathematics, and thus can bridge the division between literature and mathematics. Analysis is "a detailed examination" to determine something's "nature, structure, or essential features. Also: the result of this process" (oed.com). Analysis is often used in opposition to synthesis. Synthesis is "the combination of immaterial or abstract things, or of elements into an ideal or abstract whole" (oed.com). So, essentially, analysis is the break down of complex matters while synthesis is the combination of parts to create a complex whole. In Sidney's work the synthesis is in the creation of virtue by learning through poetry because he combines the elements of learning and poetry to reach the complex outcome of virtue. He also analyzes the function and the importance of poetry to society. In Jonson's *Timber*, analysis exists in the nature of his work as an examination and break down of varying topics encountered in a lifetime. Finally, Dee incorporates synthesis much like Sidney does: to combine elements of learning and the mathematical arts to achieve divinity. Furthermore, Dee analyzes varying areas to determine their mathematical quality. With all three authors, from both the mathematical and literary culture, the world around them is continually synthesized and analyzed in similar ways. Hence, the concepts of analysis and synthesis help to show that it is difficult to make a clear separation of the literary and mathematical cultures.

Sidney, Jonson, and Dee all agree that the reason for learning is to reach virtue or divinity. However, Sidney and Jonson believe that it is through literature that such virtuous ends are achieved; whereas, Dee believes mathematics reaches virtuous ends better than any other area. Thus, there does not seem to be a clear division between the literary and mathematical cultures because their goal is the same. Furthermore, the fact that each culture thinks they have

found the best way to virtue does not mean they think it is impossible for the other culture to reach such ends as well. In fact, Sidney, Jonson, and Dee all recognize that virtue is obtained, to some level, from learning and knowledge of all areas. Thus, there is not a clear division here. It would appear that during the Renaissance the two culture relationship is best described as a competition. The cultures both want and can achieve the same thing. Hence, the divide between the cultures is actually just an argument or competition about what is the best way to moral ends.

The examination of major works of the literary and mathematical cultures of the Renaissance has yielded a conclusion that the two cultures are not separated as we see them today. In fact, it appears that literature and mathematics are very closely related. At this point I would like to turn to a piece from the visual culture of the Renaissance, Holbein's *The Ambassadors*, to complement and solidify the above arguments. (View *The Ambassadors* on page 32 of this paper.)

Hans Holbein the Younger was a German painter who is commended for the realism he depicts in his paintings. In 1533 Holbein moved to England and stayed until his death in 1543. Most of Holbein's time in England was spent painting "court personalities" and by 1537 he had officially entered the service of King Henry VIII. In the last ten years of his life, Holbein produced "approximately 150 portraits, life-size and miniature, of royalty and nobility alike" (Britannica.com).

In 1533, Holbein was commissioned to do a portrait of French ambassador to England Jean de Dinteville and French Bishop Georges de Selve (Rynck 164). The painting depicts the men standing on either side of a table with many "objects scattered with careful casualness on the table" (Greenblatt 17). The objects include books, dials, a lute, and a case of flutes. These objects represent the "mastery of the Quadrivium… while a mastery of the Trivium…is implied

by the very profession of the two figures" (17). Holbein has managed to include all of the seven liberal arts—Music, Arithmetic, Geometry, Astronomy, Grammar, Logic, and Rhetoric—in one painting. Thus, *The Ambassadors* incorporates aspects from both the literary and mathematical cultures.

A close reading of the painting can give insight into where and how the two cultures are represented in the painting. Elly Dekker and Kristen Lippincott analyze the scientific instruments depicted in the painting. Their paper from 1999, "The Scientific Instruments in Holbein's Ambassadors: A Re-Examination," is an examination undertaken during the restoration of the Holbein's *The Ambassadors* into the torquetum, globes, and dials represented in the painting. The article deals with the inaccuracies in the construction of the scientific instruments as well as with the irregularities in the date and times they indicate.

The authors describe the function of each instrument as well as the popular beliefs about what they symbolize. For example, the pillar dial shows a shadow that "defies the laws of optics" (108). The horary dial is set aside and resting on its wrong side, implying it was not meant to tell a time or date and the polyhedral dial is telling time in equal hours, but as the gnomon is perpendicular, not parallel, the dial cannot be telling time. Finally, the equinoctial dial is composed of two parts, but Holbein draws it as unassembled (109). This would imply that this dial is not intended to tell a date or time since it is not in a functioning form. However, it is interesting that Holbein has used this same dial in another painting, also disassembled (110). This sparks ideas about whether Holbein knew how the dial worked. Thus, the dials give no conclusive results on the date and time of the painting, but they do give insight into the type of scientific time-tellers used during the Renaissance and a small glimpse into Holbein's possible

understanding of them. Regardless, Holbein may have included the dials more for their symbolic potential than their technical uses.

The painting also depicts a torquetum, an astronomical instrument whose origin is a matter of debate. Holbein depicts the most basic form of the instrument (121). However, the authors assert that the use of the torquetum in the painting marked a step "forward in the history and dissemination of scientific learning during the Renaissance" (122). During this time, the torquetum was on the cutting edge of European scientific thought. In fact, all of the instruments, with the exception of the pillar dial were new, innovative, and expensive instruments of the time (123). Furthermore, Holbein is meticulous in his depiction of these instruments. Although the instruments do not provide any scientific readings, Dekker and Lippincott think that they tell a lot about what was known at the time, as well as the relationship between painter, patron, and society.

Through Dekker and Lippincott's analysis of the scientific instruments in *The Ambassadors*, we can see that many new, innovative, and expensive instruments were included. Furthermore, we see that Holbein may not have had a complete understanding of the instruments. We cannot know if Holbein purposefully depicted the instruments in the wrong way, or if he actually did not know how they operated. For the sake of argument, let's assume he did not know. This is important because he still chose to include them in his painting. Thus, there is evidence to claim that this shows a societal stereotype or bias. The men in the painting are rich, worldly, and noble men. Holbein has included objects that record the "highest hopes and achievements of their age" (Greenblatt 17), implying that the scientific objects heighten the status of the men. Hence, it is reasonable to assume their society deemed an understanding of

science as important, worldly, and noble, and so Holbein decided to include them in his painting, despite his lack of understanding of the objects.

Holbein also paints a lute with a broken string, rendering it unusable. This decision is clearly intentional unlike Holbein's inaccurate depiction of the dials. Although we may never know why Holbein decided to draw one of the strings broken, it allows for several readings. For example, Renaissance scholar Stephen Greenblatt argues in his book *Renaissance Self-Fashioning: From More to Shakespeare* (1980) that the broken string is an "emblematic play upon the very idea of discord" (18). However, the lute and its broken string yield many interesting readings in terms of the two cultures: literature and mathematics. Music was part of the quadrivium, so this is a place where Holbein clearly represents that portion of the liberal arts. If Holbein is sending a message via the string, perhaps he is saying there is something broken or flawed in the quadrivium. In his "Preface," Dee made a clear argument that "Musike is a Mathematicall Science" (sig. b.ij v). Thus, the representation of the lute seems to pay tribute to the mathematical culture. In addition, in a modern reading Snow claims that the scientific culture "doesn't contain much art, with the exception, an important exception, of music" (14). However, this is an unusual claim in a twenty-first century argument because music as an area of study is generally considered a fine art and not a science. Regardless, from both a Renaissance and modern vantage point, the lute is a symbol of the scientific, and in particular the mathematical culture. Holbein furthers and even complicates this by placing a hymnbook next to the lute with musical symbols easily recognizable on the page. The hymnbook is a symbol of divinity by the religious nature of the music. This ties into the divine and virtuous aims of literature and mathematics. Furthermore, although the book is not a book of prose or verse, it is still literature,

by the very definition of literature as any form of printed material. Hence the hymnbook is the confluence of both the literary and mathematical cultures in one small object.

Next to the lute there is a little book. It looks like a diary. The book could be paying homage to the trivium, in particular grammar and rhetoric. However, upon closer examination, it is revealed that the book is actually a German arithmetic book (Greenblatt 17). Arithmetic is included in the quadrivium, so this book is another place where Holbein incorporates part of the liberal arts. Furthermore, the book is "kept open by a square" (17). The square seems to be a geometrical instrument, furthering the book's relation to the quadrivium. Behind the book, somewhat hidden by the lute is a geometric compass, which also clearly relates to the quadrivium. The little book, a seemingly inconsequential artifact in the painting, actually acts to tie both the trivium and quadrivium together because at first glance the book is thought of as simply a book, in particular perhaps a book of grammar or literature, but in actuality it is arithmetic. Knoespel's argument that language and mathematics cannot be separated, particularly in the Renaissance, is represented in the small book as there is clearly prose and mathematical expressions visible on its pages. Finally, as grammar and rhetoric are part of the literary culture, and arithmetic and geometry are part of the mathematical culture, we see a confluence, or at least a momentary confusion, of the two in this small book.

In the top left corner is a half obscured crucifix. The crucifix is a symbol of religion, and by extension God. Thus the crucifix is also a symbol of divinity. However, it also symbolizes heaven and rebirth, which are achieved through virtue. The crucifix is placed above the ambassadors, implying that everlasting life is above them, something to aspire to, and perhaps within their reach. Hence, we see that the ambassadors are divine and virtuous because the afterlife is something they can achieve. Furthermore, as we already saw, Holbein incorporates

images and instruments from both the literary and mathematical cultures. The painting incorporates the literary culture, and by extension virtue, and the mathematical culture, and by extension divinity. Both are emphasized by the inclusion and placement of the crucifix. This helps further the reading of the men as divine and virtuous because the instruments represent their hopes and achievements. However, the crucifix is hidden, sometimes not even noticeable depending on how the painting is framed. Thus, it is a subtle claim to divinity and virtue, which contrasts with the outright claims made by the two cultures.

The Ambassadors is widely known for the anamorphic skull in the foreground. If the painting is viewed from the front, the viewer will only see a blurred image. This blurred image is actually a human skull, which can be clearly seen when viewed close up from the right. Many scholars have claimed the skull is a symbol of mortality (nationalgallery.org). The reading of mortality in the painting is furthered by the coffin-like lute case under the table. Regardless of the skull's symbolic meaning, it is an important image in the painting because it is an anamorphosis. An anamorphosis is a distorted image that when "viewed from a particular point, or by reflection from a suitable mirror, … appears regular and properly proportioned." In other words, it is a deformation (oed.com). To create an anamorphic image requires skill and understanding of geometry, proportion, and perspective. Thus, the inclusion of the anamorphosis, regardless of what is being depicted, shows not only Holbein's adept understanding of the skills needed to create the image, but also a representation in the painting of the areas of geometry, proportion, and perspective. Furthermore, the creation of the skull required great mathematical understanding, whereas the interpretation of the skull requires literary skill.

In *Renaissance Self-Fashioning: From More to Shakespeare*, Stephen Greenblatt also addresses the anamorphic skull, which he terms the "death's-head" (18). In his argument he

points out how the shadow of the skull is not drawn at the same angle as the rest of the images in the painting. The ambassadors, scientific instruments, and other objects are painted with the same shadow indicating they are clearly being represented in the same space. However, for the skull to have a contradictory shadow implies that it is not of the same space, world, or reality as everything else. Furthermore, in order to see the ambassadors, the subjects of the painting, the skull must be obscured. In order to see the skull clearly, the viewer must lose perspective of the ambassadors. This furthers the notion that the skull does not exist in the same reality as the rest of the painting.

One reality of the painting is that in which the ambassadors exist. This reality includes the trivium and quadrivium, represented by the various objects. Thus, if the skull does not exist in the reality of the painting, then it exists where the trivium and quadrivium do not. If the skull is taken to be a symbol or mortality, then perhaps the skull is saying that when we die we cease to learn. However, to return to the divine and virtuous aspects of both mathematics and literature, the placement of the skull below the ambassadors works in a similar way as the crucifix. The ambassadors and all the objects are below God, as symbolized by the crucifix, but above death and mortality, as symbolized by the skull. However, the skull is also a symbol of the temporality of physical death because the skull cannot be seen at all times. Thus the inclusion of the skull and crucifix as boundaries of the painting supports the idea that death is only temporary for those who are virtuous and divine. This, once again, supports the reading of the divinity within the painting, relating the painting to both the literary and mathematical cultures.

Through an examination of the skull, crucifix, lute, and books, it is clear that *The Ambassadors* incorporates aspects from both the literary and mathematical cultures. However, the painting also includes concepts such as eloquence, elegance, harmony, and decorum, all of

which are important concepts to literature and mathematics. For instance, "eloquence" is the "art of expressing thought with fluency, force, and appropriateness, so as to appeal to … reason" (oed.com). "Eloquence" is thus integral to mathematics, as mathematics requires skill in expressing oneself through reasonably and fluently constructed proofs. "Eloquence" can also mean rhetoric as rhetoric is the study of principles "followed by a speaker or writer striving for eloquence" (oed.com). Thus "eloquence" clearly relates to literature. "Elegance," on the other hand, means "tasteful correctness, harmonious simplicity, in the choice and arrangement of words," (oed.com). "Elegance" is thus important to language, which as we saw before was vital to both the literary and mathematical cultures. "Elegance" also pertains to the painting because Holbein tastefully chooses the images and objects included in the greater painting.

"Harmony" is the combination of parts, "so as to form a consistent and orderly whole" or an aesthetically pleasing effect (oed.com). A good poem or well-written prose will be melodious, and thus harmonious. Both literature and visual art are the combination of parts to form a pleasing whole. Mathematics is also harmonious as it is the piecing together of facts to reach an ordered conclusion. Finally, "decorum" is polite behavior, orderliness and in particular "in dramatic, literary, or artistic composition, that which is proper to… nature, unity, or harmony" (oed.com). Thus the painting is decorous as it unifies the two cultures. Likewise literature and mathematics are decorous because both are harmonious, striving to explain and emulate nature, and attempting to reach moral and virtuous behavior. Thus, the concepts of eloquence, elegance, harmony, and decorum are found within the literary, mathematical, and visual cultures of the Renaissance, demonstrated by the exemplar piece of artwork.

The Ambassadors as an example of the visual culture helps to solidify the relation between literature and mathematics. Using skills of the mathematical culture Holbein creates a

painting that requires the literary culture for interpretation. The artwork also helps to show that a separation of the two cultures was not evident during the Renaissance because important concepts are common to both cultures. As this piece of visual art incorporates qualities from both literature and mathematics, it clearly shows that both cultures are at least of equal importance and at some level inseparable, not only in the painting, but also in the contemporaneous society. Such an effect of the painting holds true for not only the Renaissance, but also today as we view the same image, with the same confluences of literature and mathematics.

Finally, examining the confluence of literature and mathematics through art results in the discovery of the cyclic pattern of the two cultures. The Renaissance had literary and mathematical cultures, though they were not opposed. Actually, the cultures were clearly related and perhaps inseparable. Although both cultures strived for the same results, that of virtue and divinity, each culture claimed it was the best way to get there. On the other hand, today we clearly have the same two cultures, but perhaps a depreciation of using literature and mathematics to reach virtue and divinity. Instead, today we seem more preoccupied with which culture has the best economic value. We also seem to be too preoccupied with the societal stereotypes to adequately investigate the cultural divide society creates.

When James Leach spoke at our university he mentioned history has a circular quality, and that in fact sometimes it even rewinds. He claims, “history may be the story of the dead but it continues to shape who we are, [and] how we think.” Perhaps our society needs to rewind in order to see the relation and confluence of the humanities and sciences. Snow noted in 1959 that the sciences and non sciences seemed to be less bridgeable among the generation’s youth than it was even thirty years prior (18-19). The youth of the 1950s have become the adults today who

have passed down their ideas to the new generation. Thus, this is a cyclic pattern of the cultural divide in just the past fifty years.

Literature and mathematics are both important disciplines and are in fact impossible to separate as our society has commonly done. Through C. P. Snow's text and the analysis of literature and mathematics with varying modes from the Renaissance, it is also apparent that each time period was concerned with, and wanted to change different aspects of the so-called cultural divide. Thus, naturally the assumption remains that in our near future, society will once again be, indeed already is, bothered by this division of cultures and may seek to remedy it. In order to produce a remedy, an understanding of our societal biases is essential and as James Leach said, the best way to do this is to turn to our history.

The Ambassadors, 1533
Hans Holbein the Younger

(nationalgallery.org)

Bibliography

Baxandall, Michael. *Painting and Experience in Fifteenth Century Italy*. Oxford: Clarendon Press, 1972.

Dee, John. "John Dee's Mathematical Preface to Euclid." *The Gutenberg Project*. Web. 23 April 2013. <www.gutenberg.org/files/22062/22062-h/main.html>.

Dekker, E., and K. Lippincott. "The Scientific Instruments in Holbein's Ambassadors: A Re-Examination." *Journal of the Warburg and Courtauld Institutes* 62 (1999): 93–125.

"Dictionary.com: Find the Meanings and Definitions of Words at Dictionary.com." *Dictionary.com: Find the Meanings and Definitions of Words at Dictionary.com*. Web. 1 April 2013. <http://dictionary.reference.com>.

Elkins, James. *The Domain of Images*. Ithaca: Cornell University Press, 1999.

"Governors, Stop Bashing Liberal Arts - CNN.com." *CNN.com - Breaking News, U.S., World, Weather, Entertainment & Video News*. Web. 27 April 2013. <http://www.cnn.com/2013/02/20/opinion/granderson-college-majors>.

Greenblatt, Stephen. *Renaissance Self-Fashioning: From More to Shakespeare*. Chicago: University of Chicago Press, 1980.

"Hans Holbein the Younger (German painter) -- Encyclopedia Britannica." *Encyclopedia Britannica*. Web. 26 April 2013. <http://www.britannica.com/EBchecked/topic/269121/Hans-Holbein-the-Younger>.

"Hans Holbein the Younger: The Ambassadors: The National Gallery, London." *The National Gallery, London: Western European Painting*. Web. 28 April 2013. <http://www.nationalgallery.org.uk/paintings/hans-holbein-the-younger-the-ambassadors>.

Jonson, Ben. “Timber: Or Discoveries.” In *The Complete Poems*, edited by George Parfitt, 373–458. London: Penguin, 1975.

Knoespel, Kenneth J. “The Narrative Matter of Mathematics: John Dee’s Preface to the Elements of Euclid of Megara (1570).” *Philological Quarterly* 66, no. 1 (1987): 27–46.

Lakoff, George, and Rafael E. Núñez. *Where Mathematics Comes From: How the Embodied Mind Brings Mathematics into Being*. n.p.: Basic Books, 2000.

Leach, James. "The Arts and Humanities in the New Economy." Spring Humanities Festival. University of Rhode Island. Lippitt Hall, Kingston. 8 April 2013. Keynote speech.

Marchitello, Howard. *The Machine in the Text: Science and Literature in the Age of Shakespeare and Galileo*. New York: Oxford University Press, 2011.

"Oxford English Dictionary." *Oxford English Dictionary*. Web. 1 April 2013. <http://www.oed.com.helin.uri.edu/>.

Rynck, Patrick de. *How to Read a Painting: Lessons From the Old Masters*. New York: Abrams, 2004.

Sidney, Philip. *An Apology for Poetry or The Defence of Poesy*. Edited by Geoffrey Shepherd. London: Nelson, 1965.

Snow, C. P.. *The Two Cultures and the Scientific Revolution*. New York: Cambridge University Press, 1959.

"STEM Majors May Receive Tuition Break - The Independent Florida Alligator." *The Independent Florida Alligator: We Inform. You Decide.*Web. 11 May 2013. <http://www.alligator.org/blogs/monday/gator_aider/article_27a54856-9511-11e2-bd84-001a4bcf887a.html>.

"Tuition Trend Alert: Would You Switch Majors to Cut College Costs?" *Tuition I.O* Web. 26

April 2013. <www.tuition.io/blog/2013/02/tuition-trend-alert-would-you-switch-majors-to-cut-college-costs/>.

Vasari, Giorgio. *The Lives of the Artists*. Oxford: Oxford University Press, 1991.