CHAPTER ONE

TRANSFER: LEARNING IN AND THROUGH THE ACADEMIC MUSEUM

Liliana Milkova and Steven S Volk
ACADEMIC ART MUSEUMS have been developing and using pedagogic approaches that support learning in the museum for many years. As with many teaching and learning practices, these have shifted from curator-centered lecturing to visitor-centered active learning techniques.\(^1\) Concern for how learning in the art museum can leverage learning outside of the museum (what we here refer to as learning through the museum) is a more recent consideration taken up by museum directors, curators, university teaching and learning centers, and individual faculty members. This process is referred to as “transfer,” how learning in one domain can be effectively applied to other domains.\(^2\) Transfer has been called “perhaps the fundamental educational question,” since as educators we are primarily concerned with our students’ success after they finish their formal schooling; success in school is only part of that process.\(^3\)

How do we know if transfer is occurring, if insights gained in the museum inform overall learning in the classroom? A search of the literature reveals that it is considerably difficult (and expensive) to design a research program capable of yielding statistically valid and reliable conclusions that can demonstrate a causal connection between museum visits (or other arts programs) and learning in other domains. And yet, as we will argue here, well-designed qualitative approaches can provide the “thick” contextual information needed to design museum-classroom collaborations that can best support learning in and through the museum.\(^4\)

In this chapter we will discuss the ongoing collaboration between the Allen Memorial Art Museum (AMAM or “Allen”) and the Center for Teaching Innovation and Excellence (CTIE) at Oberlin College, a partnership that has broadly expanded the use...
of the museum’s resources across the campus. We will explore two sets of faculty surveys and two case studies to examine how original art can help “anchor” specific learning dispositions, the importance of planning to scaffold the process of transfer, and, finally, how one biology professor used the museum to help increase his students’ critical thinking abilities.

The museum and Crossing the Street Pedagogy
Oberlin College is a liberal arts college (2,300 students) and Conservatory of Music (600 students) near Cleveland, Ohio. It attracts intellectually motivated undergraduates who share an interest in the arts, rigorous academic coursework, and a tradition of engagement with broader concerns. Oberlin’s teaching and scholarly mission is enhanced by the Allen Memorial Art Museum, founded in 1917 as a teaching museum, and recognized today as one of the leading academic art museums in the United States. The AMAM’s rich, encyclopedic holdings have long served as a vital educational and cultural resource for Oberlin’s students, faculty, and staff.

While the AMAM had often used its holdings in expansive ways, designating a museum staff member to provide faculty and students with greater access to the collections changed the culture and scope of the museum’s outreach, pedagogical role, and visibility on campus. Facilitating access to the collection for non-art faculty spurred wider and deeper interest in exploring art’s potential as a teaching tool in disciplines that would not normally bring their classes to an art museum. With guidance from the AMAM’s academic curator, Oberlin faculty moved beyond one-time, curator-led tours towards sustained engagement with artworks in multiple museum sessions that
are conceptualized, developed, and taught collaboratively by faculty and museum staff. The success of such an approach in sheer quantitative terms is evident in Table 1. The number of class visits doubled from 2009 to 2012-13, by which point nearly 6,000 students were coming to the Allen as part of a class visit. More significantly, at least one class (and often more than one) from over 85% of Oberlin’s academic departments and programs visited the museum in the spring 2014 semester. In other words, the museum, along with the library, has become a campus-wide learning center that serves the full range of the college’s curricular diversity.

Crossing the Street Pedagogy: surveying the faculty
In March 2010, the Allen’s academic curator (Milkova) and CTIE’s director (Volk) convened a workshop to discuss the learning theory and pedagogical approaches that informed class-based museum visits, asking what the faculty hoped to accomplish at the museum, how they prepared for the visits, and the extent to which museum visits were expected to align with overall student learning in their courses. Our discussions revealed that the visits served a variety of purposes, from visually supplementing course content to supporting broader learning objectives and methodologies. We know that original art can enchant, infuriate, challenge and confuse; over the course of our discussions, we came to appreciate how it also can be broadly employed to scaffold student learning. For such generative purposes to emerge, however, museum visits must be planned with these objectives in mind. We called the approach that emerged from these discussions, Crossing the Street Pedagogy (stressing the importance of visiting the Allen
### TABLE I: Class-related museum visits, Fall 2009–Spring 2014. The AMAM was closed for renovations between January 2010 and August 2011.

<table>
<thead>
<tr>
<th></th>
<th>STUDENT VISITORS</th>
<th>CLASS VISITS</th>
<th>FACULTY TEACHING WITH COLLECTIONS</th>
<th>DEPARTMENT OR PROGRAM VISITS (FALL/SPRING)</th>
<th>INDIVIDUAL COURSE VISITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall 2009</td>
<td>2145</td>
<td>147</td>
<td>37</td>
<td>24</td>
<td>37</td>
</tr>
<tr>
<td>2011-12</td>
<td>5142</td>
<td>379</td>
<td>91</td>
<td>19/23</td>
<td>118</td>
</tr>
<tr>
<td>2012-13</td>
<td>5817</td>
<td>437</td>
<td>109</td>
<td>21/20</td>
<td>134</td>
</tr>
<tr>
<td>2013-14</td>
<td>5257</td>
<td>357</td>
<td>131</td>
<td>33/38</td>
<td>175</td>
</tr>
</tbody>
</table>
from other locations on campus), and designed a three-stage process to leverage the rich cultural resources of the museum to impact learning across the campus.5

The first phase examined museum visits both from the perspective of visual learning strategies and broader learning theory, including the encouragement of “slow pedagogy” methodologies designed to spur deep reflection, the adaptation of a “middle ground” historical approach to frame student encounters with art,6 the displacement of faculty from their location as “experts” in the classroom to a less familiar “novice” standing in the museum, and a deliberate move to foreground the emotional engagement that can come from working with original objects.7

In the second stage, to uncover the faculty’s motivation for bringing their students to the museum and to understand better what learning occurred in the galleries, we designed a pre- and post-survey for each museum visit. We circulated the surveys to professors from non-art disciplines who had brought their classes to the AMAM at least once in the fall 2012 semester, a period in which the Allen hosted more than 180 curricular visits from 68 individual courses taught by 55 faculty. Forty-four of the faculty taught in departments other than art history and studio art; of those, 37 completed the questionnaires, an 84% return rate.8

Most faculty reported that the visits bolstered student learning and encouraged deeper engagement with the subject matter; many suggested that the museum activities helped their own thinking about the course. More than half found that students were able to relate the art they had seen to the course’s content. A high percentage said that the primary reason for their visit
was a desire to interact with original objects and explore their learning potential, and many others understood the relevance of the art to their subject or wanted to make students aware of the museum as an important campus resource. The quantitative data we collected testified to the faculty’s deep interest in teaching with original works of art, yet the qualitative narratives that accompanied the questionnaires helped us appreciate in a more nuanced fashion the type of learning that was occurring in the museum beyond the strictly art-historical. Using this data, we developed a plan for preparing and conducting museum class visits to stimulate broader learning objectives. In the first iteration, this included guidance for preparing the visits and for organizing student engagement once in the galleries.

1. Preparation
In the pre-visit surveys, faculty articulated their goals for student learning at the museum. Faculty suggested a wide variety of reasons for bringing their classes to the Allen, often moving beyond traditional art historical or art appreciation approaches to an astonishingly broad spectrum of possibilities. They wanted to introduce students to visual culture, aesthetics, and cultural representations; help them think about embodied perception; and give them practice reading visual texts. They also saw museum visits as an opportunity to encourage students to grapple with ambiguity, hone skills related to evidentiary reasoning, promote dialogue, and prepare for dealing with highly traumatic subjects.

Given the variety of goals that faculty set for their museum sessions and the diverse subjects that artworks can support, the surveys forcefully spoke to the need for clear communication
between instructors and the academic curator. Making the curator aware of why faculty bring their students to the museum and what they hope to accomplish in the galleries provides the basis for a rich conversation leading to the selection of the art objects that can best help a professor accomplish her goals as well as determining the most effective pedagogic approaches to engage students meaningfully with the chosen objects. Preparation can take different forms, depending on the goals for and structure of the visit. It may include explicit discussions (often supported with access to digital images) of what students will see during their visit, designated readings or activities to be referenced and problematized once in the museum, the opportunity to respond in writing to prompts from the faculty member or academic curator, a discussion of museum rules (what constitutes appropriate museum behavior), or any obstacles they might encounter (e.g., noise level, crowds). Not surprisingly, the surveys revealed that the better the preparation, the better the visit.

2. The museum visit
While the museum’s capacity to enhance student learning is enormous and may include a number of teaching strategies, here we will focus on three specific approaches that can be deployed to further course objectives within any subject or discipline.

*Slowing down: close looking and reading*
A significant number of Oberlin faculty from disciplines as varied as biology, English, history, and music theory brought their students to the museum with the intention of using
original art as a means of developing close reading and/or listening skills. Engagement with the objects was designed to help students look in a more deliberate manner and reflect on their feelings. One Hispanic Studies professor paired up the students and asked each to analyze the visual components of a particular print, specifically noticing “what their eyes were doing as they looked and to articulate their own emotional reaction to the work and the experience.” An English professor required her students to produce a formal analysis of an artwork in order to help them think more intentionally about close reading as a method of analyzing literary texts and how literary techniques have cognates in visual representation. Her goal was for students to discover “specific ways a photographer or etcher might use her medium to do what poets do with words.”

Using close observation techniques in the museum contributes to critical pedagogies that have been shown to impact positively student learning. Close looking necessitates slowing down in order to observe in a self-conscious, mindful, and critical manner. The “slow pedagogy” movement stresses that while technology is important for its ability to speed up retrieval of information, it can distract from more contemplative and reflective moments that are essential to learning. Encounters with original works within the museum environment can facilitate learning by creating the opportunity for extended reflection. A professor who had selected a William Blake print for her students (Figure 1) commented on “how the night sky with bright stars ‘hid’ the dark mountain in the background until [one’s] eyes adjusted” to it, remarking on the “invaluable experience in favor of close reading, because it proves to them how their own eyes both deceived them and
were capable of seeing differently with patience and a slower speed of encounter with the work.”

Collaborative learning: students as teachers

Collaborative learning has been shown to be beneficial to the development of critical thinking by offering a context in which students can analyze, synthesize, and evaluate ideas cooperatively.\(^1\) As we have seen, close observation of art can promote a practice of deep engagement. In order to maximize its learning benefits, it is best done in small groups. Faculty who reported on the effectiveness of close looking and reading techniques often divided their students into pairs or small groups, and provided instruction by way of modeling these approaches. Having equipped students with strategies for close looking and a few key terms of visual analysis to support their ability to describe what they saw, faculty paired them up, providing instructions on recording observations and sharing opinions, as well as, when appropriate, how to look through the lens of a concept that had already been discussed in class. The method which consistently produced the best results involved collaborative learning: each pair “taught” their selected art works to the whole class in the second part of the museum session, allowing time for the presenters to entertain questions. One professor remarked that students are often very intimidated when they come into the museum. By having them familiarize themselves with and then teach their objects, they both “gain confidence in their interpretations,” and become “producers rather than consumers of knowledge,” as one professor put it. In the words of a science professor, peer-facilitated discussions and group work “create opportunities for students to...explain, defend
reasoning, and [develop] multiple thinking dispositions.”

*Engaging emotions in new environments*
Research has demonstrated that students’ affective responses to visual material can have a significant impact on their learning. Encounters with original artworks, in particular, elicit emotional engagement through the art’s content, subject matter, or formal characteristics, a result that was evident in our surveys. One instructor argued that engaging with original art in the museum helped students “connect emotions and thoughts” more than in the classroom. Students, another observed, were quite attuned to the way that some works helped them “feel the anguish of the subject” being examined. Our surveys further suggested that when students were encouraged to cue into their emotional reactions, their participation increased, often in unexpected ways. A language instructor noted that her “students seemed less stressed when speaking Russian in the museum,” while another commented that some students who were quiet in class became more active and talkative in the museum. Faculty reported that the museum seemed to promote more “expansive” thinking, and one suggested that dealing with unfamiliar artifacts opened her students to “the freedom of the beginner, whereas in the usual classroom they might be more self-policing.”

*Learning in and through object-based interventions*
In the third phase of our study, we considered the faculty’s reflections on student learning and began to question how museum visits could, using intentional design, bolster student classroom learning. Several studies have argued that the
arts can enhance “the growth of cognitive, emotional, and psychomotor pathways in the brain.” Some researchers claim that the arts directly and positively impact overall academic performance, while others provide evidence of a correlation between arts programming and learning at pre-university levels. Among the studies that demonstrate a strong correlation between the arts and broader learning are the School Partnership Program (SPP) conducted by the Isabella Stewart Gardner Museum and the Institute for Learning (2003-2006), a large-scale randomized-control trial carried out at the Crystal Bridges Museum of American Art in Arkansas, and a five-year, longitudinal study conducted in Byron, Minnesota which concluded that use of the Visual Thinking Strategy (VTS) “point[ed] to a complex pattern of causality in the process of transfer of critical thinking.”

But large-scale quantitative studies are not always the best way to assess learning in and through the museum. It is axiomatic that you measure only what you can measure, not necessarily what is important. That is why quantitative research in education often focuses on dominant educational paradigms and outcomes (such as multiple-choice test scores) rather than harder-to-capture indicators of significant learning. But the arts, as Winner and Cooper noted, “are messy,” often producing multiple and conflicting interpretations and fostering divergent rather than convergent thinking. Quantitative studies are unlikely to provide the contextual framing needed to understand the multiple ways that museum centered, object-based learning occurs. As Robert Kegan, of Harvard’s Graduate School of Education, argued, “General data are nearly useless in terms of transferring what we learned from them to other
situations, without knowing enough in particular about the contextual sources from which they spring.”

More important than “correlations or statistically significant differences between groups,” according to the late Elliot W Eisner, a professor of art and education at Stanford, “is a theory that links experience in the arts with academic achievement.” He distinguished between “arts-based outcomes,” such as aesthetic discernment, which are specific to the study of art, and “ancillary outcomes,” or transferrable skills gained in the arts and deployed to non-art tasks. Among these he included the disposition to imagine different possibilities and outcomes, explore ambiguity, forestall premature closure, and accept multiple perspectives. These are, of course, the attributes of critical thinking, and most studies of the impact of museum visits on student learning will focus on the way that they strengthen such skills as observation, interpretation, evaluation, association, problem finding, comparison, and flexible thinking. Other important critical thinking indicators are engagement, focus, and ownership of learning, as well as the ability to draw informed conclusions and think conceptually. This last characteristic is often considered the cornerstone of “transfer.” To put it concretely: we want to know if a student who visits the museum with her chemistry class can gain the kind of insights that will allow her to better comprehend abstract concepts, epistemologies, and methodologies which she can apply to her work in chemistry as well as motivating further metacognitive engagements that can be useful in other domains. We want to know whether the approaches used in the museum can create “thinking dispositions” that will scaffold learning outside the museum. And we want to know if these
skills and dispositions will amplify after students have visited the academic museum multiple times during their undergraduate years, with different classes and individually.

Why should object-based learning be so useful in helping learners cultivate critical thinking dispositions? According to David Perkins, such pedagogies provide readily available sensory anchoring mechanisms (physical objects which help focus thinking), a ready means of evidence-based argument and revision (assertions that can be checked and revised continually on the basis of immediately accessible evidence), personal engagement (as our first survey confirmed), and multi-connectedness (sustaining broad inter-connections with many subjects).\textsuperscript{25} Thus, an instructor who came to the Allen with her students in a course on Modern Japanese Film and Literature to experience “the materiality of the objects in the museum: size, texture, color, detail,” stressed that, “the visual arts have an immediacy that allows students an entry into that world.”\textsuperscript{26} After viewing a number of art works in the Allen, students in a history class on Europe’s Crisis of Modernity, 1871-1914, discussed Expressionism back in the classroom. By this point, the students had become accustomed to the practice of referencing what they saw in the art as evidence for their arguments, a methodology that notably informed the class discussion as students consistently provided evidence from a variety of sources to sustain points they put forward.\textsuperscript{27}

To further explore these questions and focus more clearly on how the instructors’ goals (conceptual and otherwise) shaped their museum visits, we prepared and circulated a second survey to faculty who used the AMAM with their classes during in the fall 2013 semester (with an 87% rate of
transfer). The results helped us think more clearly about planning visits to encourage transfer.

Transfer: some observations
Historically, academic art museums have served as a critical supplement for learning in a limited range of courses, usually art history and studio art. The cognitive work of such visits falls under what researchers have called “low-road transfer.”

Paintings or other artifacts serve as “illustrations” to sustain, reveal, or deepen arguments made in the class, but don’t necessarily open learning in new domains, much as the knowledge gained in learning to drive a car can be directly transferred to learning to drive a truck.

We found numerous examples of “low-road transfer” in faculty surveys carried out among faculty who brought their classes to the AMAM in the fall 2013 semester, including:

- A professor of historical performance in the Conservatory who brought his students to the museum to better contextualize their understanding of English music in the 17th and 18th centuries.
- A history professor studying Heretics and Infidels who wanted her class “[t]o see the mosaics from Antioch and understand a little bit of the wealth of the world from which they came [to] help students ground their further study of the First Crusade and why, perhaps, the Christians from Europe wanted to retake Antioch from the Seljuk Turks…”
- A professor of theater design who visited the museum with his students intending that the “confidence they
gained by discussing a work of art... will help them explain their own design projects in class during regular critiques.”

Claims of what Salomon and Perkins refer to as “high-road transfer,” on the other hand, require different cognitive transactions including the application of knowledge or learning dispositions used in one domain to solve problems in a different area. The faculty surveys revealed numerous examples of “high-road” transfers:

- Looking at art... really helped [students] understand narrative, which can be an abstract concept. Art gave them the opportunity to [see] how multiple stories (in this case, those found in each individual work) together produce a larger meaning called “narrative.” In contrast, even asking them to read three short stories or poems would not have so clearly demonstrated narrative function, ironically enough [English].
- We used the study of art as an analogy for studying cognition. Just as with cognitive processes, art can be analyzed at different “levels of explanation” [Cognitive psychology].
- I wanted them to think about how visual information is communicated, and how to transfer these techniques into computer applications. I was especially interested in form and metaphor... One of the students... felt frustrated [in] not understanding all of the metaphor and imagery in the still life – I explained that I chose that painting (Figure 2) specifically for that purpose, to
illustrate how they need to be careful in which visual metaphors they use in the computer applications they’re designing [Computer science].

• Students were able to really understand (through experiencing it) how the paucity of sources in ancient India has lead to interdisciplinary collaboration between historians, art historians, religious studies, as well as archaeologists, that these fields are not necessarily always independent of one another [History].

• I wanted students to think about different timescales, how fast things happen, and what kinds of methods are needed to study fast events. I hoped to draw connections to the very fast motions of molecules and techniques for studying them [Chemistry].

• I think that the visit helped many of [my students] to think about different and similar ways of conceptualizing in art and music [Music theory].

As suggestive as these examples are, we still need to understand how instructors can shape both museum visits and classroom practice to consolidate “high-road” transfer. The following two case studies argue for a thoughtful collaboration between curator and instructor to create the conditions for transfer and provide a specific example of close collaboration between curators and instructors to produce concrete gains in students’ analytic abilities.

Planning for transfer
“High-road” (i.e. reflective rather than automatic) transfer is most likely to occur when the instructor provides explicit
instructions aimed at “provoking or conveying well-understood abstractions,” and when automatic (“low-road”) paths are deliberately blocked. The key to transfer, in this view, is an approach that emphasizes active, reflective connection making. Our work suggests ways that such planning can occur.

Physics 103 is an introductory, algebra-based course primarily for students majoring in the life and earth sciences. It provides an introduction to classical mechanics, fluids, waves, and optics. Curators at the Allen asked Katherine Jones-Smith, the instructor, to contribute to a brochure to accompany an exhibit of photographs by mechanical engineer and Massachusetts Institute of Technology (MIT) professor Harold Edgerton (1903-1990). After her students produced some “fairly dismal” test results in their first exam, she considered how writing the description of Edgerton’s Tumblers required her “to fully understand the physical concept being depicted.” If using art helped her better comprehend abstract physical laws, she reasoned it could do the same for her students.

Edgerton invented the strobe light, facilitating high-speed photography and revealing, in his iconic “drop-of-milk” and “bullet-through-an-apple” images, physical actions that happen at a speed the unaided eye cannot perceive. Jones-Smith saw in these striking photographs a way to help students visualize concepts (including parabolic motion, inelastic collisions, and inertia) that had tripped them up in their first exam. Her assignment asked students to choose two of the photographs in the exhibit and write a short essay “describing the physics that [was] being displayed.” She also required students to view the photographs at the museum, not online,
so each student paper included a selfie of the author and the photographs they examined (Figure 3).

Jones-Smith was thrilled with the results. Those who examined *Placement Kick* (1938) dissected the kinematics of the kick, the parabola of the ball’s arc and the kicker’s leg, and the compression of the ball. Those who selected *Tumblers* (1942) investigated parabolic motion in projectiles as well as the principle of inertia. Reading the students’ assignments, one is reminded of Perkins’s definition of “high-road” transfer, which is characterized by the ability to think in abstractions. In this project, students had to understand the physical concepts at a high level of confidence before they could appropriately apply them to a different domain. Here the instructor set up a very simple exercise that created the mechanism for transfer by encouraging visual processing, the critical posing of questions, verbal reasoning, testing hypotheses, and creative imagination.33

Significantly, students captured the metacognitive implications of the assignment. “While introductory physics teaches concepts in real-world applications,” sophomore Kendra Lian wrote, “it is oftentimes difficult for students to find connections between the motions of the natural world in relation to the equations given by textbooks. With his photographs, Harold Edgerton has exposed students and curious viewers alike to a series of remarkably detailed events that effectively prove the omnipresence of those numerous equations in the everyday motions of the physical world.”34 The assignment also encouraged students to take risks (the physics on display in each photograph could be explored in numerous ways), observe their selected photographs with great deliberation, and even admit the limits of their knowledge (as with one
student who hazarded an opinion as to what happened to the air in the ball when the foot hits it in *Placement Kick*. The indeterminacy of art (its “messiness”) helped physics students understand that one cannot always expect “right” answers. A final observation suggests the value of drawing in classes from a large number of departments and programs to the museum. One student who visited the Edgerton exhibit with her physics class, returned to view the same photographs the following semester as part of a chemistry class. She reflected on how different lessons learned during the two visits helped her appreciate interconnections between the two disciplines.

**Assessing transfer: the biology of love**
Transfer of critical thinking skills and learning dispositions is best supported by a close collaboration between curators and instructors, particularly to the extent that it can link viewing pedagogies with appropriate disciplinary approaches. Biology professor Taylor Allen has rigorously measured learning results from two different classes (a first year seminar and an upper-division animal physiology course) he has brought to the museum a dozen times since 2008. Allen and his colleagues from the AMAM attempted to determine whether gains in visual analytic ability could be achieved through an art-based activity of limited duration (lasting no more than three hours, one typical lab session).  

Taylor Allen’s classes focused on what happens, physiologically, to the body in love. In class, students studied the question from neuroendocrinal and somatic perspectives, considering changes from an initial state (“lust”) to longer-term (“romance” and “stable pair-bonding”) phases of love. To
assess changes in visual analytic abilities, students were given ten minutes to examine and write an analysis of an unrelated image before the module on love began and again at the end of the course. Art historians scored the visual analyses using a rubric based on visual literacy standards.³⁶

The instructor worked closely with museum curators to select original objects in the collection that reflected the three phases of love, in both western and eastern (China, Japan, India) representations. Artworks were chosen with a view towards accessibility and expressive content and were introduced to the students by curators using a standard VTS approach as well as formal visual analysis. Students were asked to consider whether the portrayals of love in the art works aligned with their understanding of the biology of love, and whether the embodied portrayals of love were universal or culturally influenced. In the museum, students worked in small groups to select examples from a variety of categories and to curate a mini-exhibition for presentation to the whole class. As the project developed, the instructor introduced more extensive post-visit writing assignments based on the mini-exhibitions students had curated.

Much as with Smith-Jones’ physics class, students in Allen’s biology courses closely observed the original art in order to understand underlying concepts. One student observed that in “Lovers [India/Malwa (1640–1660), watercolor] …the two bodies, especially the male, have noticeably flushed skin, symbolizing the increased muscular and cardiovascular work of the bodies during intercourse.” Another selected Ernst Ludwig Kirchner’s woodcut, Union (1900), (Figure 4) to discuss both the artist’s approach (Kirchner “used dynamic lines (rather than color)
in his construction of the human figures and in his stylized depictions of nature in order to emphasize the physical activity occurring in the scene”) and the biochemistry that underlay the body’s response (“During periods of physical exertion, neuronal action potentials release ACh [acetylcholine] onto the skeletal muscles...”).

Evidence from Smith-Jones’ and Allen’s assignments underscore that teaching by way of the museum can produce clearer conceptual understandings for students in a target discipline. Further, Allen’s careful assessment of his students’ learning, specifically his use of pre- and post-test instruments to measure visual analytic skills, confirmed concrete gains. A post-project numerical survey supported advances in the students’ analytical abilities, above all the development of observational skills.38 Finally, an end-of-semester survey highlighted the way the project stimulated the students intellectually and documented gains in their critical thinking and reasoning abilities. As one student summarized, “Through integrating art with science, I can apply what I know about both of those things to better my understanding of the other. I can look at science creatively and art analytically.”39

As the literature on learning suggests, transfer, particularly “high-road” transfer, will not generally occur unless it is planned intentionally. Allen’s “biology of love” projects were deliberately designed to help students develop higher-level thinking skills in multiple ways. Students were asked to generate analyses and interpretations, to articulate their thinking in written and oral form, and to think independently. By using the mini-exhibition as a key pedagogic approach, the instructor created an environment in which students could generate their
own knowledge, an approach encouraged by the requirement that they teach their findings to their peers.\textsuperscript{40} Both the assessment data and the students’ metacognitive reflections support the conclusion that “the project succeeded in calling on higher-level thought and developing skills inherent in such thought.”\textsuperscript{41}

Conclusion
The collaborative work between the Allen and CTIE has produced a significant base of qualitative data that addresses some research questions, while raising additional ones for further examination. Four recommendations, in particular, underline the importance of the academic art museum for undergraduate learning.

\textit{Position the academic art museum as a critical center of student learning:} To the extent that academic art museums develop outreach programs which attract visits from an expanding number of university departments, they need to think of themselves as vital centers of student learning on a par with research libraries in terms of the breadth of the communities they serve. For example, Oberlin College, with 2,900 enrolled students, received over 5,000 class-based student visits (and many more from individual students returning to the museum to complete assignments) in each of the past three years. Academic museums should be in continual conversations with academic deans and college teaching and learning centers, as well as reaching out consistently to the faculty. Such collaborations will have implications for the collection curators at academic museums who should understand that the learning potential of the museum goes beyond traditional art historical framings. Further, academic curators should have a greater stake in the learning outcomes of museum visits and more generally in the
curricular and pedagogic relevance of the museum’s exhibition and academic programming.

**Plan for transfer:** Research has shown that for learning to transfer, the process has to be planned in an intentional manner. The strongest intervention that academic museums can provide to scaffold such transfer is to help faculty strategically prepare for the next stage of activities once the museum visit has ended.

**Consider the impact of multiple class visits over a student’s undergraduate years:** Academic museums need to develop mechanisms for assessing their cumulative impact on student learning. By the end of her undergraduate years, a student may have visited the museum more than a dozen times, including class-based visits and individual, non-scheduled visits. It is important to develop longitudinal studies that can identify and follow a number of students who visit the museum from their first semester on campus (usually in the context of a first-year seminar) to their last, in order to determine how their learning impacted over an entire undergraduate experience.

**Collaboratively develop and interpret robust, open-ended interview instruments:** Significant authentic assessment of class-related museum visits can provide evidence of how object-based instruction strengthens critical thinking and learning dispositions in the museum and, by way of transfer, to other domains. In many regards, qualitative research that provides essential contextual information can prove more useful than quantitative research for this work. Central to this work is the creation of a robust post-visit, open-ended interview process that can be shared among academic museums to encourage a broader basis for coding and interpretation.
NOTES


7. Volk and Milkova, “Crossing the Street.”


9. All quotes in this section are taken from Allen Memorial Art Museum (AMAM) – Center for Teaching Innovation and Excellence (CTIE) Faculty Survey, Fall 2012.


26. All quotes in this section are taken from Allen Memorial Art Museum (AMAM) – Center for Teaching Innovation and Excellence (CTIE) Faculty Survey, Fall 2013.
27. Steven Volk, classroom observation, April 30, 2014.
32. Katherine Jones-Smith, email message to authors, May 8, 2014.


38. Ibid., 694.

39. Ibid., 695.


BIBLIOGRAPHY


Allen Memorial Art Museum (AMAM)–Center for Teaching Innovation and Excellence (CTIE). Faculty Survey. Fall 2012 and Fall 2013.


http://blogs.elon.edu/cel/
lee-shulman-on-the-potential-of-aggregated-sotl-data/.


Lieberman, Matthew D. “Learning from Others.”
“Research to Practice: Testing a Tool for Assessing Critical Thinking in Art Museum Programs.”
Sousa, David A, and Tom Pilecki. From STEM to STEAM. Using


