Formal Art Observation Training Improves Medical Students' Visual Diagnostic Skills

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BACKGROUND: Despite evidence of inadequate physical examination skills among medical students, teaching these skills has declined. One method of enhancing inspection skills is teaching "visual literacy," the ability to reason physiology and pathophysiology from careful and unbiased observation.

OBJECTIVE: To improve students' visual acumen through structured observation of artworks, understanding of fine arts concepts and applying these skills to patient care.

DESIGN: Prospective, partially randomized pre- vs. post-course evaluation using mixed-methods data analysis.

PARTICIPANTS: Twenty-four pre-clinical student participants were compared to 34 classmates at a similar stage of training.

INTERVENTION: *Training the Eye: Improving the Art of Physical Diagnosis* consists of eight paired sessions of art observation exercises with didactics that integrate fine arts concepts with physical diagnosis topics and an elective life drawing session.

MEASUREMENTS: The *frequency* of accurate observations on a 1-h visual skills examination was used to evaluate pre- vs. post-course descriptions of patient photographs and art imagery. Content analysis was used to identify thematic categories. All assessments were blinded to study group and pre- vs. post-course evaluation.

RESULTS: Following the course, class participants increased their total mean number of observations compared to controls (5.41±0.63 vs. 0.36±0.53, $p< 0.0001$) and had increased sophistication in their descriptions of artistic and clinical imagery. A 'dose-response' was found for those who attended eight or more sessions, compared to participants who attended seven or fewer sessions (6.31+0.81 and 2.76+1.2, respectively, $p=0.03$).

CONCLUSIONS: This interdisciplinary course improved participants' capacity to make accurate observations of art and physical findings.

KEY WORDS: medical education; curriculum; physical diagnosis; physical examination; fine art.
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INTRODUCTION

The physical examination is an essential component of clinical diagnosis.[1,2] Careful, unbiased visual observation or "inspection" can provide information critical to the accuracy of a diagnostic evaluation.[2–4]

Despite evidence of substantial inadequacy in physical examination skills among medical students, residents, and practicing physicians,[5–7] the teaching and confidence level in such skills has diminished among trainees and faculty.[2,8] The result is a decline in the use of fundamental bedside procedures, such as inspection, which are often replaced by expensive laboratory tests and radiological studies.[9] These trends suggest broad opportunities to improve patient care with the implementation of better physical examination teaching methods.

One potential solution is the teaching of "visual literacy," i.e., the ability to find meaning in imagery, which in medical parlance translates into the ability to reason physiology and pathophysiology from visual clues.[10] Educators have confirmed that visual literacy can be developed,[11,] and limited efforts to introduce similar teaching methods into clinical training have been promising.[12–14] Clinical habits are formed early in training,[15] and therefore we designed a novel pre-clinical course to enhance medical students' diagnostic acumen by expanding their visual skills through the (1) close observation and guided discussion of visual art, (2) exploration of core artistic concepts, and (3) opportunity to apply these skills to the clinical assessment of patients with a broad range of disorders. We hypothesized that this experience would increase the frequency of visual observations made by participants compared to an otherwise similarly trained group of non-participants.

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METHODS

Design

We used a prospective, partially randomized study design with pre- vs. post-course evaluations and mixed-methods data collection[16] to assess the impact of our course on pre-clinical medical and dental students.

Sample and Randomization

In 2004–2005, all pre-clinical students, in their 1st or 2nd years, at Harvard Medical and Dental School (HMDS) were invited, via an e-mail announcement, to enroll in the course "Training the Eye: Improving the Art of Physical Diagnosis." The study was originally designed to have 24 subjects in the intervention group and 34 students in the control group based on power analysis and sample size estimations. Fifty-six students expressed an interest in the course. Twenty-four students were randomized to participate in the course, and 32 were randomized to the control group. All 24 students in the intervention group and 19 of the 32 students in the control group agreed to participate. To establish adequate power based on pre-determined calculations, an extra 15 HMDS students were recruited to the control group via an additional e-mail solicitation, leading to a total of 34 controls. We found no statistically significant differences in demographic characteristics or pre-course visual skills examination scores between the randomized (n=19) and recruited (n=15) controls. (Data available from the authors.) These groups were combined for all further analyses. All control students received a $100 gift certificate, as compensation for the estimated 2.5 h required to complete the demographic survey and pre- and post-course evaluations. Institutional Review Board approval was obtained, and all study participants gave written informed consent.

Intervention

Training the Eye:Improving the Art of Physical Diagnosis is a 9-week pre-clinical course offered to students as a spring term elective. It consisted of 8 weekly 2.5-h didactic sessions with a curriculum design based on Schubert.[17] The didactic sessions were divided into a 75-min observation exercise at the Boston Museum of Fine Arts (MFA) followed, after a short break, by a 1-h lecture linking visual arts concepts with physical diagnosis (Text Box 1).

Observation exercises were facilitated by art educators trained in Visual Thinking Strategies, a methodology that uses art discussion to develop critical thinking, communication skills, and visual literacy.[10,11] In groups of up to 12, students practiced inspecting, verbally describing, interpreting, and actively building on others' analyses of artworks that were pre-selected to strategically exercise fine arts concepts linked with medical didactics. In the associated classroom series, HMDS faculty explored the application of various artistic concepts to specific components of the physical examination. Examples of a broad array of clinical findings discussed during these sessions ranged from dermatology (palor, jaundice, erythema, vesicles vs. papules, grouped lesions) to pulmonology (stomach-breathing, use of accessory breathing muscles, pursed lips) and neurology (cranial nerve III, IV, VI, and VII palsies, and gait). At two sessions, students were guided by faculty through their observations of volunteer patients with unknown pulmonary and neuromuscular disorders. An optional ninth session was a 2.5-h opportunity to draw the human figure, from a live model, with professional art instruction. Students were asked to complete weekly assignments, including focused readings and brief visual training exercises (Text Box 2).

The major cost of the course was faculty time, which amounted to a total of 32 physician hours (3 h of preparation

Text Box 1. Examples of Observation Exercise Concepts, Corresponding Didactic Sessions and Viewed Art Works

Observation Focus	Didactics	Examples of Art Work*
Color, light, shadows	"Color and Luminance"	Paul Gauguin, *Where do we come from? What are we? Where are we going?* 1897–1898, oil on canvas Joseph Mallord William Turner, *Slave Ship (Slavers Throwing Overboard the Dead and Dying, Typhoon Coming On)* 1840, oil on canvas John Singer Sargent, *The Daughters of Edward Darley Boit*, 1882, oil on canvas
Contour	"Contour in Thoracic Radiological Imaging"	Edward Munch, *Summer Night's Dream (The Voice),* 1893 Pablo Picasso, *Portrait of a Woman*, 1910
Form	"Linking Form to Function in Pulmonary Pathophysiology"	Seated Bodhisattva, Chinese, Eastern Wei dynasty, about A.D. 530,carved limestone Jan Steen, *Twelfth Night Feast*, 1662, oil on canvas Edward Manet, *Execution of the Emperor Maximilian,* 1867, oil on canvas
Texture and pattern	"Texture and Pattern Recognition in Dermatologic Diagnosis"	Jackson Pollack, *Number 10,* 1949 *Star and Crosstiles,* Iran 13th Century, composite body (quartz, clay, and glass frit)
Line and symmetry	"Line and Symmetry in the Cranial Nerve Examination"	Susan C Waters, The Lincoln Children, 1845 *Power figure nkisi nkondi*, Kongo people sculpture, 19th–20th C, wood glass, metal, pigment
Balance	"Detecting Balance and Imbalance in the Neurological Examination"	Claude Monet, *La Japanaise* (Camille Monet in Japanese Costume), 1876, oil on canvas *Shiva as Lord of Music (Shiva Vinadhara)*, Southern India (Probably Tamil Nadu), (Female figure dancing)

Images of the artwork are available through Google.com Image searches

Text Box 2. Out of Class Assignments Completed Before Each Didactic Session

Color, light, shadows	Carefully observe and document characteristics related to color in up to five strangers, including such features as: skin, hair, iris, sclera, conjunctiva, evidence of jaundice/pallor/cyanosis/lesions
Contour	Please pick five advertisements, which use people to sell a product, from a magazine of your choice. While analyzing each image, first make a quick sketch of it in your journal. Go on to describe the role of color, contour, and shading in each picture, and how it affects the way you look at it. Please include how these elements influence your eye movement while observing the image
Form	Carefully observe three people, whom you see regularly, and document in your journal any new observations that you previously had not noticed. Please pay attention to form, including posture, shape, and body proportions, in your general assessment.
Texture and pattern	Carefully observe and document dermatologic findings in up to five strangers, including such features as: (1) skin color, and variations, (2) common skin lesions (patterns, colors, texture, size), and (3) uncommon skin lesions—blisters, vesicles, facial deformities, port-wine spots, angiomas (patterns, colors, texture, size)
Line and symmetry	Carefully observe and document characteristics related to line and symmetry in up to three people
Balance	Please complete the other half of the portrait

for each hour of presentation) and 40 h of museum supervision by art educators, including pre-selection of artworks. Costs were contained through the existing partnership between HMDS and MFA that covered admission fees and classroom rental.

Outcome Measures

Before and after the *Training the Eye* course, the intervention and control groups completed a demographic survey and 1-h written visual skills examination. Students were given 8 min to report their free-text observations and interpretations of five slides depicting three patients with a variety of clinical disorders and two artworks in different genres, none of which were shown or discussed during the course. The clinical images included physical findings associated with upper extremity DVT, Wallenberg syndrome, and relapsing polychondritis. The pre- and post-test images were different and were chosen from a larger group of images sent to a group of art experts and clinical faculty, in order to select images comparable in subject, genre, and complexity.

Analysis of students' responses was blinded to participation in the course and pre- vs. post-course evaluation. Responses were graded for frequency of accurate and unique visual components of the image. A "point" was assigned for each "accurate" observation based on observations that were initially catalogued by a group of senior art educators (art imagery) and physicians (clinical imagery). A total mean score was created for the control and intervention groups by summing the frequency of observations for each image across all images then dividing by the number of students in that group. The pre-test was then subtracted from the post-test score to obtain a change in mean scores for each image. To obtain clinical and art imagery scores, the scores on the three clinical and two art imageries were divided by 3 and 2, respectively.

In addition, to gain insight into qualitative differences, responses to the visual skills examinations were evaluated using content analysis. An iterative process, according to Miles and Huberman, was used to identify the themes that emerged from the data.[18] A group of educational researchers, faculty, and art educators: (1) read responses to the visual skills examination blinded to timing and intervention status, (2) developed codes for students' responses to each image, and (3) came to consensus on codes and categories. Students' responses were subsequently coded and categorized by three independent researchers (MAB, JPH, and SN) who analyzed the data independently for reliability.

STATISTICAL METHODS

Sample size estimations were conducted, assuming at least 80% completion of the visual skills examination in both groups. The main outcome was to compare the post-course minus pre-course change in scores between the intervention and control groups. With 20 students in the intervention group and 32 in the control group, a standard deviation as high as 2.0 and a 5% significance level, this study had a >94% power to detect a 2-point difference in the mean change score, using a non-parametric t-test. Non-parametric statistics were used since the data (frequency of accurate observations) were ordinal and would likely be skewed.

Demographic characteristics between the intervention and control groups were compared with Wilcoxon rank sum and Fisher's exact tests. Statistical analyses of the change in the mean frequency of observations (post-course minus pre-course) in the control versus intervention group were performed using non-parametric t-tests and paired t-tests from generalized estimating equations for repeated measures data.[19] This method is appropriate for non-normal outcome data (frequency of accurate observations) and also minimizes the bias that may result from subjects who drop out of the study. Statistical analyses were performed using SAS, Version 9.1. All tests were two-sided with an alpha of 0.05. We did not adjust alpha to account for multiple comparisons; thus, the p-values should be interpreted cautiously.

RESULTS

The intervention and control groups had similar demographic characteristics (Table 1). Their mean age was 24 years (SD, 21.4), 59% were women, and most of the students were in their first year of medical school. The mean frequency of observations on the pre-course visual skills examination did not differ among intervention and control students (Table 1 and Appendix 1). Study completion was high and consistent between groups, with 83% of intervention and 94% of controls completing the pre- and post-course visual skills examination (p=0.22).

Table 1. Characteristics of Study Participants

Characteristics	Intervention (n=24)	Control (n=34)	P-value*
Mean age (median), years	24 (21.4)	24 (21.4)	0.97
Women, n (%)	14 (58)	20 (59)	0.99
Follow-up, n (%)†	20 (83)	32 (94)	0.22
Race, n (%)			0.46
Caucasian	15 (62)	15 (44)	
African American	1 (4)	3 (9)	
Asian	7 (29)	11 (32)	
Hispanic	1(4)	5 (15)	
Professional school, n (%)			0.69
Medical student	22 (92)	29 (85)	
Dental student	2 (8)	5 (15)	
Year in school, n (%)			0.53
Year 1	18 (75)	28 (82)	
Year 2	6 (25)	6 (18)	
Social medicine courses, mean (SD)‡	1.7(1.3)	2.1(1.0)	0.36
Clinical medicine courses, mean (SD)‡	2.0(1.7)	1(0.1)	0.29
Art courses, mean (SD)§	2.4(1.8)	1.9(2.0)	0.41
Pre-course visual skills exam scores, mean (SD)			
Clinical imagery	12.3 (0.71)	11.6 (0.58)	0.44
Art imagery	15.0 (1.0)	15.0 (0.86)	0.60
All imagery	13.2 (0.75)	13.0 (0.62)	0.60

**P-values are derived from the Wilcoxon rank sum test for ordinal variables and Fisher's exact test for categorical variables*
†Number of students who completed all pre- and post-course assessments
‡Students' mean number of social medicine (e.g., ethics, history of medicine, health-care policy, health-care administration, creative writing for physicians) or clinical courses beyond those required in the medical and dental curriculum
§Students' mean number of prior art history and/or studio art courses and experiences

After completing the course, intervention students made more overall observations on the visual skills examination compared to control students (mean 18.67, SD 0.79 vs. mean 13.29, SD 0.63, respectively, p<0.0001) (Appendix). For intervention students, this was an increase of 5.41 (SD 0.63, p<0.001) observations, on average, after the course compared to before the course (Table 2). The control group had no improvement in their total mean observation score (0.36, SD 0.53, p=0.49). In other words, intervention students had a 38% increase in observations over the control students. This pattern was similar for all five pre- and post-course image pairs. Improvements in observation scores for the intervention group were seen in both the clinical and art imagery slides (Appendix).

The average number of sessions attended was 8.15 out of 9 sessions (range 6–9). Students who attended 8–9 sessions did not differ on pre-course scores from those who attended fewer than 8 sessions (Fig. 1). However, students who attended 8 or 9 sessions (n=15) had a greater increase in their mean change score, compared to those who attended 7 or fewer sessions (6.31, SD 0.81; 2.76 SD 1.2, p<0.030).

Qualitative analysis of students' responses by expert reviewers resulted in the emergence of five categories of responses and their clinical correlates: (1) observations, (2) interpretations supported by evidence, (3) speculative thinking to generate multiple interpretations (using words such as "suggest," "seem," "appears," "judging from," "as evidenced by"), (4) awareness of absence of observations (pertinent negatives), and (5) use of fine arts concepts (Text Box 3). Qualitative data demonstrated that students who completed the course compared to control students used more fine arts concepts linked to physical findings in their post-course descriptions of images (Table 3), including specific mention of color/shadow/light and symmetry/balance. There was no increase in use of any fine arts concepts by the control group.

Table 2. Change in Mean Frequency of Accurate Observations for Intervention and Control Groups

Paired Pre- and Post-course Images	Intervention (n=24)		Control (n=34)		Difference Between Intervention and Control (SD)	
	Mean Δ Score* (SD)	P-value†	Mean Δ Score* (SD)	P-value†	Mean Δ Score (SD) ‡	P-value†
1	5.87 (0.89)	<.001	0.75 (0.73)	0.31	5.12 (1.16)	<.001
2	4.99 (0.99)	<.001	1.30 (0.81)	0.11	3.68 (1.29)	0.006
3	2.48 (0.81)	<.001	−0.61 (0.67)	0.36	3.09 (1.05)	0.005
4	4.72 (1.12)	<.001	−0.74 (1.0)	0.46	5.46 (1.57)	0.001
5	8.89 (1.44)	<.001	0.73 (1.19)	0.54	8.15 (1.86)	<.001
TOTAL‡	5.41 (0.63)	<.001	0.36 (0.53)	0.49	5.05 (0.82)	<.001

**Post-course frequency of accurate observations minus pre-course frequency*
†P-values based on paired t-tests from generalized estimating equations
‡Total score were calculated by adding mean umber of accurate observations for each image then dividing by five

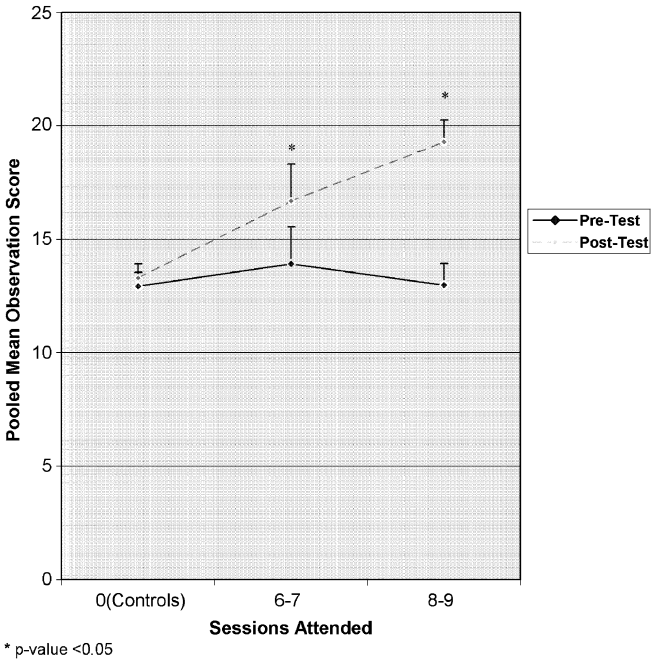

Figure 1. Graded impact of attendance on total mean observation score on pre- vs. post-test observations of all images.

DISCUSSION

The goal of *Training the Eye: Improving the Art of Physical Diagnosis*, a multidisciplinary course, was to improve the visual literacy skills of medical and dental students by developing the practice of "active looking"-unbiased inspection, and accurate reporting. The course was based on the Visual Thinking Strategies methodology[10,11] and facilitated by professional art educators. It provided a focused structure for the use of fine art to build these skills. Our qualitative and quantitative findings suggest that observation skills, including those directly relevant to clinical medicine, can be successfully acquired through active, structured study of works of art and medical imagery. Participants demonstrated improved ability to make accurate observations and were more likely to incorporate fine arts concepts relevant to physical diagnosis (e.g., color and symmetry) into their written descriptions. These findings suggest a more sophisticated level of visual literacy achieved by course participants. In addition, there may be a graded effect of class attendance on post-test observation scores, suggesting that the more the students practiced the better their visual skills.

Educational activities designed with a similar intent have been shown to be beneficial, but have been more limited in their scope, duration, participation of professional art educators, and evaluation. Previous interventions have typically been brief, occurring in one to three sessions. Dolev et al. conducted a randomized controlled study to analyze the impact of the observation of art on 81 1st year medical students.[12] During a one-afternoon session, students described pre-selected representational paintings, including landscapes and human figures, moderated by the museum's curator of education. Compared to the controls, who attended a clinical tutorial session focused on history taking and physical examination skills, course participants showed improvement in accuracy of visual diagnostic skills based on higher scores in describing patient dermatology photographs. Bardes et al. found that pre-clinical and clinical students enrolled in a three-session course focused on examining and discussing painted portraits and patient faces demonstrated improved precision in observations and enhanced awareness of emotion in human facial expression in unblinded post-course assessment.[20] A single structured discussion of artwork facilitated by a museum instructor at a family medicine residency retreat was enthusiastically received by residents and faculty, and stimulated dialogue, listening skills, and analytic thinking as judged by self-report. However, this program's impact on learning was not formally studied.[21]

The current study expands on prior studies by introducing an extended nine-session multidisciplinary course, including didactics and coordinated observation exercises to increase the depth and duration of exposure, practice of active looking, and likelihood of content retention. This intervention promotes strategies for confronting and deciphering visual information. Students exercise visual problem-solving in art and medical imagery using the repeated practice of observing and describing. By exploring a wide range of artistic concepts, art genres, and medical conditions, course faculty challenged students to see beyond specific content areas. The attainment of visual skills that cross subject content, in the current study, is consistent with the findings of prior educational research demonstrating that core principles of visual literacy transfer to problem-solving in other fields, such as reading, writing, and mathematics.[10,11,22]

This study has several limitations. First, the decision to establish an adequately sized control group came at the cost of true randomization. Randomized and recruited controls did not differ demographically or on the pre-course visual skills examination; however, unmeasured variables may confound the relationship between course participation and improved scores on the visual skills examination. In addition, we did not adjust alpha for multiple comparisons, so some of the statistically significant differences between the student groups may have occurred by chance alone. Second, students were evaluated immediately after the course. Long-term follow-up was not done, precluding the assessment of sustained learning. Third, the combined effect of fine art observation and didactics was studied, limiting our ability to distinguish the relative contributions of each. Comparison of this course to an alternative physical examination course was not performed. Fourth, clinical outcomes were not measured, so there is no direct evidence that these skills can be transferred into improved patient care. Finally, the study was located at one medical school, and although other schools have successfully implemented shorter courses with similar design elements, the ability to generalize these findings to other schools is unknown. This course may be difficult to replicate at medical schools that do not have art museums or art educators available to them.

CONCLUSION

Improved inspection skills can play an instrumental role in an accurate medical evaluation. A novel course that combines

Text Box 3. Themes That Emerged from the Qualitative Analysis of Visual Skills Examinations and Examples of Students' Observations

CATEGORIES FOR ART IMAGERY	CORRESPONDING CATEGORIES FOR PATIENT PHTOGRAPHS
Observations	Visual findings
This is a color painting…at the right side, at the foot of the bed is a miniaturized young male figure who is leaning over the edge of the bed, with his [left] hand on his cheek and [right] hand on the bed, with…red circular object in his hand	The sclera is almost completely red-uniformly across the eye with no visible blood vessels. There is a small ring of white sclera around the brown iris that is more visible on the left
At the foot of the bed is a blue can that gives off white twists of smoke that are hardly distinguishable from the white floor of the room	An actively weeping, bright red bloody circular ulcer on the [right] index finger that appears 3 mm in diameter…beside it is another 2-mm lesion that has healed and appears to be scabbed since there is a deep brown hue to the ulcerated area
Interpretations supported by evidence	Clinical diagnosis or interpretations supported by evidence
A religious home (judging from cross, painting of Virgin Mary on bureau, votive candle and the ceremony with which this woman brings palm branches to the ailing woman)	It seems like this rash causes open lesions on the skin. There are evidences of the lesion process…red spots, blisters, open-bleeding blisters, and scabs
The lady appears young because her hair is dark black without any gray—as is the young male's-but the elderly woman brooding over her has dark black hair with shades of gray mixed	
Speculative thinking to generate multiple interpretations	Speculative thinking to develop a differential diagnosis
On the back of the door is a poster for nonsmoking campaign. The skeleton icon in the poster is of the same white bony patterning as the patient. Or, perhaps it not a poster for no smoking—it is ambiguously a poster or a window in the door. It could be the grim reaper looking through the window coming to collect the patient	A man's right hand pathology…maybe contact dermatitis. Alternatively it may be a superficial burn, self-induced excoriations, or a viral eruption
Awareness of the absence of observations	Pertinent negatives or awareness of the absence of visual findings
The back wall is blank, not decorated…The purposeless movements of the women, the agitated, angular poses, the blankness of the room and the mesh on the window suggest a madhouse/psychiatric ward	There is no scleral icterus…no cuts or obvious scars
	The patient's eyes do not appear properly aligned, as there is a slight esotropia of the L eye, which is medially displaced as evidenced by her [left] iris being more towards the midline, whereas her [right] eye appears normal since it is centrally aligned with no evidence of strabismus or esotropia
Use of fine arts concepts	Use of fine arts concepts
There are color motifs that run through the painting. Red—mother's dress, medication, candle, flowers, object in the child's hand and slippers; all these objects signify hope and recovery	The man's eyes are asymmetrical. His right eyelid droops (ptosis) over his pupil
There is a lot of imbalance in the picture-awkward motions, odd figures, disproportionate bodies…and a range of moods from anger to…timid and calm	

systematic fine art observation exercises with lectures linking artistic concepts to physical examination skills led to increases in frequency of participants' observations and sophistication of responses on a structured post-course evaluation. At a time when physical examination skills are waning, an interdisciplinary course developing visual literacy can expand medical students' observational acumen and diagnostic capabilities.

Table 3. Mean Frequency of Fine Art Categories Used by Control and Intervention Students Pre- and Post-course*

Category	Control (n=34)		Intervention (n=24)	
	Pre	Post	Pre	Post
Observations	12.9	13.3	13.3	18.7
Speculative thinking	18.5	18.8	18.6	21.7
Interpretations + evidence	11.8	12.1	12.0	14.2
Pertinent negatives	2.7	3.0	2.8	4.9
Use of fine arts concepts	67.8	68.8	67	124.8

*Based on the content analysis of students' descriptions of five images on a visual skills examination

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