Effectiveness of Online Art Instruction of Color Concepts to Fifth Grade Students

by

Michael Delahunt

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Graduate Supervisory Committee:

Mary Erickson, Chair
Robert Atkinson
Bernard Young

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ABSTRACT

This quantitative, quasi-experimental study examined the effectiveness of three types of online guided-practice activities designed to increase learning of visual art concepts, the color concepts of hue, tint, shade, value, and neutral colors in particular, among fifth grade students in a large school district in the southwestern United States. The study's results indicated that, when students are given a limited amount of time to engage in practice activities, there is no statistically significant difference among the three types of guided practice and the control group. What was effective, however, was the instructional component of this study's instruments.

DEDICATION

To Alison Delahunt, greatest love of my life.

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GLOSSARY OF TERMS

Application — Application, as a learning outcome ability, occurs when a learner uses one set of constructs (such as an art concept) to make decisions (such as considering or manipulating) a second set of constructs (such as an artwork) that results in a third set of constructs (such as an assessment of the use of the art concept in the artwork).

Confirmation — A type of application that occurs when a learner activates (applies, uses) one or more constructs to examine another set of constructs, and confirms — makes a yes or no decision — whether the second set of constructs represents one or more or all of the items in the first set of constructs.

Artworks or art reproductions — Depictions of works of art. Objects members of the art world recognize as meriting this designation.

Construct — A construct is a cognitive entity that is produced as a learning outcome during any internal neural processing or operation activity. Concepts and definitions are each examples of types of constructs.

Diagrams — Diagrams are graphic images in whose design components concepts are embedded in such a controlled manner that they are usually easy to differentiate from artworks. In this study, "diagrams" are those designed to achieve educational objectives, as "self-explanatory diagrams" or "explanatory visuals," displaying relationships between concepts. The art world generally considers diagrams not to be works of art, or to be low in aesthetic esteem. Examples are organizational plans, maps, tables, plots, charts and graphs.

Direct instruction — Highly teacher-directed instructional strategies, among the most

commonly used because they are effective for providing information, developing step-by-step skills, introducing other teaching methods, and actively involving students in knowledge construction.

Feedback — Educational reinforcement. Types of feedback are (1) confirmation that work is correct; and (2) corrective, indicating that work is incorrect, what a correct work would be, how to achieve correct work, and sometimes further explanation or elaboration. Feedback is called feedforward when emphasizing that useful feedback doesn't address only *prior* work because its goal is to improve *future* work.

Hue — Individual color of the spectrum or rainbow. A color is a hue when it is neither lightened (whitened), dimmed (darkened), nor mixed with another hue.

Mark, mark making — Instead of asking some participants to practice by *drawing* colors, and all participants in the pre- or post- test to *draw* colors, this study's instruments ask participants to *mark* colors. The instruments employ this terminology to reflect the artworld's expectations that drawing carries considerable technical skill along with some personal expression. When a person is expected to make marks, on the other hand, the artworld suspends expectation that marks show either technical skills or self-expression, so that when the instrument conveys the expectation that a mark will reveal a specific type of color, this will primarily require the participant to choose one or more pencils containing pigments that will leave on the paper form the kind of color needed to correctly respond to a challenge to mark such colors. In this way, a participant's success is *primarily* indicated by that participant's selection of colored pencil (the pigment in it), and less to the physical method by which s/he applies that pigment. Instruction conveys information regarding various ways pencils can make

marks that alter the kinds of colors resulting from those differing means of application. Examples: when marks are made so the area where they are applied reveals some white areas of paper (the color appearing to be lighter the more white is visible; which is to say that distributing the pigment of a pure hue so that it fails to cover the paper completely results in the creation of a tint) or other colors that are simultaneously visible in that area. Since a participant could make one or more tints either by choosing pencils with tint pigments or by choosing pencils with pure hues and letting white paper show (as flecked or dotted, so that chosen pigment and the paper's whiteness mix optically), the instruction informs participants about criteria for their production of the correct color on paper, while evaluation of test results recognizes that both actions result in a correct response, just as variants of them can result in an incorrect response. Consequently, given that the manner in which a pigment is marked doesn't powerfully optically modify the color produced, identifying the colored pencil(s) a participant uses to mark the paper will be sufficient to show satisfactory recollection and application of the corresponding color concept.

Neutral colors — Colors in which no single hue dominates. Achromatic colors, grays and some browns.

Practice — A component of direct instruction, practice is an activity in which a learner exercises or rehearses the use of an ability (connecting sets of constructs in appropriate ways) in preparation for occasions when the ability will be needed (transferred), whether in school or in life (as when needed for another task, such as art production, discussion, or evaluation). Following the presentation of information, practice (aka drill-and-practice) promotes the acquisition of knowledge or skill through repetitive

recall, recognition, and/or application of information. Practice helps learners, especially beginning ones or those experiencing problems, to reinforce and master information at their own pace. Drill and practice software packages offer structured reinforcement of previously learned concepts. They are based on question and answer interactions, and give feedback. To be meaningful to learners, the skills learned through practice produce the building blocks for more meaningful learning.

Recall — Recall (aka recollection), as a learning outcome ability, occurs when, once a learner has stored a set of constructs, and this set of constructs has been set aside, the learner recollects (aka supplies, makes, or produces) this set of constructs.

Recognition — Recognition, as a learning outcome ability, occurs when, once a learner has stored a first set of constructs, the learner looks at a second set of constructs, and correctly identifies whether the second set of constructs is the same as the first set of constructs.

Value — The lightness and darkness in any color. Luminosity. Every color has a value. White has the lightest possible value, and black the darkest.

Visual culture, works of popular art — Images taken from such regions of low or popular culture that include entertainment, fashion, advertising, and other commercial industries.

CHAPTER 1

INTRODUCTION

Statement of the problem

Considering the rapidity with which computer-assisted educational resources are advancing, some of today's art teachers are not equipped to bring their twentieth century practices into the twenty-first century.

Direct instruction strategies (see Glossary of Terms, above) are teacher-directed learning activities that are effective in conveying information, developing step-by-step skills, transitioning to other teaching methods, and actively involving students in constructing knowledge. Art teachers use direct instruction, but, as teachers of other disciplines do, art teachers need to increase the effectiveness of the limited time they interact with students on maximizing students' skills in viewing, discussing, and producing art, or, as Hetland, Winner, Veenema, and Sheridan frame this (2007, p. 15), developing studio habits of mind. Consequently, much as students practice and drill basic math and reading skills, there is a great need for art students to engage in direct instructional activities to learn important art concepts, activities that computer-based instructional designs can effectively deliver, without requiring art teachers' constant attention.

An important goal of the current reform movement in art education in the United States is to promote visual literacy. One way to achieve this is to help students develop a better understanding of art concepts, among which are the elements of art. As uses of computer-based instruction grow across many fields, art instructors need to identify what

objectives this mode of instruction can most effectively address in support of achievements in studio classrooms.

Historical perspective on artists' learning about and use of color

Elements of design

Art educators have long considered color among the *elements of design* (line, shape, form, space, value, color, texture). Arthur Wesley Dow originated this formulation in 1899. Color was one of three formal (having outward form) elements Dow presented, along with line and *notan* ("a Japanese word meaning 'dark, light'"), in an effort to define an underlying structure of art with universal application (Efland, 1990). Dow explained his desire to "...direct the thoughts, awaken a sense of power and point to ways of controlling it" (Dow, 1899, 1920, p. 3). He went on to explain his dissatisfaction with the traditional way of teaching art at the time. "For a great while we have been teaching art through imitation of nature and the 'historic styles' leaving structure to take care of itself; gathering knowledge of facts but acquiring little power to use them" (p. 5). The standing of elements and principles of design within the field of art education has been uneven in the intervening period, especially among postmodernists, who de-emphasize formal issues in order to stress the literal content of works, typically conveying symbolic or abstract meanings.

The Bauhaus regarded the elements and principles as fundamental to the study of design. D'Amico and Lowenfeld, according to Kim (2006), voiced serious concerns that such a rule-based approach would interfere with creative self-expression. Discipline Based Art Education (DBAE) embraced the elements and principles (Kim, 2006). Proponents of postmodernism saw this structure as neither universal (but rather Euro-

American) nor adequate. Objecting to the status elements and principles have accrued, Gude (2004) asserts that they, “are presented as the essence of art making.” However true or false this assertion may be, the elements are unquestionably present in all imagery. Aside from visual art that is purely conceptual, none is without physicality, and therefore its formal attributes. An analogy I have often put to K-12 students: The elements of design are to every artist what alphabets are to writers. In other words, although the elements are not the ultimate goal of art, they are invariably among its component parts, at least to Western viewers. Given the potential variety to the contexts for art, the *principles of design* (balance, emphasis, eurythmy, harmony, *horror vacui*, limitation, movement, pattern, proportion, rhythm, tension, unity, variety) do not permit as universal an understanding as do the elements. Nevertheless, no image is possible without the elements — among the several kinds of information from which we might develop understanding, although their meanings too are variable across contexts.

Color

Color theory in the visual arts is a body of practical guidance to color qualities, categorization, mixing, and the visual impacts of specific color combinations. Chinese artists of the T’ang Dynasty (618-907 CE) and Roman and Byzantine muralists from the first millennium CE displayed a sensitive awareness and control of color. Painters of the Romanesque, Gothic, Renaissance, and later periods of European art are renowned for their uses of color. Although color theory principles first appear in the writings of Leon Battista Alberti (c.1435) and the notebooks of Leonardo da Vinci (c.1490), a tradition of color theory began in the 18th century, initially within a partisan controversy around Isaac Newton's scientific theory of color (1704) and the nature of primary colors.

Artists since Newton's time have weighed in on color's importance.

The elements of color theory have been neither analyzed nor taught in our schools of art, because in France it is considered superfluous to study the laws of color, according to the saying, "Draftsmen may be made, but colorists are born." Secrets of color theory? Why call those principles secret which all artists must know and all should have been taught?
Eugène Delacroix (c.1828, 1995)

Of all God's gifts to the sight of man, color is the holiest, the most divine, the most solemn. We speak rashly of gay color and sad color, for color cannot at once be good and gay. All good color is in some degree pensive; the loveliest is melancholy, and the purest and most thoughtful minds are those which love color the most.
John Ruskin (1851-53, 2007, p. 145)

Color is my day-long obsession, joy and torment.
Claude Monet (Clemenceau, 1926, 1930, p. 20)

Color is the keyboard, the eyes are the harmonies, the soul is the piano with many strings. The artist is the hand that plays, touching one key or another, to cause vibrations in the soul.
Wassily Kandinsky (1912, 1977, p. 45)

Color possesses me. I don't have to pursue it. It will possess me always. I know it. That is the meaning of this happy hour: Color and I are one. I am a painter.
Paul Klee (1914, p. 297)

Color helps to express light, not the physical phenomenon, but the only light that really exists, that in the artist's brain.
Henri Matisse (1945)

The craving for color is a natural necessity just as for water and fire. Color is a raw material indispensable to life. At every era of his existence and his history, the human being has associated color with his joys, his actions and his pleasures.
Fernand Leger (1943, 2008, p. 94)

Colors, like features, follow the changes of the emotions.
Pablo Picasso (Barr, 1946, p. 173).

I'm always trying to get to a danger point in color, where color either becomes too sweet or it becomes too harsh, it becomes too noisy or too quiet, and at that point I still want the picture to be strong, forceful, and the carrier of everything that a painting has to have: contrast, drama, austerity.
Wolf Kahn (Spring, 1966, p. 79)

Color theory developed as an independent artistic tradition with occasional reference to colorimetry (scientific measurement of colors) and vision science (scientific study of visual systems, visual perception). The peak of color's import arrived with modernism's emphasis on formal qualities. Yet contemporary artists explore additional reasons for the study and use of color theory. Byron Kim, a Korean-American painter (born 1961), whose first one-person museum exhibition was at the Scottsdale Museum of Contemporary Art in 2004, is, "one of the most important artists of his generation... a masterful colorist, in the lineage of Mark Rothko and other New York School painters of the abstract sublime" (Lewallen, 2004, p. 1). Kim's principle reason for color choice in this body of work referenced skin pigmentation.

The Museum of Modern Art's exhibition, *Color Chart: Reinventing Color, 1950 to Today* (2008), included works by forty-four artists who work with ready-made sources of color. The commercial color chart is this exhibition's point of departure, thereby declaring the status of color as mass-produced and standardized. Emblematic of these works are Damien Hirst's "spot" or "pharmaceutical paintings," grids of colored dots. The selection and "absolutely random placement" of their ordinary, wall-paint colors, follow a rigid formula.

Many other contemporary artists' attitudes toward color contrast to those represented in the MoMA show. Anne Appleby (born in Pennsylvania, 1954, lives in Montana), another contemporary painter, produces compositions that at a glance appear to be monochrome — flat planes of single colors — but with longer looking, one perceives their subtle infusions of color variation. Appleby applies upwards of fifty thin layers of paint in order to produce images that, she says, meditate on aspects of nature

through their very gradually modulated colors. Appleby compares her artwork "to time-lapse films in which plants break through the frozen ground" (Appleby, 2011).

Odili Donald Odita (born in Nigeria, 1966, lives in Philadelphia) paints abstract designs composed of flat shapes of color. Of his own work, Odili said, "Color in itself has the possibility of mirroring the complexity of the world as much as it has the potential for being distinct…. The colors I use are personal: they reflect the collection of visions from my travels locally and globally. This is also one of the hardest aspects of my work as I try to derive the colors intuitively, hand-mixing and coordinating them along the way. In my process, I cannot make a color twice — it can only appear to be the same. This aspect is important to me as it highlights the specificity of differences that exist in the world of people and things" (Odili, no date, c. 2011).

I surveyed contemporary art textbooks, and found that the five I examined (Turner, 1998, Mittler, 2000, Ragans, 2001, Hobbs, 2005, Stewart, Katter, Weisman Topal, Chapman, & Walkup, 2008) almost universally present instruction regarding *hues*, *tints*, *shades*, *values*, and *neutrals*, indicating that these concepts are likely to be of importance to learners of art at the fifth grade level. In a few cases, the texts employ synonymous terms. Ragans (p. 37) makes no use of the term *neutral* colors per se, but in discussing color intensity, notes that "mixing amounts of complementary colors makes colors become duller," and that "equal amounts… make a low-intensity gray." Four out of five texts present instruction regarding *tints.* Only Mittler fails to mention it. All five texts present instruction regarding the concepts of *shades* and *values*.

The textbook publishing industry has undergone changes in the 2000s. McGraw-Hill/SRA (Ragans, 2001) and Barrett Kendall (Turner, 1998) no longer publish

elementary art texts. Davis Publications has produced *Explorations in Art* (Stewart et al, 2008) in an online e-book edition. I browsed the first chapter of this version, and found its content identical to the print text — hardly more than a digital, searchable repackaging of the analog book.

A DVD designed to instruct elementary students about color (Wilton/Crystal, no date, c.2005) presents information regarding each of the five color concepts employed in this study. Describing this program, the publisher states, "This Wilton Art Appreciation program is designed to give students the basic rules, characteristics and properties of color necessary to appreciate art. The four main lessons focus on Primary & Secondary Colors, Complementary & Neutral Colors, Warm & Cool Colors, and Tints & Shades" (DVD box's text).

The concepts of hues, tints, shades, values, and neutral colors are essential starting points for the accurate identification and use of colors, and for inquiries into relationships among them. Limiting selection to five concepts was practical because this number satisfied my study's need for instructional instruments that might effectively educate its target fifth grade learners regarding a set of concepts within a manageable amount of time. In learning this set of concepts students would construct a foundation upon which to build a formidable edifice of color knowledge and art appreciation and production abilities.

Purpose of the study

Instruction in many subjects has moved away from paper-based drill and practice systems to computer-based systems. Art instruction has yet to robustly employ computer-based practice exercises with appropriate software to enhance daily classroom

experience. Given the personalized, interactive potential of software, the computer can lend itself to providing extended, programmed practice. In small doses, electronic learning experiences can supplement many lessons effectively, helping students to reinforce specific skills.

Research has identified several principles instructional designers need to follow to improve learning in computer-based learning environments (Clark, Nguyen, & Sweller, 2006, pp. 19-22), and yet, how best to enhance online learning of art concepts has not been explored in the current literature. This study helps to address this gap by identifying principles, particularly ones art educators need to employ to identify and produce more efficient and effective direct instruction for online delivery.

I expected this study to lead to hypotheses concerning the efficacy of multimedia instruction of the types I expose to participants in the study. These primarily concern comparisons of three types of guided-practice activities in instructional treatments with the goal of improving students' recognition of and abilities to apply certain art concepts, comparing pre and post test results for students in four groups.

CHAPTER 2

LITERATURE REVIEW

Three types of guided practice in learning

This study examines the effectiveness of the following three types of guided-practice on fifth grade students' learning of color concepts: 1) practice with diagrams, 2) practice with artworks, and 3) practice with mark making. Learning theory sheds light on the characteristics of these three types of practice on learning.

Learning is a constructive process in which learners store information and abilities in their long-term memories, especially when the constructs learners store become transferable to new situations, such as when learning to recognize and to apply concepts. In this conversion process, in order to store new constructs, learners engage such strategies as rehearsal, repeating mnemonic devices, making connections between new meanings and old ones. Research has shown that novice learners benefit from such active processing of learning material. In this respect the generation of self-explanations, in which learners try to explain to themselves the rationale of what they are learning, has proven to be an effective instructional method (Renkl & Atkinson, 2002; Roy & Chi 2005). Also the provision of example-practice pairs, that is, learners first study a worked out solution and subsequently face similar challenges to reach appropriate solutions themselves, has proven to be an effective way to foster the development of such skills (Sweller & Cooper, 1985; Trafton & Reiser, 1993). Each of the three types of guided-practice activities (independent variables) to which the study's participants are exposed (instruments) employ these strategies among their components.

This study's instruments also integrate audio-narration into instruction. Baddeley's research (1992) supports the use of audio-narration in combination with text display. Baddeley observed that working memory has two subcomponents: one for phonetic (auditory) information called the phonological loop and a separate one for visual information called the visual-spatial sketch pad. The brain utilizes both the phonological loop and the visual-spatial sketchpad to maximize its ability to process and store information. This study uses audio-narration in the instructional segment of its instruments in order to take advantage of this capacity of the brain.

Cognitive load theory, first advanced by George Miller (1956), asserts that our cognitive system can process only *seven plus-or-minus two* items of information. Applying the set of learning principles in cognitive load theory has been shown to result in efficient instructional environments as a consequence of leveraging human cognitive learning processes (Clark et al, 2004). The instruments for this study were designed to conform to cognitive load theory in order to maximize participants' learning, in that the instruments consistently present a deliberately limited amount of information. In other words, the instruments present a reduction in potentially distracting components.

Diagrams and other images

Clark, Nguyen and Sweller (2006) discuss diagrams in computer-based multimedia instruction, calling them "self-explanatory diagrams" and "explanatory visuals." Research shows learners are capable of performing spatial tasks faster when they study self-explanatory diagrams than when they study text descriptions. "When the learning goal requires a deep understanding, explanatory visuals that show relationships work best (p. 49)." Clark et al indicate the reason this is so is that, "All elements in a

visual can be viewed simultaneously, unlike sentences, which must be processed sequentially, one at a time. This leads to a lower visual search for tasks that involve coordination of multiple spatial elements. Greater psychological processing efficiency is the result." Clark et al advocate three guidelines for the use of diagrams to promote learning. (1) Use diagrams to optimize performance on tasks requiring spatial manipulations. (2) Use diagrams to promote learning of rules involving spatial relationships. (3) Use diagrams to help learners build deeper understanding. Color concepts lend themselves to representations of spatial relationships in the relationships between colors. Such designs can filter out distracting, cognitively overloading information in representing color concepts.

Clark and Lyons (2004) say, "Not all visuals are equally effective. Different types of visuals are best suited for various educational goals. For example, a representational visual is a diagram that illustrates the appearance of an object. In contrast, explanatory visuals show relationships among the content elements. Some examples of explanatory visuals include organizational maps and bar charts to show qualitative and quantitative relationships and interpretive diagrams to illustrate abstract relationships and principles (p. 33)." By this interpretation ("representational images as a type of diagram") reproductions of artworks are diagrams, although they are diagrams of a different sort than images designed to be "self-explanatory diagrams" or "explanatory visuals." They are explanatory visuals to the degree that they display information that shows relationships among the content elements.

For purposes of this study, diagrams, in contrast to artworks, are graphic images like charts and graphs, designs whose components embed concepts in such a distilled and

heuristic manner that these images are unlikely to be considered (by the art world) as works of art. However aesthetically pleasing they may be, however they may express their maker's or culture's thoughts or feelings, they are intended to serve a rather narrow, pragmatic, even mechanical function in representing qualities of and relationships between a proscribed set of concepts.

A principal goal for art students is to apply art concepts in their viewing, discussion, and production of artworks, but novice learners may begin to understand some concepts by scaffolding their learning through examination of diagrams designed more for the purpose of encoding concepts in a more focused manner than artworks are apt to encode them. It may be best for students to proceed to study applications of these concepts in artworks only later, whether the artworks are exemplars or not, and whether the artworks have been produced by others or by students themselves. It is not unusual for art teachers to challenge learners to observe applications of art concepts in works of art, even though a non-art image might more purely encode the concept and mask applications of other, potentially distracting (distorting, confusing, or even contradictory) concepts. Many artists are fond of confronting difficult issues. With conflicting material in an artwork, multiple concepts might be encoded in its media, themes, and the contexts in which it is produced. However more pedagogically effective it may be to display images in which target concepts are encoded in greater isolation from other concepts, an art teacher might deviate from this principle. Whatever reasons an art teacher could have for selecting images for class consideration, the purpose of this study is to identify principles that might advantageously inform pedagogical decisions concerning the relative effectiveness of diagrams and artworks in teaching art concepts.

Art production

Art students are expected to produce their own works, first in the lower-expectations context of practice activities, and later in the making of products worthy of public display. As such, the art world expects artists' original works to reveal applications of various art and non-art concepts. Although the instrument I devised for use in this study might have asked participants who practice by mark-making to do more than to apply color in small rectangular spaces (create works that might be called art), the objective of the practice activities and test is quite delimited and clear. In this context, therefore, it is appropriate to expect that marks are effective if the marking demonstrates the encoding of the color theory concept that is its target (in Methodology, see Rubric for scoring marks made in tests). There are innumerable precedents in art education in which teachers have taught students color theory by asking them to formulate colors, choose or mix pigments, and apply swatches of color that satisfy specifications in order to practice diagrammatic applications of and demonstrate knowledge of various color concepts.

Practice and feedback

This study examines how practice and feedback affect learning of art concepts, and specifically of color concepts used in art, while comparing three types of practice in order to inquire into how effective these are in promoting learning.

During the study segment of any instructional sequence, learners construct a preliminary schema. Then learners can further refine this schema with the information they obtain during the practice stage by performing the skill themselves (Weeks and Anderson, 2000; Gagné, Wager, Golas & Keller, 2005). The alternation between first

studying and then practicing enriches the schema and also helps learners to integrate newly learned information with prior knowledge, which yields a more integrated knowledge base with increased accessibility, better recall, and higher transfer of learning (Foshay, Silber & Stelnicki, 2003).

Research has shown the effectiveness of practice with feedback as a component of learning particularly in computer-based art education. Martin and Klein (2008) examined the effects of several instructional elements (objectives, information, practice with feedback, and review) on achievement, attitude, and time in a computer-based multimedia program. Undergraduate college students used a multimedia lesson to learn about artists and their painting styles. Results indicated that, "Participants who used the program with practice performed significantly better than those who did not receive practice (p. 184)."

Feedback, as a component of guided practice, is reinforcement, information about how the learner's present state of learning and performance relates to the goals and standards of an educational program (Merrill, 2002; Delgado & Prieto, 2003). Types of feedback are (1) confirmation that work is correct; and (2) correction, indicating that work is incorrect, what a correct work would be, how to achieve correct work, and sometimes further explanation or elaboration. Occasionally feedback is called feed-forward, particularly when emphasizing that useful feedback doesn't address only *prior* work because its goal is to improve *future* work. Qualities of effective feedback include their being (Nadler, 1977) concrete, specific, descriptive, balanced, non-threatening, and constructive, as feedback increases both learning and motivation (p. 385). Any course design that seeks to achieve enhanced skills development through greater emphasis on

learning transfer, then, must ensure quality in terms of both the practice opportunity and the feedback provided.

Instruments designed for this study provided feedback immediately after each participant responded to the challenges in the practice activities of each of its three kinds (recognizing concepts embedded in diagrams, recognizing concepts embedded in artworks, and applying concepts by embedding them in mark-making). When a response is correct, feedback confirmed the learner's achievement, and reinforced the connection between student action and learned constructs. When a response was incorrect, feedback alerted the learner to the meaning of the error, and reinforced the meanings of targeted constructs.

Comparing types of abilities to be learned, it is apparent that learning to recognize concepts and applications of concepts is similar to learning to solve problems (e.g., math problems) in that seeking to understand and use (not to devise) a concept challenges the learner to identify and use a synonym for that concept. (The field of linguistics considers the term *synonym* to mean an equivalent; a synonym possibly taking the form of a single word, a longer phrase or sentence, as in a definition, or an image or set of images.) Learning concepts requires engagement in solving problems, albeit problems having specific parameters, problems for which the recognition of and use of the concept is required for success. Instruments designed for this study provided practice activities in each of its three kinds (recognizing concepts embedded in diagrams, recognizing concepts embedded in artworks, and applying concepts by embedding them in mark-making) that are problems the instruments expect learners to solve, either by selecting the

best from among a field of potential responses, or by selecting colored pencils from a set of pencils, and making marks in order to apply the concept that has been named.

The conclusions of various investigators regarding learning and guided practice address the potential effectiveness of various kinds of practice. Here I consider how other investigators' work regarding guided practice and learning relate to (align with) these variables, in order to support the predictions I make.

Research by Ericsson, Krampe, and Clemens (1993) frames four conditions that must be in place in order for practice activities to be most effective in moving students closer to skillful performance.

1. Because practice requires intense, focused effort, students may not find it inherently enjoyable; therefore, teachers can encourage students to practice more by pointing out every time that practice has actually improved their performance. Teachers ... can motivate students to practice by designing activities that maximize students' opportunities to succeed.
2. Teachers should design practice tasks with students' existing knowledge in mind. When students succeed at practice-problems the benefits of practice are maximized. On the other hand, when students become frustrated with unrealistic or poorly designed practice-problems, they often lose motivation, will not receive the full benefits of the practice they have done, and will be less motivated to attempt future practice problems.
3. Students receive the greatest benefits from practice when teachers provide them with timely and descriptive feedback.

4. Students should have repeated opportunities to practice a task through practicing other tasks like it.

In regard to Ericsson et al's condition #1, this study doesn't allow "encourag[ing] students to practice more by pointing out every time that practice has actually improved their performance." Nevertheless, it purports to "motivate students to practice by [delivering] activities that maximize students' opportunities to succeed." Which of the three methods of practice — seeing concepts embedded in diagrams or artworks, or by mark making — are learners most likely to find "enjoyable" and "motivating" in general? I predict based upon my experience as a learner and as an art teacher working with learners that looking at artworks is most likely to be enjoyable and motivating among 11-year-olds, because (1) the challenge to decode an artist's application of art concepts is more varied and intriguing than decoding a diagram or marking colored pencils, when an artist has encoded color concepts in combination with other concepts in an artwork. Artworks present a greater variety of imagery than diagrams do, and the varied (including admittedly extraneous) information that artworks convey is more likely to result in engaging as well as meaningful (aesthetic) experiences than those in which participants decode diagrams or mark with pencils. As much as such varied information might distract from attention to the target concept (i.e. possibly overload working memory), it will nevertheless *increase motivation*. (2) The learner who practices by selecting pencils with which to demonstrate understanding an art concept, when redirecting attention from the computer screen to colored pencils and paper, can as greatly overload the learner's working memory (ability to apply the concept), as much or more than the learner might by responding to a problem via the computer's input devices.

In regard to Ericsson et al's condition #2, "design practice tasks with students' existing knowledge in mind," which form of practice is most likely to help students to build upon their existing knowledge? Seeing concepts embedded in diagrams or artworks, or by mark-making? Since the form of no participant's practice activity results from assessment of that participant's existing knowledge, there can be no claim that the instrument's practice activities respond to existing knowledge. Nevertheless, since the instrument provides participants with information with which to construct knowledge in its instructional component, it might be asserted that, to the degree at which instruction is effective, the benefits to participants in a practice activity are maximized when the practice activity is richly aligned with instruction. Is there any basis upon which to predict whether students' existing knowledge is strongest in analyzing diagrams, in analyzing artworks, or in mark making?

It is fair to suppose that all students have some facility in analyzing diagrams and other human-made imagery, as well as in making marks, but with which of these activities does their knowledge predispose them to frustration that might be caused by a practice activity that is "unrealistic or poorly designed"? Learners look at images more than they produce them. Diagrams are designed to provide minimal distracters, while artworks are apt to provide numerous distractors. Consequently I hypothesize that analyzing diagrams is likely to be the form of practice (of three forms) that most strongly helps students build upon their existing knowledge.

In regard to condition #3, "provide students timely and descriptive feedback," which form of practice best lends itself to feedback that is timely and effective, resulting in giving learners the greatest learning benefits? A dry run of the study that I conducted

in spring of 2012 revealed that mark-making activities were the most time-consuming of the three types of practice. A machine that measures colors (wavelengths) of light reflecting from a surface might assess whether pencil marks have been applied correctly, but this researcher did not gain access to such equipment. Since assessment of these items had to be made by a human analyst, feedback to mark-makers in (this iteration of) mark-making guided-practice activities, could not be quite as robust as was feedback to responses to multiple-choice items, mark-making is the form of practice that least provides "feedback that is timely and effective, resulting in giving learners the greatest learning benefits." Providing feedback to responses to colors embedded in either diagrams or artworks presents no such hindrance to timeliness.

In regard to condition #4, "Students should have repeated opportunities to practice a task through practicing other tasks like it," the instrument in this study provided but one opportunity to practice each task in every type of practice activity. It permitted participants to repeat views of screens presenting these activities, but did not offer additional activities of an identical kind.

It is worth considering which type of practice offers the greatest potential for adaptations for "repeated opportunities to practice a task through practicing other tasks like it." An instructional designer could easily embed concepts in diagrams of various styles, but they must be essentially the same as each other, and consequently risk being too similar to each other.

Analyzing artworks is the type of practice that best affords the capacity to furnish "repeated opportunities" because there are so many artworks that one might reference without repetition.

Providing alternative mark-making tasks challenges material limitations that are typical of and overcome in art studios, where learners typically engage in varied opportunities to make marks. Given that mark-making media might be digital or analog, a learner might select from various types of crayon, chalk, marker, paint, etc., when not choosing colors from an on-screen palette. Such a variety of media offers tremendous potential for transfer of color concepts across these media. However conventional is the use of varied media in studio classroom settings, doing so in the context of a computer-mediated instrument might present difficulties manifesting in limitations in space, funding for or availability of supplies, or electrical hazard (malfunctions/damages when an art material gets into electrical/electronic devices).

Research on how limitations of human memory might also inform speculation regarding which type of practice activity is likely to be most effective. (See the discussion of cognitive load theory above.) Moving information to permanent storage is sometimes explained as a "multistore" model of memory (Atkinson & Shiffrin, 1968; Baddeley, 1996). According to this model, our brains have three memory storage systems: sensory memory, short-term (or working) memory, and long-term memory. Learning occurs when we move information from working memory to long-term memory, and practice helps with this process.

Practice keeps the information that starts in our short-term memory long enough for it to move to long-term memory. Once it is in long-term memory, it can be built upon to create more and more complex associations.

Learning might be said to newly establish a permanent connection between a concept and the learner's memory of it, which is all the stronger when the learner is able to apply the concept.

One might characterize a learner's experience of an activity as following a sequence of actions or steps. One might also characterize a learner's experience of a guided practice activity in this way. In unpacking the learner's experience of the sequence of events that comprise a guided practice activity, one might expect that the more elegant (in other words, requiring fewer steps, more straightforward) the activity, the more efficiently it contributes to learning, and the more directly the target of learning becomes a fully stored concept.

While any activity that results in desired learning is a worthwhile activity, we are apt to consider most highly effective such activities that are *efficient*, allow the learner to take less time, take fewer steps, and focus attention (encounter fewer distractors). In light of this principle, I will identify the steps a learner experiences while engaging in each of the three types of practice activities (independent variables), while attending to the demands each step places upon the learner's memory-forming capacities.

With only two exceptions, the steps for users engaging in each type of practice activity are very *similar* to each other.

The steps that are similar in each type of guided practice are:

1. Reads text explaining the problem in the practice activity, and decodes it
2. Examines images, and decodes them
3. Decodes the combined text and images — the problem — making a cognitive connection between concept(s) referred to in the problem, the images, concept(s)

presented in instruction, in other past experiences, and focuses on concept(s) that are needed for solution(s), or makes a richer connection between them

4. Recognizes and/or visualizes colors and/or identifies qualities of the colors that correspond to the concept that would solve (answer) the problem (or fails to do so)
5. Might review problem and response to see if response is satisfactory
6. Advances to the next problem.

There are two steps learners take that are *different* from those taken by learners in three kinds of guided-practice activities:

(1) Learners who engage in the activity involving artwork have a step that learners engaged in the other kinds of practice activities do not encounter. These learners risk becoming distracted by aspects of the artwork that have little or no bearing on the concept or the problem. This is supported by the cognitive load theory, that "teachers must be careful not to have too much extraneous information in the classroom. Too much stimulation can put too much demand on working memory (Paas & Kester, 2006, p. 283)."

(2) The second variation between the sets of steps is the one in which two groups select the best of four potential responses and click, while the mark-makers select from among colored pencils in order to mark an answer sheet. The marking activities demand more varied eye and hand movements. Although engagement in additional eye and hand movement might distract learners, it might also increase learning because it is more hands-on. Disciples of Piaget might argue that a more hands-on activity is likely to result in greater learning.

CHAPTER 3

METHODOLOGY

Randomized control-group pre test - post test design

This study uses a methodology called "pre test - post test design." Such designs are widely used in behavioral research, primarily for the purpose of comparing and/or measuring change resulting from experimental treatments (See Appendix I, Scripts of Instruments). Accompanying this method was the study's engagement of participants in a survey (See Appendix II, Survey of Computer Use and Attitudes Toward Art Instruction). The survey's objective was to collect data describing participants' experiences with and attitudes toward related issues. Perhaps this data would add nuance or help to triangulate analysis of the study's quasi-experimental components.

This study has been designed to conform as much as possible to methodologies characteristic of a true experiment, employing pre and post tests, a control group, and randomized assignment to four groups of students at diverse socio-economic levels. Nevertheless, because it engaged students in public schools in one suburb of a city in the American southwest, and not randomly selected from an even broader population, and then studied in an isolated, laboratory setting, at best it can expect to attain no more than the status of a quasi-experiment.

Participants' randomized assignment to this study's four groups nevertheless ensured the researcher's ability to measure the effectiveness of the independent variables — three treatments (each a kind of guided practice) plus a control (no guided practice) within this framework. (See Appendix III, Instructions to Facilitators.)

With this randomized design, all conditions were the same for both the experimental and control groups, with the exception that the separate groups were exposed to a treatment, whereas the control group was not.

In this study the independent variables are types of guided practice activities:

1. Participants practiced recognizing applications of concepts embedded in diagrams, with feedback
2. Participants practiced recognizing applications of concepts embedded in reproductions of artworks and images from visual culture (See Appendix IV, Selection of Artworks), with feedback
3. Participants practiced recognizing applications of concepts and producing marks (See Appendix V, Colored Pencils, and Appendix VI, Sheet on Which to Practice Marking Colors) that represent these concepts
4. Participants in the control group engaged in an activity that was educationally worthwhile, but did not involve reinforcing learning of art concepts of the type with which other participants were engaged.

Other variables, such as the instructional content, the level of learner control were held constant. Participants were randomly assigned to the experimental and control groups. This study addresses the dependent variable that is participants' learning outcomes.

Diagram of the research design:

Group I R——————O [Pre Test]——————X:1——————O [Post Test]

Group II R——————O [Pre Test]——————X:2——————O [Post Test]

Group III R——————O [Pre Test]——————X:3——————O [Post Test]

Group IV R——————O [Pre Test]——————X:4——————O [Post Test]

"X" stands for the instrument to which this group was exposed. The qualifiers to the exposure, "1," "2," and "3," specify independent variables; "4" specifies the control group, which was exposed to no independent variable.

All participants engaged first in an online pre test (See Appendix VII, Test Answer Sheets). The second segment presented an online instructional instrument (introducing and explaining) information about color concepts for use in art: *hue*, *value*, *tint*, *shade*, and *neutral colors*. This segment was identical for all participants — participants in each of the four groups.

Aspects of the online instructional instrument's second segment that were *identical* for all subjects:

1. Lesson objectives
2. Lesson content
3. Definition of each art concept
4. Illustration of each art concept
5. Audible narration
6. Display of text
7. Display of diagrams, photographs, and artworks

The third segment of the instructional design was the part of the design in which participants received opportunities to practice recognizing the same art concepts about which they received information in the second segment, encoded in applications of these concepts. Some aspects of this segment were identical across all groups, and some were variables.

Aspects of the online instructional instrument's third segment that were *identical* for all subjects were the objectives of the instructional practice in:

Recognizing art concepts (e.g., pure red, pure yellow, and pure green are examples of _____; and pure red, pure yellow, and pure green are each examples of a. shades, b. tints, c. hues, or d. average intensity.)

Recognizing an application of the art concepts (e.g., recognize an application of the concept in an illustration and select a text response to demonstrate your having recognized the application of this concept)

Answer and feedback (e.g., the correct response is... ; the reason it is correct is... ; the reason other responses are incorrect is....).

In alignment with randomized control-group pre test - post test methodology, participants in each group other than the control group received challenges to participate in one practice activity from the three potential kinds of practice activities.

What differed among the three treatments is whether participants practiced applying concepts by seeing illustrations (examples) of those art concepts embedded in (1) diagrams or in (2) artworks, or (3) by embedding these concepts in marks they made. This allowed analysis of the resulting data in order to determine the effectiveness of these types of practice activities by which participants attempted to increase their learning of

art concepts, to analyze the relative effectiveness of those means of practice by the statistical methods. (See the section on data analysis.)

Independent variables:

Instructional practice activities in which participants

(1) recognized applications of art concepts encoded in diagrams with feedback,

(2) encoded in images of artworks with feedback; and one in which participants

(3) applied those concepts by encoding them in marks, with feedback

(4) participated in no practice activity (control group).

Dependent variable:

Learning outcomes, as measured by the pre and post tests, to recognize applications of five art concepts (color theory) in diagrams and artworks; and in marking with colored pencils to produce colors that align with art concepts.

Variance in participants' performance on the test could depend on the effectiveness of instruction (with independent variables), and other potentially moderating variables:

Each participant's abilities to use the English language. ELL and Non-ELL students participate in the study. I asked all participants whether a language other than English was principal language used in their homes so that I could see to what degree this was a factor in performance on tests. I considered identifying ELL participants in order to remove their data prior to analysis of the data, but instead included their data in order to better reflect the actual student population. I elected also to retain data generated by the few students with disabilities (motor, hearing, seeing, etc.).

Each participant's gender — Participants self-reported gender on a form within online instruments so that relationships between these and other dependent variables could be measured. In other words, data identifying the genders of participants could be shown to correlate to variations in measures of a subject's ability to recall, recognize, and apply art concepts (color theory).

En-route variables:

Learning time, because there is no time restriction in the learning phase, was measured (reported by SlideRocket.com) as an en-route variable. The sole time restriction is the length of time (40-45 minutes) facilitators had for each class session in art and computer classrooms. The dry run of the study conducted in the spring of 2012 suggested that all or nearly all participants would have adequate time in which to submit full responses on all instruments, and this assessment was born out in the actual study.

Potentially moderating variables:

Each participant's knowledge of art concepts prior to the study

Each participant's subjective cognitive load. This was held to minimal levels by adherence to established principles of instructional design.

Research questions

Which of three types of practice activities (independent variable) that might be incorporated into online instruction is most effective in increasing students' art learning for application, or recognition of application (dependent variable) of art concepts? Sub-questions answers to which I expected would contribute to an answer to the main question:

Is there a statistically significant difference in achievement scores by students engaged in the three types of practice?

Are the post test scores of participants who engaged in practice recognizing applications of art concepts encoded in diagrams with feedback higher than their pre test scores?

Are the post test scores of participants who engaged in practice recognizing applications of art concepts encoded in images of artworks with feedback higher than their pre test scores?

Are the post test scores of participants who engaged in practice applying art concepts by encoding them in marks with feedback higher than their pre test scores?

Is there any relationship between patterns of participants' achievement on tests and their self-reported

1. Uses of computers and comparable devices
2. Uses of video and computer games
3. Ages at which they first used computers
4. Owning of a smartphone
5. Attitudes toward what can help them to understand color concepts
6. Attitudes toward getting classroom or online instruction

Participants and facilities

Participants are fifth grade students at six, socio-economically diverse schools in Maricopa County, Arizona. Consistent with IRB approved protocol for studies involving human subjects, I assured the school district, the schools, and students that this and all

other reports of this study would include no identification of the school district and particular schools (See Appendix VIII, IRB, and Appendix IX, Permission Letters).

An *n* of thirty for each group meets the assumption of normality in experimental studies. I had an *n* of 43-50 in each of this study's groups.

I selected six schools to participate within a large, socioeconomically diverse school district to ensure that the body of this study's subjects would represent a broad range of backgrounds (school communities at lower, middle, and higher levels).

A further criterion for school selection was whether instructors (technology and art teachers) who would be study facilitators appeared to be the best prospects for their dedication and ability to support the successful conduct of the study.

I communicated with the school district's assistant superintendent of instructional support at the elementary level, who expressed her support for my pursuing the conduct of this study in her district. She subsequently obtained the approval of the district's governing board. The district's fine arts coordinator also supported my work on this study.

After students completed the pre test, facilitators of the study assigned participants to the four groupings completely randomly. I prepared slips of paper, each indicating to which one of four instruction and guided-practice (or control) instruments a participant would connect, there being an equal number of slips tied to each of the instruments' URLs. As participants approached their use of the instructional instrument, each selected one of the randomized slips. Each participant reported demographic data: his/her name, gender, school, and whether English is the principal language spoken at home. Each

participant accessed one of the four instructional instruments by matching the randomized slip with a link on the school's web page.

Each of the study's five facilitators enthusiastically participated in supporting the study without remuneration for their participation.

Procedures

I trained four art instructors and one technology instructor, who were in position to facilitate the presentation of instructional and testing instruments to participants at six elementary schools, each class of students engaging in these activities during two class sessions. (See Appendix III, Instructions to Facilitators.) The instructional instruments that I produced were delivered in a computer-based environment with each student receiving instruments separately from other students. The instructional objectives were that fifth grade students learn a set of five concepts in color theory, concepts that students can and should use in examining, discussing, and producing art.

The objectives of the instruction:

Students had the means and opportunities to

1. Obtain information from online instruction (I produced) in order to
2. Recall and recognize each of five art concepts and
3. Recognize applications of or apply these art concepts in practice activities.

Data collection — alternating pre and post tests for all participants

Before participants engaged in the instructional segment of the study, they each took a pre test. A day or more after participants completed the instructional segments of the instrument, participants took the post test. Half of all participants took one of two

equivalent tests ("X" and "Z") as their pre test, while the other half took the alternate test as their post test.

The pre and post tests challenged participants to (a) recognize each of the five art concepts from a mix of correct and incorrect synonyms, and (b) confirm or apply the correct concept from among several possible choices that is or is not demonstrably applied within a diagram or an art reproduction the learner sees in the instrument. Participants generated data (scores) that are records of their responses to the pre and post test.

Following participants' engagement with the post test, participants completed a survey in which they self-reported their

1. Uses of computers
2. Uses of video and computer games
3. Ages at which they first used computers
4. Possession of a smartphone
5. Attitudes toward what can help them understand color concepts
6. Attitudes toward getting classroom and online instruction

Data analysis

The study's methodology permitted comparisons between the pre and post test results in the four groups, and further analysis permitting interpretation of the strengths and weaknesses of the various types of practice in learning activities and conclusions with survey results.

I entered data (scores) participants generated via their responses to the pre and post tests into data files (Excel spreadsheets), then transferred these files to SPSS software that

facilitated making statistical analyses of the data. This analysis permitted the use of highly reliable scales and measures, whose significance could be determined.

In this process I prepared a codebook summarizing the instructions I used to convert the information I obtained from each subject into a format SPSS could process. Preparing the codebook involved deciding (and documenting) how I defined and labeled each of the variables; and assigned numbers to each of the possible responses on the pre and post tests. I utilized resources that helped to manage these files, chose what scales to employ, obtained the resulting statistics, and employed optimum means of presenting them.

The following statistical methods are traditionally used in comparing groups with pre test and post test data: (1) one-way analysis of variance (ANOVA) on the pre, post, and gain scores, and (2) *t*-tests to evaluate differences among the mean scores on pre and post tests achieved by participants in each group. In all these methods, the use of pre test scores helps to reduce error variance, thus producing more powerful tests than designs with no pre test data (Stevens, 1996). Generally speaking, the power of the test represents the probability of detecting differences between the groups being compared when such differences exist.

Kent Sabo, an expert in quantitative research analysis, earned a doctorate in educational technology in 2012. Kent expertly assisted me in the analysis of data my study's instruments generated in order to answer my research questions.

Rubric used in scoring marks made in tests

The test is comprised of fifteen items, ten of which demand participants select correct responses from sets of four possible responses in order to convey evidence of

participants' recall and application of color concepts, making the scoring of these items entirely clear. Five of the fifteen items ask participants to use colored pencils to make marks on a paper form that will evince participants' recall and application of color concepts. Each of these test items asks for the marking of a different color in each of three spaces, each  (each 3/8 of an inch high by 3/16 of an inch wide) on paper. On the pre and post tests of 183 participants there were a total of 5,490 marked items to score in order to determine levels of achievement at producing marks that encode specific art concepts. I designed and consistently utilized a rubric to guide the scoring process, one that would settle scoring questions in the instances in which marks indicated a level of correspondence to the concept to be encoded that straddled success and failure. The need to evaluate participants' actions necessitated determining empirical criteria that would indicate either yes or no, whether there had been success or failure to encode the concept with a mark. Directions each test-taker found at the top of the paper test form (see Appendix VII) were:

> There are fifteen questions. For ten of them, use the computer's mouse to click on your selection. Respond to five questions by using colored pencils to mark in spaces below. To choose pencils well, test them outside the spaces before drawing.
> Completely fill each space. You are asked to mark a single color in each space. When you are finished, if color variations or white paper show within a space, your marks do not present a single color.
> Corrections: If you wish to replace a marking, you may draw additional spaces near those printed spaces, then cross out spaces that will not be scored.

These directions were consistent with and essentially repeated components of instruction that every participant received in the instructional segment of the online instrument. The scoring procedure was to examine the mark in each space, determine whether the mark in each space aligned with the test item's challenge to the participant,

and therefore merited a + (= correct) or a – (= incorrect). I scored these responses in the manner I describe here. Evidence for my determination of whether the participant succeeded seldom presented difficulty. Nevertheless, if the mark was one that was problematic, whether it indicated partial but not complete encoding of the concept, I noted this by scoring it as a "+/-." A yellow or blue mark, for example, would receive this score if I found it difficult to determine with certainty whether it were a tint or a bright rendition of its hue.

As clear and nearly universally applicable as this rubric proved to be, there were items that proved difficult to determine a score because they straddled conceptual criteria. Of the 2,700 test items I scored, fewer than 30 fit into this last category (-1.1%).

Table 1. Rubric used in scoring marks made in tests

Scores for marks in 3 spaces	Result in one score for the item
+, +, + +, +, +/-	+ (correct)
+, +, - +, +/-, - +, +/-, +/- +, -, - -, -, -	- (incorrect)

Ethical issues

The researcher anticipated that there would be no ethical issue arising in the conduct of the study. Although he watched for any that might arise, he is confident that there were none.

Each participant attached his/her name to documentation of participation in each of the study groups, and to documentation of the survey of attitudes toward computer

technology and art instruction. The researcher permanently assigned an identifying number to each participant, and, before completion of the study, no participant's name appeared in any other portion of the study, and no participant's name appears in any publication concerning the study.

The researcher secured permission or assent to participate from parents and/or students, as needed to satisfy all concerned individuals, schools, and ASU's IRB (See Appendixes VIII and IX). Elementary school administrators and facilitators had ample opportunity to preview components of the study, and accepted that these (instruction, practice activities, and testing) were sufficiently aligned with their institutions' goals, that they (school officials) bore no responsibility to secure parent permissions to conduct any portion of the study, and that student assent to participate would be assumed because the schools see the study as part of their curricula. A permission form was distributed to potential participants, describing the study, identifying the researchers, their contact information, and asking parents to return either a form withdrawing their child from participation, or a form acknowledging receipt of the letter.

Study facilitators encouraged all participants' best involvement in the study, and implemented appropriate techniques of classroom management, especially to curb activities of participants which would interfere with other participants' attention, safety, or wellbeing. None of the study's facilitators reported interfering activities, so no such activities needed to be figured into analysis of the study's results.

Preliminary (dry run of the) study

The researcher conducted a dry run of a similar, previous version of the study with a small number of fifth grade students using the instructional and test instruments in the spring of 2012 after the IRB approved conducting the study.

Limitations and delimitations

Limitations

The study involves the use of a test that I have produced in two essentially identical forms, a pre and a post test, which participants in this study took online. This test utilizes photo reproductions of art diagrams and works of fine art and visual culture in which are encoded certain art concepts in the field of color theory. The degree to which these images and these art concepts could represent all potential images in which these concepts are embedded is a limitation. The degree to which these art concepts could represent all art concepts is also a limitation.

Some participants may have been physically or psychologically impaired in their abilities to see and hear instruments, think clearly about, or submit responses to the test. I am aware of very few participants who were so impaired.

Factors in the testing environment may have unduly influenced the performance of participants. Such factors might include air quality, ambient sounds, distracting activities of test givers or test takers. I am aware of very few participants who might have been negatively influenced by such environmental factors.

Delimitations

The study focuses on students at the fifth grade elementary school level, typically at age 11, although some may have been a bit younger or older.

The study employs a computer-based, online art instructional unit as the instrument through which participants learn art concepts, and through which participants' knowledge of these concepts is tested.

Validity of the study

The main problem with this design is that it improves internal validity but sacrifices external validity to do so. There is no way of judging whether the process of pre testing actually influenced the results because there is no baseline measurement against groups that remained completely untreated. For example, children given an educational pre test may be inspired to try a little harder in their lessons, and both groups would outperform children not given a pre test, so it becomes difficult to generalize the results to encompass all children.

The other major problem, which afflicts many sociological and educational research programs, is that it is impossible and unethical to isolate all of the participants completely. If two groups of children attend the same school, it is reasonable to assume that they mix outside of lessons and share ideas, potentially contaminating the results. On the other hand, if the children are drawn from different schools to prevent this, the chance of selection-bias arises, because randomization is not possible. Although it was possible for students within participating schools to converse about the study's components outside of its activities, the students in the study attended six schools of such socio-economic diversity in a large school district, that this diversity would increase the degree of validity this study might provide.

The researcher is able to discuss and defend the study's *internal validity*, what Campbell (1957) first defined as the question, "did in fact the experimental stimulus

make some significant difference in this specific instance?" (p. 297), its *external validity*, what Shadish, Cook, and Campbell (2002) define as, "the validity of inferences about whether the causal relationship holds over variation in persons, settings, treatment variables, and measurement variables," (p. 38) its *statistical conclusion validity*, what Cook and Campbell (1979) defined as, "the appropriate use of statistics to infer whether the presumed independent and dependent variables covary," (p. 37) and its *construct validity*, what Shadish et al define as, "the degree to which inferences are warranted from the observed persons, settings, and cause and effect operations included in a study to the constructs that these instances might represent" (p. 38).

CHAPTER 4

RESULTS

The study's facilitators and participants

Five teachers (four art teachers, and one computer technology teacher) facilitated this study at six schools at varying socio-economic levels within one large suburban district in the southwest of the United States. Schools where the study was conducted had enrolled a total of 494 fifth grade students (the majority eleven years old). Some students returned forms indicating permission to participate. Those who either lacked parental permission or their own assent engaged in an alternate activity. Students who submitted qualifying permission forms and whose participation resulted in the collection of sufficient data through test and instructional instruments resulted in a total *n* of 183. Eighty-nine were male; ninety-four female. Twenty-three indicated that English is spoken less at home than another language.

Table 2. Participants

Categories	frequency	percent (%)
Total *n*	183	99.9
Males	89	48.6
Females	94	51.4
English used most at home, Yes	179	82.2
English used most at home, No	23	12.5

Participants within the study's groups

Once participants were randomly assigned to the study's four groups (Diagrams, Art, Marking, and Control), the resulting *n* in each group was 43-50 (See Table 3).

I retained twenty-one additional participants whose data did not allow association with a group. I included the data generated by these participants only when responding to research questions that did not require associating them with the groups.

Table 3. Participants within groups

Categories	frequency	percent (%)
n = Group I, Diagrams	43	23.5
n = Group II, Art	50	27.3
n = Group III, Marking	46	25.1
n = Group IV, Control	44	24.0
n unidentifiable by group	21	
n including subjects unidentifiable by group	204	

Participants engaged in pre and post tests that were equivalent to each other. These tests were labeled "X" and "Z." To prevent test bias, about half of all participants engaged in test X as pre test, the other half in test Z as pre test, later engaging in the other test as post test.

Table 4. Participants taking tests in two orders

Categories of Participants	frequency	percent (%)
Took Test X as pre test, Test Z as post test	99	48.5
Took Test Z as pre test, Test X as post test	105	51.5

A mechanism of the online instruments facilitated the recording of data participants generated as a result of their activities into online spreadsheets. I scored the marking activities that participants performed on paper forms (in Methodology, see Rubric for scoring marks made in tests). I assembled a master spreadsheet of data

generated by participants' engagement with all of the instructional and test instruments along with participants' responses to a survey of their computer use and attitudes toward art instruction (see Appendix II).

Statistical analyses

I conducted three one-way analysis of variance (ANOVA) tests, regarding pre test scores, post test scores, and the gain scores achieved from pre to post tests (Table 5) to evaluate the relationship between three types of practice activities that might be incorporated into online instruction and scores of tests of students' application, or recognition of application of art concepts. The independent variable, differing practice activities, included four comparable interventions: practice with diagrams, practice with art, practice with marking, and no practice at all (the control group, substituting an alternative, unrelated activity in place of practice). The dependent variable was the learning outcomes, as measured by pre and post tests, to recognize applications of five art concepts (color theory) as decoded from diagrams and artworks, and as encoded by making marks.

Table 5. Three One-Way ANOVAs

	F	*p*
Pre Test Scores	0.875	0.455
Post Test Scores	0.406	0.749
Gain (Pre to Post Test Scores)	0.979	0.404

The ANOVA regarding pre test scores revealed that differences among them were not significant, $F(3, 179) = 0.88$, $p = 0.46$ (p is not < 0.05). Although this measure did not reach the level of significance, the pre test ANOVA establishes that each group

was statistically equivalent in their knowledge of the targeted art concepts. In other words, each of the groups' knowledge of these art concepts was at comparably similar levels prior to receiving instruction.

The ANOVA regarding post test scores was also not significant, $F(3, 179) = 0.41$, $p = 0.75$ (p is not < 0.05). This suggests that there was little difference in the mean post test scores among the groups, and that, statistically, all groups performed comparably well on the post test.

The ANOVA regarding gain scores was not significant, $F(3, 179) = 0.98$, $p = .40$ (p is not $< .05$). There was no significant difference in the mean post test scores among the groups, and all groups performed comparably well on the post test.

Paired-samples *t*-tests (Table 6) were conducted to evaluate differences among the mean scores on pre and post tests achieved by participants in each group. All were significant ($p < .01$), and reveal that every group attained gains in their mean test scores. One can infer that the instructional instruments were effective to various degrees for all participants.

Paired-samples *t*-tests were conducted to evaluate the differences in means between dependent groups. The results indicated that the mean post test scores achieved by the diagrams group ($M = 50.54$, $SD = 20.53$) were significantly higher than this group's pre test scores ($M = 29.77$, $SD = 13.12$), $t(42) = 7.22$, $p = < .01$. The standardized effect size index, d, was 1.2057. This measurement, resulting from Cohen's test of effect size, indicates that it is appropriate to interpret this intervention as having a large effect (Cohen, 1988).

Table 6. Paired Samples *t*-Tests

	Mean difference scores	*SD*	*p*
All Groups' Pre & Post Scores	17.42%	19.58	0.00
Diagram Group's Pre & Post Scores	20.78%	18.87	0.00
Art Group's Pre & Post Scores	18.10%	22.03	0.00
Marking Group's Pre & Post Scores	13.62%	19.42	0.00
Control Group's Pre & Post Scores	17.19%	19.04	0.00

Cohen's effect size, *d*, is one in a family of indices that measure the magnitude of a treatment effect. Cohen said (1992) that, "The power of a statistical test of a null hypothesis is the probability that the null hypothesis will be rejected when it is false, that is, the probability of obtaining a statistically significant result (p.98)." Significance tests that lack statistical power are of limited use because they cannot reliably discriminate between a null hypothesis and its opposite, hypothesis of interest. Because power analyses are indispensable for rational statistical decisions, it was not until the late 1980s that power charts and power tables were supplemented by more efficient, precise, and easy-to-use power analysis programs for personal computers. Now, having been posted on numerous scholarly web sites, such effect size calculators are readily available.

The results indicated that the mean of post test scores attained by the art group ($M = 50.54$, $SD = 18.87$) were higher than the mean test scores achieved by the art group in their mean pre test scores, and achieved a level of statistical significance ($M = 33.74$, $SD = 14.17$), $t(48) = 5.75$, $p = < .01$. The standardized effect size index, *d*, was 1.00681.

Based upon this Cohen's *d* statistic (Cohen, 1988), I interpret the effect of this intervention as having been large.

The results indicated that the mean of post test scores attained by the marking group ($M = 47.54$, $SD = 20.54$) were higher than the mean test scores achieved by the marking group, and achieved a level of statistical significance ($M = 33.91$, $SD = 13.54$), $t(45) = 4.76$, $p = < .01$. The standardized effect size index, *d*, was 0.78352. Based upon this Cohen's *d* statistic (Cohen, 1988), I interpret the effect of this intervention as having been large.

The results indicated that the mean of post test scores attained by the control group ($M = 49.33$, $SD = 18.88$) were higher than the mean of the post test scores achieved by the control group in the mean of their pre test scores, and achieved a level of statistical significance ($M = 32.15$, $SD = 13.95$), $t(44) = 6.04$, $p = < .01$. The standardized effect size index, *d*, was 1.03499. Based upon this Cohen's *d* statistic (Cohen, 1988), I interpret the effect of this intervention as having been large.

The mean gains achieved by the four groups ranged from 13.62 to 20.78 %. The greatest gains were achieved by participants who practiced by decoding concepts by looking at diagrams (20.78 %). The group that practiced by decoding concepts from looking at artworks achieved the second greatest gains (18.10 %). The control group achieved lesser gains (17.19 %) than these two groups, but greater gains than the group of participants who practiced by encoding concepts by making marks (13.62 %).

Why do the statistical tests that, separately, I have displayed and explained above show that there was no statistical difference between the gains achieved by the four groups, but that there was a significant difference between the mean pre and post test

scores achieved by the four groups? Although each group's gains were robust and measurable, comparing each group's gains between the groups is problematic. I'll discuss the issues concerning this phenomenon in the next chapter.

Following their engagement in the post test, all participants responded to thirteen questions on a survey, of which five questions pertained to experiences with computers. Table 7 reports participants' responses to this set of questions.

Asked to recall, and to state how old they were when they first used computers, responses ranged from 2 years old to ten. The mean of the ages stated by all respondents was 5.5 years. Considering how potentially inaccurate the memories of eleven-year-olds are apt to be of their earlier years, the reliability of these responses is questionable.

Seventy-four percent reported using computers no more than ten hours during the last seven days. Only 11.4% reported using computers more than twenty hours during the same period.

Forty-five percent reported having "played video or computer games" in the previous week. Almost a quarter (23.4%) reported playing 2-10 hours, 14.7% ten to twenty hours, and 13% more than twenty hours. This attests to the broad familiarity participants have with computer technology, and to the high degree to which participants have employed computers as a platform for leisure-time entertainment.

Asked to characterize the purposes to which they direct their uses of computers, 78% said they use computers for schoolwork. This response strikes me as surprisingly low, considering the emphasis educators in these students' schools have placed on engaging students in developing their facility in using computers to reach educational objectives from kindergarten. Every one of these students spends as much time in a

computer laboratory as s/he does in an art classroom. Each student has access to computers in his/her grade-level classroom, and typically at home as well.

Half of participants (49.7%) said they used computers to use email. This too is a surprisingly low percentage. Every one of these participants have been provided with an email account (Gmail) by their school district, and lessons in using them well. Additionally, some students have personal email accounts in addition to school accounts.

Although the school district has placed technological impediments within its schools which block students' access to social media, three out of ten students (30.8%) reported using such social media as Facebook.

Twenty-eight percent reported using "graphic software (making pictures: drawing, painting, photo editing, etc.)" on computers. Much higher proportions of participants reported using computers to play games (75.7%) and and to watch videos (69.7%).

Sixteen participants submitted written responses to the question asking how they have used computers. Three said they've used computers to Skype. Another said, "Talking to friends." One said "Music." Two others specified "listening to music." Four referred to "research," one indicating research regarding "Biology (Embriology)," and another, "what I want to be when I grow up and looking at photos." Additional individuals responses were: "Looking things up," "Project," "Reading at night," "Shopping," and "Instagram." Considering how few written responses participants submitted, it is difficult to assess the degree to which these experiences are either typical or unusual among the study's participants.

Although use of smartphones (cellular phones that contain computer processors) has become ubiquitous among American adults, their ownership among this study's eleven-year-olds (24.1%) naturally lags behind smartphone use in the adult population.

Table 7. Responses Concerning Use of Computers and Smartphones

Question	Frequency	%
"In the last seven days I have used a computer (desktop, laptop or tablet/iPad)"		
less than 2 hrs/wk	83	44.9
2-10 hrs/wk	54	29.2
10-20 hrs/wk	27	14.6
more than 20 hrs/wk	21	11.4
"In the last seven days I have played video or computer games"		
less than 2 hrs/wk	90	44.9
2-10 hrs/wk	43	23.4
10-20 hrs/wk	27	14.7
more than 20 hrs/wk	24	13.0
"I use computers for (Check all that apply.)"		
school work	145	78.4
email	92	49.7
Facebook and/or other social media	57	30.8
graphic software (making pictures: drawing, painting, photo editing, etc.)	51	27.6
playing games	140	75.7
watching videos	129	69.7
"I have my own smartphone"	68	24.1

Eight of the questions on the survey were in the form of Likert-like statements to which participants were asked to select "the best response."

This study's participants strongly agreed (71.3% agreed, 11.4% disagreed) with the statement, "During my art class time, I would like to decrease the time I get instruction and increase the time I make art." Art teachers commonly report that students prefer art production activities to instructional ones, so it is no surprise that a majority of this study's participants got behind decreasing instructional time in order to increase art

production time. Nevertheless it is noteworthy that participants aligned with this idea as vehemently as they did. I'll discuss the implications of this response in the next chapter.

When asked their attitudes toward the statement, "If I could get online instruction outside of art class time (as homework) and increase the time I can make art during art class time, I'd like that!" more participants indicated disagreement than agreement (32.0% agreed, 45.5% disagreed). One might expect children to invariably favor reducing time on homework, so it is striking that almost a third of participants found an increase in homework appealing if it would increase the time they'd produce art during art classes. I'll discuss this finding in the final chapter.

The last two questions were nearly identical to each other: "I learn more by making art than I do from the teacher's instruction," and "I learn about the same amount from the teacher's instruction as I do when I am making art." 45.9% agreed, and 22.7% disagreed with the first of these, while 45.4% agreed, and 26.5% disagreed with the latter. Although more participants agreed much more than they disagreed with these statements, 22-31% of all respondents were ambivalent (neither agree nor disagree) to these questions.

Table 8. Responses Concerning Attitudes toward Art Instruction

Attitude Statement Response	Frequency	%
"Looking at diagrams can help me understand color"		
Agree a lot	36	19.4
Agree a little	67	36.0
Neither agree nor disagree	54	29.0
Disagree a little	18	9.7
Disagree a lot	11	5.9
"Looking at art can help me understand color"		
Agree a lot	60	32.2
Agree a little	40	21.5

Neither agree nor disagree	44	23.7
Disagree a little	23	12.4
Disagree a lot	19	10.2
“Making marks with colored pencils can help me understand color”		
Agree a lot	42	22.7
Agree a little	52	28.1
Neither agree nor disagree	39	21.0
Disagree a little	29	15.7
Disagree a lot	23	12.4
“During my art class time, I would like to decrease the time I get instruction and increase the time I make art”		
Agree a lot	101	54.0
Agree a little	32	17.3
Neither agree nor disagree	31	16.8
Disagree a little	7	3.8
Disagree a lot	14	7.6
“If I could get online instruction outside of art class time (as homework) and increase the time I can make art during art class time, I’d like that!”		
Agree a lot	31	16.8
Agree a little	28	15.2
Neither agree nor disagree	41	22.3
Disagree a little	40	21.6
Disagree a lot	44	23.9
“I learn more by making art than I do from the teacher’s instruction.”		
Agree a lot	45	24.3
Agree a little	40	21.6
Neither agree nor disagree	58	31.4
Disagree a little	18	9.7
Disagree a lot	24	13.0
“I learn about the same amount from the teacher’s instruction as I do when I am making art.”		
Agree a lot	38	20.5
Agree a little	46	24.9
Neither agree nor disagree	52	28.1
Disagree a little	29	15.7
Disagree a lot	20	10.8

CHAPTER 5

DISCUSSION AND CONCLUSIONS

Primary research question

Which of three types of practice activities (independent variable) that might be incorporated into online instruction is most effective in increasing students' art learning for application, or recognition of application (dependent variable) of art concepts?

The answer to this question remains uncertain. The mean gains achieved by the four groups ranged from 13.62 to 20.78%. Participants who practiced by decoding concepts by looking at diagrams showed the strongest evidence of learning (20.78% gains in mean scores from pre to post tests). The group that practiced by decoding concepts from looking at artworks achieved the second greatest gains (18.10 %). The control group achieved lesser gains (17.19 %) than these two groups, but greater gains than the group of participants who practiced by encoding concepts by making marks (13.62 %). Although t-tests showed these gains to be significant, the differences between them are not significant.

Secondary research questions

Is there a statistically significant difference in achievement scores by students engaged in the three types of practice?

The results of three ANOVAs show that there was not a significant difference in achievement scores between participants who engaged in three types of practice activities.

I theorize that among the reasons that differences between my study's groups' scores are not significant:

There were insufficient:

- variation between the types of practice activities. Additional categories of practice activities could include practice decoding concepts entirely by reading texts. This was eliminated at this study's planning stage, because it is an obviously less than optimal mode for visual art. Nevertheless it was a dominant mode in educational media well into the twentieth century.
- variation within the types of practice activities. Considering the uniformity of the meaning of each art concept, any two ways of presenting those concepts are apt to overlap unavoidably. As much as diagrams, works of art, and colored pencils differ from each other, similarities between activities engaging them to focus on individual art concepts are likely to have hindered the achievement of measurement of significant differences between participants' engagements in practice activities of differing types.
- time participants devoted to engaging in practice activities. One of the practical limitations of this study's design was the amount of time I could take students away from their other school activities. Consequently I limited the time for participants' involvement to two 40-minute sessions. I speculate that if participants' time on the study's activities were to have increased greatly, participants' engagement in practice activities might have increased the potential for significant differences in measurements of the study's outcomes. By increasing the time participants engaged in practice activities, participants could have utilized a greater number of comparable practice activities. Just as learning any skill is more apt to succeed when a person practices over a longer period of

time, participants' longer engagement in a study's activities might make measures of learning via differing types of practice more pronounced.

- numbers of participants who engaged in practice activities. Higher sample size allows a researcher to increase the significance level of the findings, since confidence in the result is likely to increase with a higher sample size. A researcher follows this principle because the larger the sample size, the more accurately a researcher can expect the actions of the study's participants to reflect the actions of the group about which one seeks to generalize. So, if enlarging the size of the sample results in an increased ability to generalize, and statistical tests result in measures lacking significance, a researcher seeking statistics that reveal significance considers increasing sample size to achieve it. Nevertheless, since my sample sizes were as large as they were, I suspect that increasing their size is the weakest of the changes I am suggesting.

Are the post test scores of participants who engaged in practice recognizing applications of art concepts embedded in diagrams with feedback higher than their pre test scores?

Yes. Participants who practiced by decoding concepts by looking at diagrams achieved significant gains from mean pre to post test scores of 20.78%. These were the greatest gains achieved by any group, and they reached a level of statistical significance.

Are the post test scores of participants who engaged in practice recognizing applications of art concepts embedded in images of artworks with feedback higher than their pre test scores?

Yes. The group that practiced by decoding concepts from looking at artworks achieved gains from mean pre to post test scores of 18.10 %. These were the second

greatest gains achieved by any group, and they reached a level of statistical significance.

Are the post test scores of participants who engaged in practice applying art concepts by encoding them in marks with feedback higher than their pre test scores?

Yes. The group of participants who practiced by encoding concepts by making marks achieved significant gains from mean pre to post test scores of 13.62 %. Dampening one's esteem for this measure of learning, however, is evidence that the control group, which engaged in no practice activity that might increase learning of the targeted art concepts, achieved more powerful gains of 17.19 % than did the group that practiced by encoding the targeted concepts by making marks.

Among the 24 slides that made up the instructional component of the online instruments, there were four slides designed solely to help participants optimally use colored pencils to mark responses on the paper form for the post test. Marks on pre and post tests were judged by identical criteria (see Rubric for scoring marks made in tests). To optimize objectivity, the scorer was prevented from differentiating test forms of pre and post tests. I speculate that gains were as modest as they were because, despite participants' instructions on how to make marks well, participants were

- more physically and mentally adept at using a computer to select the best response from the four offered than they were at using colored pencils to make marks on the paper forms.
- distracted from attention to the test and to working memory by the challenge to select colored pencils from the seventeen they had in a plastic bag, and to enter responses with pencils on the paper form. Each participants could otherwise focus

attention on a computer screen, moving seamlessly between its image and text to clicking an on-screen selection of the best response to a question.

- needed more time to engage with practice activities for these to be powerful.
- As I pointed out earlier, disciples of Piaget might be surprised at the finding that the most hands-on practice activity was the weakest among them, because Piagetians are prone to promote hands-on activities for their power to affect learning.

Is there any relationship between patterns of participants' achievement on tests and their reports of their use of computers and comparable devices?

Among the various ways participants might indicate they had used computers in the last seven days, a *t*-test revealed a statistically significant gain between post test scores and participants who indicated that they used "graphics software (making pictures: drawing, painting, photo editing, etc.)" ($M = 1.72$, $SD = .45$), $t(184) = 32.80$, $p < .04$). If there is a relationship between abilities to learn color concepts and abilities to use graphic software, then perhaps using graphics software is a means to learning color concepts. This is all the more likely since no such relationship was found among participants who indicated having used computers for school work, email, social media, playing games, or watching videos.

Uses of video and computer games

A *t*-test also revealed a statistically significant gain between participants who devoted more time than others ("more than 20 hours in the last seven days") on playing video and computer games and participants' gains from pre to post tests ($M = 1.87$, $SD = .34$), $t(184)=10.75$, $p < .03$). Evidently frequent use of gaming skills might be a predictor

of the ability to learn color concepts. I wonder to what degree this is because there is a similarity between these two abilities, or whether devoting so much attention to computer and video gaming has a causal effect, tending to increase children's ability to learn a variety of abilities. This may bear further investigation.

Asked to characterize the purposes to which they direct their uses of computers, 78% said they use computers for schoolwork. This response is surprisingly low, it seems to me, considering the emphasis educators in these students' schools and elsewhere in the United States have placed on engaging students in developing "twenty-first century skills" — facility in using computers to reach educational objectives, and from an early age. Every one of these students spends as much time in a computer laboratory as s/he does in an art classroom. Each student has access to computers in his/her grade-level classroom, and typically at home as well.

Ages at which they first used computers and whether they own a smartphone

Results revealed no statistical relationships either between when participants first used computers nor whether they own a smartphone and their achievements on tests.

Attitudes toward what can help them to understand color concepts and getting classroom or online instruction

None of participants' responses to these items revealed a statistical relationship to participants' scores on tests.

Implications for further study

Online direct instruction and assessment are poised to expand, for students at the elementary level, as they have for secondary and undergraduate students, partly because

the necessary technology is increasingly available, and the effectiveness of such online learning activities is considerable. Researchers who pursue lines of inquiry that relate to the research objectives of this study may wish to further inquire into issues I have addressed to some extent in this paper. I'll list some:

- There is a growing body of research that helps to guide designers of instructional materials, but the preponderance of such inquiry has attended to principles for instructional designs intended either for a broad range of learners, or for learners in disciplines other than visual art. Further inquiry is needed into how students of art most effectively learn the sorts of abilities that are specific to art, which will lead to the formulation or refinement of design principles that will guide designers to produce the most effective online instructional materials for students of visual art.
- Researchers might find ways to better understand the relationship between various modes of guided practice, implementing methods that will overcome the lack of statistical significance that resulted from ANOVA tests of this study's data.
- Researchers might investigate the merits of how online instruction of art concepts might be most effective within the pedagogical environment known as the *flipped classroom*, which I will describe and discuss in the next section.

Implications for practice

Art educators, whether delivering instruction directly in classrooms or indirectly online, occasionally design their own instructional instruments or choose from instruments others have designed. This study advances principles that might improve instructional designs, and specifically for the instruction of students of visual art.

Although the guided-practice activities of three types increased the learning of participants in this study, they did so modestly. The study revealed impressive increases in learning occurred as a result of the study's pre-practice, instructional component. Very likely this increase in learning came as a result of following such instructional design principles as,

- Chunk, sequence, and layer
- Minimize the user's cognitive load (eliminate distractors, including information that is irrelevant or rarely needed)
- Align visual components vertically and horizontally
- Use text and image styles consistently (avoid changing styles unnecessarily)
- Find ways to restate and review important concepts
- Make directions easy to find and to understand
- Make controls (forward, backward, etc.) easy to find and to use
- Engage multiple senses when possible
- Provide feedback (especially advice that's useful in the future)

Among the optimal environments for learning art concepts may be the pedagogical setting known as the *flipped classroom*. In the flipped classroom, growing in popularity since about 2007, students engage with their teachers in active, problem-solving activities during classroom time; while during homework time, students view asynchronous video lectures (or slide shows with audio) and engage in practice activities. Raths (2014) observes that, "There is no one correct way to flip the classroom, and approaches vary both by subject and philosophy (p. 15)." A common limitation of the

flipped classroom model, however, is the challenge to teachers' abilities to assess students' use of videos and practice activities. The instruments employed in this study present a solution to this problem. Since such instruments as these include pre and post tests, and their results can be seamlessly accessible to the teacher, the teacher can fully monitor each student's achievements at learning the concepts the teacher expected students to learn (the concepts the online instruments targeted). Whether or not an art classroom's setting fits the flipped classroom paradigm, however, if art teachers value their curriculum's art production and discussion activities as the most valuable uses of their class time, and students take a similar attitude, and art teachers had a variety of instruments comparable to those in this study, teachers could target whatever concepts students need to learn outside of class time, and obtain data on students' gains in knowledge as soon as students have engaged in those activities.

Noting the level of effectiveness of this study's instructional instruments, instructional designers may wish to emulate some qualities of these instruments in order to engage students in online instruction of art concepts that replicate or surpass the level of this study's success in creating learning outcomes. There are plenty of art concepts that such instructional materials might target. Since 1996, I have authored and published an online art resource, *ArtLex Art Dictionary* at artlex.com. *ArtLex* offers articles about four thousand concepts used in the fields of art and visual culture. It displays texts bearing definitions, context, quotes of authorities, and links to related resources, along with diagrams, photographs, and reproductions of artworks. ArtLex provides translation into languages other than English, among other services. (Upon completing my doctoral work, I plan to turn my attention to *ArtLex*'s improvement.) Visiting this art dictionary, I

identified hundreds of candidate concepts for such instructional treatments as I produced in conducting this research. Here is a sample:

- chiaroscuro
- emphasis
- figure-ground
- harmony
- linear perspective
- modernism
- postmodernism
- transformation
- wabi-sabi
- xenophobia

Appendix XI presents a list of 166 such concepts. Each of these might effectively be learned by students who experience a well-designed video or slide presentation of imagery, text, and audio, along with guided practice activities that incorporate (1) decoding concepts for recognition and application from diagrams and artworks, and (2) encoding into imagery. Students might engage in such computer-assisted instruction either in or outside of classrooms.

Students often express preference for art production over instruction. This historical tendency is inconsistent with the study's finding that making marks was found to be a less effective means by which to reinforce the learning of art concepts than was that of decoding the same concepts from diagrams and artworks. Making marks is a component of production in the art studio. It is a learning activity that's central to, and

inseparable from the study of art. So if there are problems with mark-making's effectiveness as a means of reinforcing learning, that recommends it as a subject for further inquiry. It might be useful to investigate principles that can guide art teachers in how best to allocate and to use class and homework time for instructional and studio (mark-making) activities, so that these are as robust as possible, and result in optimal learning.

A third of participants in this study found it appealing to engage in art homework activities in order to increase the time they would devote to producing art during art classes. One might expect *all* children to favor reducing time on homework, so it is striking that almost a third of participants felt it advantageous to engage in additional homework if that would increase the time they'd produce art during their classes. Since there may be a need and desire among students for effective art instruction outside of the school day, art educators might consider this to indicate an opportunity to advance curricular goals by promoting improved uses of class and homework times to increase learning.

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APPENDIX I

SCRIPTS OF INSTRUMENTS

The slides are numbered, both here and onscreen (obscurely dark along the right edge, or in the upper-right corner). In the script displayed below the audio-narration is in black. The onscreen text is displayed here as either gray or blue-green.

[neutrals] Jean Dubuffet, *The Cow with the Subtle Nose*, 1954, oil and enamel on canvas
French, male, 20th century, fine art
Q Excepting the blues and blue-greens in this painting, these colors are all
shades
tints
neutrals
hues
[tints] Ilya Bolotowsky, *White Circle*, 1958, oil on canvas, 60 3/4 inches (154.3 cm) in diameter
Russian-American, male, 20th century, fine art
The somewhat purple, somewhat green, and somewhat blue colors are examples of
tints
shades
hues
neutrals
[hues] David Edgar, *Ragged-Tailed Dragon-Fish*, c. 2010, cut and assembled plastic containers
Anglo-American, male, contemporary, fine art
[shades] Morgan Russell, Creavit Deus Hominem (Synchromy Number 3: Color Counterpoint), 1913, oil mounted on cardboard
American, male, 20th century, fine art
Most of the darker colors in this composition are
shades
tints
hues
neutrals
[values] Virginia Aguero, *Santa Teresita (Saint Theresa)*, 2001, gouache on paper
Mexican-American, female, contemporary, fine art
The artist who painted this picture used a wide range of
values
tints
hues
shades

Part One: Test Version X (pre test for half, post test for half)
Participants in the four groups receive the same pre and post test as participants in all groups, although the pre and post tests differ in the arrangement of their items, and in their diagrams and artworks. All 15 test items are aligned with practice activities (five for each of the three types of practice, three for each of the five color concepts) to which the separate groups will be exposed. The first four slides include audio-narration.

[narration:] Color Concepts for use in art[text on slide:] Color Concepts for use in art / Michael R. Delahunt / © 2013
Color Concepts for use in art. Part Three: A test of abilities to recognize and apply color conceptsColor Concepts for use in art. Part Three: Test

[no narration]About You...Your first name _____ [form in which to key text]Your last name _____ [form in which to key text]The name of your school _____ [form in which to key text]O Male O Female [form allowing a click to select response]When you are home, is English the language you use most? O Yes O No [form allowing a click to select response]
This is a short test to see whether you have already learned to recognize the color concepts studied in this program. There are fifteen questions. Use the computer to enter most of your responses. Use the sheet of paper your teacher gives you for the questions that ask you to use colored pencils to mark colors in spaces on the answer sheet. At this time use any dark color to write your name, first and last, at the top of the answer sheet.INSTRUCTIONS for responses. Respond to ten questions by using the computer's mouse to click on your selection. Respond to other questions by marking with colored pencils in spaces on the answer sheet. Now, please write your name on the answer sheet.
[no narration][9, art, hue] The colors in this sculpture (David Edgar, *Ragged-Tailed Dragon-Fish*, c. 2010, cut and assembled plastic containers), the artist applied colors having a range of differentSelect one response- tints of red- hues- tints- values
[no narration][12, dia., tint (use the diagram that has a series of color wheels, progressively] The lighter colors in this diagram areSelect one response- neutrals- hues- shades- tints
[no narration][8, dia., hue] All of the colors in this diagram haveSelect one response- values- qualities of tints- qualities of neutrals- qualities of shades
[no narration][6, dr. hue] Some of the colors in this color wheel are hues. Using colored pencils, mark three hues, filling in spaces on the answer sheet. To choose pencils well, test them outside the spaces before marking. Completely fill each space. If there is white paper showing within a space your marking does not present a pure hue.
[no narration][5, art, shade] The This painting's (Morgan Russell, *Creavit Deus Hominem (Synchromy Number 3: Color Counterpoint*) darkened colors areSelect one response- lighter values- tints- shades- hues
[no narration][20, dia., neutral] The colors in this diagram are allSelect one response- tints- neutrals- shades- hues
[no narration][14, dr., tint] Select three tints from the diagram above, and, using colored pencils, mark those tints, filling in three spaces on the answer sheet. To choose pencils well, test them outside the spaces before marking. If there is any color other than the one(s) you intend to place in the space where you draw, the color in that space may not be correct.
[no narration][18, dr., shade] Select three shades in the color wheel above, and, using colored pencils, mark those shades in three spaces on practice paper. To choose pencils well, test them outside the spaces before drawing. If there is any color other than the one(s) you intend to place in a space, the color in that space may not be correct.

[no narration][21, art, value] In this painting (Virginia Aguero, *Santa Teresita (Saint Theresa)*, 2001, gouache on paper), the colors in the saint and her clothing areSelect one response- no shades- many hues- no tints- many values
[no narration][16, dia., shade] The colors in the lowest four rows of this diagram are allSelect one response- hues- neutrals- shades- tints
[no narration][13, art, neutral] Jean Dubuffet, *The Cow with the Subtle Nose*, 1954, oil and enamel on canvas), the colors in most of the cow areSelect one response- shades only- tints only- hues only- neutrals only
[no narration][22, dr., neutral] Select three neutral colors in the color wheel above, and, using colored pencils, mark the neutral colors, filling in three spaces on the answer sheet. To choose pencils well, test pencils' colors outside the spaces before marking. If there is any color other than the one(s) you intend to place in the space where you mark, the color in that square may not be correct.
[no narration][10, dr., value] The diagram above displays colors with different values. Select three values from the diagram above, and, using colored pencils, mark those values, filling in three spaces on the answer sheet. 1) In the first space mark the lightest value of the three values you have selected. 2) In the second space mark the middle value you have selected. 3) In the third space mark the darkest value you have selected. To choose pencils well, test them outside the spaces before marking. If there is any color other than the one(s) you intend to place in the space where you draw, the color in that space may not be correct.
[no narration][17, art, tint] In the oval shape in this painting (Ilya Bolotowsky, *White Circle*, 1958, oil on canvas) most of the colors areSelect one response- tints- hues- shades- darker values
[no narration][4, diagram, hue] The colors in this diagram areSelect one response- shades- tints- neutrals- hues
[no narration]The test ends here.Thanks for your participation!Please make sure you've responded to every question on the computer or the answer sheet!Place every pencil in the envelope.

Part Two: Instruction

Color Concepts for use in art. Michael R. Delahunt, copyright 2013
From the AuthorThe lesson you receive today is part of a research study.The goal of the study is to increase understanding of activities that promote student learning.Data generated by your participation may influence designers of educational programs for years to come.Thank you for your participation Michael R. Delahunt Art Teacher, PVUSD, Phoenix, AZ Doctoral Candidate, Arizona State University
About You...Your first name _____ [form in which to key text]Your last name _____ [form in which to key text]The name of your school _____ [form in which to key text]O Male O Female [form requesting indication of gender]When you are home, is English the language you use most? O Yes O No [form requesting indication of whether or not English is primary language]
Color Concepts for use in art. Part One: InformationColor Concepts for use in art. Part

One: InformationThis program has audio narration. To avoid interfering with others, please use earphones.
Consider all the colors *possible* — an amazing variety! Even if you had a huge set of crayons or paints, there would be lots of colors you would be missing, some inbetween, some lighter and darker colors, along with odd ones you might like to see and use.
[image: a colorful design]
This short lesson (about 20 minutes) will help you to better - see colors and their qualities- describe colors and relationships between them- produce colors from their parts- and apply colors in making art[image: a colorful design]
White light becomes a rainbow when it passes through rain drops.[image: photo of a rainbow above trees]
How does white light separate into different colors? Drops of water act like prisms that divide white light into its parts.white light > water drops > different colors
The colors in the rainbow are called **hues**.Hues
This is a "**color wheel**." This color wheel has twelve **hues**.A color wheel. Twelve Hues
In this version of the color wheel, the pure hues are placed around the outer edges. Arrows point to the circle of hues between two black lines.hues [image: two arrows point to hues]
In the center of this color wheel the hues have been lightened. If these were paints, tints would be hues that are mixed with white. Lightened colors are called **tints**. Although tints have hues, be careful not to call them hues.hues tints [image: two arrows point to hues, and two arrows point to tints]
The painter of this picture painted it entirely in tints, because tints would express the emotion he felt or intended.painted in tints for expression Barton Church, *Girl in a Chair*, 1951, oil on canvas
This series of color wheels shows that all colors can be darkened. When hues are darkened, we call them **shades**.All hues can be darkened.Darkened hues are shades.
Some people call sunglasses "shades." To recall that darkened hues are called shades, imagine sunglasses darkening bright colors.shades
Making a computer animated movie about a blue-green lizard named Rango, an artist **contrasted tints** against **shades** in the lead character's skin to show that the sun shines brightly on his face.Tints beside shadesGore Verbinski, Director, *Rango*, 2011, computer animated film
This gray has no hue at all. We call colors with no dominant hue **neutral** colors, or simply neutrals. Neutrals can also be browns.Colors with no dominant hue are neutral colors. [image: one gray]
The painter of this humorous picture made it entirely with neutral colors. We see no evidence of any hues. This give the picture the look of an old photograph.painted in neutral colors as in an old photoMark Tansey, *Not Just for Laughs*, 1981, oil on canvas
Although **neutral** colors can be grays (colors lacking a dominant hue), many neutrals are browns and other dull, muddy colors — colors having at least two very different hues.Neutral colors can be grays, browns, and other dull, muddy colors. [image: field of neutral colors]
These three grays differ in their lightness or darkness. We can also say they have different "**values**" because, in art, **value** is a color's lightness or darkness.Value is a

color's lightness or darkness. [image: three grays]
Here are fifteen neutral colors, a wider range of **values**. Call this a **value scale**.value scale
This value scale displays even more neutral colors because its values change so very gradually.[image: value scale]
Just as neutral colors can have different values, colors with hues can have different values too. Here are value scales for six hues.value scale for six hues
Here is a value scale in which red is the only hue. Excepting white and black, each color in this scale is a red. Only one is the hue red. The others are tints or shades of red.a value scale in which red is the only hueother colors are tints or shades of red
Later you will take a short test. Ten questions will ask you to select the best responses on the computer. Five questions will ask you to use colored pencils to mark colors on paper. The colors you mark will reveal that you know the color concepts hue, value, tint, shade, and neutral. [audio file: slide_25_later.band and mp3][**New! on screen text:**] Making marks[image: a photo of colored pencils on paper, revealing spaces like those on the test form. Spaces are marked.]
First, you'll choose a colored pencil from the set your teacher will lend you, then mark the color to fill the space on a form. Your response will be correct if you mark a color that is as light or dark, gray or brown, or pure as the color concept demands. Your response will be incorrect if the way you mark a color makes it appear too light, too dark, too gray or brown, too pure, or if it includes extra colors you don't need. Consider whether it is important to mark a color permitting no white paper to remain in a space. To ensure a color isn't lighter than it needs to be, you may need to mark in this manner — pressing strongly and evenly — not too lightly.[audio file: slide_26_first.band and mp3]1. Choose pencils. 2. Mark colors by filling spaces. [image: A red pencil, and on the paper: "Red = [ ]" and a space filled with red. "Red doesn't = [ ]" spaces filled not filled with red — some pressed too lightly (an unwanted tint), another spread too unevenly, leaving areas of white (unwanted white).]
When you need to mark a shaded color, you can either use a pencil that marks a shade when it fills a space, (and you press hard,) or blend marks of two pencils: a pencil in a hue and a pencil in black. Marks that permit some white of the paper to show will be incorrect, because these present lightened colors. To make shades, press hard and fill the space with marks![audio file, located in the Music folder on my computer, in a folder of files prepared in November, 2012: slide_27_shade.band and mp3]How to mark a shade of red.And, how not to mark a shade of red.[image: "Shade of red = [ ]" (a space filled with dark red pigment. Another) "Shade of red = [ ]" (a space filled with a blend of the hue red and black. Then) "Shade of red doesn't = [ ]" (a space not fully filled with dark red pigment, because it's too lightly drawn. Then) "Shade of red doesn't = [ ]" (a space not fully filled with dark red pigment, because it reveals areas of white paper)]
When you need to mark a neutral color, you can either use a pencil that marks a neutral when it fills a space, or you can blend marks of two or more pencils. Press hard for a color that has no white. Press more lightly for a color that includes some white.[audio file: slide_28_neutral.band and mp3]How to mark a neutral color.And, how not to mark a neutral color.[image: "Neutral color = [ ]" and a space filled with dark red pigment. Another "Neutral color = [ ]" and a space filled with a blend of the hue red and black. "Neutral color doesn't = [ ]" and a space not fully filled with dark red pigment, because

it's too lightly drawn. "Neutral color doesn't = [ ]" and a space not fully filled with dark red pigment, because it reveals areas of white paper.]
This concludes the introduction of information you can use to better - see colors and their qualities - describe colors and relationships between them - produce colors from their parts - and apply colors in making artThe second half of this lesson presents five activities in which you'll practice recognizing and applying the color concepts you have learned in the first half. Click to proceed when you are ready.[audio file: slide_29_concluding_instruction.band]Next: Practice recognizing and applying the color concepts you've studied in the first half of this program.

Part Two: Practice Activities
Each of three groups receives a set of five guided practice activities of one type, as aligned with the 2 x 3 factorial methodology.
Types of guided practice activities:

1. Practice recognizing applications of concepts embedded in diagrams, with feedback
2. Practice recognizing applications of concepts embedded in reproductions of artworks and images from visual culture, with feedback
3. Practice recognizing applications of concepts and producing markings that represent these concepts

A. Practice recognizing applications of concepts embedded in diagrams, with feedback
Color Concepts for use in art. Part Two: Practice Activities — five activities in which you will either practice recognizing applications of five color concepts, or you will practice recognizing them at the computer and apply them on paperColor Concepts for use in art. Part Two: Practice Activities
The colors in this diagram are
hues
neutrals
tints
shades
[image: six blocks of color]

The colors in this diagram are
hues Hues are the colors in a rainbow.
neutrals Neutrals reveal no dominant hue.
tints Tints are hues that have been lightened.
shades Shades are hues that have been darkened.

The colors in the center of this diagram are
hues
neutrals
tints
shades

[image: color wheel with tints at center]

The colors in the center of this diagram are
hues Hues are the colors in a rainbow.
neutrals Neutrals reveal no dominant hue.
tints Tints are hues that have been lightened.
shades Shades are hues that have been darkened.

The colors inside the black circle are
neutrals
hues
shades
tints
[image: color wheel with shades inside black circle]

The colors inside the black circle are
neutrals Neutrals reveal no dominant hue.
hues Hues are the colors in a rainbow.
shades Shades are hues that have been darkened.
tints Tints are hues that have been lightened.

The colors in this diagram are
neutrals
shades
hues
tints
[image: value scale in smooth gradations]

The colors in this diagram are
neutrals Neutrals reveal no dominant hue. Neutrals are typically grays and browns.
shades Shades are hues that have been darkened.
hues Hues are the colors in the rainbow.
tints Tints are hues that have been lightened.

All of the colors in this diagram have
pure hues
qualities of shades
values
qualities of tints
[image: value scale for violets in sixteen stepped gradations]

All of the colors in this diagram have
pure hues Pure hues are the colors in the rainbow. Only one of these colors is a hue; others are tints or shades of that hue.
qualities of shades Shades are hues that have been darkened. Few of these colors are

darkened.
values Values are degrees of lightness or darkness. All of these colors have degrees of lightness or darkness.
qualities of tints Tints are hues that have been lightened. Some but not all of these colors are lightened.

B. Practice recognizing applications of concepts embedded in reproductions of artworks and images from visual culture, with feedback
Color Concepts for use in art. Part Two: Practice Activities — five activities in which you will either practice recognizing applications of five color concepts, or you will practice recognizing them at the computer and apply them on paperColor Concepts for use in art. Part Two: Practice Activities

The colors in the circular shape in this painting (Alma Thomas, *Snoopy — Early Sun Display on Earth*, 1970, acrylic on canvas) are mostly
neutrals
tints
shades
hues

The colors in the circular shape in this painting are mostly
neutrals Neutrals reveal no dominant hue.
tints Tints are hues that have been lightened.
shades Shades are hues that have been darkened.
hues Hues are the colors in a rainbow.

In the center-right of this painting (Aaron Douglas, *Aspiration*, 1936, oil on canvas) the artist applied
shades
neutrals
tints
hues

In the center-right of this painting the artist applied
shades Shades are hues that have been darkened.
neutrals Neutrals reveal no dominant hue.
tints Tints are hues that have been lightened.
hues Hues are the colors in a rainbow.

In this painting (Eugene Von Bruenchenhein, *Untitled (#63)*, 1954, oil on canvas) darkened colors are
pure hues
shades
tints

hues

In this painting darkened colors are
pure hues Pure hues are the colors in the rainbow.
shades Shades are hues that have been darkened.
tints Tints are hues that have been lightened.
hues Hues are the colors in a rainbow.

In this movie poster (Rob Marshall, Director, *Pirates of the Caribbean: On Stranger Tides*, 2011, digital image), all of the colors are
hues
neutrals
tints
shades

In this movie poster all of the colors are
hues Hues are the colors in a rainbow.
neutrals The colors are browns and grays, and reveal no dominant hue.
tints Tints are hues that have been lightened. Many of these colors are very dark.
shades Shades are hues that have been darkened. Many of these colors are very light.

For this movie scene (George Yepes, *Soy Ilegal (I am illegal)*, c.2004, oil on canvas), the director chose red and neutral colors in a wide range of
values
tints
light shades
hues

For this movie scene the director chose red and neutral colors in a wide range of
values Values (in art) are degrees of lightness and darkness.
tints Tints are hues that have been lightened. This painting has a narrow range of tints.
light shades Shades are darkened colors. This painting has dark as well as light shades.
hues Hues are the colors in a rainbow.

C. Practice recognizing applications of concepts and producing marks that represent these concepts
Color Concepts for use in art. Part Two: Practice Activities — five activities in which you will either practice recognizing applications of five color concepts, or you will practice recognizing them at the computer and apply them on paperColor Concepts for use in art. Part Two: Practice Activities
Select three hues in the color wheel above, and, using colored pencils, mark the hues, filling in three square spaces on practice paper.To choose pencils well, test them outside the spaces before drawing.If there is paper showing within a space, your marking cannot present a pure hue. The next slide shows a correct response. [image: color wheel diagram]

Any three of the markings above would be correct responses to this challenge.You needed to make only three, but there are more than these six hues possible. Look at a color wheel to see other hues. [image: markings in each of six spaces]

Select three tints from the diagram above, and, using colored pencils, mark those tints, filling in three square spaces on practice paper.To choose pencils well, test them outside the spaces before drawing.If there is any color other than the one(s) you intend to place in the space where you mark, the color in that square may not be correct.The next slide illustrates a correct response.[image: color wheel diagram]

Here are three tints of red. Tints are hues that have been lightened.Your response would be correct whether you chose to mark tints of red or tints of any other hue (orange, yellow, green, and so on).[image: markings in each of three spaces]

Select three shades in the color wheel above, and, using colored pencils, mark those shades, filling in three spaces on practice paper.To choose pencils well, test them outside the spaces before marking.If there is any color other than the one(s) you intend to place in a space, the color in that space may not be correct.The next slide shows a correct response.[image: color wheel diagram]

Your markings of shades are correct if you made any three of these hues that have been darkened. Others are possible.[image: markings in each of six spaces]

Choose three neutral colors from the diagram above, and, using colored pencils, mark those neutral colors, filling in three square spaces on practice paper.To choose pencils well, test them outside the spaces before drawing.If there is any color other than the one(s) you intend to place in the space where you draw, the color in that square may not be correct.The next slide shows a correct response.[image: diagram of color gradations of twelve colors]

Neutral colors reveal no dominant hue.These six examples — black, four shades of gray, and white — are all neutral colors. If any of your colors look brown, they are also neutral colors, as long as no individual hue is too strong.[image: markings in each of six spaces]

The diagram above displays colors having many different values.On your answer sheet are three spaces labeled, “Three different values.”In the first space, mark the lightest value color of the three you mark.In the second space, mark a middle value color.In the third space, mark the darkest value color of the three you mark.[image: diagram of color wheels at five differing shades]

Here are three colors an artist might select as having the lightest and darkest values, and a third with a value in the middle.[image: markings in each of three spaces beside hand lettered phrases]

Part Three: Test Version Z (pre test for half, post test for half)
Participants in each of the four groups receive the same pre test (half version X and half version Z, solving the order-effect problem), and the same post test (the version opposite the one taken as pre test). All 15 test items are aligned with practice activities (five for each of the three types of practice, three for each of the five color concepts) to which the separate groups were exposed. The first four slides include audio-narration.

[narration] Color Concepts for use in art[text on slide:] Color Concepts for use in art / Michael R. Delahunt / © 2013
Color Concepts for use in art. Part Three: A test of abilities to recognize and apply color concepts
Color Concepts for use in art. Part Three: Test
[no narration] About You...Your first name _____ [form in which to key text]
Your last name _____ [form in which to key text]
The name of your school _____ [form in which to key text]
O Male O Female [form allowing a click to select response]
When you are home, is English the language you use most? O Yes O No [form allowing a click to select response]
This is a short test to see how well you've learned to recognize the color concepts studied in this program. There are fifteen questions. Use the computer to enter most of your responses. Use the sheet of paper your teacher gives you for the questions that ask you to use colored pencils to mark colors in spaces on the answer sheet. At this time use any dark color to write your name, first and last, at the top of the answer sheet.
INSTRUCTIONS for responses. Respond to ten questions by using the computer's mouse to click on your selection. Respond to other questions by marking with colored pencils in spaces on the answer sheet. Now, please write your name on the answer sheet.
[no narration]
1. [4, diagram, hue] The colors in the circles at the outside of this diagram are
Select one response.
    tints
    hues
    neutrals
    shades
2. [6, mark, hue] Some of the colors in this color wheel are hues. Using colored pencils, mark three hues, filling in spaces on the answer sheet. To choose pencils well, test them outside the spaces before marking. Completely fill each space. If there is white paper showing within a space your marking does not present a pure hue.
3. [18, mark, shade] Select three shades in the color wheel above, and, using colored pencils, mark those shades in three spaces on practice paper. To choose pencils well, test them outside the spaces before drawing. If there is any color other than the one(s) you intend to place in a space, the color in that space may not be correct.
4. [21, art, neut.] In this painting (John Rogers Cox, *Gray and Gold*, 1942, oil on canvas), the colors in the clouds are
    shades only

tints only
hues only
neutrals only

5. [16, diagram, shade] The colors inside purple rectangles are
shades
tints
neutrals
hues

6. [13, art, tint] In most of this painting (Georgia O'Keefe, *Pedernal*, 1941-42, oil on canvas) the artist applied
tints
hues
shades
neutrals

7. [22, mark, neut.] Select three neutral colors in the color wheel above, and, using colored pencils, mark the neutral colors, filling in three spaces on the answer sheet. To choose pencils well, test pencils' colors outside the spaces before marking. If there is any color other than the one(s) you intend to place in the space where you mark, the color in that square may not be correct.

8. [5, art, hue] The colors in this painting (Hans Hofmann, *Lumen Naturale*, 1962, oil on canvas) are mostly
shades
neutrals
tints
hues

9. [20, diagram, neut.] The colors in this diagram are all
shades
hues
neutrals
tints

10. [14, mark, tint] Select three tints from the diagram above, and, using colored pencils, mark those tints, filling in three spaces on the answer sheet. To choose pencils well, test them outside the spaces before marking. If there is any color other than the one(s) you intend to place in the space where you draw, the color in that space may not be correct.

11. [10, mark, val.] The diagram above displays colors with different values. Select three values from the diagram above, and, using colored pencils, mark those values, filling in three spaces on the answer sheet. 1) In the first space mark the lightest value of the three values you have selected. 2) In the second space mark the middle value you have selected. 3) In the third space mark the darkest value you have selected. To choose pencils well, test them outside the spaces before marking. If there is any color other than the one(s) you intend to place in the space where you draw, the color in that space may not be correct.

12. [17, art, shade] This painting's (Albert Bierstadt, *Sunrise in the Sierras*, about 1872, oil on canvas) darkened colors areSelect one response- tints- hues- lighter values- shades

13. [9, art, val.] In this painting (Thomas Cole, *Wooded Landscape*, 1837, oil on canvas),

the artist applied colors having a range of different
    shades of blue
    hues
    tints
    values
14. [12, diagram, tint] The colors in this diagram are
    shades
    tints
    neutrals
    hues
15. [8, diagram, hue] All of the colors in this diagram have
    qualities of shades
    qualities of tints
    qualities of neutrals
    values

This concludes the test. Thanks for your participation!
Please make sure you've responded to every question on the computer or the answer sheet!
Place every pencil in the envelope.

APPENDIX II

SURVEY OF COMPUTER USE
AND ATTITUDES TOWARD ART INSTRUCTION

Your First Name _____

Your Last Name _____

Name of Your School _____

Respond to each question by marking this sheet with a dark color.

Directions: Mark the box beside the best response.

1 In the last seven days I have used a computer (desktop, laptop or tablet/iPad)

- **O** less than 2 hours
- **O** between 2 and 10 hours
- **O** between 10 and 20 hours
- **O** more than 20 hours

2 In the last seven days I have played video or computer games

- **O** less than 2 hours
- **O** between 2 and 10 hours
- **O** between 10 and 20 hours
- **O** more than 20 hours

3 I use computers for [Check all that apply.]

- **O** school work
- **O** email
- **O** Facebook and/or other social media
- **O** graphic software (making pictures: drawing, painting, photo editing, etc.)
- **O** playing games
- **O** watching videos
- **O** other: describe here _____

4 I first used a computer at the age of _____

5 I have my own smartphone.

O Yes

O No

Directions: Circle the number of the best response. The numbers mean…

1 = Agree a Lot

2 = Agree a Little

3 = Neither agree nor disagree

4 = Disagree a Little

5 = Disagree a Lot

6 Looking at diagrams can help me understand color.

1 - - - 2 - - - 3 - - - 4 - - - 5

7 Looking at artworks can help me understand color.

1 - - - 2 - - - 3 - - - 4 - - - 5

8 Making marks with colored pencils can help me understand color.

1 - - - 2 - - - 3 - - - 4 - - - 5

9 During my art class time, I would like to decrease the time I get instruction and increase the time I make art.

1 - - - 2 - - - 3 - - - 4 - - - 5

10 If I could get online instruction outside of art class time (as homework) and increase the time I can make art during art class time, I'd like that!

1 - - - 2 - - - 3 - - - 4 - - - 5

11 During art classes, I learn more from the teacher's instruction than when I am making art.

1 - - - 2 - - - 3 - - - 4 - - - 5

12 During art classes, I learn more when I am making art than from the art teacher's instruction.

1 - - - 2 - - - 3 - - - 4 - - - 5

13 During art classes, I learn about the same amount from the art teacher's instruction as I do when I am making art.

1 - - - 2 - - - 3 - - - 4 - - - 5

APPENDIX III

INSTRUCTIONS TO EACH FACILITATOR

Art or Computer Teacher with 5th grade students,

The district's assistant-superintendent of curriculum and instruction at the elementary level, the Governing Board, and all concerned at Arizona State University (ASU) have approved my conducting this study.

The study is the culmination of the years I've been in a doctoral program, and will be at the core of the dissertation I'll write in the spring.

I designed this study to be conducted in a computer lab, or with laptops in an art room, for each of several groups of fifth grade students, each of which will engage in the study during three class sessions. I wrote a thoroughly detailed description of the study, citing authorities on a variety of relevant topics, theories, methods, etc. I offer you that in case you're curious to see that very formal proposal.

Here's what I ask you to do:

Schedule three consecutive class sessions for each of your different fifth grade sections. Please schedule these as soon as possible.

Before the first session
Create a web page each student will easily and quickly access when you direct them to do so in each of three class sessions. On this web page must be the links, to the pre test in the first session, to each of the instructional instruments in the second session, and to the post test in the third session.

How to post links students can use to access online instruments

Go to your Gmail account page. That's the page listing the email messages you've received.

Along the top of this page are menu items: Search, Images, Mail, Drive, Calendar, Sites, Groups, Contacts, etc. Click on "Sites."

In red letters is the word "Sites," and below it is a button labeled "Create." When you have completed the steps I describe below, there will be a link on this "Sites" page that you must pass along to the EMES official who edits the school's web page. Then that official can create the link students will click on to access the page you are about to create. The title of the web page you are going to create will hold the URL the official will need to place on the school's web page. The web page you will create will display the links through which students will access the study instruments.

1. Click on "Create."

2. In the upper right is an icon resembling a pencil. Click on this icon to create the page students will see.

3. The page has become an editable version of the page you are creating. Title it, "Art Instruction Research Study."

4. In the heading space, type the word "Links."

5. Link to the pre test
Make the two tests ("X" and "Z") interchangeable as the pre and post test, because half of your class groups must take test "X" as the pre test, and the other half take test "Z" as the pre test. Students who take one as the pre test must access the opposite URL when they take the post test. In other words, the half who take "X" as pre test must take "Z" as post test, and those who take "Z" as pre test take "X" as post test.

Link to test "X" at
http://portal.sliderocket.com/AZYYG/Pre-Test-of-Color-Concepts-instruction--v1

Link to test "Z" at http://portal.sliderocket.com/AZYYG/Test-of-Color-Concepts-instruction--v3

Make note of which test link you post on each day because you must distribute the corresponding test answer sheet to participants, and alternate test links for pre and post tests.

Before the first session, copy the text below to direct students to the pre test. Paste this text into the lower space on the "Links" page.

Click here.
Let's see what you know before instruction!

Post the following text and links in advance of the second session:

On the die you received, how many dots are there?
Click on that number, your link to today's activities.

1 2 3 4

In order to turn each of these numerical figures into the link it needs to be, click on

1 = http://portal.sliderocket.com/AZYYG/Color-Concepts--control--v1
These participants will need the alternative activity.

2 = http://portal.sliderocket.com/AZYYG/Color-Concepts--practice-draw--v2
These participants will need to receive a bag of colored pencils, and a practice sheet for marking colors.

3 = http://portal.sliderocket.com/AZYYG/Color-Concepts--practice-art--v2
These participants need no other materials.

4 = http://portal.sliderocket.com/AZYYG/Color-Concepts--practice-diagrams--v2
These participants need no other materials.

Before the second session, copy the text below to direct students to the post test:

Click here.
Let's see what you learned last week!

6. Once you have pasted this text, you will need to convert the appropriate segments of text into links bearing the URLs I provided above. To convert each phrase the into link in needs to be, select the text you wish to carry a link, then click on the icon that resembles three-links-in-a-chain at the top of the window [when your cursor hovers over this icon, a label "Link" is displayed right beside the cursor]. A small new window will open, and toward the left of this are links to "Sites page" in red, and to "Web address" in gray. Click on "Web address." On the screen that appears is first a form toward the right, labeled "Text to display." This shows the text you have selected to carry a link. Below this is a form labeled "Link to this URL:" in which to paste the URL the user ought to access by clicking this text. Copy from the section above the text and URLs participants will need for accessing the study's instruments — the tests (X and Z) and the four instructional and practice instruments (1 [control], 2 mark-making], 3 [artwork], and 4 [diagram]).

Over the course of the study, you must (before the next class session) rearrange / select what you copy and paste from here, so that the uppermost section on your "Links" page displays the link(s) appropriate to the activity the next class session's participants must access — the right pre test (X or Z), then the instructional instruments (1, 2, 3, and 4), and then the post test (X or Z).]

Once you have produced the web page bearing the links participants will need to use, return to the "Sites" page, copy the URL of the **"Art Instruction Research Study"** page, and send this URL to the school official who will post this link on one of the school's web pages, and to which it will be easy for you to direct the study's participants.

Procedure for the first class session

Non-participants engage in the alternative activity.

Participants engage in the online pre test.

1. Tell participants, "You have this great opportunity to participate in a research study designed by a PVUSD art teacher (Mr. Delahunt, as part of his doctoral studies at ASU). The results of your work will not affect your grades, but the learning you will achieve will be rewarding. The study examines three kinds of activities that can improve how students learn to recognize and apply concepts involved in the use of color in art. Today you will take a *pre test* to determine what you already know. In a test like this, it is normal to be asked about things you know little or nothing about. Here you will be asked what you know about things you will learn later. If you don't know how to respond to a question, you can guess what the correct response might be, or you can choose not to respond at all. Next class you will get an online lesson about things you'd normally learn in an art class. The third time we meet for this project, you'll take a test to measure what you learn in the lesson. Nothing you do will affect a grade in any class, but you may ask your art teacher about the lesson or the study during your next art class."
2. Also tell them, "Participation in this project is voluntary. You may stop your participation in this study at any time. If you choose not to participate, it will not affect your grade in any way, and you will engage in an alternative activity." To ensure compliance with the wishes of such students, please note their names.
3. Explain controls for levels of audio, and stop and replay options, saying:
4. "The instructional material gives you the ability to control delivery of audio, and to stop and replay its parts."
5. Explain feedback, saying, "The instructional material gives you feedback about your responses during practice activities."
6. There is a glitch in the design of the third slide. At the top of this slide are three forms in which to key responses. The first form is for the student's first name, and displays white letters in the form on a dark background. The second (last name) and third (school) forms display black letters on the dark background, making the letters nearly impossible to read online, though they will be recorded. Sliderocket tells me there's no way to fix this short of a complete redesign, so advise students to carefully key the lettering, even though they can't read letters in the display. A somewhat related problem some students have experienced is an inability to enter any test. The solution is to hit the "esc" (escape) key, which apparently transfers the page to a better format.
7. Distribute two things to each participant: (a) a set of colored pencils ("Please return your set at the end without mixing in pencils from a different set"), and (b) an answer sheet corresponding to the test linked to. "X" or "Z" is displayed in the upper-right corner on these sheets.
8. Collect answer sheets with legible names, pencil sets, and alternative activity sheets.

Before the second session

Change the links page to display the numbers 1, 2, 3 & 4. Each of these must be coded to act as a link to a specific URL as described below:

Which of the dice is the one you received?
Click on that number.

1 2 3 4

This will take you to today's lesson.

1 must link to http://portal.sliderocket.com/AZYYG/Color-Concepts--control--v1
Distribute to these students (the control group) materials for the alternative educational activity. If you use the one I suggest, the materials are a handout of three pages and a graphite pencil. If you distribute a different assignment, it must not involve the color concepts, and must not distract students engaged with study activities.

2 must link to
http://portal.sliderocket.com/AZYYG/Color-Concepts--practice-draw--v2
Distribute to these students the one sheet for practice in marking with colored pencils, and a bag of colored pencils.

3 must link to
http://portal.sliderocket.com/AZYYG/Color-Concepts--practice-art--v2

4 must link to
http://portal.sliderocket.com/AZYYG/Color-Concepts--practice-diagrams--v2

In advance of the first session, I will give you the materials necessary to conduct every session — the paper handouts, pencils, and die-faces (Ellison punched faces of dice, numbered 1-4) used to randomize assignment to groups.

Procedure for the second session

Engage students in the online instruments (for instruction and practice activities). If there are students who will not engage in the study, tell them how to approach the alternate activity. The rest of the students will engage in a segment of online instruction. Before they do, and they know their seating locations, distribute the randomizing die-faces, 1, 2, 3, and 4. You can wait to distribute other materials until all participants have connected to the sliderocket.com site and begun the lesson. Some may need help getting there, advancing from one slide to another, adjusting sound level, or keying in name and school (four letter abbreviation is best).

1. Tell students, “I volunteered to include you in a study that a PVUSD art teacher, Mr. Delahunt, is doing as part of his doctoral studies at ASU. The study examines three kinds of activities in which students might better learn to recognize and apply concepts involved in the use of color in art. First you will take a brief test to determine what you already know, and then a narrated online slideshow will instruct you today regarding information that you would normally learn offline. The next time we meet you’ll take a test to measure what you learn today. This will not affect a grade in any class, but you may ask your art teacher about the lesson or his study during your next art class.”
2. Also tell them, “Participation in this project is voluntary. You may stop your participation in this study at any time. If you choose not to participate, it will not affect your grade in any way, and you will engage in an alternative activity.” (Please note how many do this, and their reasons.)
3. Tell students, “Part of the design of this study is that you must be *randomly* (by chance) assigned to one of three programs the computer can deliver. Each of the three programs provides good instruction, but differs in the practice activities it provides. To each of you I am handing a face of a six-sided die (Ellison punched die-face). This will randomly determine which of the three programs you will receive. Place this between the keyboard and the monitor.” Hand each participant one die-face. To maintain the random order in which these are stacked, distribute one die face at a time, and from the top of the pile. Do not permit any students to trade or otherwise disregard the die-face s/he receives.
4. Say, “You must wear earphones to hear the narration accompanying the instruction.” Tell students how to get and use the earphones.
5. Tell students how to access the web page displaying die-face numbers/links. Say, “Click on the same number as the one on your die-face. When you reach the page the link takes you to, you will see how to proceed.”
6. One of the first pages presents a form in which students key their first name, last name, name of school, and responses to "O Male O Female" and "When you are at home, is English the language you use most? O Yes O No"
7. To each student with die-face number 2, distribute an envelope containing seventeen colored pencils and a *Practice Drawing Sheet*. Collect pencils in their envelopes, and *Practice Drawing Sheets* at the end of the session.
8. Please write notes about problems you observe or suspect. Your notes will help make the study more successful. In this effort, please identify participants who are either physically or psychologically impaired in their abilities to see or hear instruments, think clearly about, or submit responses to the test. In a message to me, note the name of each such participant and the reason these participants’ abilities are impaired. Test responses generated by participants who are identified as colorblind, or whose abilities are otherwise impaired, may be discarded.

In case students ask:

- Students should look for directions inside the computer delivered program and follow those directions.

- Students can/may proceed at their own pace.
- Students can/may move backward or forward through slides as needed.
- Students using colored pencils can get replacement pencils if the pencil point breaks or wears down too far. You will need to monitor this.
- Practice work is not scored.

Prior to the third session

The web page you made on which you displayed the numbers/links must this time display a link to the test form (X or Z) that is opposite to the one they took as the pre test.
Students won't divide into groups, and won't need earphones.
Colored pencils do not need to be very pointed, but please sharpen any that are either broken or too worn down.

Procedure for the third session

Students take a Post Test

1) Say to students, "Today you'll take a short test to measure what you learned from last week's lesson about color concepts. The test will not affect your grade, either in computer class or in art, but do your best so the study can determine which of the different programs is most effective in teaching art concepts."
2) Say, "The computer will record multiple-choice responses to 10 of the 15 questions. For five of the 15 questions you'll need the colored pencils to draw colors on an answer sheet." Distribute to every student:

a) a test answer sheet for five pencil-marked responses. Make sure the answer sheet (X or Z) corresponds to the test participants take, and that this test is different from the one from the one they took as the pre test.
b) a set of colored pencils.

3) Direct students to the web page on which you posted a link to the post test.

a) Say, "One of the first pages displays the same form you saw in the previous session, when you keyed information about you — your name, and so on. Please enter the same responses you submitted last time. This will link what you did on previous days with the test you take today."
b) Say, "During the test, please avoid talking to each other, and looking at each other's screens or papers."
c) Urge students to write names on the answer sheet (just like the online form).
d) When students finish the test, collect the pencils and papers.
e) Write notes about any problems you observe or suspect. Your notes will help make the study more successful.

I encourage you to preview this activity. You may choose any of the three instructional instruments. Unlike the students, you may explore as you wish! To give you an idea how long the program takes, note the time you start and end a session's activities. My experience is that although a very few students will not complete a session's activities on time, no students will need more than a single class session for any activities.

The final activity is a short survey of participants' computer experience and attitudes toward art instruction. Participants must engage in this activity as soon after they complete the post test as practical — that is either during the same class session or the one immediately following it. Data the survey generates will permit more nuanced interpretation of meaning revealed by the data collected through other instruments. The survey can be administered in either of two ways. (1) On paper, or (2) online. The paper version is pasted below. The online version can be found at https://docs.google.com/a/pvlearners.net/forms/d/1LY-L6KRIcDk1NNww3WNANRKq605eas-eMqjACwKFn6Y/viewform
To give students access to the online version, create a link to this URL on the page on which you have posted links to the other instruments.

I am SO GRATEFUL to you for your help with this project! Thank you!

Notes written by facilitators

Every facilitator was asked to identify individual students whose participation they perceived to be significantly affected or disrupted by any of the following potentially moderating variables:

- physical disabilities
- lack of computer skills
- unusual lack of motivation
- low test-taking abilities
- low attention to online instruments (tests, instruction, practice activities)
- emotional disequilibrium

APPENDIX IV

SELECTION OF ARTWORKS

Eighteen images were needed for the instructional, practice, pre and post test portions of the instructional instrument. Alongside the presentation of each image is the name of the artist, the work's title, year of production, and medium. Of greatest importance was the presence of five color concepts. Given that I could select these from among many potential images, I felt it wisest to choose works by artists whose genders, cultures, time periods, and genres reflect the backgrounds of the study's participants. All works are by Americans of various ethnic origins. Most works are fine art. I added a few images from popular culture. More than half of the art was produced during the last fifty years, 30% within the last ten.

All but one of the eighteen art images were produced by Americans (one French artist), ten Americans of European descent, two African-Americans, three Latino-Americans. Thirteen of the artists are male, three female. Fifteen images are fine art. Three images came from popular culture. All but two are two-dimensional works. Varying media was given low priority, but there are eleven works in oil on canvas or board, one acrylic on canvas, two digital images, two gouache on paper, and one assemblage of plastic bottles. Seven works center on human figures, five on animals, three on landscapes, and three are non-objective.

Part One: Test X (interchangeable as pre test with test Z)
[neutrals] Jean Dubuffet, *The Cow with the Subtle Nose*, 1954, oil and enamel on canvas
French, male, 20th century, fine art
Q Excepting the blues and blue-greens in this painting, these colors are all
shades
tints
neutrals
hues
[tints] Ilya Bolotowsky, *White Circle*, 1958, oil on canvas, 60 3/4 inches (154.3 cm) in diameter
Russian-American, male, 20th century, fine art
The somewhat purple, somewhat green, and somewhat blue colors are examples of
tints
shades
hues
neutrals
[hues] David Edgar, *Ragged-Tailed Dragon-Fish*, c. 2010, cut and assembled plastic containers
Anglo-American, male, contemporary, fine art
[shades] Morgan Russell, Creavit Deus Hominem (Synchromy Number 3: Color Counterpoint), 1913, oil mounted on cardboard
American, male, 20th century, fine art
Most of the darker colors in this composition are
shades
tints
hues

neutrals
[values] Virginia Aguero, *Santa Teresita (Saint Theresa)*, 2001, gouache on paper
Mexican-American, female, contemporary, fine art
The artist who painted this picture used a wide range of
values
tints
hues
shades

Part Two: Instruction

- Barton Church, *Girl in a Chair*, 1951, oil on canvas
  Anglo-American, male, 20th century, fine art
- Gore Verbinski, Director, still from *Rango*, 2011, computer animated film
  Polish-American, male, contemporary, popular culture
- Mark Tansey, *Not Just for Laughs*, 1981, oil on canvas
  Anglo-American, male, 20th century, fine art

Part Three: Practice Activities (the group practicing with applications in works of art and visual culture) [final draft]

- Alma Thomas, *Snoopy — Early Sun Display on Earth*, 1970, acrylic on canvas
  African-American, female, 20th century, fine art
- Aaron Douglas, *Aspiration*, 1936, oil on canvas
  African-American, male, 20th century, fine art
- Eugene Von Bruenchenhein, *Untitled (#63)*, 1954, oil on canvas
  German-American, male, 20th century, fine/folk art
- Rob Marshall, Director, poster from *Pirates of the Caribbean: On Stranger Tides*, 2011, digital image
  Anglo-American, male, contemporary, popular culture
- George Yepes, Soy Ilegal (I am illegal), c.2004, oil on canvas
  Mexican-American, male, contemporary, fine art

Part Four: Test Z (interchangeable as post test with test X)

- John Rogers Cox, *Gray and Gold*, 1942, oil on canvas
  Anglo-American, male, 20th century, fine art
- Georgia O'Keefe, *Pedernal*, 1941-42, oil on canvas
  Irish-American, male, 20th century, fine art
- David Edgar, *Yellow-Finned Cascader*, c. 2010, cut and assembled plastic containers
  Anglo-American, male, contemporary, fine art
- Albert Bierstadt, *Sunrise in the Sierras*, about 1872, oil on canvas
  German-American, male, 19th century, fine art
- Cristina Cárdenas, La niña de los espejos (The looking glass girl), 1997, gouache on paper
  Mexican-American, female, contemporary, fine art

APPENDIX V

COLORED PENCILS

Each set of colored pencils used in this study had seventeen colors:

1. red
2. orange
3. yellow
4. green
5. turquoise
6. blue
7. violet
8. pink
9. light blue
10. light green
11. dark red
12. dark blue
13. dark green
14. peach
15. brown
16. gray
17. black

Each pencil was sharpened. A set of these pencils was contained in a transparent, zippered bag, so that each participant would have one set for the participant's exclusive use during the pre and post tests, and the group practicing marking would have one during the practice session.

APPENDIX VI

SHEET ON WHICH TO PRACTICE MARKING COLORS

Only participants in group III receive this sheet and colored pencils with which to practice marking colors.

Your First Name _____

Your Last Name _____

Name of Your School _____

Directions

Practice marking the colors you are learning about by using colored pencils in spaces below. Your response will be correct if you mark a color that is as light or dark, gray or brown or pure as the color concept requires. Your response can be incorrect if the way you mark a color is too light, too dark, too gray or brown, too pure, or if it includes extra colors you don't need. To ensure a color isn't too light, mark in a solid manner — press strongly and evenly, not too lightly. It is best to fill each space with marks without leaving white paper showing.

To choose pencils well, test them outside the spaces before marking. This is just practice, but on the test, if you decide you dislike how you have marked in a space, you may draw additional spaces near printed spaces, then cross out spaces that will not be scored.

Mark a single color in each space. When you are finished, if color variations or white paper show within a space, your marks do not display a single color.

Completely fill as many spaces as you need to practice. There are extra spaces.

hues

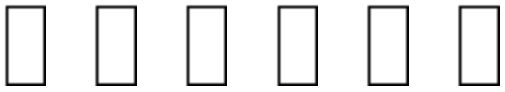
tints

To mark a shaded color, you can either use the pencil that marks a shade when it fills a space and you press hard, or you can blend marks of a hue and black. Marks that permit some white to show will be incorrect, because they present lightened colors.

shades

values

To mark a neutral color, either use the pencil that marks a neutral when it fills a space, or blend marks of two or more pencils. Press hard for a color that has no white. Press more lightly for a color that includes some white.

neutrals 

APPENDIX VII

TEST ANSWER SHEETS

All participants received this sheet and a set of colored pencils so they can respond to test questions expecting application of five color concepts. Test form X is used with the test at , and test form Z is used with the test at .

Form X [http://portal.sliderocket.com/AZYYG/Pre-Test-of-Color-Concepts-instruction--v1**]**

Your First Name _____ x

Your Last Name _____

Name of Your School _____

Directions
There are fifteen questions. For ten of them, use the computer's mouse to click on your selection. Respond to five questions by using colored pencils to mark in spaces below.

To choose pencils well, test them outside the spaces before drawing.
Completely fill each space. You are asked to mark a single color in each space. When you are finished, if color variations or white paper show within a space, your marks do not present a single color.

Corrections: If you wish to replace a marking, you may draw additional spaces near those printed spaces, then cross out spaces that will not be scored.

1 click to select response
2 click to select response
3 click to select response

4 Mark three hues:

5 click to select response
6 click to select response
7 Mark three tints:

8 Mark three shades:

9 click to select response
10 click to select response
11 click to select response

12 Mark three neutral colors:

13 Mark three values:

lightest
middle
darkest of the three

14 click to select response
15 click to select response

If you have time left, please make sure you answer every question. Thank you!

Form Z [http://portal.sliderocket.com/AZYYG/Test-of-Color-Concepts-instruction--v3]

Your First Name _____ z

Your Last Name _____

Name of Your School _____

Directions
There are fifteen questions. For ten of them, use the computer's mouse to click on your selection. Respond to five questions by using colored pencils to mark in spaces below.

To choose pencils well, test them outside the spaces before drawing.
Completely fill each space. You are asked to mark a single color in each space. When you are finished, if color variations or white paper show within a space, your marks do not present a single color.

Corrections: If you wish to replace a marking, you may draw additional spaces near those printed spaces, then cross out spaces that will not be scored.

1 click to select response

2 Mark three hues:

3 Mark three shades:

4 click to select response
5 click to select response
6 click to select response

7 Mark three neutral colors:

8 click to select response
9 click to select response

10 Mark three tints:

11 Mark three values:

lightest middle darkest of the three

12 click to select response

13 click to select response
14 click to select response
15 click to select response

If you have time left, please make sure you answer every question. Thank you!

APPENDIX VIII

INSTITUTIONAL REVIEW BOARD

On February 6, 2012, ASU's Institutional Review Board approved proceeding with this study in email to the researcher from Shana Clark, IRB Coordinator, Office for Research Integrity & Assurance, Office of Knowledge Enterprise Development, Arizona State University, CenterPoint, 660 South Mill Avenue,Suite 315, Mail Code 6111, Tempe, AZ 85287-6111Fax (480) 965-7772
Email: research.integrity@asu.edu or shana.clark@asu.edu
Phone (480) 727-5617
Fax (480) 965-7772
http://researchintegrity.asu.edu

APPENDIX IX

PERMISSION LETTERS

Letter to Administrators or Teachers in Paradise Valley Unified School District #69, Phoenix, AZ, Recruiting Student Participants

I am a graduate student under the direction of Professor Mary Erickson, PhD, in the Mary Lou Fulton Teachers College at Arizona State University. I am conducting a research study of "Effectiveness of three types of practice in online art instruction of color concepts to 5th grade students."

I am recruiting individuals to study five color concepts used in art through a computer-mediated online lesson during two periods of time, each less than 40 minutes in duration. This lesson's objective is that students will satisfy Arizona Visual Arts Standards: Strand 1, Concept 3: Elements and principles - "The student will judge the effectiveness of the artist's use of principles and elements of design in communicating meanings and/or purposes, in artworks." At the beginning level: "PO 101. Identify and use elements and principles in his or her own artwork." At the intermediate level: "PO 201. Identify, select, and use elements and principles to organize the composition in his or her own work."

Your students' participation in this study is voluntary. If you have any questions concerning the research study, please call me at 480-254-0483, or Dr. Erickson at 480-965-3629 or 480-961-3193.

Michael R. Delahunt
PhD Candidate and Art Teacher at Copper Canyon Elementary School
17650 North 54th Street, Phoenix, AZ 85254

Since the objectives of the instructional instruments to which participants will be exposed are aligned with national and state academic standards, (identify these), it is possible that Paradise Valley Unified School District #69 will determine that no form need be signed by parents of participants to signify their permission to allow children to participate. Similarly, it is possible that PVUSD will determine that no form need be signed by children to confirm their consent to participate. In the event that PVUSD requires that parents be informed and signify consent, the following form will be employed.

Parental Letter and Form Granting Consent for a Child's Participation

August 22, 2013
Dear Parent:

I am your child's art teacher and a doctoral candidate under the direction of Professor Mary Erickson, PhD, in the College of Education at Arizona State University. I am conducting a dissertation research study of "Effectiveness of three types of practice in online art instruction of color concepts to 5th grade students."

The lesson's objective is that students demonstrate understanding of art concepts (specifically color concepts), as mandated by Arizona (Department of Education) Visual Arts Standards.

I am requesting your fifth grade child's participation, in three segments:

5. less than 30 minutes for a pre test of knowledge of five color concepts used by artists.
6. one 40 minute class in which students receive online instruction regarding the five color concepts; some also receive practice activities.
7. less than 30 minutes for a multiple-choice test of learning of the five color concepts.

The school district has authorized me to conduct this study, and considers its content consistent with the district's curriculum. Your child's participation in this study is voluntary. If you choose to withdraw your child from this study or your child chooses not to participate or to withdraw from the study at any time, there will be no penalty, and no affect to any grade, and your child will engage in an alternative educational activity. The results of the research study may be published, but your child's name will not be used.

The study involves testing the effectiveness of differing instructional designs. Although there may be no other benefit to you or your child, a possible benefit of your child's participation is to help build the research base of this field. The information your child provides as a research participant will become the basis for our future models and theories.

If you have any questions concerning the research study, please call me at 480-254-0483, or Dr. Erickson at 480-965-3629 or 480-961-3193.

Sincerely,

Michael R. Delahunt
PhD Candidate at ASU, and Art Teacher at Copper Canyon Elementary School
17650 North 54th Street, Phoenix, AZ 85254

By signing below, and returning this to Mr. Delahunt, you withdraw your daughter or son from participation in the above study.

_____	_____	_____
Your Signature	Print Child's Name	Date

If you have any questions about your child's rights as a subject/participant in this research, or if you feel you or your child have been placed at risk, you can contact the Chair of the Human Subjects Institutional Review Board, through the ASU Research Compliance Office, at 480-965-6788.

_ _ _ _ _ _ _ _ — _ _ _ _ _ _ _ — _ _ _ _ _ _ _

Please acknowledge that you have received this letter by signing below, and return this part of the page to Mr. Delahunt.

I received the message from Mr. Delahunt about his research study.

_____	_____	_____
Your Signature	Print Child's Name	Date

APPENDIX X

ART CONCEPTS THAT MIGHT BE LEARNED BY ENCODING AND DECODING ACTIVITIES

1. aesthetics
2. allegory
3. ambiguity
4. amorphous
5. analogy
6. animation
7. annotation
8. appropriation
9. archetype
10. architect
11. architecture
12. art
13. art conservation
14. art criticism
15. artifact
16. artificial
17. artist
18. asymmetrical balance
19. blend
20. blocking in
21. camera obscura
22. camouflage
23. cast
24. catalogue raisonné
25. censorship
26. chaos
27. chiaroscuro
28. chroma
29. cloisonné
30. closed shape
31. CMYK
32. coil construction
33. collage
34. commodification
35. complementary colors
36. complexity
37. conceptual art
38. cool colors
39. copyright
40. cosmetic
41. costume
42. counterpoint
43. craftsmanship
44. creativity
45. critique

46. cross-section
47. cryptic
48. Cubism
49. curator
50. cyan
51. Dada
52. deconstruction
53. design
54. distortion
55. documentation
56. dry brush
57. emphasis
58. elegance
59. ephemera
60. ethnocentrism
61. expressionism
62. exquisite corpse
63. extrusion
64. fabrication
65. figure-ground
66. focal point
67. folk art
68. form
69. Gemütlichkeit
70. genre
71. gradation
72. greenware
73. Harlem Renaissance
74. harmony
75. horror vacui
76. human scale
77. icon
78. ideogram
79. imbrication
80. impasto
81. incident light
82. incongruity
83. inlay
84. kitsch
85. light
86. linear perspective
87. mask
88. meaning
89. memory
90. middle ground

91. modernism
92. monoprint
93. montage
94. movement
95. museum
96. mythology
97. narrative art
98. negative space
99. new media
100. opaque
101. originality
102. palimpsest
103. papier-mâché
104. pattern
105. performance art
106. peripheral
107. pigment
108. plagiarism
109. pneumosparkylosis
110. polyhedron
111. pornography
112. portfolio
113. posterity
114. postmodernism
115. principles of design
116. proportion
117. radial balance
118. readymade
119. realism
120. reflection
121. refraction
122. reification
123. representation
124. reproduction
125. romanticism
126. saturation
127. scumble
128. secondary colors
129. sfumato
130. sgraffito
131. simulacrum
132. slip-trailing
133. solvent
134. sprue
135. still life

136. stylization
137. subliminal message
138. suiseki
139. surrealism
140. synthesis
141. telephoto
142. template
143. tensile strength
144. texture
145. three-quarter view
146. tondo
147. tracking shot
148. transformation
149. translucent
150. trompe l'oeil
151. underdrawing
152. unpack
153. vanishing point
154. vector graphic
155. verisimilitude
156. viewfinder
157. visual culture
158. vitrify
159. volute
160. wabi-sabi
161. waste mold
162. Weltanschauung
163. wireframe
164. wonder cabinet
165. xenophobia
166. zoom lens

BIOGRAPHICAL SKETCH

Among the principal influences on me as a child, while growing up in Milwaukee, Wisconsin, were my grandparents, George and Katharine Manierre. Granddad was a mechanical engineer, manufacturer, and an inventor. I remember him most for the toys he created in his workshop: scale models of mechanical devices, and full-size slides, swings, teeter-totters, rope ladders, zip-lines, and floating platforms on which to sleep in a tent or jump from off of a diving-board. My grandmother studied at the School of the Art Institute of Chicago in the 1890s. This colored everything she did in the seventy years to follow. My uncle Sam Manierre was an art historian and lecturer. My grandparents, aunts and uncles were each collectors and tellers of children's stories. Sam told an especially wondrous story involving two black bottles with magical powers, and produced these bottles from their hiding places for each retelling. He loved to tell the stories of the artworks he'd collected too, and of the art he most admired elsewhere in the world. When I was about ten, I asked him to explain *abstraction* in art, and what he said so richly delighted me, that I have been trying to find ways of achieving the same effect with children ever since, as an art lexicographer for eighteen years, and as an art teacher for thirty-eight.