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STEAM Based Color Wheel Applications and Outcomes with Gifted and Talented Students

Üstün ve Özel Yetenekli Öğrencilerle STEAM Temelli Renk Çemberi Uygulamaları ve Sonuçları

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ABSTRACT

This study aimed to compare two different implementations of a STEAM-based color wheel, digitally designed with CMY science-based paint colors, one grounded in measurement precision and the other in experiential precision, and to reveal the advantages offered by these two implementations within the framework of the integrated STEAM learning model. A total of 16 students participated in the color wheel painting activity, including five gifted middle school students identified in the domain of general intellectual ability, six middle school students identified in the domain of artistic talent, and five university students selected as talented individuals in the field of art. The findings demonstrated that STEAM-based activities and their associated practices meaningfully integrated participants' existing skills with the new competencies they developed throughout the process. In this respect, both gifted and talented middle school students and talented university students completed the activity successfully. In addition, the results indicated that students actively employed skills such as attention, visual perception, proportional reasoning, comparison, decision-making, and creative problem-solving during the implementation process. While measurement-precision-based practices supported systematic thinking and controlled procedural steps, experiential-precision-based practices made students' artistic interpretations, visual evaluation skills, and original forms of expression more visible. These findings suggest that the STEAM approach provides both structured and flexible learning opportunities for individuals with diverse talent profiles. Furthermore, the teaching of color was found to represent not only a technical or artistic process, but also a holistic learning experience that fosters interdisciplinary connections. The findings also demonstrated that students restructured their prior knowledge throughout the implementation process and engaged in a more holistic learning experience in terms of interdisciplinary thinking, the development of aesthetic awareness, and the production of a shared outcome. In this process, skills such as collaboration, patience, evaluation, and responsibility were also supported.

Keywords: STEAM based color wheel, gifted and talented students, measurement precision, experiential sensitivity

ÖZ

Bu çalışmada, CMY bilimsel temelli boya renkleriyle dijital ortamda STEAM temelli tasarlanan renk çemberinin, ölçüm ve deneyim hassasiyeti temelli iki farklı yolla yapılan uygulamasının karşılaştırılması ve bu iki uygulamanın STEAM bütünleşik öğrenme modeli çerçevesinde sağladığı avantajların ortaya konulması amaçlanmıştır. Renk çemberi boyama etkinliğinde, genel zihinsel yetenek alanında tanılı üstün zekâlı 5 ve resim özel yetenek alanında tanılı 6 ortaokul öğrencisi ile resim alanına seçilmiş özel yetenekli 5 üniversite öğrencisi olmak üzere toplam 16 öğrenci yer almıştır. Çalışmada elde edilen sonuçlar, STEAM temelli etkinliklerin ve beraberindeki uygulamaların, bireylerin var olan becerileri ile süreç içinde geliştirdikleri yeni becerileri anlamlı biçimde bütünleştirdiğini göstermiştir. Bu sayede hem üstün zekâlı ve özel yetenekli ortaokul öğrencileri hem de özel yetenekli üniversite öğrencileri etkinliği başarılı performansla tamamlamıştır. Ayrıca uygulama sürecinde öğrencilerin dikkat, görsel algı, oranlama, karşılaştırma, karar verme ve yaratıcı problem çözme becerilerini etkin biçimde kullandıkları belirlenmiştir. Ölçüm hassasiyeti temelli uygulamaların sistematik düşünme ve kontrollü işlem basamaklarını desteklediği; deneyim hassasiyeti temelli uygulamaların ise öğrencilerin sanatsal yorumlarını, görsel değerlendirme becerilerini ve özgün ifade biçimlerini daha belirgin hâle getirdiği görülmüştür. Bu bulgular, STEAM yaklaşımının farklı yetenek profillerine sahip bireyler için hem yapılandırılmış hem de esnek öğrenme olanakları sunduğunu ortaya koymaktadır. Bununla birlikte, renk öğretiminin yalnızca teknik ya da sanatsal bir süreç olmadığı, aynı zamanda disiplinler arası bağlantılar kurmayı destekleyen bütüncül bir öğrenme yaşantısı sunduğu anlaşılmaktadır. Elde edilen bulgular, öğrencilerin mevcut bilgi birikimlerini uygulama sürecinde yeniden yapılandırarak disiplinler arası düşünme, estetik farkındalık geliştirme ve ortak ürün oluşturma açısından daha bütüncül bir öğrenme deneyimi yaşadıklarını göstermektedir. Bu süreçte iş birliği, sabır, değerlendirme ve sorumluluk gibi becerilerin de desteklendiği söylenebilir.

Anahtar Kelimeler: STEAM temelli renk çemberi, üstün ve özel yetenekli öğrenciler, ölçüm hassasiyeti, deneyimsel duyarlılık

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Introduction

In our century, where talent and creativity remain continuously at the forefront, the STEAM (Science, Technology, Engineering, Arts, and Mathematics) integrated learning model emerges as the approach most strongly aimed at empowering individuals in this context. This model was defined in 2014 by the National Art Education Association (NAEA) as "the infusion of art and design principles, concepts, and techniques into STEM education" (National Art Education Association, 2014). More broadly, the STEAM integrated learning model is described as the integration or incorporation of the arts into the STEM fields Science, Technology, Engineering, and Mathematics (Chu et al., 2019).

A review of the literature indicates that integrative teaching models enhance learning and foster creative thinking skills (Ahmad et al., 2021; Sanders, 2008). For example, integrated science and mathematics teaching programs have been found to be effective across all grade levels and particularly for students performing below the average (Hartzler, 2000). In particular, programs such as STEAM education, which incorporate integrated arts instruction, support students in making connections between disciplines and real-life contexts (Kang et al., 2012). Furthermore, programs integrated with arts education encourage the production of more creative solutions by leveraging the creative dimension of arts education (Henriksen, 2014).

The STEAM integrated learning model supports students' engagement, creativity, innovativeness, problem-solving abilities, and other cognitive skills through interdisciplinary integration (Liao, 2016). In their study, Wilson and Hawkins (2019) observed that when students attempted to understand real-world problems using the STEAM model, they effectively employed a combination of skills including critical thinking, creativity, and imagination drawing simultaneously from the arts and sciences. Moreover, by integrating a wide range of knowledge and skills derived from scientific and engineering practices, this model also provides students with a foundation for teaching the nature of science (NGSS Lead States, 2013).

In 2013, a bipartisan commission established within the U.S. Congress announced that "only the activation of both hemispheres of the brain would teach people to think creatively and innovatively, which is crucial for economic growth and the creation of high-performance jobs in the 21st century" (Shatunova et al., 2019). Ülger (2019), in his study, found that creative education limited solely to science did not produce the same cognitive or practical outcomes in students as arts education. Therefore, STEAM education through its interconnected content, the coexistence of multiple disciplines, and the inclusion of collaborative tasks has been observed to offer opportunities that dismantle disciplinary boundaries and promote creative learning (Harris & Carter, 2021). Moreover, with its interdisciplinary structure, the STEAM model supports both divergent thinking generating multiple options and convergent thinking selecting and effectively utilizing one of the generated options which constitute the core components of creative thinking (Liao, 2006). It also provides students with opportunities to use their skills more confidently by strengthening their logical reasoning abilities and technology use (Morrison, 2006). In addition, the Next Generation Science Standards (NGSS) highlight that the scientific inquiry and engineering design skills embedded in the STEAM model enable students to establish meaningful connections among scientific concepts only through interdisciplinary collaboration (Next Generation Science, 2013).

Innovation is achieved through individuals who persistently seek truth, know how to combine their strengths across various fields to accomplish their goals when necessary, and can employ problem-solving and critical thinking skills (Maeda, 2013). The framework of the STEAM integrated learning model also supports this understanding. In such an educational model, students aiming to synthesize what they have learned in the classroom can work on framework problems identified through their own observations, such as those related to ecosystems, industry/commerce, or housing, and engage in initiatives to raise awareness about these issues (Costantino, 2018). Considering this, the core task of STEAM education is to ensure the effective use of individual learning, social responsibility, and creative problem-solving processes within design thinking to produce meaningful and lasting solutions (Rolling, 2016). Within such an educational model, students can fluidly and integratively apply their skills such as visual design, sound coding, and applying their scientific knowledge (Gross & Gross, 2016). As in every field, change in education proceeds through a challenging and unpredictable process (Rolling, 2015); however, the literature shows that 21st-century skills such as innovation, creativity, and flexibility largely develop within the framework of STEAM integrated education (Graham, 2020).

Designing a Science-Based Color Wheel in a Digital Environment

The scientifically grounded primary colors of cyan (C), magenta (M), and yellow (Y) are widely adopted as the primary colors (referred to as "Primary Colors") in printing technologies, paint manufacturing, artistic paint production, and almost all technologically based coloring systems, and they are extensively present in our daily lives. Within the framework of color theory, the CMY pigment primaries are in full harmony with the primary light colors red (R), green (G), and blue (B) which allows digitally generated images to be printed accurately and realistically using CMY pigment primaries. There are numerous studies demonstrating the compatibility and coherence between RGB light colors and CMY pigment colors (Hirai et al., 2025; Kim & Lee, 2023; Meyn, 2008; Planinsic, 2004; Ruiz & Ruiz, 2015). These studies explain the nature of both light colors and pigment colors through light–pigment interaction.

Image 1.

Framework of the Color Wheel in a Digital Environment

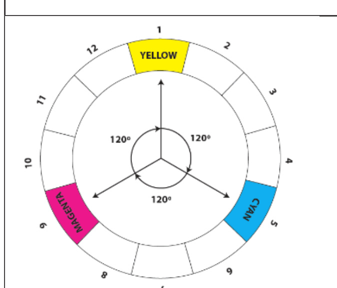
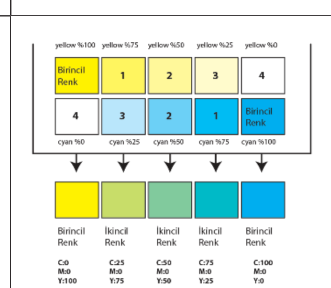


Image 2.

Framework of the Intermediate Color Design in a Digital Environment



In this study, Adobe Illustrator software was used to design a color wheel in a digital environment. Within the CMYK document setting (where "K" represents the rich black formed from the combination of CMY), the aim was to organize the primary colors and the nine secondary colors created from mixtures of the primary colors. The area formed by two overlapping circles was divided into twelve equal sections of 30 degrees each to accommodate twelve colors. The primary colors yellow, cyan, and magenta were placed sequentially at 120-degree intervals, leaving three equal color spaces between them (see Image 1). These primary colors were specified in the program's CMYK color input panel by assigning their own hue to "100" while setting all other values to "0" for each designated area.

To identify the secondary colors in the circle design, an approach was employed in which the primary colors were gradually and equally reduced toward one another in successive steps. Considering the number and placement of colors in the circle, this reduction was structured in four stages until reaching the other primary color. In four stages, the hue of the first color is reduced to zero, at which point the new primary color begins. Exemplifying this formalized approach between yellow and cyan, the primary color at 100% yellow was gradually graded through four stages 75% yellow, 50% yellow, 25% yellow, and finally 0% yellow until reaching the next primary color at 100% cyan (see Image 2). The same procedure also applies when progressing from cyan toward yellow on the color wheel. Through this successive reduction approach, the two primary colors reach equal quantities at the exact midpoint, thereby producing the secondary color. At the exact midpoint between yellow and cyan, the CMY values of the secondary color are C:50, M:0, Y:50. This demonstrates that the secondary color green formed by mixing yellow and cyan in equal amounts was accurately produced. According to the same approach, the CMY values of the secondary colors adjacent to the midpoint were as follows: the secondary color closer to yellow was C:25, M:0, Y:75, while the one closer to cyan was C:75, M:0, Y:25. Using this method, all the colors on the circle can be determined with accurate placement and hue values. In parallel with the current significance of STEAM education, this study aimed to compare applications of the scientifically based CMY pigment colors (Science) in a digitally designed color wheel (Technology and Design) with measurements (Mathematics) and artistic practices (Arts), and to reveal the advantages these two applications provide within the framework of the STEAM integrated learning model.

Methods

This research is a comparative application study conducted within the design of a qualitative case study. In the study, the CMY color wheel activity was implemented through two different methods measurement-based and experience-based participant performance products were examined, and the advantages of these two applications within the context of the STEAM integrated learning model were evaluated. Qualitative case studies represent a flexible and multifaceted research approach that allows for an in-depth examination of a specific phenomenon (Creswell & Poth, 2018).

The research was carried out during the spring semester of the 2022–2023 academic year at a Science and Art Center (BİLSEM) located in the city center of İzmir, which provides support education for gifted students. The study group consisted of a total of 16 students: five middle school students identified as gifted in the area of general intellectual ability attending BİLSEM, six middle school students identified as having special talent in visual arts, and five university students selected for the field of visual arts through a special talent examination

Ethics committee approval was received for this study from the ethics committee of Dokuz Eylül University (Date: 03.03.2022, Number: E-67493393-302.08.01-208976).

Before the interviews, a consent form was prepared and consent was obtained from the families of the participants who were minors, and from themselves for the participants who were of legal age.

Design, Development, and Implementation Process

In this STEAM-integrated learning study, five sixth-grade middle school students identified as gifted in the area of general intellectual ability, six sixth-grade middle school students identified as gifted in the area of visual arts, and five second-year university students with special talent in visual arts participated, making a total of 16 students. The first group of middle school students possessed basic painting skills and scientific color knowledge, while the second group consisted of students with advanced painting skills and scientific color knowledge in the field of art. A common characteristic of both groups was their possession of the fundamental painting skills and scientific color knowledge determined within the scope of this study. Before the implementation began, both groups were informed about the process. The implementation lasted approximately two hours for each group separately and was observed by one science educator and one art educator. In this STEAM-based activity, two different pathways aiming at the same outcome for working with the color wheel were defined. In the first pathway, which involved the students identified as gifted in the area of general intellectual ability, students mixed the primary colors using mathematical ratios and painted the primary and secondary colors on a blank color wheel (see Image 4) without looking at the pre-colored color wheel (see Image 3). In the second pathway, the middle school students and university students with special talent in visual arts used their unique color sensitivity to paint the primary and mixed colors on the blank color wheel (see Image 4) by looking at the pre-colored color wheel (see Image 3), employing their artistic skills. At the end of the study, the work of both groups was compared and integrated for interpretation.

Image 3.

CMY Primary Colors and Their Binary Mixtures Designed in Adobe Illustrator

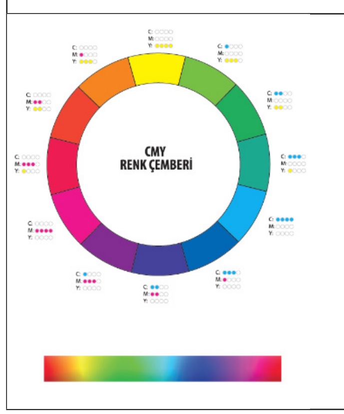
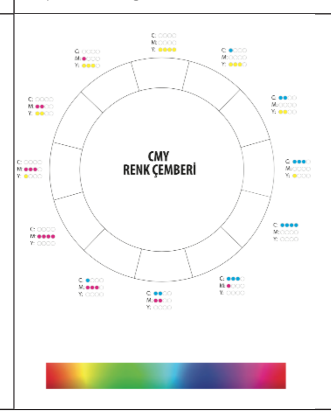


Image 4.

Activity Worksheet on CMY Primary Colors and Their Binary Mixtures Used in Adobe Illustrator Graphic Design



Results

The first pathway represents a reliable method for everyone, requiring careful attention and allowing results to be replicated with the same level of precision. Using this method, applications were carried out with a randomly selected group of gifted students (n = 5), and consistent outcomes were obtained in our color wheel painting activities. The students painted the color wheel on the basis of measurement accuracy by taking paint from pre-weighed (see Image 5) proportional mixtures using an electronic scale (see

Image 6). Despite minor variations due to differences in students' painting experience and the amount of paint used resulting in differences in brightness or saturation the students were able to complete the color wheel accurately with minimal deviations. Additionally, due to limited painting experience, some instances of painting beyond the designated area were observed. In the second stage, students obtained black by taking equal amounts of pre-measured CMY paints, mixing them, and applying the mixture to a circle they had drawn at the center of the color wheel. They then gradually reduced the amount of paint on one half of the circle, achieving shades of gray. In this way, students discovered that they could reach black and gray through equal-ratio mixtures. After this stage, each student was able to name the colors they had painted on the color wheel using familiar color names (see Image 7). In the subsequent stage, to systematically name each mixed color on a scientific basis, and with the support of a science and art teacher, the colors on the CMY color wheel were named sequentially as follows: yellow, yellowish-green, green, cyan-green, cyan, cyan-blue, blue, magenta-blue (purple), magenta, magenta-red, red, and yellow-red (orange), returning to yellow. This process marks a step toward a systematic method of locating hundreds of pigment colors identified and labeled differently in the pigment color universe within the CMY color universe.

Image 5.

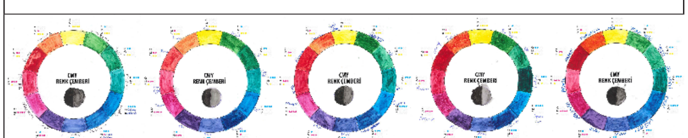
Precise Measurement of Paint Colors to Be Used in the Color Wheel Painting

Image 6.

Gifted Students Painting the Color Wheel

Image 7.

Experiences of Gifted Students (n = 5) Creating a Color Wheel Using CMY Primary Colors with Oil Paints



Although the second pathway poses greater risks for a novice, it offers a more flexible and creative approach for students with stronger color knowledge and artistic skills. In this option, even though there may be minor shifts in mixed colors with each new trial, it was observed that the colors still appeared in the correct positions on the color wheel and that students could flexibly adjust toward the desired hue with small touches. Below are examples of the color wheel painting results produced via the second pathway. In the color wheel activity carried out without using a precision scale, specially gifted middle school students (n = 6) and university art students (n = 5) were able to produce a color wheel equivalent to the experimentally and technologically developed one by using CMY primary colors, their unique color sensitivity, and their experience (see Image 8 and Image 9). It was also observed that all students were successful in creating the intermediate colors between the primary and secondary colors using only their visual sensitivity (see Images 10 and 11). Because the specially gifted students were able to select the appropriate amount of paint they applied to the surface, there were no issues related to saturation that is, the amount of paint per unit area. In the second stage, students again obtained black by taking approximately equal amounts of CMY paints without measurement and mixing them, then applied the mixture to a circle they had drawn at the center of the color wheel. They subsequently reduced the amount of paint on one half of the circle (lowering the saturation value), achieving shades of gray. In this way, they discovered that they could reach black and gray through equal-ratio mixtures without measurement. After completing the color wheel painting, the students named the intermediate colors based on their prior knowledge, just as they had done in the first stage. In the final stage, to adopt a more systematic and universal naming convention on a scientific basis, and with the support of a science and art teacher, the intermediate colors were renamed in a way that would be consistent for everyone.

Image 8.

Visual (Eye-Based) Measurement of Paint Colors to Be Used in the Color Wheel Painting

Image 9.

A Specially Gifted University Student in the Field of Art Painting the Color Wheel

Image 10.

Experiences of Gifted Middle School Students (n = 6) Creating a Color Wheel Using CMY Primary Colors with Oil Paints

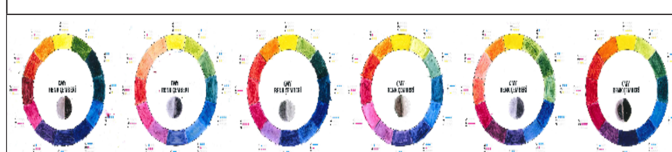
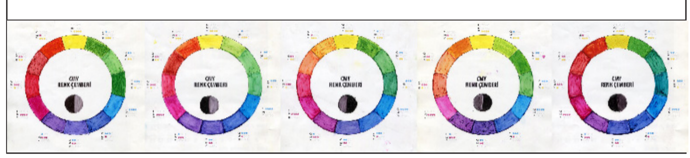


Image 11.

Experiences of Specially Gifted Second-Year University Students (n = 5) Creating a Color Wheel Using CMY Primary Colors with Oil Paints



The two pathways discussed above represent a complementary combination of structured and flexible methods. They are scientifically, mathematically, and artistically coherent. Both methods are suitable for any student or individual possessing basic color knowledge and painting skills. Within these two pathways, we may encounter two types of student groups or individuals. The first group consists of students who possess basic mathematical proportional reasoning and painting skills but lack experience in color mixing. These students, prior to the activity, completed the color wheel by mixing colors according to measured ratios and thus developed their color-mixing experience. The second group consists of students who are already knowledgeable about colors and their mixtures. These students applied their knowledge of color and painting experience to a primary color-based proportional wheel. The aim is to transition from a more ambiguous and flexible domain toward a more structured and scientific one.

Discussion

In the present study, the CMY-based color wheel activity implemented through measurement precision offered a learning experience that enhanced both the cognitive and psychomotor skills of the students. The measurement-based approach was found to enable students to achieve repeatable and reliable results in color mixing. This, in turn, particularly increased the motivation of gifted students in tasks requiring accuracy and precision and allowed them to employ their problem-solving strategies in a more systematic manner. Indeed, the literature also emphasizes that STEAM-based activities improve students' analytical thinking and problem-solving skills and enhance success in tasks requiring experimental precision (Yakman & Lee, 2012; Bequette & Bequette, 2012; Perignat & Katz-Buonincontro, 2019). Minor deviations experienced by students while painting the color wheel such as painting beyond the designated area or differences in saturation should be evaluated as consistent with the nature of experiential learning. Such small errors enabled students to observe, analyze mistakes, and regulate their own learning processes.

In the study, students' ability to achieve black and gray tones through equal-ratio mixtures strengthened their conceptual understanding of color theory. This finding supports one of the core principles of the STEAM approach integrating scientific processes with artistic creativity (Henriksen, 2014; Land, 2013). Henriksen (2014) emphasizes that STEAM practices enhance creativity and interdisciplinary thinking, while Land (2013) highlights that the integration of art into STEM processes deepens learning and fosters innovative problem-solving skills.

Overall, it was observed that both experimental pathways established a balance between structured scientific processes and flexible artistic creativity, enabling students to consolidate their color knowledge and painting skills. This situation successfully reflects in practice the core principle of the STEAM approach integrating scientific processes with artistic creativity (Sanders, 2008; Henriksen, 2014). Consequently, implementing both the measurement-based and experience-based pathways together creates an integrated learning environment that supports students' analytical and creative skills, offering a flexible and effective learning pathway for individuals with diverse ability backgrounds. It is anticipated that these two pathways, proposed for different knowledge and skill backgrounds, can simultaneously support both the conceptual learning of color theory and the processes of individual creativity and discovery.

Conclusion and Recommendations

The color wheel is a scientifically grounded system based on the binary mixing of primary colors. However, when colors are mixed not only in pairs but also in triplets, much darker tertiary mixtures can be produced compared to binary mixtures. For example, an equal CMY triplet mixture results in black or various shades of gray depending on the saturation level (see the central points in Images 7, 10, and 11). Beyond this, a wide range of darker tones than those obtained from binary mixtures can be produced through the simultaneous use of three primary colors. In conclusion, with this systematic method of mixing primary colors in binary and ternary combinations, pigment colors found in nature can be imitated with great accuracy. The universal consistency of science and the creativity of art together provide us with this power today. Naturally, there is no barrier to painting with the rich variety of color pigments found in nature. However, this is an effective way to produce colors scientifically accurately, cost-effectively, and with unlimited creativity. Ensuring that this color standardization, which aligns with scientific principles, can be used in all educational institutions requires the collaboration of all stakeholders. All these efforts can today be methodologically implemented within the framework of the STEAM integrated learning model.

When we evaluate the results of the study as a whole, it becomes evident that STEAM-based activities and their accompanying implementations have enabled individuals to meaningfully integrate their existing skills with newly acquired ones, allowing both gifted and specially talented students to demonstrate successful performance in the activities. In this context, it can be stated that STEAM-based activities provide individuals with flexible, creative (Wilson & Hawkins, 2019), and integrative learning opportunities drawn from a broad and comprehensive skill set.

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Image References

Image 1.

Framework of the Color Wheel in a Digital Environment

Image 2.

Framework of the Intermediate Color Design in a Digital Environment

Image 3.

CMY Primary Colors and Their Binary Mixtures Designed in Adobe Illustrator

Image 4.

Activity Worksheet on CMY Primary Colors and Their Binary Mixtures Used in Adobe Illustrator Graphic Design

Image 5.

Precise Measurement of Paint Colors to Be Used in the Color Wheel Painting

Image 6.

Gifted Students Painting the Color Wheel

Image 7.

Experiences of Gifted Students (n = 5) Creating a Color Wheel Using CMY Primary Colors with Oil Paints

Image 8.

Visual (Eye-Based) Measurement of Paint Colors to Be Used in the Color Wheel Painting

Image 9.

A Specially Gifted University Student in the Field of Art Painting the Color Wheel

Image 10.

Experiences of Gifted Middle School Students (n = 6) Creating a Color Wheel Using CMY Primary Colors with Oil Paints

Image 11.

Experiences of Specially Gifted Second-Year University Students (n = 5) Creating a Color Wheel Using CMY Primary Colors with Oil Paints

Yapılandırılmış Özet

Amaç:

Bu araştırmanın amacı, CMY (cyan, magenta, sarı) bilimsel temelli boya ana renkleri kullanılarak dijital ortamda tasarlanan STEAM temelli renk çemberinin, ölçüm hassasiyetine dayalı yapılandırılmış uygulama ile deneyimsel duyarlılığa dayalı esnek uygulama olmak üzere iki farklı yöntem üzerinden karşılaştırmalı olarak incelenmesidir. Araştırmada, söz konusu iki uygulama yolunun yalnızca ortaya çıkan ürünler bakımından değil, aynı zamanda STEAM bütünleşik öğrenme modeli bağlamında sunduğu öğretimsel olanaklar açısından da değerlendirilmesi amaçlanmıştır. Bu doğrultuda çalışma, bilimsel doğruluk, teknolojik tasarım, matematiksel oranlama ve sanatsal üretimi aynı öğrenme zemini üzerinde bir araya getiren disiplinler arası bir uygulama çerçevesinin nasıl işlediğini ortaya koymaya yönelmiştir. Renk çemberi etkinliği, bu bağlamda yalnızca bir boyama çalışması olarak değil; kavramsal öğrenmeyi, süreç temelli problem çözmeyi, dikkat ve işlem hassasiyetini, görsel ayırt etme becerisini ve yaratıcı üretimi bütünleştiren çok boyutlu bir öğrenme deneyimi olarak ele alınmıştır. Araştırmanın temel yönelimi, farklı yetenek profillerine sahip öğrencilerde aynı öğrenme hedefinin farklı uygulama yollarıyla nasıl gerçekleştirildiğini ortaya koymaktır.

Yöntem:

Araştırma, nitel araştırma yaklaşımı çerçevesinde kurgulanmış karşılaştırmalı bir durum çalışmasıdır. Çalışma, 2022–2023 eğitim-öğretim yılı bahar döneminde, İzmir il merkezinde üstün yetenekli öğrencilere destek eğitimi sunan bir Bilim ve Sanat Merkezi (BİLSEM) ve bir Üniversitede Resim-İş Eğitimi Anabilim Dalında öğrenim görmekte olan öğrencilerle yürütülmüştür. Çalışma grubunu toplam 16 öğrenci oluşturmuştur. Katılımcıların 5'i genel zihinsel yetenek alanında üstün olarak tanılanmış ortaokul öğrencisi, 6'sı görsel sanatlar alanında özel yetenekli ortaokul öğrencisi ve 5'i görsel sanatlar alanına özel yetenek sınavı ile kabul edilmiş ikinci sınıf üniversite öğrencisidir. Uygulama öncesinde araştırmada kullanılacak renk çemberi, Adobe Illustrator yazılımında CMYK doküman olarak hazırlanmıştır. Tasarım sürecinde iki çemberin kesişiminden oluşan alan 12 eşit parçaya ayrılmış, her bir dilim 30 derece olacak biçimde düzenlenmiş; ana renkler 120 derecelik aralıklarla konumlandırılmış, ara renkler ise ana renklerin birbirine doğru aşamalı ve eşit azaltılması ilkesine göre yapılandırılmıştır. Uygulama sürecinde aynı öğrenme çıktısına yönelen iki farklı yol izlenmiştir. Birinci uygulamada, genel zihinsel yetenek alanında üstün öğrenciler, önceden boyanmış örneğe bakmaksızın, boş renk çemberini matematiksel oranlara dayalı boya karışımlarıyla tamamlamıştır. İkinci uygulamada ise görsel sanatlar alanında özel yetenekli öğrenciler, önceden hazırlanmış örnek renk çemberinden yararlanarak aynı etkinliği görsel duyarlılıkları ve sanatsal deneyimleri doğrultusunda gerçekleştirmiştir. Her bir uygulama yaklaşık iki saat sürmüş; süreç bir fen eğitimcisi ile bir sanat eğitimcisi tarafından gözlemlenmiştir. Araştırmanın temel veri kaynağını, uygulama sonunda elde edilen öğrenci performans ürünleri oluşturmuştur.

Bulgular:

Araştırma bulguları, her iki uygulama yolunun da öğrencilerin renk çemberi etkinliğini başarıyla tamamlamasına olanak sağladığını göstermektedir. Ölçüm hassasiyetine dayalı yapılandırılmış uygulamanın, dikkat, süreç denetimi ve tekrarlanabilir sonuç üretimi bakımından daha kontrollü ve güvenilir bir öğrenme zemini sunduğu belirlenmiştir. Bu uygulamada öğrenciler, önceden tartılmış oransal boya karışımlarını elektronik terazi aracılığıyla kullanmış; boyama deneyimine bağlı olarak parlaklık, doygunluk ya da sınır taşması gibi sınırlı farklılıklar gözlense de, renk çemberini yüksek doğruluk düzeyinde tamamlamışlardır. Ayrıca öğrencilerin, eşit oranlı CMY karışımları yoluyla siyah ve gri tonlarına ulaşabilmeleri, renk kuramına ilişkin kavramsal anlamalarını desteklemiştir. Deneyimsel duyarlılığa dayalı esnek uygulamanın ise, özellikle renk bilgisi ve sanatsal becerisi daha gelişmiş öğrenciler açısından daha yaratıcı ve uyarlanabilir bir süreç sunduğu saptanmıştır. Bu uygulamada ölçüm aracı kullanılmaksızın, öğrenciler yalnızca görsel sezgileri ve sanatsal deneyimleriyle ana ve ara renkleri doğru konumlarda oluşturabilmiş; küçük ton kaymalarına karşın hedef renge yakın sonuçlar elde edebilmişlerdir. Bunun yanında, yüzeye uygulanan boya miktarının daha kontrollü seçilebilmesi nedeniyle doygunlukla ilişkili sorunların daha sınırlı olduğu gözlenmiştir. Her iki uygulama yolunda da öğrenciler, ana renkler, ara renkler, siyah ve gri tonlar arasındaki ilişkileri doğrudan deneyimleyerek bilimsel bilgi ile sanatsal üretim arasında işlevsel bir bağ kurmuştur. Bulgular, bu iki uygulama yolunun birbirine alternatif değil, birbirini tamamlayan öğretimsel yapılar olarak değerlendirilmesi gerektiğini göstermektedir.

Sonuç ve Öneriler:

Araştırma bulguları, STEAM temelli renk çemberi etkinliğinin öğrencilerin sahip oldukları bilgi ve beceriler ile uygulama sürecinde geliştirdikleri yeni yeterlikleri bütünleştiren etkili bir öğrenme aracı olduğunu göstermektedir. Ölçüm temelli uygulamanın analitik düşünme, oranlama, dikkat ve işlem basamaklarını izleme becerilerini desteklediği; deneyim temelli uygulamanın ise görsel değerlendirme, sanatsal esneklik ve yaratıcı uyarlama becerilerini öne çıkardığı belirlenmiştir. Bu bağlamda, iki yaklaşımın birlikte ele alınmasının farklı yetenek profillerine sahip öğrenciler açısından hem yapılandırılmış hem de esnek öğrenme olanakları sunduğu söylenebilir.

Araştırma kapsamında ayrıca, ana renklerin ikili ve üçlü karışımları yoluyla doğadaki pigment renklerinin bilimsel olarak tutarlı, ekonomik ve yaratıcı biçimde üretilebildiği ortaya konmuştur. Bu bulgu, renk öğretiminin yalnızca sanatsal bir uygulama alanı olarak değil, aynı zamanda fen, teknoloji, matematik ve sanat disiplinlerinin bütünleştirildiği işlevsel bir öğrenme alanı olarak değerlendirilmesi gerektiğine işaret etmektedir.

Bu doğrultuda, bilimsel ilkelere dayalı renk standardizasyonunun eğitim ortamlarında öğretim aracı olarak kullanılması ve benzer STEAM temelli uygulamaların farklı yaş ve yetenek gruplarına uyarlanarak yaygınlaştırılması önerilmektedir. Ayrıca gelecekte gerçekleştirilecek araştırmalarda, bu tür uygulamaların farklı örneklemler üzerinde ve daha kapsamlı araştırma desenleriyle incelenmesi, STEAM yaklaşımının öğrencilerin bilişsel ve yaratıcı gelişimleri üzerindeki katkısının daha ayrıntılı biçimde ortaya konmasına katkı sağlayacaktır. Sonuç olarak araştırma, STEAM bütünleşik öğrenme modelinin bilimsel tutarlılık ile yaratıcı üretimi eş zamanlı olarak destekleyen güçlü bir pedagojik çerçeve sunduğunu ortaya koymaktadır