



Colorigins: Disrupting Color Theory Pedagogy with a Tactile Color Mixing and Matching Game

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Abstract

This paper briefly introduces *Colorigins*, a tactile color mixing and matching game designed and developed for the Sifteo Cubes platform. *Colorigins* presents a softly gamified approach to learning elements of subtractive color theory. The game objective is to accurately match a randomly generated target color by mixing it from a set of source (conventional primary and secondary) colors. Throughout the process of color mixing, players can gain experience with concepts such as value, saturation, tints, shades, tones, complements, chromatic neutrals, and the relative visual strengths of particular colors.

Keywords

Colorigins, color theory, color mixing algorithms, gamification, pedagogy, interaction design, interface design, design process, Sifteo Cubes, physical / tangible computing

Overview

Colorigins is the first in a series of speculative art and design learning experiences (designed and developed by the Experimental Interface Lab) that leverage emerging and novel digital technologies. These experiences take the form of manipulatives / tools intended to supplement—and disrupt—conventional approaches to foundational art and design pedagogy. *Colorigins* specifically focuses on the pedagogy of subtractive color theory by softly gamifying the process of color mixing. Throughout this process, players can gain experience with concepts such as value, saturation, tints, shades, tones, complements, chromatic neutrals, and the relative visual strengths of particular colors.

The term *manipulative* implies physicality and tangibility. Yet, these are not often characteristics that are immediately associated with digital media. Leveraging the Sifteo Cubes platform to develop *Colorigins* provides an opportunity to amalgamate both the physical and the digital, and simultaneously maximize the affordances of each. The distinctively physical experience of mixing color (like paint on a palette) is maintained, although it is transformed by the responsiveness and accuracy / objectivity of the digital medium.

The (now defunct) Sifteo Cubes tangible computing platform forms the basis for *Colorigins*, and has carefully informed the design of the *Colorigins* interface. The Sifteo

base stores and runs software built for the platform, connecting wirelessly to up to twelve 1.7-inch square cubes. The cubes each feature a touch sensitive LCD, an accelerometer, and proximity sensors so that the cubes know when and where they are in contact with one another.

Playing *Colorigins*



Figure 1. *Colorigins* runs on a set of 12 Sifteo Cubes. A video demonstration is available at <https://vimeo.com/97997307>.

Cube Types

Upon running *Colorigins*, the player is presented with several different cube types that perform various functions of the game:

- The target cube (shown in the top left of Figure 1) displays the color that a player needs to match through color mixing. This color is generated randomly using *Colorigins*' color mixing algorithm.
- The empty mix cubes (shown in the bottom right of Figure 1) are workspaces in which a player can create color mixtures. Once filled with a color, these cubes become filled mix cubes. Mix cubes are analogous to the wells of a paint palette.
- Source cubes (the remaining cubes not identified in Figure 1) hold conventional primary and secondary colors to be combined into new color mixtures. These cubes are analogous to tubes of paint.

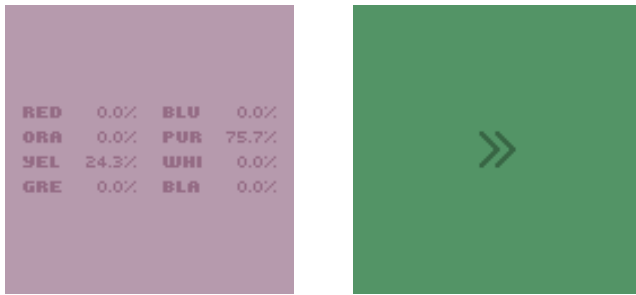


Figure 2a. (left) The percentage analysis of a filled mix cube.
Figure 2b. (right) Filled mix cubes display a set of arrows to indicate the direction of color flow.



Figure 2c. (left) A progress bar shown during color mixing, visually displaying the current proportion of mixture.
Figure 2d. (right) The match accuracy score display.

Cube Actions

A player physically manipulates *Colorigins'* set of cubes to control the game. There are three moves that a player can perform, and they each result in different outcomes depending on the type(s) of cubes involved.

Shake The shake action involves agitating a cube:

- Shaking a target cube will randomly generate a new target color for the player to match. This action is most useful when a player feels a color is presenting too much of a challenge to mix.
- Shaking a filled mix cube will clear the color currently stored, causing the cube to revert to being an empty mix cube.

Tap The tap action involves touching the display surface of a cube:

- Tapping a filled mix cube allows the player to reference a percentage analysis of the components of the cube's color mixture (see Figure 2a).
- Upon winning a round of the game, tapping the target cube will initiate another round with a new color to match.

Neighbor The neighbor action involves touching the side of one cube to the side of another:

- Neighboring a source or filled mix cube to an empty mix cube will fill the empty mix cube entirely with the source or filled mix color.
- Neighboring a source or filled mix cube to another filled mix cube will fill the second filled mix cube with a mix of the source / first filled mix cube and the second filled mix cube. A set of arrows

displayed on filled mix cubes indicates the direction of color flow; the color from a filled mix cube placed to the left of another filled mix cube will flow to the right, mixing in and with the right filled mix cube (see Figure 2b). The components of the new color mixture will be proportional to the amount of time the two cubes are neighbored with each other; this is represented visually with a progress bar (see Figure 2c). A color mix is calculated by a custom mixing algorithm that uses spectral reflectance values of Munsell Color System colors to create a perceptually accurate subtractive color mixing experience.

- Neighboring the target cube to a filled mix cube will display a score representing how accurately the color stored in the filled mix cube matches the target color. A player needs to achieve 97% accuracy to win a round of the game (see Figure 2d).

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Bibliography

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Author Biography

Brad Tober, an Assistant Professor of Graphic Design at the University of Illinois at Urbana-Champaign, is a designer, educator, and researcher whose work explores the potential of emerging code-based and interactive visual communication technologies, with the objective of developing applications of them to design practice and pedagogy. His practice-led research entity, the Experimental Interface Lab, is characterized by a speculative approach to design (a manifestation of pure research) that recognizes that forms of and methodologies for contemporary practice that spans design and technology are best developed through fundamentally flexible and exploratory processes. Brad holds an MDes from York University (Toronto, Canada), a BFA in graphic design from the Savannah College of Art and Design, and a BA in mathematics from the University at Buffalo.