


## Article

# Content Analysis of Mobile Device Applications for Artistic Creation for Children between 4 and 12 Years of Age

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**Abstract:** This article presents the results of the content analysis of 32 painting and drawing mobile applications aimed at children between 4 and 12 years old. The characteristics of the artistic dimension were studied, such as the possibilities of drawing, color, and experimentation, as well as the characteristics of the technical dimension related to the visual design of the interface, usability, and adaptability to users. The results collected show that mobile apps offer tools that have great potential for artistic and creative development, but also reveal certain limitations and problems in the quality of the graphic tools and interface design. One of the central problems of the interfaces of these apps is related to decontextualization and the lack of attention to the diversity and the heterogeneity of users in that age group.

**Keywords:** educational apps; mobile devices; content analysis; arts; ubiquitous learning



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## 1. Introduction

New digital and media technologies are present in our daily lives. We are without doubt immersed in a mediatized society moving at the pace of technological advances. Such advances are responsible for the changes in the way we relate to each other, create, access and use information, and also the medium with which we perform those activities.

It is therefore essential to understand that teaching and learning processes have changed in all educational scenarios both inside and outside the classroom because of what many researchers call the digital revolution. This change has caused the way we understand education to change fundamentally in terms of access to information and collaborative learning, connecting formal, non-formal, and informal spaces [1,2].

Websites, apps, mobile devices, and social networks have transformed searching processes, times, and the way we generate and share knowledge. This development of the digital and technological world has become a facilitating means of our daily routines and has become a relevant factor in the construction and interpretation of the reality that surrounds us [3].

At present there is a constant coexistence among the use of technologies. These technologies are governed by two basic principles: ubiquity (U-Learning) and mobility (M-Learning). These principles considered part of the learning process of the 21st century society [4]. Johnson Adams and Cummins [5] stated that people want to work, study, and learn anytime, anywhere.

In this context, digital environments are a reality, and new generations have appropriated these media by integrating them into their natural habitat to an extent no other generation has experienced [6–8]. Some of the key factors in this development have been the

proliferation of increasingly advanced mobile devices and the development of connectivity and communication, with a focus on entertainment and information networks [9].

The National Institute of Statistics [10,11] shows that the age at which young Spaniards receive their first mobile device has advanced. On the other hand, the study “Net Children Go Mobile: Risks and opportunities on the Internet and the use of mobile devices among Spanish minors (2010–2015)” [12] concludes that the age at which children begin to interact with new technologies is decreasing, as they commonly use devices to play games, connect to social networks, create or watch movies.

The use of painting and drawing apps for mobile devices such as smartphones and tablets offer specific resources for painting, decorating, drawing, video editing, 3D modeling, and photo editing, among other possibilities. These visual arts mobile applications (apps) for children can effectively encourage the acquisition of skills related to media competencies such as production and dissemination processes, reception and interaction processes, values, and the aesthetic and creative dimension [2,13].

Social networks and the use of apps have also irremediably modified the teaching and learning processes in both formal and informal contexts. Technological and digital development has undoubtedly become a medium that influences the construction and interpretation of the reality around us [4]. The term “app” is used as an abbreviation of the Anglo-Saxon term “application” and extends to computer applications for mobile devices and tablets.

All apps have the potential to be intuitive, useful, and simple learning resources for learning, but not all applications are [14]. Villalonga and Marta-Lazo [15] praise applications for mobile devices that facilitate tools, activities, and sources of information that are used in everyday life for the purpose of learning. This is what they call a Personal Learning Environment—PLE.

Zabala and Arnau [16] considered adaptation in the way of teaching to be fundamental to the new reality, specifically establishing digital competence in students; therefore, the incorporation of mobile devices in classroom activities is necessary.

These apps have become new spaces for creation and collaboration, democratizing art, and expanding the traditional category of contemporary art by adding value to the forms of representation and construction of images. It could be said that the art of these new media goes beyond its context of origin, reception, and theoretical formulation. It is a resource of “computable art that is created, stored and distributed through digital technologies” [17], a space that takes over aesthetic and artistic codes to create other protocols of use and creation.

Apps have a relevant link to informal learning experiences that do not depend on the school context but on the free choice of the user and their desire to learn. Apps offer the possibility of ubiquitous learning, of accessing information and teaching anywhere and at any time [18], which allows for meaningful learning and a direct relationship with the immediate environment.

As Armas [19] points out, “flow” must be present in learning since it prompts children to seek new challenges and produces a greater sense of discovery.

In this context, this article aims to conduct a content analysis of children’s artistic creation mobile applications focused on the artistic and technical dimensions. The study presented explores the technical and artistic tools that apps offer for the improvement of the artistic creation processes of children in visual arts.

## 2. Materials and Methods

A retrospective descriptive study was carried out, gathering relevant information on the main characteristics of the apps for artistic creation, both at a technical and operational level [20].

2.1. Procedure

To develop this study, the following process was followed: determine the objectives of the content analysis, search for apps, analyze the apps, and write the article.

In July 2020, a search of the apps was accomplished to locate those apps that had the artistic process of drawing and painting as an objective, and the two channels that currently function as documentary sources for mobile devices were used: Google Play and AppStore.

The keywords used to search for apps were drawing and painting, whilst the search parameter was: “painting children” or “drawing children” in the title; therefore, the same search algorithm was used in both shopping portals.

This research was raised from a descriptive approach where a quantitative method was used.

Two dimensions were established for the analysis, which are: the artistic-expressive and technical aspects with their corresponding variables. The researchers arrived at this classification after the analysis of numerous articles about the evaluation and content analysis of mobile device applications [21,22].

The artistic-expressive dimension is made up of 4 categories with their corresponding 11 subcategories. The technical dimension consists of 3 categories and 18 subcategories (Table 1).

**Table 1.** Description of the analyzed categories and subcategories dimensions.

Dimension	Category	Subcategory
Artistic-Expressive	Stroke customization	Diversity of brushes and pencils
		Smudges
	Degree of experimentation that allows.	Allows deletion actions
		Allows you to select and work with different color profiles (RGB, CMYK . . . )
Technical	Rich Interface	Draw and paint freely
		Draw and paint different styles and techniques
		Predefined shapes and symbols
		Design options
		Layer options
	Usability	Work with textures
		Add photos
		Add text
		Selection tool
		Arrangement of elements.
Ability to adapt to different user needs	Rich Interface	Multilayer
		AnimationsScreen color
		Efficiency
	Usability	Consistency between the purpose of use and the app
		Operation: ease or difficulty of using the app
		Access to the program
		Forms of use
		Forms of navigation
		Classification by levels of difficulty
		Advertising adapted to age
Format adapts to different ages		
The form of coloring is adapted		
The letter is adapted		
Customize the interface		
Adapts to work in a group		
Adapts to special educational needs		

This analysis was carried out using an Excel sheet and contingency tables through Statistical Software IBM SPSS Statistics. Frequency analysis and contingency tables were used to identify and associate statistical results.

The evaluation was carried out using a Likert scale 5, where 1 is “does not contain it” and 5 is “highly developed”.

## 2.2. Inclusion and Exclusion Criteria

Once the results were reviewed, the final selection of the apps to be analyzed was performed. In the search and selection of the apps, the following inclusion criteria were established: the apps were either updated or created from 2015 to 2020, the minimum user rating was four stars in both portals, and the user profile was children or families.

In the 60 apps initially found, 28 were excluded because they were not directly related to the object of study, nor did they present any type of pedagogical or educational interest.

Apps that were variations of others selected apps or came from the same developer were not included; therefore, a total of 32 apps were considered for the content analysis.

To elaborate on the inclusion criteria, we did not close criteria around the gender of the target audience or the age range of the participants, and we excluded applications that required previous knowledge or were for professional use.

The apps finally selected for this analysis were Kids Doodle, 2020; Doodle Master-Glow Art, 2020; Kawaii Easy Drawing, 2020; PaperColor, 2020; PaintX, 2020; Coloring Book, 2020; Painting for Kids, 2020; How to Draw Cute Food, 2020; Paintastic, 2020; Penup, 2020; ColorPlanet: oil painting, paint by numbers, 2020; Paint Dropper, 2020; Drawely-How to Draw Girls, 2020; Drawing-Paint Free, 2016; Pocket Painting: Drawing and Editing, 2020; Coloring Book for Me and Mandala, 2020; Sandbox Pixel Colorin, 2020; Kawaii Glitter Coloring Games, 2020; Draw Kawaii, 2019; Masha and the Bear: Animal Coloring Drawings, 2020; Sketcher PRO, 2020; FlipaClip, 2020; PicsArt Color Paint, 2020; Glitter Dress Up Coloring and Drawing, 2020; How to Draw Anime Step by Step, 2020; Simple Drawing Kids Line, 2019; Paint and Learn Animals, 2020; Tiny colors-Coloring Book Kids Paint and Draw, 2020; Coloring and Painting for Kids, 2020; Coloring on line, 2020; Sand Drawings, 2019; SketchBook, 2020.

## 3. Results

### 3.1. Characteristics of the apps

Most apps, a total of 12 (37%) were developed by developers based in Asia, whilst in Europe, a total of 9 (29%) are developed, 5 apps (16%) in North America, 4 (12%) in South America, and in Africa, only 2 (6%) are developed.

The age range of applications for mobile devices is mostly set for use of the whole family with a total of 26 apps (82%); in contrast, only 4 (12%) are for a specific age group from 4 to 8, and 2 apps (6%) are in the 6–12 years age range.

Most of the apps for mobile devices were updated or developed in 2020, with a total of 28 apps (87%), while only 3 (10%) were created or updated in 2019, and only 1 (3%) had their last update in 2016, resulting in a total of 18 apps (57%) that are free to download; however, there find several restrictions on the tool bar that you can activate with in-app purchases, in contrast to only 12 apps (37%) that are presented as completely free downloads. Alternatively, only one application (3%) is priced between EUR 5 and 10, and another one (3%) is offered for a price lower than EUR 5.

The apps are diversly rated by the users. Four of them (12%) have a rating of 4 stars. Two apps (6%) have a rating of 4.1 stars, while three apps have a rating of 4.2 stars (10%). Nine applications (29%) have a rating of 4.3 stars. Four apps have a rating of 4.4 stars (12%), and six apps (19%) have a rating of 4.5 stars. The highest rating of the analyzed apps belongs to two apps (6%), with a rating of 4.7 stars. The operating systems for the use and installation of the analyzed apps are mostly for Android, with a total of 20 apps (63%), while 12 (37%) apps of those analyzed were developed both for Android and IOS operating systems.

### 3.2. Analysis of the Artistic Domain of the Applications

Most of the apps (71%) (Figure 1) offer the function of customizing the stroke, of which 53% have brushes and pencils of various shapes and styles, 46% allow the use of brushes and pencils varying the size of the stroke, and a smaller number (12%) allows for varying the opacity of the stroke. Two other functions examined concerning the stroke were the possibility of blurring and controlling dispersion and dithering, and it was found that only 21% of the apps can blur; likewise, only 12% can control the dispersion and dithering of the stroke.

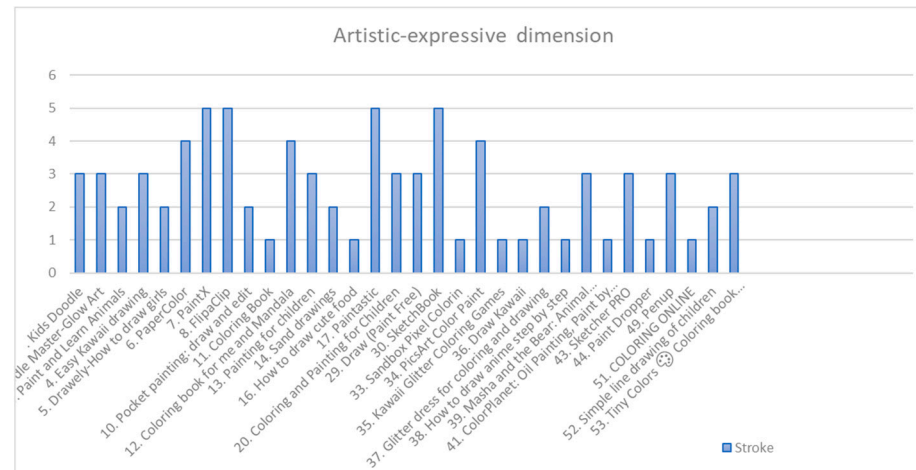


Figure 1. Stroke analysis results.

The erase action is a function appearing in 23 apps (71%), of which 62% offer the possibility of erasing in parts, and 6% can erase in parts or as a whole; however, some apps offer the possibility of modifying the size of the eraser (62%), its opacity (25%), erasing as a line (46%) and a smudge (6%), whereas we found that only two apps (6%) allow erasing with effects, and only one App (3%) offers various shapes of erasers: iconic, hard iconic, soft, square, smooth, or paisley, among other options.

Color is a tool present in 24 apps (75%), but only 7 of them (21%) were found to have good diversity of color range; likewise, only four apps (12%) offer the option of selecting and working with a variety of color profiles, whereas most of the apps (75%) do not have a color selector, but more than half of them (56%) have a paint bucket function.

Another aspect examined was the degree of experimentation. It was observed that only 18% of the apps had highly developed functions for this, and in 42% of them, the functions for experimentation are scarce or deficient. Concerning this aspect, the possibility of free drawing was examined, finding that the function is integrated into 20 apps (62%). The function for creating canvases (34%) and the ability to restore the canvas at any stage of the creation process (68%) was examined. Additionally, nine apps (28%) support changing the canvas background with color and adding photos from the gallery. In addition, two apps (6%) allow playing with background transparency, one App (3%) allows the use of gradient backgrounds, and two apps (6%) had different types of frames. Fourteen apps (43%) allow to resetting the canvas completely and recovering what has been done at any stage, while nine apps (25%) only offer a limited number of recovery actions.

### 3.3. Evaluation of the Artistic Dimension in Apps for Children's Drawing and Painting Mobile Devices

Regarding experimentation, we have analyzed other parameters such as whether they allow working with different artistic styles and different artistic techniques. In summary, we found that only three apps (9%) provide such options. Something very different happens with the presence of predefined shapes and symbols. Most of the apps (75%) contain some selection of geometric shapes, emoticons, or templates for painting and drawing.

A total of 12% of the apps offer layering options. Additionally, 50% allow experimentation with textures, of which 31% have the option of stroke textures, and 37% offer the option of filling textures by incorporating images or their backgrounds.

A total of 46% of the apps allow photos from the gallery to be inserted into the drawing. A total of 21% of the apps allow adding text on the drawing and painting, changing the font style (18%), size (18%), color (15%), and even creating effects with the text (12%). In addition to this, another relevant element is the possibility of creating a video of the creation process, a tool that is present in three cases (9%).

#### 3.4. Analysis of the Technical Domain of the apps

Regarding the interface for the studied painting and drawing apps, only three apps (9%) meet all the functionality criteria in a relevant way, 56% do so moderately, and in 34% we found issues in the interfaces; moreover, sixty-five percent of the apps are committed to minimizing the functionality of the interface by making it simple, compared to 35% that do not do so adequately. Relevant to this aspect, 81% use a vertical positioning of the screen design, 12% horizontal, and 6% allow for the change of orientation of the screen.

Additionally, the layout of the elements for drawing and painting on the screen was examined. Most of the apps (59%) place the icons in a row at the bottom of the screen, 12% in a row at the top, 9% in a column on the right side, 9% in a column on the left side, and the remaining 9% are tutorial apps that do not have icons for drawing and painting.

We found that half of the apps have an attractive and aesthetic design (50%). In 22 apps (68%) the main screen maintains an adequate contrast between the background and figures to discern shapes, and in 24 apps (75%) there is an adequate use of color that facilitates reading and visualization. In 18 apps (56%) the icons and buttons have an adequate size for the ages of the users. In 53% the color and symbology of the icons and buttons are not found to be adequate. The most apps (81%) the icons are distributed in a harmonious and balanced way. (18%) there are an exaggerated number of icons and buttons in only six cases, and/or they are very too close together (21%).

The number of elements actively shown on the drawing screen ranges from 2 to 17, whereas in 28% of the applications, there are between 2 to 5 elements, 43% show between 6 to 10 elements, 25% show between 11 to 15 elements, and some applications display up to 17. Regarding usability, only 15% of the apps were considered to optimally meet the criteria an easy access about age. Additionally, the level of clarity in the purpose of the apps is unclear in 15 of the apps (46%), and it was found that most of the apps (90%) can be accessed without an internet connection. Regarding navigation, the interactions or taps to access the drawing screen range between two taps (21%), three taps (62%), three taps (12%), and five taps (3%); only 6% can directly access the drawing screen with a single tap. Additionally, 100% of the apps allow the screen to be used by touching with either a finger or a stylus. On the other hand, most of the applications (78%) allow saving the content created in phases without interruption, although 21% of the apps do not allow it.

A total of 56% of the applications involve reading and writing skills on the home screen, during its use, or as feedback. In 50% of the apps, there is text information, 21% in instructions, 3% in written feedback, and 18% contain information written in English; moreover, in seven apps (21%) we found feedback in response of the user's actions, in contrast to two apps (9%), in which we found textual feedback, with one of these apps (3%) also offering audio and verbal feedback. In total, there are four apps (12%) that offer audio feedback, two apps (6%) with textual feedback, two apps (6%) with verbal feedback, and three apps (9%) with visual feedback.

In addition, the results indicate that 50% of the apps have several advertising interruptions. Forty-six percent of the apps have a permanent advertising strip on the drawing screen, of which 9% are located at the top and 37% are at the bottom of the screen.



### 3.5. Evaluation of the Technical Dimension in Apps for Children's Drawing and Painting Mobile Devices

Concerning adaptability, the evaluation indicates that approximately half of the apps (56%) present theme selection as setting, and only 18% have a system of levels or multilayers by difficulty.

A remarkable fact is the possibility of customizing the gesture and the interface. A total of 93% of the apps do not offer a gesture selection option. Only two (6%) do have options such as undo with a two-finger press, redo with a three-finger press, or a pinch or long-click enlargement method, among others. This is similar to interface customization; 78% of the apps do not allow the interface to be modified, compared to seven apps (21%) that have different functions such as choosing the screen color, adding, or removing sound, extracting drawing after importing, showing, or hiding the label in the tools section, etc.

Other important aspects of adaptability include some technical features of the applications such as the ability to zoom in and out to draw (75%), the enhancement or contrast to discern active objects (59%), and the possibility of performing reversible actions (75%). Furthermore, adaptability for users between 6 and 12 years of age was also examined, and it was found that in all cases (100%), the advertising was not suitable for the age group analyzed. In addition, it was found that none of the applications are adapted to work with groups (100%), and none are designed for the functional diversity of the users.

## 4. Discussion and Conclusions

Currently, access to mobile devices is very widespread, and the platforms Google Play and Appstore offer easy access to this type of content compared to traditional ways of acquiring information, which favors the lifelong learning process [17]. The use of new technologies, especially by children, as well as their interaction with technology for artistic creation, is evident. Undoubtedly, education must consider the use of apps as an educational resource, although it is paradoxical that applications that often function as entertainment can be highly educational and formative.

Another conclusion drawn is that the market for this type of drawing and paintings applications is mostly children or families. A total of 7 out of 10 children under 12 years use some mobile form of devices, 10% of children under one year, 39% of children under 4, and 50% of children up to 8 years [23]. This explains the continuous development of the current market, which offers a wide selection of drawing and painting apps for children.

The aim of this research was to evaluate the possibilities for artistic creation of 32 drawing and painting Apps for users between 6 to 12 years, focusing on the artistic and technical dimensions. This study serves to offer a general framework through a content analysis of the potential of mobile applications for artistic creation. The results indicate that these apps are a potential resource for artistic experimentation and research, which leads us to consider that some of these applications are optimal for their use because they meet the criteria and quality standards that have been defined. Considering the tools and adapted activities that some of these apps offer [24], users can develop self-expression, learning, participation, and develop creativity in using tools [25] Conversely, however, many apps were found to present limitations and problems for artistic expression.

The analysis of the artistic dimension of apps highlights the lack of tools available for tracing graphics, brushstrokes, coloring, and erasing. For example, it was found that most apps have a coloring tool, but a smaller number of apps allow the customization the color with different profiles with a variety of shapes and styles of brushes and pencils.

The purpose of the research is to contribute to the study of mobile applications to establish lines of action that show the technical and creation potentialities, as well as some problems.

We also encountered certain limitations and problems regarding interface, usability, and adaptability. Applications, for the most part, do not have a balanced and optimal visual design for interaction and communication with users.

One of the central problems of the interfaces of these apps is related to decontextualization and the lack of attention to the diversity and heterogeneity of the users. The interfaces do not consider the evolutionary development of users of this age or the different cultures and social realities, which can hurt the perception of technology and its use.

Knowledge of the language and the need to know how to read and interpret written messages to access information and instructions are cultural barriers for some applications. There are also other inclusion problems, such as not considering users who follow atypical development paths and/or users with special educational needs [26].

The design of the apps analyzed presents limitations due to the lack of artistic tools; the excessive number of active elements and advertisement interference [27]; the small size of icons and buttons; the lack of visual, sound, or verbal feedback; the difficulty to quickly access the main screen; and, among others, the impossibility of not being able to rotate the screen. Therefore, there is huge opportunity for improvement to enhance artistic expression and learning in these group of apps.

In future research work, we intend to evaluate the interaction and learning process of children using apps for artistic creation to define the effectiveness of the acquisition of content and promote developers to have an action guide for the improvement of this type of resources. We believe that the extension of our study will undoubtedly help to glean information on new variables which influence learning outcomes through new technologies.

Concerning to the limitations that the study may pose, we found that the sample may be small considering the large volume of apps that are on the market; on the other hand, with the constant updating of the apps and purchase platforms, there is a continuous movement in user reviews. However, we found that developers are constantly implementing new improvements and fixing bugs In app updates.

We believe that this study, despite the limitations that may arise, allows us to learn about the characteristics that apps currently present as a tool for creative processes, observing that these tools are an important factor in the development of creativity.

Through this analysis, we have tried to provide both, families and education professionals with a series of guidelines to facilitate the choice of apps based on their functionality, whether educational or recreational.

Apps are undoubtedly presented as resources for teaching and learning processes and have revolutionized the artistic creation landscape, taking technology and creation to a new terrain. For this reason, it is essential to review the applications from a didactic point of view.

All this should be considered a challenge to design technologies that respond to the needs and experiences of children. We need to provide children with technologies adapted to the age and development. Technologies where children can become the authors and creators of their own realities. Without a doubt, it is necessary for teachers to assume the apps are useful and necessary teaching resources for the artistic training of students, knowing and providing designs that meet the training needs of teachers through experiences.

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