Validation of an instrument to evaluate art apps that enable the development of artistic skills in digital settings*

Validación de un instrumento de evaluación de apps de arte que permiten desarrollar la competencia artística en entornos digitales

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Abstract:

Apps that help art teachers work on areas relating directly to artistic competences are a valuable digital teaching resource. In this study we call them art apps. Aims: To validate a measurement instrument for digital applications based on the results we obtained in the first design phase, and to modify the items and identify factors. Methodology: We carried out three processes in this second phase. An exploratory factorial analysis, a pre-confirmatory analysis, and a confirmatory factorial analysis adjusted by the global or absolute fit indices for all of the scales of the test. This was

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based on an evaluation battery comprising 98 items distributed in three dimensions and four scales: artistic dimension (expressive and perceptive domain), technical dimension, and pedagogical dimension. Results: We obtained a definitive model of all the scales with optimal values in all the adjustment indicators. Discussion/Conclusion: After completing this process, we designed the definitive test based on the results of the fitting. Taking into account the resulting number of items (74), the number of factors (8), and the wording of each one, we consider it to be a useful and viable tool for evaluating art apps by connecting their artistic, technical, and pedagogical dimensions according to the needs and possibilities of the educational activities.

Keywords: construct validity, reliability, artistic competence, apps, evaluation instrument.

Resumen:

En el contexto digital encontramos como recurso didáctico apps que permiten al profesorado de artes trabajar aspectos relacionados directamente con la competencia artística y a las que en este estudio hemos denominado *apps de arte*. Objetivo: validar un instrumento de medida de aplicaciones digitales a partir de los resultados obtenidos en la primera fase de su diseño para ajustar los ítems e identificar los factores. Metodología: en esta segunda fase se han seguido tres procesos. Un análisis factorial exploratorio medinet, un análisis preconfirmatorio y el análisis factorial confirmatorio ajustado mediante los índices de Ajuste Global o Absoluto en todas las escalas de la prueba. Se partió de una batería de evaluación compuesta por 98 ítems distribuidos en tres dimensiones y cuatro escalas: dimensión artística (dominio expresivo y perceptivo), dimensión técnica y dimensión pedagógica. Resultados: se consigue un modelo definitivo de todas las escalas con unos valores óptimos en todos los indicadores de ajuste. Discusión/Conclusión: una vez finalizado el proceso se diseña la prueba definitiva en base a los resultados del ajuste. Teniendo en cuenta el número de ítems resultante (74), el número de factores (8) y la redacción de cada uno, consideramos que es una herramienta útil y viable para evaluar apps de arte articulando las dimensiones artística, técnica y pedagógica conforme a las necesidades y posibilidades de las experiencias formativas.

Descriptores: validez de constructo, fiabilidad, competencia artística, apps, instrumento de evaluación.

1. Introduction

Digital innovations have changed human relations that are based around technology (Schwab, 2016) as well as ways of teaching and learning (Prensky, 2001). Art, in its drive to connect with the contemporary, has assimilated all of the technological innovations relating to teachers and learners in education (Hart, 2001; Giráldez, 2013), redesigning and identifying its own models (Escaño González, 2010; Saura Pérez, 2011; Marín García, 2011; Caeiro Rodríguez, 2015). This interrelation with the digital has opened art education up

to mobile (Iglesias, 2012; Vernet, 2014), ubiquitous (Burbules, 2014), and hybrid learning contexts (Aiello & Willem, 2004; Bajardi, 2015) creating new educational challenges and opportunities.

Digital applications (apps) designed for use on tablets and smart phones now offer teachers many options for combining the extensive use students make of these digital devices with their rapidly increasing use in class. The world of apps has become ever more important in the arts and their teaching (Navarro Martínez, 2014; Iglesias Antón, 2015; García de Rozas, 2017; Sasiain Camarero-Núñez & Aberasturi Apraiz, 2018; Mora Castro, 2018; Del-Moral et al., 2019). We identify art apps as a category within these applications: art apps are ones intended and designed to enable participation in art activities or to provide for work on art content (Caeiro Rodríguez, Ordóñez et al., 2020). This differentiates them from educational (or didactic) apps, which are principally intended to support teaching (Fombona Cadavieco et al., 2020).

Some studies relating to the world of apps have considered technical and pedagogical questions relating to the use of mobile devices such as tablets and smart phones (Sarrab et al., 2014; Camilleri & Camilleri, 2019). We have found research that focusses on the design of easy-to-use assessment tools, considering their software and interfaces (Norman, 1988; Norman & Drapper, 1988) or relating to general didactic aspects (Prieto, 2015) and heritage education (López Benito, 2013; Martín Ezama, 2016; Luna et al., 2019). In the international sphere, we have found works, such as those by Walker (2011, 2013), who has focussed on integrating technology and digital apps in the academic sphere. These studies have inspired and been the foundation of further research (Malone & Peterson, 2013; Bentrop, 2014; Cherner et al., 2014; Lee & Cherner, 2015; Lee & Kim, 2015; Bouck et al., 2016; Papadakis et al., 2017). However, there are few instruments that provide art teachers with guidance, using quality criteria and indicators, on how to make better use of apps in the educational setting, on the lines of those by Vicent (2013), Hernández (2014), Rico Rico (2017), and Kortabitarte et al. (2017), whose works form our starting point, comparing their development and design with other instrument validation processes relating to digital competence (Fernández et al., 2018; García & Córdoba, 2020).

Accordingly, it is essential to carry out research that provides academic guidance for artistic education proposals teachers create in which artistic competence must be linked to the digital universe. In the first phase of our research, we identified expressive apps (used for creating and doing art or working on artistic processes: painting, drawing, sculpting, photography, video, etc.) and perceptive apps (these allow for discovering art and artistic contexts: visiting museums, seeing works of art, exhibition spaces, etc.). This evaluation instrument, which is designed specifically for use by primary and secondary school teachers, positions itself here. This analysis corresponds to the second stage of research, where we have made progress in the validation and reliability of the instrument.

2. Methodology

2.1. Objectives

The main aim of this work is to validate a measurement instrument for digital applications on the basis of the results obtained in the first phase of its design, taking into account the three dimensions and four scales we obtained to adjust the items and identify the factors. The aim is for the evaluation matrix to combine the necessary conceptual and technical characteristics to measure, using criteria of quality, apps that help develop artistic competences in both the expressive and perceptive domains and also to connect the technical and pedagogical aspects from the perspective of the needs of primary and secondary-level art education.

2.2. Sample

The sample analysed comprised 125 apps identified in a general search of different websites and downloaded from Google Play and Apple's App Store depending on whether the devices run iOS or Android and selected in accordance with the following criteria:

- Apps designed around art activities that involve carrying out expressive processes (drawing, painting, sculpting, animating, photography) or perceptive processes (seeing, visiting, discovering, analysing, etc. work of art).
- A variety in the selection of art apps that reflects processes relating to developing artistic skills, including apps covering the whole spectrum of activities.
- A balanced sample with regards to the artistic dimension and expressive or perceptive activities in line with the number of apps found for each activity.
- Apps that can be used at the primary and/or secondary educational levels.

After the apps were selected, eight active academics from the fields of fine art, history of art, and architecture from five different universities who are experts in emerging digital technologies evaluated them. In order to evaluate the 125 apps, we distributed them among the experts in accordance with their knowledge and historical, creative, and educational profiles. The measurement used to evaluate each item was a Likert-type scale with ratings from 0 to 6, including a "Not Applicable" option for rating items that are not relevant to the dimension assessed in each part of the scale and so do not apply to the app being evaluated (it might be designed for photography and not for video, or be perceptive instead of expressive).

2.3. Instrument

2.3.1. Preparation of the evaluation matrix

To develop the evaluation matrix for the apps, we designed a system of dimensions and indicators that considers art education content for primary and secondary educational stages, as well as the technical and pedagogical aspects that the art apps should combine as they are instruments for use in educational contexts that include digital possibilities and not just creative contexts. This enabled us to set the same criteria for the items to be selected and assessed by the evaluators at all stages of the project (Muñiz & Fonse-

ca-Pedrero, 2019). Accordingly, and starting at all times from artistic competences, the instrument comprised three major dimensions that identify technical and pedagogical possibilities associated with the artistic processes themselves (expressive or perceptive) in the art apps.

2.3.2. Method

The methodology we used to establish this measurement instrument in its first phase was the attribute agreement analysis method, which determines the degree of agreement between experts (Aiken, 2003). By using this, we were able to eliminate items that did not have optimal values, and in this first phase we went from more than 500 initial items to the eventual 98. This technique enabled us to measure the degree of agreement between different experts when they evaluate the items and so reject any items that did not reach the established threshold.

In the first phase we used the kappa statistic, which is the most widely-used in the social sciences (Escobar-Pérez & Cuervo-Martínez, 2008), to determine the degree of agreement between experts. However, as we used ordinal data, it was necessary to include a coefficient of concordance, Kendall's W, which is of use when asking experts to rank items. Kappa is initially designed for nominal variables with two evaluators and a dichotomous response, and so it was necessary to use Fleiss' kappa for ordinal variables and more than two evaluators. Based on the results of the concordance analysis, we rejected items with scores lower than 2, with the final scales being as follows:

1. Artistic Dimension:
   a) Expressive Scale (28 items).
   b) Perceptive Scale (24 items).
2. Technical Dimension: Technical Scale (21 items).
3. Pedagogical Dimension: Pedagogical Scale (25 items).

2.4. Data analysis

In this second phase we analysed the consistency of the scales used for the initial and final configuration of the measurement instrument using Cronbach's α and McDonald's ω (ordinal reliability). The initial reliability of the scales in the study is included, and we can see that they have excellent values in both indices (Table 1).

TABLE 1. Analysis of initial reliability of the scales in the study (98 Items).

Dimension	Scales	McDonald's ω	Cronbach's α	95% Confidence Interval	
				Minimum	Maximum
D1: Artistic	E1 Expressive	0.953	0.956	0.949	0.970
	E2 Perceptive	0.970	0.970	0.961	0.977
D2: Technical	E3 Technical	0.887	0.883	0.859	0.916
D3: Pedagogical	E4 Pedagogical	0.893	0.887	0.868	0.921

Source: Own elaboration.

The validation process had three phases. First, we analysed all of the items in an exploratory factor analysis (IBM, 2016). This enabled us to determine the number of possible factors that comprise the different scales; following this initial analysis we carried out a first fitting through a pre-confirmatory factor analysis using the FACTOR program (Lorenzo-Seva & Ferrando, 2018). The advantage of this analysis is that it makes it possible to interpret the proportion of the variance for each of the factors, and it enables us to work with polychoric matrices which are the appropriate type for Likert-type scales (Lorenzo-Serva & Ferrando, 2013). Finally, we checked the fit of the model using confirmatory factor analysis. To do this, we used the JASP free software program (JASP, 2019).

We used the diagonally weighted least squares estimation procedure (DWLS) to analyse the indicators of the fit. We chose this because our objective was to obtain a saturation vector that reproduces the observed matrix with the best possible fit. DWLS is recommended when the linear model is inappropriate; for these models this estimator has proven to be more robust than ML and ULS (Li, 2016; Lloret, Ferreres, Hernández, & Tomás, 2017). We fitted the confirmatory factor analysis using the global or absolute fit indices (Montaño Armendáriz, 2014):

- Chi square, which tests the significance of the model (greater than 0.05).
- The root mean square error of approximation (RMSEA). In this index, scales with values below 0.05 (Steiger & Lind, 1980) are classed as valid.
- The goodness of fit index (GFI), which identifies the variability explained by the model. Values greater than 0.90 are considered to be good (Jöreskog & Sörborn, 1986).
- The normed fit index (NFI), where values close to one are recommended (Bentler & Bonett, 1980).
- We have added the incremental comparative fit index (CFI), which indicates a good fit for values close to one and greater than 0.95 (Bentler & Bonett, 1980).

3. Results

3.1. Internal consistency (reliability)

We performed the reliability calculations for the definitive scales using Cronbach's α and McDonald's ω and obtained: in Scale 1. Artistic Dimension Expressive: α= 0.958 and ω= 0.960; in Scale 2. Artistic Dimension Perceptive: α= 0.970 and ω= 0.970; in Scale 3. Technical: α= 0.889 and ω= 0.892; and in Scale 4. Pedagogical: α= 0.896 and ω= 0.900. Tables 2, 3, 4, and 5 show the results by item and the descriptive statistics (Ordóñez & González Fernández, 2021) for the definitive configuration of the different scales.

TABLE 2. Descriptive Statistics, Reliability (McDonald's ω and Cronbach's α), and Correlation by Item: Expressive Scale.

	Mean	*SD*	Item-total correlation	McDonald's ω	Cronbach's α	Skew	Kurtosis
E1	1.476	2.078	0.863	0.955	0.953	0.892	-1.006
E2	1.347	1.976	0.846	0.956	0.953	1.014	-0.686
E3	0.306	1.091	0.368	0.964	0.963	3.664	12.139
E8	1.589	2.134	0.850	0.956	0.953	0.187	-1.129
E9	1.806	2.133	0.901	0.954	0.952	0.532	-1.486
E10	1.476	2.097	0.885	0.955	0.952	0.872	-1.079
E11	0.782	1.523	0.667	0.959	0.956	1.777	1.714
E12	1.274	1.952	0.885	0.955	0.952	1.109	-0.524
E13	1.863	2.100	0.844	0.956	0.953	0.480	-1.491
E15	1.097	1.694	0.747	0.958	0.955	1.410	0.580
E17	1.831	2.140	0.892	0.954	0.952	0.535	-1.464
E18	1.048	1.812	0.745	0.958	0.956	1.315	0.005
E20	0.669	1.447	0.634	0.960	0.957	2.159	3.295
E28	0.782	1.565	0.678	0.959	0.956	1.848	1.856

SD: Standard Deviation.
Source: Own elaboration.

TABLE 3. Descriptive Statistics, Reliability (McDonald's ω and Cronbach's α), and Correlation by Item: Perceptive Scale.

	Mean	*SD*	Item-total correlation	McDonald's ω	Cronbach's α	Skew	Kurtosis
P1	1.863	1.948	0.722	0.722	0.969	0.398	-1.401
P2	1.565	1.897	0.852	0.852	0.967	0.619	-1.247
P3	1.000	1.577	0.783	0.783	0.968	1.348	0.428
P4	1.919	2.015	0.857	0.857	0.967	0.355	-1.509
P5	1.556	1.884	0.875	0.875	0.967	0.575	-1.348
P6	1.323	1.699	0.837	0.837	0.967	0.907	-0.632
P7	1.040	1.522	0.783	0.783	0.968	1.269	0.420
P8	0.702	1.487	0.595	0.595	0.969	2.028	2.676
P9	1.468	1.973	0.645	0.645	0.969	0.891	-0.889
P10	1.605	2.047	0.839	0.839	0.967	0.675	-1.271
P11	1.661	2.052	0.860	0.860	0.967	0.682	-1.277
P12	1.927	2.123	0.852	0.852	0.967	0.399	-1.599
P13	1.379	1.978	0.777	0.777	0.968	0.980	-0.794
P14	0.831	1.486	0.714	0.714	0.969	1.696	1.604
P15	1.242	1.745	0.807	0.807	0.968	0.883	-0.799
P16	1.016	1.546	0.775	0.775	0.968	1.376	0.613

P17	0.750	1.555	0.614	0.614	0.969	1.936	2.174
P18	0.540	1.315	0.587	0.587	0.970	2.483	4.923
P19	1.040	1.736	0.644	0.644	0.969	1.396	0.354
P21	1.137	1.659	0.694	0.694	0.969	1.179	-0.010
P22	0.984	1.443	0.702	0.702	0.969	1.278	0.567
P23	0.952	1.529	0.749	0.749	0.968	1.283	0.111
P24	0.895	1.475	0.715	0.715	0.969	1.644	1.615

SD: Standard Deviation.
Source: Own elaboration.

TABLE 4. Descriptive Statistics, Reliability (McDonald's ω and Cronbach's α), and Correlation by Item: Technical Scale.

	Mean	*SD*	Item-total correlation	McDonald's ω	Cronbach's α	Skew	Kurtosis
T4	1.848	1.723	0.458	0.889	0.886	0.480	-1.082
T5	2.312	1.668	0.692	0.880	0.877	0.138	-1.147
T7	2.192	1.921	0.470	0.889	0.886	0.193	-1.487
T8	1.336	1.718	0.398	0.892	0.889	0.903	-0.612
T9	1.248	1.899	0.684	0.879	0.876	1.107	-0.489
T10	0.896	1.635	0.637	0.882	0.879	1.728	1.458
T12	1.784	2.150	0.674	0.880	0.876	0.585	-1.421
T13	1.312	1.829	0.543	0.886	0.883	0.970	-0.648
T14	1.456	2.018	0.687	0.880	0.876	0.872	-0.981
T15	2.992	2.069	0.561	0.886	0.882	-0.352	-1.520
T16	1.512	1.882	0.612	0.884	0.880	0.789	-0.938
T17	1.232	1.863	0.580	0.884	0.881	1.108	-0.439
T20	0.440	1.201	0.560	0.885	0.884	2.860	6.998
T21	0.592	1.380	0.425	0.891	0.887	2.389	4.372

SD: Standard Deviation.
Source: Own elaboration.

TABLE 5. Descriptive Statistics, Reliability (McDonald's ω and Cronbach's α), and Correlation by Item: Pedagogical Scale.

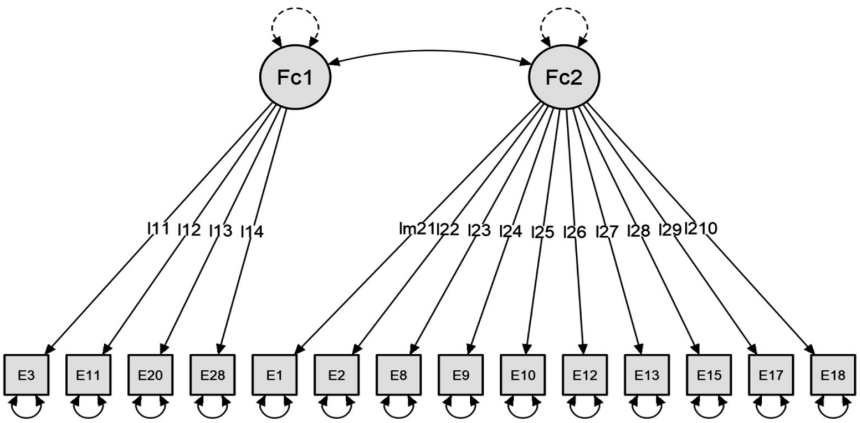
	Mean	*SD*	Item-total correlation	McDonald's ω	Cronbach's α	Skew	Kurtosis
PD1	2.200	1.976	0.567	0.895	0.890	0.204	-1,528
PD2	1.904	1.653	0.643	0.893	0.888	0,404	-0.854
PD3	2.544	1.604	0.673	0.892	0.887	-0.083	-1.023
PD4	3.064	1.324	0.687	0.892	0.888	-0.245	-0.404
PD5	2.824	1.374	0.711	0.891	0.887	-0.076	-0.489
PD6	0.824	1.350	0.574	0.894	0.890	1.505	0.976
PD7	2.184	1.902	0.315	0.901	0.898	0.060	-1.551
PD8	0.648	1.065	0.317	0.900	0.896	1.561	1.819

PD9	1.104	1.373	0.475	0.897	0.893	1.041	-0.002
PD10	1.872	1.475	0.361	0.900	0.895	0.330	-0.779
PD11	2.088	1.680	0.517	0.897	0.891	0.422	-1.009
PD12	2.208	1.643	0.565	0.895	0.890	0.217	-1.098
PD13	1.448	1.766	0.704	0.891	0.886	0.919	-0.552
PD14	0.400	1.063	0.370	0.899	0.895	2.857	7.446
PD15	0.904	1.494	0.312	0.900	0.896	1.503	1.065
PD16	1.456	1.860	0.610	0.894	0.889	0.879	-0.771
PD17	0.536	1.208	0.435	0.898	0.893	2.463	5.150
PD18	0.824	1.617	0.704	0.891	0.887	1.799	1.730
PD19	1.240	1.752	0.622	0.893	0.889	1.085	-0.290
PD20	2.704	1.814	0.349	0.900	0.896	-0.117	-1.261
PD21	0.688	1.573	0.370	0.899	0.895	2.107	2.790
PD23	2.368	1.644	0.342	0.901	0.896	0.128	-1.019
PD25	0.504	1.168	0.167	0.903	0.898	2.536	5.628

SD: Standard Deviation.
Source: Own elaboration.

The results from Scale 1. Expressive (Dimension 1: Artistic), in the initial exploratory factor analysis (EFA) show a total of 6 factors with 28 initial items (SPSS v. 24). A pre-confirmatory factor analysis (PFA) with the FACTOR program reduces the number of factors to 2 and the items to 14. With these data, we performed a confirmatory factor analysis (CFA) with the JASP program, fitting the model using the global or absolute fit indices: c2 (91) = 4209.416, p = 0.999; RMSEA = 0.000 [0.000 – 0.000]; GFI = 0.995; NFI = 0.993, and CFI = 1.000 (Graph 1).

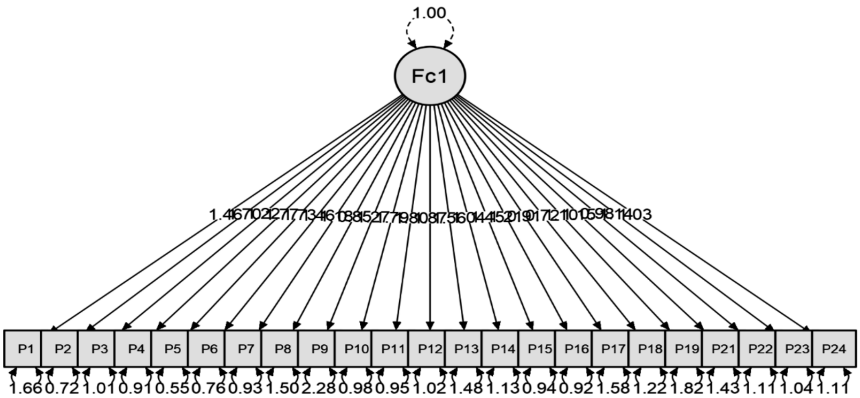
GRAPH 1. Expressive Scale Model. JASP Program.



Source: Own elaboration.

The results from Scale 2. Perceptive (Dimension 1: Artistic), in the initial exploratory factor analysis (EFA) show a total of 4 factors with 24 initial items (SPSS v. 24). A pre-confirmatory factor analysis (PFA) using FACTOR reduces the number of factors to 1 with 23 items. With these data, we performed a confirmatory factor analysis (CFA) using JASP, fitting the model using the global or absolute indices of fit: c2 (253) = 10212.851, p = 0.998; RMSEA = 0.000 [0.000 – 0.000]; GFI = 0.986; NFI = 0.983 and CFI = 1.000 (Graph 2).

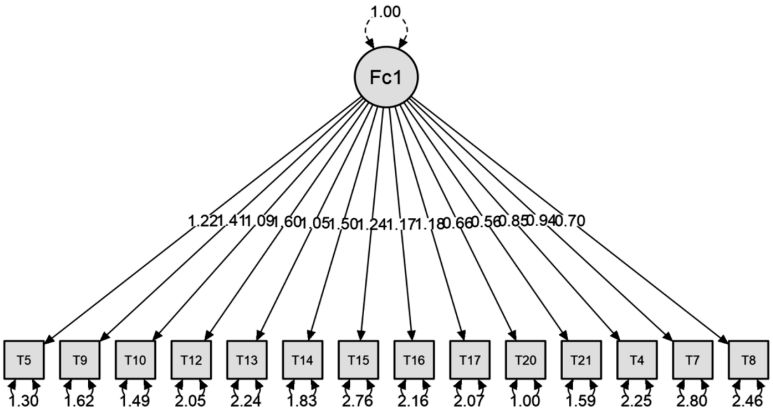
GRAPH 2. Perceptive Scale Model. JASP Program.



Source: Own elaboration.

The results from Scale 3. Technique (Dimension 2) follow the same process. We started with a total of 6 factors and 21 initial items. A pre-confirmatory factor analysis (PFA) reduced the number of factors to 1 with 14 items. We performed a confirmatory factor analysis (CFA) with JASP, fitting the model with the global or absolute indices of fit: c2 (91) = 1411.784, p = 0.184; RMSEA = 0.034 [0.000 – 0.063]; GFI = 0.972; NFI = 0.938 and CFI = 0.992 (Graph 3).

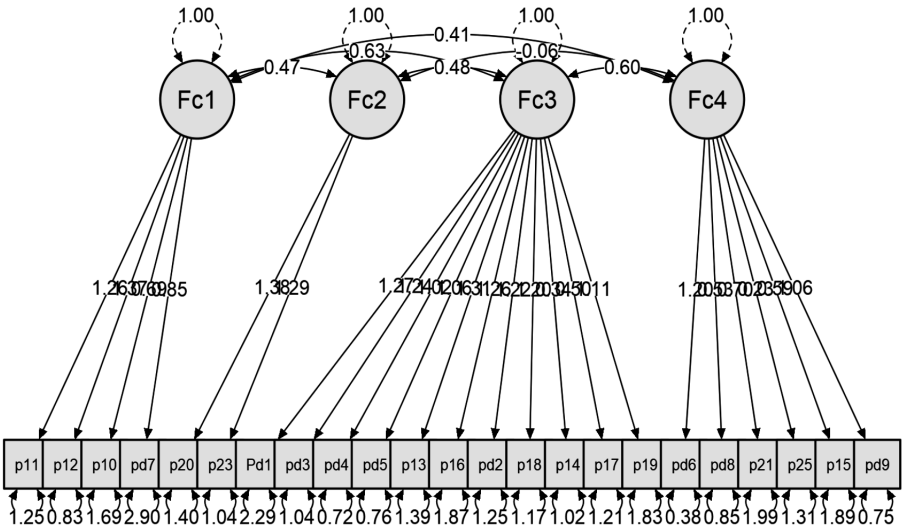
GRAPH 3. Technical Scale Model. JASP Program.



Source: Own elaboration.

The results from Scale 4. Pedagogical (Dimension 3), initially displayed a total of 7 factors and 25 items. We took the 7 factors and performed a pre-confirmatory factor analysis (PFA), reducing the number of factors to 4 with 23 items. After performing a confirmatory factor analysis (CFA), the model did not initially fit as there were 3 items that could be in more than one factor. The JASP software analyses the possibilities of the items and factors for a better fit, and so can locate these items without repetition across factors. Having made these changes, the model did fit: global or absolute fit indices of c2 (253) = 2704.131, p = 0.001; RMSEA = 0.032 [0.032 – 0.065]; GFI = 0.941; NFI = 0.900 and CFI= 0.972 (Graph 4).

GRAPH 4. Pedagogical Scale Model. JASP Program.



Source: Own elaboration.

4. Discussion

Based on the results from the different analyses, we can state that we obtained excellent levels of reliability in the different scales, both in Cronbach's α and in McDonald's ω as the values of the different scales vary between 0.889 and 0.970 in both coefficients. If we analyse the different criteria when interpreting reliability, we find that authors such as Oviedo and Campo-Arias (2005) state that values greater than 0.7 are regarded as acceptable. As for omega (ordinal alpha/McDonald's omega), a value of between 0.70 and 0.90 is regarded as acceptable reliability.

In the confirmatory factor analysis, we followed the standard steps. Firstly, exploratory factor analysis, which helps us analyse a set of data without any type of prior hypothesis about its structure, with the results of the analysis providing the model (Ondé, 2019). This initial analysis enables us to distinguish a first structural hypothesis. After this model we continued with the pre-confirmatory

FACTOR program, which enabled us to choose between a linear model and a non-linear model, which is not possible in SPSS. Taking into account the scoring used in our Likert-type model, FACTOR enabled us to use polychoric correlation matrices establishing a number of definitive factors and items. For a better fit, values > 0.50 (Ferrando & Lorenzo-Seva, 2016) are taken as the minimum item-factor load value.

This process fits the model quickly as it already has the number of factors and items that would enter into the confirmatory factor analysis. In fact, the pre-confirmatory and confirmatory models are almost identical except in the pedagogical scale as this has items that could be part of more than one factor. The definitive fitted model was prepared using the JASP open-source program. The advantage of this program is that it provides the option of using different estimation of factor models, not just the standard ML from SPSS but also ULS and DWLS. Based on the type of items that we have dealt with and the results obtained in FACTOR, the estimation model that best fits our data is DWLS. It is not currently possible to use this model in FACTOR and analyse the tetrachoric matrices that allow a better fit in non-linear models than the ULS and ML models where convergence problems can occur (Li, 2016; Lloret, Ferreres; DiStefano, Liu, Jiang, & Shi, 2018). Finally, we used the chi-square, RMSEA, GFI, and NFI goodness of fit indices grouped into global and absolute indices of fit as well as CFI which is an incremental or comparative index of fit that makes it possible to determine the definitive model with the independence model, or model with no relation among the variables (Montaño Armendaríz, 2014; Rojas-Torres, 2020).

After the evaluators had studied and analysed the resulting items (74), we decided to improve the wording of some items, given that they might cause confusion for end users of the instrument. The fitted and revised model incorporating the name of each of the eight factors is as follows:

- Artistic Dimension.
  - Expressive Scale with two factors and 14 items.
    - Two-dimensionality and movement factor (10).
    - Multi-dimensionality factor (4).
  - Perceptive Scale with one factor and 23 items.
    - Perceptive factor.

- Technical Dimension.
  - Technical Scale with one factor and 14 items.
    - Technical factor.

- Pedagogical Dimension.
  - Pedagogical Scale with four factors and 23 items.
    - Didactic factor.
    - Applicability factor.
    - Transdisciplinarity and complementarity Factor.
    - Activities and self-evaluation factor.

This definitive structure for the instrument is the response to the logical

phases expected for a validation process. We completed Phase I, starting from the objectives and theories that initially gave the instrument its basic shape. Validation through expert opinions and concordance analyses finalised phase II (Fleiss' Kappa and Kendall's W). In phase III we moved on to the final wording of the items and the selection of the sample of apps to analyse, and ended with Phase IV, data processing and analysis (classical test theory), testing internal consistency through Cronbach's alpha and McDonald's omega, and configuring the definitive scale through confirmatory factor analysis, with the final wording (Soriano, 2014).

Artistic competence being a benchmark and being at the heart of the configuration of the instrument means that the items and their grouping into factors are not affected by digital competences or by technical aspects of using the apps that might overshadow artistic processes, something that often occurs in the design of these instruments (Rico, 2017). The three dimensions are located in and at all times take shape in the experiences demanded by the development of artistic competence through digital means. Using this instrument does not mean there will be no variance in the scores between different teachers, as this is inevitable in the context of artistic education. The objective of the instrument is not to harmonise scores across evaluators, but to have criteria and items that offer an academic and artistic perspective on the selection and use of art apps, making it possible to compare them.

5. Conclusions

The definitive instrument (Table 6, Appendix) after the validation phase comprises 74 items and is effective and reliable for selecting and evaluating art apps, and it enables the most suitable ones to be identified in accordance with the artistic activities to be covered, both in primary education and in secondary education (Caeiro Rodríguez & Navarrete, 2020). Accordingly, the instrument, dimensions, scales, and factors contribute to a better perception of what this type of digital apps must provide to make educational experiences more effective. In order to evaluate these apps, we recommend the use of a comprehensive evaluation (Stake, 2006) in which teachers are guided by their experience, based to a large extent on personal interpretation. Our instrument provides a foundation for choosing art apps by identifying expressive, perceptive, pedagogical, and technical aspects that come into play during artistic learning, and it makes it possible to compare them and identify which ones are most appropriate for use in class and offer the most options. Our research is situated within the educational context of art, and comes as close as possible to teachers in the field of art — the final users of the instrument — and to students — the users of the art apps who will create or perceive art with them, applying them to their artistic processes. Accordingly, designing instruments that are directly related to expressive and perceptive art apps is necessary in order to implement digital apps and make progress in pedagogical and didactic knowledge of them (Caeiro Rodríguez, 2020).

Finally, it is expected that the rapidly growing use of digital devices in classrooms and activities that use art apps will favour the use of this evaluation instrument, enabling further research on the same line. We believe that identifying percentiles for each action and type of app would be the next step, as well as adapting it to the context of other artistic areas, such as musical competence.

Appendix

TABLE 6. Dimensions, domains, and factors with the final items of the art apps evaluation instrument.

DIMENSION 1. ARTISTIC							
Expressive Domain							
Items							
Factor1	*Two-dimensionality and movement*	*N/A*	*1*	*2*	*3*	*4*	*5*
E1	Drawing process.						
E2	Painting process.						
E8	Process of creating own images: posters, photographs, videos, animations, etc.						
E9	Process of visual and/or audiovisual composition.						
E10	Process of doing illustrations.						
E12	Personalising the stroke.						
E13	Degree of experimentation it allows: testing ideas, compositions, forms, etc.						
E15	Allows creation of visual or audiovisual adverts.						
E17	Allows erasure during the creative process.						
E18	Allows work in different artistic techniques: oil, watercolour, etc.						
Factor2	*Multidimensionality*						
E3	Process of sculpting in three dimensions in virtual space.						
E11	Process of creation in perspective.						
E20	Enables creation in various spatial dimensions: planes, three dimensions, etc.						
E28	Process of working on volume using various graphic-plastic resources.						

Perceptive Domain							
Items							
Factor3	*Perceptive*	*N/A*	*1*	*2*	*3*	*4*	*5*
P1	Perceptive technical process in the art work: lines of interest, forms, colours, textures, representing volume, depth, perspective, etc.						

P2	Perceptive critical process in the art work: knowledge of and connecting works, artists, personal, social, and political contexts, etc.						
P3	Immersive process with the virtual exhibition space.						
P4	Range of works, artists, and styles offered.						
P5	Process of comprehension of works in relation to their place in the history of art.						
P6	Process of knowledge of artistic techniques: traditional, contemporary, etc.						
P7	General process of interaction it allows with each work.						
P8	Allows virtual guided tours of the space.						
P9	Allows different views of the works: zoom, pull out, etc.						
P10	Textual or auditory information about the work: artist's life, history of the work, stories, etc.						
P11	Enables familiarisation with more than one type of art work: painting, sculpture, photographs, installations, videos, etc.						
P12	Eanbles viewing works from different periods.						
P13	Eanbles viewing works from different cultures.						
P14	Enables discovering visual and audiovisual works.						
P15	Links the history of art to other contexts from the period: social, political, scientific, etc.						
P16	Makes it possible to discover creative processes used by artists in their works.						
P17	Enables viewing museum-based works and works in public spaces: art in nature, public art, etc.						
P18	Enables viewing contemporary art works such as: art installations, happenings, performance art, etc.						
P19	Links works to related information and external spaces: texts, blogs, etc.						
P21	Enables users to select the information they want to see: artists, periods, styles, etc.						
P22	Enables comparison of works from different artists, periods, and styles.						
P23	Makes it possible to analyse the art works in depth within the app.						
P24	Makes it possible to understand how artists solve problems in their works: colour, perspective, etc.						

DIMENSION 2. TECHNICAL							
Items							
Factor4	*Technical*	*N/A*	*1*	*2*	*3*	*4*	*5*
T4	Ability to adapt to different user needs: formats, text size, age, etc.						
T5	Quality of the tool box: levels, configuration, range of resources, areas of work, etc.						
T7	Quality of communication: input and/or output peripherals (printer, scanner, camera, microphone, speakers), email, etc.						
T8	Quality of editing materials available to the user: effects, transitions, filters, image and audio archives, etc.						
T9	Quality of layered work.						
T10	Scope for personalisation: tool box, elements, resources, interface, etc.						
T12	Allows work to be saved and continued in stages, creating without interruption.						
T13	Enables various ways of saving: autosave, saving when wanted, etc.						
T14	Allows copying and pasting.						
T15	Allows various ways of sharing work: email, social media, etc.						
T16	Allows more than one type of file to be created and worked on: photo, video, audio, image, etc.						
T17	Allows configuration of tools: paintbrushes, pencils, etc.						
T20	Allows different colour profiles to be selected and worked with: RGB, CMYK, etc.						
T21	Allows integration of still and/or moving images and audio.						

DIMENSION 3. PEDAGOGICAL							
Items							
Factor5	*Didactic*	*N/A*	*1*	*2*	*3*	*4*	*5*
PD1	Quality of complementary materials: tutorials, summary tables, instructions, etc.						
PD2	Adaptable to users' age and educational stage.						
PD3	Capacity for connecting didactics and art: methodological strategies, etc.						
PD4	Capacity for working on a range of content and artistic objectives.						
PD5	Capacity to work on art concepts and processes.						

PD13	Capacity to respond to the needs of the art educator: levels of complexity of use, directing artistic learning, collaborative online work, etc.						
PD14	Option to create educational profiles: teacher, student, etc.						
PD16	Includes examples of the app's possibilities.						
PD17	Intended for functional diversity of users: motor, visual, special educational needs, etc.						
PD18	Enables teacher to do different types of evaluation based on learners' work: initial, formative, summative, etc.						
PD19	Linked to art education communities or networks.						
Factor6	*Transdisciplinarity and Complementarity*						
PD20	Enables work on non-artistic competences.						
PD23	Complements physical artistic processes adding value to learning.						
Factor7	*Applicability*						
PD7	Implementation of artistic content.						
PD10	App's capacity to allow users to focus on artistic aspects rather than the technical aspects of using it.						
PD11	Capacity to guide the user through the materials it contains: index of content, categories, etc.						
PD12	Ability to work on artistic thinking: artistic concepts, terminology, etc.						
Factor8	*Activities and Self-Evaluation*						
PD6	Student self-evaluation of the art they create: online, summative, progress, etc.						
PD8	Range of activities contained: initial, developmental, expansion, etc.						
PD9	Degree of pedagogical interaction with the learner: feedback on learning, encouraging independent and personalised learning, free discovery, etc.						
PD15	Templates to work from.						
PD21	Enables creation of original artistic content and adding it to the app.						
PD25	Includes activities relating to works of art.						
Total Score for the Art App							

N/A (does not apply to this app); 1 (least value); 5 (most value).
Source: Own elaboration.

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