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«TO TRANSFORM THE BLACKBOARD INTO A BLANK SCREEN»: MAGIC LANTERNS AND PHANTASMAGORIAS IN NINETEENTH-CENTURY SPANISH SECONDARY SCHOOLS»

«Transformar la pizarra en una pantalla blanca»: linternas mágicas y fantasmagorías en los institutos españoles del siglo xix

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ABSTRACT
The first national network of public secondary schools in Spain was created in the mid nineteenth-century. Among the instruments for education that these institutions had, magic lanterns can be found everywhere. This paper shows what kind of lanterns and lantern slides were used in these collections and what use they could have had. This case study focuses on specific practices of the history of the magic lantern and, in consequence, of the history of the audiovisual media and its relation with education. The paper is divided in three parts. The first one explains the case study and the data found. The second and third sections give examples related to other education centres in Spain and provide a contemporary text on the use of the lantern in education.

Key words: magic lantern, education, phantasmagoria, media archaeology, audiovisual media and education

RESUMEN
A mediados del s. XIX, se creó la primera red estatal de institutos de educación secundaria del estado español. Entre los materiales para la enseñanza con los que se equipó cada instituto, se incluía, casi invariablemente, una linterna mágica. Este artículo investiga qué tipos de linterna y placas se encontraban en esas colecciones de instrumentos durante la segunda mitad del s. XIX, así como cuales podían ser sus funciones. Este estudio de caso permite poner el foco en prácticas concretas de la historia de la linterna mágica y, por ende, de la historia del audiovisual y sus relaciones con la educación. El artículo se divide en tres partes. La primera explica el estudio de caso y los datos hallados. La segunda y tercera proporcionan ejemplos de otros centros educativos así como recuperan un texto contemporáneo acerca del uso de la linterna en la enseñanza.

Palabras clave: linterna mágica, educación, fantasmagoría, arqueología de los media, audiovisual y educación.

1. INTRODUCTION

The first national network of secondary schools in Spain was created in the mid nineteenth-century. These secondary schools were equipped with the necessary materials for teaching. This heritage has been partially preserved until our days and it has been studied from an academic perspective —see, among others, the studies by Simón & Cuenca-Lorente (2012) or Sánchez, Cuenca, García & Simón (2011)— and by local historians —in books and journals about the history of these secondary schools—. Magic lanterns were in almost all cases among the items acquired by these centres. This study focuses on this device and research the types of lanterns and slides that were acquired in the 19th century, as well as on their possible functions. Consequently, emphasis is placed on a specific piece of equipment which is often lost among the rest of equipment in comprehensive studies about these collections. The time framework chosen for this research allows us to integrate it with other studies that are being made about the magic lantern in Spanish secondary schools, and here we do not focus on the preserved heritage, which dates mostly from the 20th century, but on the acquired heritage that was used during the second half of the 19th century.

The device and the case that we study is part of different practices and institutions. It is present in the field of technology and audiovisual shows, of science —especially physics and optics— and of education —the teaching of sciences and educational resources for the classroom—. We will try to analyse, as far as possible, the complexity of this case, but it is necessary to state from the start that this work is mainly based on an approach that studies the history of the magic lantern as history of the audiovisual media. Our goal is to focus on relatively unknown practices in the history of the magic lantern and, consequently, of the history of audiovisual communication and its relation with education.

In the history of the magic lantern, the second half of the 19th century represents the period of maximum presence and audience of the lantern, in line with the social, technological and industrial changes of the century. This was the time of creation of organizations such as the Royal Polytechnic Institution (1838-1881) of London, with regular programming in an auditorium with more than 1,000 seats and with a screen of 10 x 8 metres (Weeden, 2008 and Brooker, 2013). This was also the time when photography was introduced as a method for the production of slides —a system that spread in the 1850s and 1860s, see the entry «Photographic slides» in the *Encyclopaedia of the Magic Lantern* (Crangle, Herbert & Robinson, 2001)—, as well as other methods for the reproduction of images —such as colour chromolithography in the 1870s, see the entry «Transfer slides» in the same encyclopaedia— that coexisted throughout the century with hand-painted slides. Finally, the constant innovation in lighting techniques is also applied to the lantern, which uses more powerful sources of light that make it possible to obtain brighter and larger projections, such as the ones achieved with Drummond light or limelight.

2. THE MAGIC LANTERN IN SECONDARY SCHOOLS (1846-1900)

The history of secondary schools, which in the 19th were called «secondary teaching schools», can be studied thanks to the annual reports published by each centre. These reports contain a text about the evolution of the centre, or related to educational topics, as well as tables with administrative summaries —including the purchase of materials— and inventories. Thanks to the details in the purchases section and to the inventories we can know what types of lanterns and slides were bought by the centres.

In our study, we have been able to access 142 reports from 31 secondary schools. The amount of documents is significant, but it is far from being a complete corpus —it is an estimated 4% of the total number of reports—[1], and it is also not particularly restricted over time —the reports are dated from 1849 to 1899— or balanced between the different centres —some of them contribute with only one report and others with two dozens, as in the case of Lleida or Pamplona—. In spite of the precautions derived from the partiality and the heterogeneity of the corpus, these reports contain very interesting data that let us have an idea of the different uses of the lantern in education. The following pages provide an analysis of these details which are not mere anecdotes, since they make it possible to verify specific practices.

The first finding we observe is that the magic lantern is indeed a common device in the collections of secondary schools. Out of the 30 secondary schools from which we have partial information, we can find lanterns or slides in 22 of them (Table 1; this article also contains information from other documents, apart from the reports, that provide information from different years). Most of these lanterns are part of the physics laboratory and, more specifically, from the optics section.

Table 1. References to magic lanterns or slides found in the reports from the secondary schools

City	**Year of publication of the report**
Barcelona	1880
Burgos	1876
Cádiz	1869
Cuenca	1863
Figueres	1861
Girona	1861, 1880, 1885 and 1893
Granada	1882
Guadalajara	1862
Huelva	1862, 1877 and 1881
Lleida	1859, 1861, 1883 and 1885
Logroño	1859
Lugo	1861
Madrid	1857 and 1865
Osuna	1865

[1] The calculation is approximate, and this is only an estimate. It is based on the claim by Simón and Cuenca-Lorente (2012, 230), who say that in 1868 there were 66 secondary schools in Spain. Although this figure varies over time, it has been multiplied by 50 years to obtain an estimated total of 3,300 reports published in the second half of the 19th century, and this is the figure that was used to calculate the percentage.

Palencia	1866
Pamplona	1861
Santander	1866
Segovia	1860 and 1861
Soria	1862
Tarragona	1861
Valladolid	1865 and 1870
Xàtiva	1868

With the creation of a network of secondary schools, different regulations were issued, including a *Circular previniendo que los institutos se provean de los instrumentos necesarios para la explicación de las ciencias físicas y naturales* [Circular establishing that secondary schools must acquire the necessary instruments for the teaching of physical and natural sciences] of 1846 that includes a "Model catalogue of the machines and instruments that are necessary for a chair in Experimental Physics" (Spanish Home Office. Department of public education, 1846, pp. 545-557). This model catalogue did not contain any magic lantern, but most secondary schools acquired one, or more than one, throughout the years. The model catalogue was based on the sales catalogue of the French company Lerebours et Secretan, and it mentioned the French company Pixii as another possible supplier (although the text pointed out that their instruments had a lower quality). The reports also mention other French firms that manufactured and sold these instruments, such as Deleuil or Breton (in this regard, see, for example, the report from the year 1849-50 from the secondary school of Girona [Llach y Soliva, 1849], or the report from the year 1861-62 from the secondary school of Segovia [Valcarce, 1861]). French manufacturers seem to be the main suppliers of these devices.

2.1 PHANTASMAGORIAS, POLYORAMAS AND PROJECTION DEVICES

Apart from verifying the presence of the lantern in these laboratories, it is interesting to take a closer look at the information regarding the types of lanterns that the centres had. As well as including a magic lantern in their inventories or as part of their purchases, we can find references to phantasmagorias and polyoramas. These are lanterns with a more complex construction system that offered more functions or effects than a simple lantern. Up to eight secondary schools in our corpus had a phantasmagoria: the ones in Figueres, Girona, Madrid, Osuna, Palencia, Pamplona, Tarragona (this secondary school does not include a phantasmagoria in its inventory, but rather a «magic lantern with a mechanism for phantasmagorias» [Torá y Marcé, 1861]. We will explain below what this may mean), and perhaps Burgos (no direct reference was found to a phantasmagoria, but to «phantasmagoria tables» [Camarero y García, 1876, p. 28], that is, projection slides). References to a polyorama can be found in two other secondary schools: the ones in Granada and Segovia. Most of the secondary schools which have one of these lanterns also have a magic lantern, which reveals that one did not

necessarily replace the other. Instead, more than one could be acquired due to their different functions or characteristics.

One of these lanterns has been preserved until our days. It was a phantasmagoria lantern acquired by the secondary school of Girona towards 1849 (Figure 1). This lantern was found in 2014 in a warehouse of the History Museum of Girona by Jordi Pons —director of the Cinema Museum of Girona, where the piece is currently exhibited—, who identified it as an item from the historical collection of the school. More information on this object and its history can be found in an article by Jordi Pons and Daniel Pitarch (2017). However, it is interesting to present a brief description of its characteristics so that we can understand the type of lantern that is being mentioned when a phantasmagoria is added to these inventories. The lantern that has survived to our days has large dimensions (approximately 1.80 m high, with a box of 50 x 50 cm), and it contains a condenser lens of 12 cm[2]. It is mounted on a structure with wheels that makes it possible to project images while moving, which is one of the main characteristics of phantasmagoria as a show and projection technique: changing the distance between the lantern and the screen to make the image larger or smaller. In order to apply this technique, it is necessary to change the focal distance of the projection, while the image remains constantly in focus. This variation was achieved with a mechanism —also described as a rack— that changes the distance of the lens, in some cases even automatically —this is the mechanism that the report from the secondary school of Tarragona must be referring to—. The phantasmagoria of Girona has three outlets for the light sources: one in the centre and two at the sides. This means that it could be used not only for the projection of slides, but also for the projection of opaque objects; that is, it acted as a megascope, according to the terminology of that time. In a megascope, light is not used directly as in the projection of slides (where the source is behind the slide and light goes through it and projects it thanks to the transparent nature of the slide) but indirectly, because the light that is projected is reflected off the object. The fact that this is an indirect use of light increases its power, which becomes twice as intense in the case of this lantern (the two outlets at the sides are used as a megascope). The inventories from the secondary school of Girona —see the reports from years 1861-62 (Ametller y Marill, 1861) and 1879-80 (Moraleda y Sierra, 1880), as well as a manuscript inventory from 1849 preserved in the Historical Archive of Girona— include busts and paintings together with the phantasmagoria (the manuscript from 1849 details the amount: «Phantasmagoria with six busts and eight paintings»). The paintings were probably magic lantern slides and the busts would be small sculptures created for their projection with the megascope. These figures were also offered in the lantern sales catalogues, such as the one by Lerebours et Secretan from 1846, who were the suppliers of this phantasmagoria, according to the documents of the secondary school[3].

[2] The condenser lens is part of the optical system of the lantern. It concentrates the rays from the light source on the slide so that it can take advantage of the power of the light source (a reflector behind the source could also be used to increase the power).

[3] The specific purchase date of the phantasmagoria of Girona comes from two manuscript inventories: the abovementioned inventory from 1849 that includes it for the first time, and the previous one, from 1847. In this temporal frame, according to the report of the year 1849-50 (Llach y Soliva, 1849, p. 8), only two purchases of scientific material were made, both of them to the firm Lerebours et Secretan.

Figure 1. Phantasmagoria lantern attributed to the secondary school of Girona (Museum of Cinema–Col·lecció Tomàs Mallol)
Source: Museum of Cinema–Col·lecció Tomàs Mallol (Girona)

This case is particularly interesting because it combines information from documentary sources with the preserved object. The presence of phantasmagorias in the inventories of other secondary schools shows us that the case of this lantern in Gerona is not an isolated and exceptional example, but instead could be a common occurrence. In the case of Pamplona, the documents reveal that their phantasmagoria device was acquired almost in the same year as in the secondary school of Girona (Ministry of Commerce, Instruction and Public Works, 1848, p. 575), which increases the possibilities that it was acquired to the same manufacturer —because it was also the firm recommended by the model catalogue, as it has been said before—. In addition, and as in the case of Girona, the phantasmagoria in Pamplona could also act as a megascope, and it may have been purchased together with a series of busts. The full inventory of the physics department in the year 1861-62 establishes that the school had a «Phantasmagoria and Megascope with a collection of paintings and moving figures» (Mata Uriarte, 1861: 5). The secondary school of Madrid had purchased a phantasmagoria in the year 1856-1857 (Universidad Central, 1857, p. 162), the one in Osuna in the year 1864-65 (Varona, 1865, p. 5) and the one in Palencia in the year 1865-66 (Domínguez, 1866, p. 34). In the cases of Burgos, Figueres (Boix y Monrós, 1861, p. 6) and Tarragona, no references have been found to the purchase of the equipment, but there are references in the inventories of materials. In the case of Madrid there is a reference that suggests that their phantasmagoria may not have had wheels (in a publication from 1875 that explains the history of the laboratories in the school, they refer to it as a «phantasmagoria without a cart» [Santisteban, 1875, p. 56]), but this does not mean that it had less power than the one in Girona, because another document (Instituto de San Isidro, 1860, p) 13], specifies that the size of the lens of the phantasmagoria was 12 cm; the same as in the phantasmagoria of Girona. The fact that

this characteristic is detailed in the texts highlights the importance of this factor regarding the lantern. Smaller lanterns had condenser lenses of between 5 and 8 cm (Lerebours et Secretan, 1853, p. 26).

The other example of a lantern with special characteristics that can be found in the secondary school centres is the polyorama. There are references to polyoramas in the secondary schools of Granada and Segovia. As usual in historical research, the terminology of each period is a complicated topic, and in this case we observe that the word «polyorama» has multiple meanings (as, indeed, is the case with the Spanish term for «magic lantern», «linterna mágica», which also refers to optical views and which, in spite of our precautions, may have led to some confusion in this study). The catalogue from French manufacturers features this word, either referring to a magical lantern with more than one lens (see the catalogue Lerebours et Secretan from 1853, whose item 159 refers to «Fantasmagories et polyoramas»), or to a box with optical views or cosmorama (for example, in the catalogue from the Breton company of 1859 that contains a section called «Optique et polyorama» and another one called «Lanternes magiques et fantasmagories»). The very meaning of the word seems to refer to the possibility of transforming one image by altering its state —for example, changing from day to night—. This is the way in which it is used in both catalogues —Lérebours et Secretan and Breton— where some lanterns are labelled as «polyoramas» or as devices that can offer «polyorama effects». The catalogue by Lerebours et Secretan establishes an even more precise difference which is interesting in this field —and which can also be found in other texts like *Cours de physique purement expérimentale* by Ganot (1859, p. 382-384)— between «polyorama» and «dissolving views», and says that the first concept involves transitioning within the same image —the abovementioned change from day to night—, whereas the second one involves moving from one image to another, creating a «bizarre confusion» and unexpected effects (Lerebours et Secretan, 1853, p. 27).

In this case, we know that the secondary school of Granada had a similar projection lantern, whereas in the case of Segovia it is difficult to establish that this was indeed a lantern —although the possibility cannot be completely ruled out—. The report of the year 1882-83 of the secondary school of Granada mentions the following purchase:

> «Projection device with polyorama effects, with three illuminated achromatic condenser lenses, 11 cm in diameter; three achromatic lenses in a brass frame with racks and diaphragms for the production of dissolving views; three lamps with brass tubes to prevent the petroleum from burning; and four metres of wick for the lamps» (cited in Sánchez Tallon, 2012, p. 362).

In the case of Segovia, references can be found in two consecutive reports. In the year 1860-61, the report mentions «a polyorama with an effect of double view» and a «polyorama with twelve paintings» (Valcarce, 1860, p. 4). In the report from the following year they are described as follows: «Small polyorama with an effect of double view. 31 [this is the price]» and «a larger polyorama with 12 glass paintings. 330» (Valcarce, 1861, p. 43). These same lists include a «magic lantern with 12 glass paintings». The fact that the second report describes them together and refers to them as a small one and a larger one would mean that this is the same object, and it would rule out the possibility that this is a projection device, because there are no small polyoramas among magical lanterns, but rather large devices similar to phantasmagorias.

The examples of phantasmagorias and polyoramas that we have mentioned above show us that educational institutions did not only acquire simple lanterns, but also large devices that could produce

specialized effects. We will see some of those effects in the next section, which discusses the types of slides purchased by the secondary schools.

To conclude this review of the different types of lanterns, we must refer to another term that appears in some reports from the decade of 1870 on. The abovementioned report of Granada referred to the lantern with polyorama effects as a «projection device». This is also the term used in the reports from the secondary schools of Girona (Ferrando y Plou, 1885, p. 46), Huelva (Fernández García, 1877, p. 52) and Lleida (Combelles y Navarra, 1885, p. 40). Throughout its history, the magic lantern has received different names —either due to commercial motives or for reasons of cultural prestige, mainly—. These examples from the schools show a change in vocabulary in which the adjective «magic» is lost in favour of the reference to «projection» (the secondary school of Barcelona mentions a «projection lantern» in its report from the year 1880-81 [Campo y Rodríguez, 1880, p. 102]) or other more neutral names (the report from Girona in the year 1893-94 includes a «universal lantern» [Civil y Vendrell, 1893, p. 11]).

The purchase of magic lanterns —and of these special lanterns that we would not expect to find, a priori, in an educational centre, due to their specific nature and their higher prices— can be put in context with the physics manuals of that time. In these texts by authors like Ganot (1859, p. 379-384) or Bonet y Bonfill (1868: 225-226), the magic lantern is a topic of study in the field of optics[4]. Phantasmagorias, polyoramas and megascopes also appear as techniques that are derived from the lantern, but not equivalent to it. Lanterns, therefore, were not seen as educational resources to illustrate other topics (to project, for example, images of botany), but as objects of study in themselves. They were not an invisible tool; instead, they became the centre of attention. In the next section we will see how this was not the only use for the lantern in the 19th century. This device could also become invisible to make the projected image be the only important element.

We cannot finish this section without making a reference to another projection device, different from the magic lantern, which all these schools also possessed: the solar microscope. In this case, as the name suggests, it was a projection microscope that uses the sun as a source of light. The historical relationship between these two devices —the solar microscope and the magic lantern— is at the same time a story of mixture and of separation. Although the microscope may seem to have a more scientific use, shows were also held around it —as we can see in the article, with its corresponding illustration, of a show in Barcelona in 1840 cited by Bernardo Riego (2001, p. 70) or a description of a session in London recorded by Humphrey Jennings (1985, p. 201-202)—, and a book of physics like the one by Ganot (1859) includes this device as part of its «optics recreational tools» (together with the magic lantern, phastamagoria, polyorama, diorama and camera obscura). These data can give us an idea of the continuity that exists between both devices and their uses (the projection in front of an audience for recreational and/or educational purposes). On the other hand, the fact that they were conceived as instruments with differences between them is evidenced, for example, by the sales catalogues of the manufacturers, where they are separated and without any continuity between them. In the catalogue from Lerebours et Secretan of 1853, the solar microscope —together with the gas and the electric microscopes— occupies items 79 to 101, among the microscopes, spyglasses and telescopes; whereas the section «Magic lanterns and phantasmagories» goes from item 157 to 201, right after «Optical devices and cosmoramas» and before camera lucida. This is the reason why the solar

[4] Another example of this can be seen in the curriculum of physics and chemistry of the secondary school of Cádiz. Unit 64 of this curriculum is called: «Theory and description of the magic lantern and the solar and photoelectric microscope» (Alcolea, 1873, p. 10).

microscope has not been included as part of the study, but as an additional reference; although it should not be left aside for a global understanding of projection in the 19th century.[5]

2.2 PROJECTED PAINTINGS: ASTRONOMICAL AND TERRESTRIAL GEOGRAPHY

The reports from the centres also include the purchase of lantern slides, which were then referred to mainly as «paintings». While most entries in the report refer only to their existence and their number (which is variable and can range, when specified, from a few slides to several dozens —the report from the year 1866-67 in Palencia shows the purchase of 36 slides [Domínguez, 1866, p. 34]—), there are other cases in which we can only see references to the topic they portray or some technical specification.

Chronologically, the first cases in our corpus of study belong to the phantasmagorias that were acquired in Girona and Pamplona at the end of the 1940s. The note that detailed this purchase in Pamplona added: «Perfected phantasmagoria and a collection of astronomical slides» (Ministerio de Comercio, Instrucción y Obras Públicas, 1848, p. 575). A later inventory reveals that these slides were mobile: «Collection of moving paintings for the explanation of astronomical geography» (Mata Uriarte, 1871: 5). In the case of the secondary school of Girona, the documents do not show any detail regarding the type of slides that were bought, but the Secondary School Vicens Vives of Girona still preserves, together with a wide collection of photographic slides from the 20th century, five mobile slides on astronomy (Figure 2). Each slide has a handwritten title that details the specific topic they discuss: «Comet», «Tides», «Earth Rotation», «Solar eclipses and passage of a star» and «Moon eclipses». The coincidence between the dates and the type of institution invites us to think that the slides in Pamplona may have been very similar. Years later, the Secondary School San Isidro of Madrid purchased, in the year 1863-84, ten astronomical slides with a similar topic:

> «Ten astronomical paintings that can move for the phantasmagoria, which represent constellations; the solar system according to Copernicus and Ptolemy; the passage of a comet ; the movement of the Earth; the day and the night; the shape of the Earth; a solar eclipse; and a moon eclipse» (de la Corte y Ruano-Calderon, 1865).

Yet again, the slides have survived until our days and they are part of the Spanish National Museum of Science and Technology (Lana, López & Martín, 2006).

[5] A future work on the use of projections in education should include this aspect. This kind of methodological problem is common in the field of study that has been called «media archaeology», and it is also part of its attractive regarding the way of creating stories that can move through different disciplines. This is the type of problems that we referred to in the introduction of this work, when we stated that the perspective of the study was mainly the history of the magic lantern and the audiovisual media. The choice of a point of view creates inevitable blind spots. The fact that both the history of the magic lantern and media archaeology are still largely unknown fields should contribute to the visibilization of their blind spots and it should make us think how to create stories that allow their object of study to be both a central element and eccentric to it. The extension and the aim of this article do not allow us to discuss these theoretical and methodological questions further.

Figure 2. Collection of astronomical slides from the Secondary School Jaume Vicens Vives (Girona)

Source: Museum of Cinema–Col·lecció Tomàs Mallol (Girona)

These astronomical slides are provided with mechanisms that allow the projected image to move in order to recreate astronomical phenomena such as the eclipses and their phases or types. In some cases, such as in Granada, the documents specify that the slides acquired were «mechanized or movable» (Sánchez Tallón, 2012, p. 362). Before fixed photographic slides, we can see how moving slides were used in educational centres. In the case of astronomical slides, there was a balance between their educational purposes and the attractive derived from the moving effects they include. However, there are other cases in which the scales are tipped in favour of the effect. The secondary schools of Burgos (Camarero y García, 1876, p. 28), Granada (Sánchez Tallón, 2012, p. 362), Madrid (de la Corte y Ruano-Calderón, 1865) and Valladolid (Álvarez y Álvarez, 1870) include several chromathropes in their inventories under the name «cromatropos». Chromathropes are mobile slides that produce abstract kinetic effects by rotating two glass panels with geometric patterns. In magic lantern shows, they were generally used in the last section of effects (see, for example, the programme proposal by Moigno for his «progress rooms» in *L'art des projections* [Moigno, 1872, p. X]). In the same category of effects, we can find «two views with matching colours that dissolve» acquired by the secondary school of Granada (Sánchez Tallón, 2012, p. 362) which, together with their «projection device for polyorama effects» would make it possible to project an example of dissolving views (Figure 3). The secondary school of

Figueres mentions the purchase of a slide with a «snowing effect» (Boix y Monrós, 1861, p. 6). In this case, this could be a specific type of slide which, through the movement of a perforated cloth, projected dots of white light on another image to imitate the effect of snow. If it was indeed this type of slide, this would imply that the phantasmagoria in the secondary school of Figueres had more than one lens to project more than one slide at the same time.

Among the details of the slides, we can find some with a seemingly anecdotal topic. In Figueres there are slides that represent «a castle» or a «view of St. Etienne» (Boix y Monrós, 1861, p. 6), and in Burgos we can see «Two phantasmagoria boards with maritime races» (Camarero y Garcia, 1876, p. 28). This anecdotal character, compared with the clearly educational approach of astronomical phenomena, would place these slides in the category of lantern effects.

With regard to the type of slides that were purchased, we found one entry that specifies that they were photographic slides. It appears in the report of the year 1882-83 from the secondary school of Granada —the same one that acquired the polyorama and the abovementioned slides—, which refers to «A photographic view with a statue over a black background» and «Eight photographic views in black, 1.50 pesetas a piece» (Sánchez Tallón, 2012, p. 362).

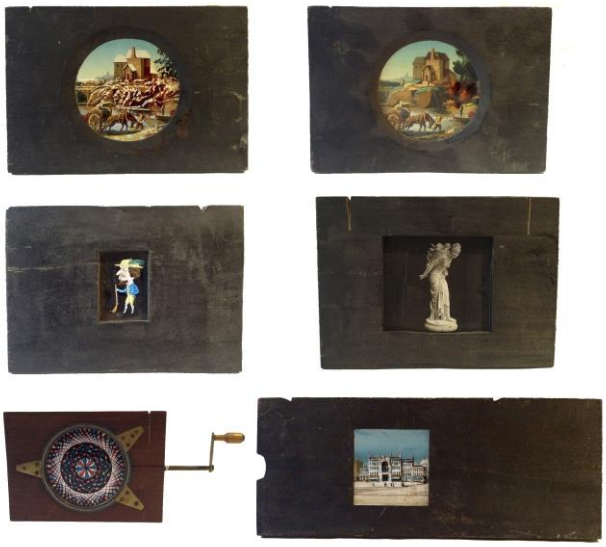


Figure 3. Lantern slides from the secondary school of Granada kept in the Science Museum Padre Suárez (Granada)
Source: Science Museum Padre Suárez (Granada)

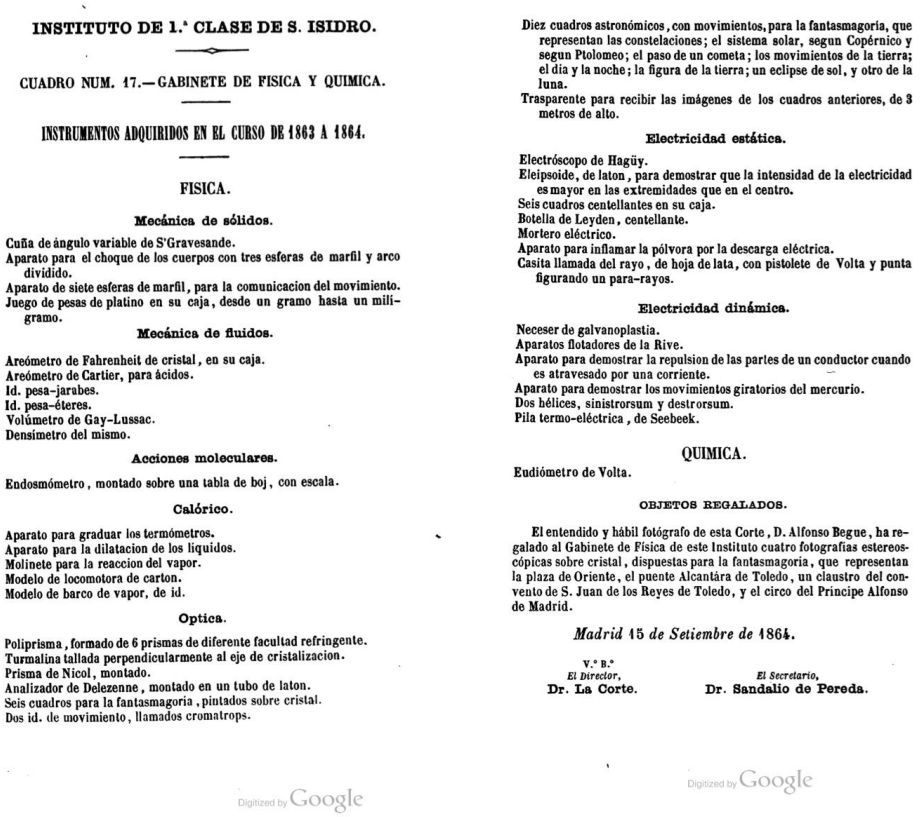
Finally, we must focus on the purchase of 40 slides by the secondary school of Barcelona which is included in the report from the year 1879-80 (Campo y Rodríguez, 1880, p. 102). The importance of this acquisition lies in the fact that it was not ordered by the physics laboratory, but by the department of geography. In the year 1878-79, the Chair of Geography purchased «A projection lantern» and «40 paintings of Geography for their projection». In that same year, the department also acquired several wall maps and atlases, as well as a planetarium and a *tellurium*. We cannot rule out the possibility that the slides had the astronomical theme that we saw in the first examples; but regardless of whether they

focused on the geography of the land or of the skies, their presence in the list of the Chair of Geography clearly signals their use as an educational resource, rather than as an object of study in itself.

Nevertheless, as we have already mentioned, the corpus of our study does not allow us to create a final history of the uses of the lantern in these centres. This reference in the list of the Chair of Geography seems to indicate the evolution of the slide collections and the uses of the lantern. As we said before, the presence of phantasmagorias among the objects acquired in the mid-19th century could mean a greater significance of the object than of the image projected (the lantern is the device that makes it possible to create the effects that are projected). Meanwhile, the preserved collections of photographic slides and illustrations, which come mainly from the 20th century, clearly show the importance of the lantern as an educational resource, rather than as an object of study. It is thus relevant here to detect the presence of lanterns and slides in collections that do not belong to the physics laboratories.

After a review of the references to lanterns and slides in the reports of these centres, we must mention the heterogeneity of the vocabulary that was used to refer to these devices back then. We have already discussed this point when talking about the possible polyoramas that were acquired, or to the use of the term «paintings» when referring to what we would now call «magic lantern slides». Although the matter of lexis, which is inherent to historical research, exceeds the limits of this article, we must at least mention the words that are used to refer to the magic lantern in our corpus of study. The projection device, as we saw in the previous section, is referred to as «linterna mágica» [magic lantern], «fantasmagoría» [phantasmagoria], «poliorama» [polyorama] (or «efectos de polyorama» [polyorama effects]), «aparato de proyección» [projection device], «linterna de proyección» [projection lantern] or «linterna universal» [universal lantern]. In the case of the slides, the terms that we found are: «cuadros» [paintings] (either simple, mechanical or moving), «cristales» [glass panels] (Combelles y Navarra, 1885, p. 40), «vistas» [views], «láminas» [sheets] (La-Rosa, 1861, p. 32) or «tablas» [tables] —as well as the technical and specific term of «cromatropos» [chromathropes]—. This vocabulary associated to slides, as we can guess, is not exclusive to these objects, which makes their identification more difficult. Finally, we find references to screens. In some cases this same word appears in the inventories (such as the one of Girona in the year 1861-62 [Ametller y Marill, 1861]), but it does not necessarily refer to a screen for image projection. When it appears right after projection devices, it is generally described as «transparent» (de la Corte y Ruano-Calderon, 1865) or as a «cloth frame» (Domínguez, 1866, p. 34). The first example even describes its considerable height («Transparent, to receive the images of the previous paintings [astronomical paintings for phantasmagoria], and 3 metres high), which allows us to further conceptualize some of the projection practices in the schools.

Figure 4. Double page of the report from the secondary school of Madrid in 1865 (de la Corte y Ruano-Calderón, 1865)



INSTITUTO DE 1.ª CLASE DE S. ISIDRO.

CUADRO NUM. 17.—GABINETE DE FISICA Y QUIMICA.

INSTRUMENTOS ADQUIRIDOS EN EL CURSO DE 1863 A 1864.

FISICA.

Mecánica de sólidos.

Cuña de ángulo variable de S'Gravesande.
Aparato para el choque de los cuerpos con tres esferas de marfil y arco dividido.
Aparato de siete esferas de marfil, para la comunicacion del movimiento.
Juego de pesas de platino en su caja, desde un gramo hasta un miligramo.

Mecánica de fluidos.

Areómetro de Fahrenheit de cristal, en su caja.
Areómetro de Cartier, para ácidos.
Id. pesa-jarabes.
Id. pesa-éteres.
Volúmetro de Gay-Lussac.
Densímetro del mismo.

Acciones moleculares.

Endosmómetro, montado sobre una tabla de boj, con escala.

Calórico.

Aparato para graduar los termómetros.
Aparato para la dilatacion de los líquidos.
Molinete para la reaccion del vapor.
Modelo de locomotora de carton.
Modelo de barco de vapor, de id.

Optica.

Poliprisma, formado de 6 prismas de diferente facultad refringente.
Turmalina tallada perpendicularmente al eje de cristalizacion.
Prisma de Nicol, montado.
Analizador de Delezenne, montado en un tubo de laton.
Seis cuadros para la fantasmagoria, pintados sobre cristal.
Dos id. de movimiento, llamados cromatrops.

Diez cuadros astronómicos, con movimientos, para la fantasmagoría, que representan las constelaciones; el sistema solar, segun Copérnico y segun Ptolomeo; el paso de un cometa; los movimientos de la tierra; el dia y la noche; la figura de la tierra; un eclipse de sol, y otro de la luna.
Trasparente para recibir las imágenes de los cuadros anteriores, de 3 metros de alto.

Electricidad estática.

Electróscopo de Hagüy.
Elelpsoide, de laton, para demostrar que la intensidad de la electricidad es mayor en las extremidades que en el centro.
Seis cuadros centellantes en su caja.
Botella de Leyden, centellante.
Mortero eléctrico.
Aparato para inflamar la pólvora por la descarga eléctrica.
Casita llamada del rayo, de hoja de lata, con pistolete de Volta y punta figurando un para-rayos.

Electricidad dinámica.

Neceser de galvanoplastia.
Aparatos flotadores de la Rive.
Aparato para demostrar la repulsion de las partes de un conductor cuando es atravesado por una corriente.
Aparato para demostrar los movimientos giratorios del mercurio.
Dos hélices, sinistrorsum y destrorsum.
Pila termo-eléctrica, de Seebeek.

QUIMICA.

Eudiómetro de Volta.

OBJETOS REGALADOS.

El entendido y hábil fotógrafo de esta Corte, D. Alfonso Begue, ha regalado al Gabinete de Física de este Instituto cuatro fotografías estereoscópicas sobre cristal, dispuestas para la fantasmagoria, que representan la plaza de Oriente, el puente Alcantára de Toledo, un claustro del convento de S. Juan de los Reyes de Toledo, y el circo del Príncipe Alfonso de Madrid.

Madrid 15 de Setiembre de 1864.

V.º B.º
El Director,
Dr. La Corte.

El Secretario,
Dr. Sandalio de Pereda.

Source: Complutense University of Madrid, digitalized by Google.

The previous section, related to lanterns, referred to solar microscopes as another projection device that the centres had. Similarly, we cannot end this section without mentioning the existence in the inventories of devices that may have been bought for these microscopes. The report from the secondary school of Granada in the year 1863-64 refers to the purchase of a «Collection of 10 glass slides with transparent objects for the microscope», followed by «Idem, 6 units with photographic views for the microscope» (Moreno González, 1863).

Similarly, we could focus, for a complementary study, on other objects in these inventories that could be used in combination with magic lanterns, and which were not slides. These are different types of prisms, lenses, mirrors or other devices that were used to study optics and light. In this case, the lantern was used only as a source of focused light that was subject to different experiments. A good example of all these possibilities, together with an illustration for each of them, can be found in the catalogue from the Dubosq company in 1885 —as well as the catalogue of its successor, the Pellin company, circa 1900—, included under the category of «Main optical phenomena for projection».

3. OTHER EDUCATIONAL CENTRES: EDUCATIONAL EXHIBITIONS

The case of secondary schools has the advantage of being a closed and relatively homogeneous corpus of centres —although the documents about them are partial and heterogeneous, as we have already discussed—. In order to complete the knowledge that emanates from these documents, we will now refer to three short pieces of information about the use of the lantern in other educational centres. Whereas official information from secondary schools can be obtained from their reports, there are other centres that we know about thanks to the press.

In 1882, an Educational Conference was held in Madrid —promoted by the society «El fomento de las artes» [The promotion of arts]— that included an Exhibition. In a news article about it that was published in the journal *La Iberia* of June 7th 1882 there is a special mention to the hall of the centre Escuelas Pías and its projection device:

> «After the hall there is a smaller room in which the Escuelas Pías school have placed their equipment, with objects wonderfully arranged and classified. Suffice it to say that it contains what even the most meticulous teacher might desire, or the most eager student. There is a projection device with limelight to explain Geography, Sacred History, Natural History, etc.» (*La Iberia,* 1882, p. 3).

As we can see, there is an emphasis on the device itself and on the technical features of its lighting source, but also on its uses for specific purposes. The fact that these purposes —although only two are mentioned and more may be inferred thanks to the «etc.»— are not the teaching of physics and optics can be explained by the shift from the physics laboratory to other departments of the schools that was mentioned above.

During the Universal Exhibition of Barcelona in 1888, one school, called Academia Gerundense, exhibited part of its collection of 300 magic lantern slides. This case is known thanks to the work of Jordi Artigas (2012), who found an article in the journal *El barcelonés* that mentioned it. The article described different objects exhibited by the centre —such as a collection of historical maps, for example—, and it details the issue of the slides:

> «25 views drawn on glass for projection devices, as an example of the ones owned by the Centre (the collection includes 300 views): Vegetable egg, blood cells, Trichinus spirales, Scabies mite, pharynx and larynx, stomach of a ruminant, Speros of Phra, scheme of a heart, peritoneum, female lobster, Venus flytrap, brain (horizontal section), chicken embryo, Bacillus anthracis, Greek fire, Judgement of the dead, bat, neuroskeleton, lacrimal duct, joint of the elbow and the hip, history of Spain, coat of arms of Gerona, Hannibal, the parliament of Caspe, the Battle of Las Navas, Fiveller.» (*El Barcelonés,* 1888).

The topics of the slides illustrate the use of projections in very different subjects, from biology to history.

The Academia Gerundense was not the only centre who exhibited material related to projections in the Universal Exhibition of Barcelona. The list of exhibitors of «General teaching» also included the following reference: «Normal school of Logroño. Magic lantern, projections, etc.» (*La exposición*, 1888, p. 33).

These three cases show how the magic lantern and its slides are educational materials that a centre can exhibit as a sign of its quality. Obviously, this does not mean that the lantern is the only device that can fulfil this function —after all, these are only three examples from a large amount of exhibitors—. Instead, the importance of these data lies in the fact that they show that the lantern is an educational material which is fully integrated in the teaching practices of the decade of 1880, and that the particular characteristics of a collection of slides or devices can be a distinctive feature that a centre might want to emphasise.

4. «TO TRANSFORM THE BLACKBOARD INTO A BLANK SCREEN»

The main objective of this study is to collect data that let us know the types of lanterns and slides that were used in secondary school teaching in the mid-19th century. An entirely new complementary field of analysis would involve research on the presence of the lantern in the writings about pedagogy from that period, both for primary and secondary education. For example, there are documents by Pedro de Alcantara García, who said the following in his *Compendio de pedagogía teórico práctica* in 1891:

> «…whenever possible, a light projection device and some microscopes. With the first of these devices, which is easy to manage, similar in style to the magic lantern (which can be used in its absence), we can offer educational material for almost all ages, so that children can observe objects on a large scale with some perspective, with their natural colours and in motion, in the cases of objects that move naturally. Therefore, and with these attractions, schoolchildren can observe and study the planets, with their complex constitution and their rhythmic movements; views of landscapes and towns; architectural monuments, sculptures and paintings; the smallest animals and the faintest organs; everything, in sum, which can be represented graphically, including the experiences of capillarity, the decomposition of water and of a salt through a battery and the recomposition of white light. This short list should be enough to understand the enormous help that light projections can represent for school teaching» (de Alcantara García, 1891, p. 300).

The study of the presence of the lantern in education literature would be much broader than the research that is presented here. However, and as a conclusion to this article, we want to refer to a specific text that focuses on the use of the lantern in education. It is the article «Las proyecciones luminosas como medio de enseñanza» [Light projections as a means for education], published in instalments in the journal *El Faro*, from Lima, Peru, in 1889 by Federico Villareal (1889a, 1889b, 1889c, 1889d, 1890a, 1890b, 1890c and 1890d).[6]

[6] There could well be more publications with this same title. We know, for example, that there is a book that was published in Montevideo with the same name, but we were not able to consult it for this research. Pedro de Alcantara García (1891, p. 303) provides the following reference for this work: Arocena (D. Carlos A.). *Las proyecciones luminosas como medio de enseñanza. Noticia, uso y utilidad de las proyecciones*, etc. Montevideo, lib. nacional de Barreiro y Ramos.

This text shows a profound knowledge of the lantern from a historical perspective (the first two sections are called «1. First period of the projections» and «2. Second period of the projections») and from a technical one (the three last sections are: «4. Light sources», «5. Preparation of paintings» and «6. Screen on which the projection is shown / Projection devices»). It is interesting to take a closer look to the terminological distinction it draws:

> «Although the same device is used for the amusement of children and for scientific teaching, a difference has been established by habit: it is referred to as a *magic lantern* when it has a basic construction with vulgar projections that are only used for fun, and it is known as *projection device* when it is a perfected lantern used to amplify photographs for educational purposes» (Villareal, 1890d, p. 40) (emphasis in the original).

This distinction, and the rejection of the connotations of the adjective «magic» —and with it, everything which may be «vulgar» or «only used for fun»— had also been observed in the evolution of the vocabulary in the reports from the secondary schools. This need to establish a difference is a constant factor in the history of the magic lantern, in which there is a permanently perceived duality between science and entertainment which is reflected, in the public discourse of many scientific or educational articles, in the duality between prestige and disdain. The same article warns us that «There is nothing shameful about operating a magic lantern» (Villareal, 1889a, p. 245); a warning that is similar to the ones issued by the physicist Jean Antoine Nollet in the mid-18th century (Nollet, 1738, p. 168 and 1745-1775, p. 567-568).

In the third section of the article, which has the same name as the article itself, we can find further considerations about the lantern and about teaching. The principle presented there deserved to be quoted in full:

> «To transform the blackboard into a blank screen, to project the objects that are admirably captured in the photographs, to include sudden or gradual changes, to liven up the scene with natural movements, to call the attention so remarkably, so that the contents of the image are etched in our memory without the slightest effort; to remember the tiniest details that appeared or were transformed while they were being explained… This is the teaching method that arouses curiosity and it is one of the greatest advantages that modern Pedagogy has acquired» (Villareal, 1889c, p. 278).

It is very interesting to see how a possible projection is described and how it specifies aesthetic resources related to the animation of images or to staging (the «sudden or gradual changes»). These resources are part of the effects that were described above regarding the different types of lanterns and slides, not as an object of study in themselves, but as a means to convey the contents of the images.

This section offers —as a sample rather than as a description of its entire potential, according to Villareal— different examples of the use of projections in astronomy, geography, history and optics (Villareal, 1889d). Lessons in optics use the lantern, combined with other objects like prisms, to study phenomena such as light decomposition. With regard to astronomy, collections of 150 and 30 slides are mentioned, and a more detailed explanation is offered about a set of 10 slides which matches al-

most perfectly the ones that we could find in Spanish secondary schools: the sphericity of the Earth, the planet system, the annual revolution around the Sun, the daily rotation of the Earth, the movement of the Moon around the Earth, tides, the orbits of Venus and Mercury, the movement of a comet, lunar eclipses and solar eclipses. In the field of geography, according to Villareal, projections could be used to relieve the lessons from part of the abstract burden of words and to bring students face to face with the images of the topics they study. This same virtue of images, «which cannot be replaced by words» (Villareal, 1889d: 288), is also applied to history («Sacred History», in this case), with special emphasis on the aesthetic effects that would help students to commit the contents to memory:

> «…but if those figures could move, if the fire of sacrifices could be seen, if we could see the water falling in the Flood, if the solemn moment in which the Law was dictated from the top of Mount Sinai could be seen coming to life, it would surely immediately engrave those events on their memory» (Villareal, 1889d: 288)

5. Conclusions

In this article we have discussed a specific case of study —the acquisition of lanterns and slides in Spanish secondary schools in the 19th century—, which has been complemented with some contextual data and references. We could see how the magic lantern was a common device in secondary education in Spain during the second half of the 19th century. A detailed review of the reports from the schools has let us observe the presence of special lanterns —phantasmagorias and polyoramas—, as well as different types of slides associated with the creation of effects —chromathropes or slides for dissolving views—. These acquisitions may be surprising because these lanterns and slides are more commonly linked to entertainment than to education. However, the secondary schools probably bought them as an object of study in themselves —which does not only contribute to understanding education practices, but also to complementing an understanding of the lantern as a device for shows—. This does not mean that projected images were no longer considered to have an educational value because, as we have seen, the first slides that were purchased contained images of astronomy —they represented mobile examples of astronomical phenomena that could not be conveyed as effectively with a fixed illustration—. Although we have already stated that the corpus in our analysis does not allow us to draw an entire history, the data suggest that there was an evolution in the use of the lantern in the physics course towards other departments —a situation that was perfectly normal in the 20th century, as seen in the collections that have been preserved—. These reports reproduce an evolution of the term «magic lantern» to the more neutral «projection device» which we have also witnessed, in general terms, throughout the history of the magic lantern.

The cases from other educational centres, as well as the article by Villareal, complete the images that these reports show us. These examples highlight the thematic versatility of the lantern, the use of its varied effects in teaching and its usual presence as another educational device.

All these data confirm that the magic lantern was a technology that could be found in schools in the 19th century, and they help us to know more details about the history of audiovisual media and their relationship with education.

6. REFERENCES

Alcolea, J. (1873). *Programa de las lecciones de física y química que da en el Instituto de Segunda Enseñanza de Cádiz el catedrático de dicha asignatura.* Cádiz: Imprenta de la Revista Médica.

Álvarez y Álvarez, A. (1870). *Memoria acerca del estado que ha tenido la enseñanza en el Instituto de Valladolid durante el curso de 1869 a 1870 leída el dia 1º de octubre de 1870*. Valladolid: Imprenta y librería Nacional y Extranjera de Hijos de Rodríguez.

Ametller y Marill, M. (1861). *Memoria leida en la apertura del curso académico de 1861 a 1862 en el Instituto provincial de 2a enseñanza de Gerona*. Girona: Imprenta de F. Dorca.

Artigas, J. (2012). La llanterna i les seves variants com antecedents dels diferents gèneres cinematogràfics. In Quintana, A. & Pons, J. (ed) *La construcció de l'actualitat en el cinema dels orígens* (pp. 277-287). Girona: Museu del Cinema y Ajuntament de Girona.

Barcelonés, El (1888), Monday, June 14th, 1888, year V, no. 2435, evening edition.

Bertomeu, J. R., Cuenca, M., García, A. & Simon, J. (2011). Las colecciones de instrumentos científicos de los institutos de enseñanza secundaria del siglo XIX en España. *Historia de la educación*, 21, 167-193.

Bonet y Bonfill, F. (1868). *Compendio de elementos de física y de nociones de química inorgánica para uso de los institutos de segunda enseñanza*. Barcelona: Imprenta del Diario de Barcelona.

Boix y Monrós, J. (1861). *Memoria leída en el acto de la apertura del curso académico de 1861 a 1862 en el Instituto local de 2ª enseñanza de la villa de Figueras*. Figueres: Imprenta de Lorenzo Mirgeville.

Breton, frères (1859). *Instruments de physique, de chimie, d'optique, de mathématiques et d'astronomie, qui se trouvent et s'exécutent dans les magasins et ateliers* (…). Paris: Imprimerie de L. Martinet.

Brooker, J. (2013) *The Temple of Minerva: Magic and the Magic Lantern at the Royal Polytechnic Institution, London, 1837-1901*. London: Magic Lantern Society.

Camarero y García, E. (1876). *Resumen del estado del Instituto provincial de Burgos en el año académico de 1875 a 1876*. Burgos: Imprenta de D. Timoteo Arnaiz.

Campo y Rodríguez, J. (1880). *Memoria acerca del estado del Instituto Provincial de Segunda Enseñanza de Barcelona durante el curso de 1879 a 1880*. Barcelona: Tipografia de la Casa P. de Caridad.

Civil y Vendrell, P. (1893). *Memoria del curso de 1891 a 1892 acerca del estado del Instituto Provincial de 2a Enseñanza de Gerona leída en la solemne apertura del de 1892 á 1893*. Girona: Imprenta y librería de Paciano Torres.

Combelles y Navarra, J. O. (1885). *Memoria sobre el estado del Instituto de Segunda Enseñanza de la Provincia de Lérida durante el año escolar de 1883 a 1884 (…)*. Lleida: Tipografía provincial de la Casa de Misericordia.

Crangle, R., Herbert, S. & Robinson, D. (2001). *Encyclopaedia of the Magic Lantern*. Londres: The Magic Lantern Society.

de la Corte y Ruano-Calderon, J. A. (1865). *Memoria acerca del estado del instituto de 1ª clase de San Isidro de Madrid (antiguos reales estudios del mismo nombre) leida el día 16 de setiembre de 1864*. Madrid: Imprenta de D. Alejandro Gómez Funtenebro.

Domínguez, I. (1866). *Memoria leida el día 16 de setiembre en la inauguración del curso de 1866 a 1867 en el Instituto provincial de 2º enseñanza de Palencia*. Palencia: Imprenta de José M. de Herran.

Dubosq, Maison Jules (1885). *Historique & Catalogue de tous les Instruments D'Optique Supérieure Appliqués Aux Sciences et a L'industrie*. Paris.

Exposición, La (1888), April 1888 – December 1888, issues 72, 73, 74 & 75.

Fernández García, A. (1877). *Memoria acerca del estado del Instituto Provincial de Huelva leída en la solemne apertura del curso académico de 1877 a 1878*. Huelva: Establecimiento tipográfico de la Sra. Vda. De Galvez e Hijos.

Ferrando y Plou, Pedro. 1885. *Memoria del estado del Insituto Provincial de segunda enseñanza de Gerona durante el curso de 1883 a 1884, leída en la solemne apertura del curso académico de 1884 a 1885*. Girona: Imprenta y librería de Paciano Torres.

Ganot, A. (1859). *Cours de physique purement experimental à l'usage des gens du monde, des aspirants au brevet supérieur, des élèves des écoles normales, des institutions de demoiselles et en général despersonnes étrangères aux connaissances mathèmatiques*. Paris: Ganot (author-editor).

Instituto de San Isidro (1860). *Catálogo de los instrumentos de física y química que existen en el gabinete de la Cátedra de Física del Instituto de San Isidro de Madrid*. Madrid: Imprenta y librería de D. Eusebio Aguado.

Ibéria, La (1882), Wednesday, June 7th, 1882, year XXIX, no. 7910, first edition.

Jennings, H. (1985). *Pandaemonium 1660-1886: The Coming of the Machine as Seen by Contemporary Observers*. New York: Free Press.

La-Rosa, M. (1861). *Memoria leída por D. Manuel La-Rosa, catedrático de psicología, lógica y ética, director del Instituto de Segunda Enseñanza de Lérida en la solemne apertura del curso de 1861 a 1862*. Lleida: Establecimiento Tipográfico de D. José Sol.

Lana Celaya, A., López Camps, R. & Martín Latorre, Rosa Mª (2006). La enseñanza a través de la imagen proyectada: placas para linterna mágica en las ciencias exactas, físicas y naturales. In Batlló

Ortiz, J & Ferran Boleda, J. *Actes de la VIII Trobada d'Història de la Ciència i de la Tècnica* (pp. 307-314). Barcelona: Institut d'Estudis Catalans.

Lerebours et Secretan. (1846). *Catalogue et prix des instruments d'optique, de physique, de mathématiques, d'astronomie et de marine qui se trouvent et s'exécutent dans les magasins et ateliers de Lerebours et Secretan, opticiens de l'Observatoire Royal et de la Marine*. Paris.

Lerebours et Secretan. 1853. *Catalogue et prix des instruments d'optique, de physique, de chimie, de mathématiques, d'astronomie et de marine, qui se trouvent et s'exécutent dans les magasins et ateliers de* (…). Paris.

Llach y Soliva, J. (1849). *Memoria leída en la solemne apertura del año escolar de 1849 a 1850 en el Instituto provincial de Gerona*. Girona: Imprenta de don Vicente Oliva.

Mata Uriarte, J. (1861). *Memoria leída el día 16 de Setiembre de 1861 en la solemne apertura de los estudios del Instituto de 2a enseñanza de Pamplona*. Pamplona: Imprenta de Francisco Erasun.

Ministerio de Comercio, Instrucción y Obras Públicas (1848). *Boletín oficial del Ministerio de comercio, instrucción y obras públicas.*

Ministerio de la gobernación de la península. Sección de instrucción pública (1846). Circular. Previniendo que los Institutos se provean de los instrumentos necesarios para la esplicacion [sic] de las ciencias físicas y naturales. *Boletin oficial de instruccion pública*, 6 (19).

Moigno, A. (1872). *L'art des projections*. Paris: Journal *Les mondes.*

Moraleda y Sierra, M. (1880). *Memoria histórica, administrativa y económica del Instituto Provincial de segunda Enseñanza de Gerona. Publicada como apéndice a la memoria leída en la apertura del curso de 1879 a 1880*. Girona: Imprenta y librería de Vicente Dorca.

Moreno González, J. M. (1863). *Memoria leída en la solemne apertura del curso académico de 1863 a 1864 del Instituto de Segunda Enseñanza de la Provincia de Granada en el día 16 de setiembre de 1863*. Granada: Imprenta de D. Francisco Ventura y Sabatel.

Nollet, J. A. (1738). *Programme ou Idée générale d'un cours de physique expérimentale. Avec un catalogue raisonné des Instruments qui servent aux expériences.* Paris: Chez P. G. Le Mercier.

Nollet, J. A. (1745-1775). *Leçons de physique expérimentale*. 6 vol. Paris: chez les frères Guérin.

Pellin (ca. 1900). *Instruments D'Optique Et de Précision. Ier et II Fascicules. Sources Lumineuses et Appareils de Projection*. Paris.

Pons, J. & Pitarch, D. (2017). History of a fantascope: a device for education in nineteenth-century Girona. *Early Popular Visual Culture*, 15 (1), 83-99, doi: 10.1080/17460654.2016.1270403

Riego, B. (2001). *La construcción social de la realidad a través de la fotografía y el grabado informativo en la España del siglo XIX*. Santander: Ed. Universidad de Cantabria.

Sánchez Tallón, J. (2012). *Los instrumentos de física en los manuales y en los gabinetes del s.XIX en España. Estudio de caso: el gabinete del I.E.S. «P. Suárez» de Granada.* (Doctoral thesis) Granada: Editorial de la Universidad de Granada.

Santisteban, Mariano (1875). *Breve historia de los Gabinetes de física y química del Instituto de San Isidro de Madrid*. Madrid: Imprenta de la viuda de Aguado e hijo.

Simon, J. & Cuenca-Lorente, M. (2012). Science Education and the Material Culture of the Nineteenth-Century Classroom: Physics and Chemistry in Spanish Secondary Schools. *Science & Education*, 21 (2), 227-244. doi: 10.1007/s11191-010-9258-7

Torá y Marcé, F. (1861). *Memoria leída en el acto solemne de la aparetura del curso de 1861 a 1862 por D. Félix Torá y Marcé, presibtero, catedrático de lógica y ética y director del Insituto Provincial de 2ª enseñanza de Tarragona.* Tarragona: Imprenta de los sres. Puigrubí y Arís.

Universidad Central (1857). *Anuario de la Universidad central para el curso de 1857 a 1858*. Madrid: Imp. de J. M. Ducazcal. (note: the Secondary School San Isidoro of Madrid was dependent on this institution back then)

Valcarce, S. R. (1860). *Memoria leída en el solemne acto de la apertura del curso académico de 1860 a 1861 en el Instituto provincial de segunda enseñanza de Segovia*. Segovia: Imprenta y librería de D. Juan de Alba.

Valcarce, S. R. (1861). *Memoria leída en el solemne acto de la apertura del curso académico de 1861 a 1862 en el Instituto provincial de segunda enseñanza de Segovia*. Segovia: Imprenta y librería de D. Juan de Alba.

Varona, J. M. (1865). *Memoria leída el 16 de setiembre de 1865 en la solemne apertura del curso académico de 1865 a 1866 en el Instituto local de segunda enseñanza de Osuna*. Sevilla: Imprenta y librería de D. Antonio Izquierdo.

Villareal, F. (1889a). Las proyecciones luminosas como medio de enseñanza. *El Faro*. I (20), 244-247.

Villareal, F. (1889b). Las proyecciones luminosas como medio de enseñanza. *El Faro*. I (22), 264-266.

Villareal, F. (1889c). Las proyecciones luminosas como medio de enseñanza. *El Faro*. I (23), 277-279.

Villareal, F. (1889d). Las proyecciones luminosas como medio de enseñanza. *El Faro*. I (24), 287-289.

Villareal, F. (1890a). Las proyecciones luminosas como medio de enseñanza. *El Faro*. II (25), 4-5.

Villareal, F. (1890b). Las proyecciones luminosas como medio de enseñanza. *El Faro*. II (27), 28-29.

Villareal, F. (1890d). Las proyecciones luminosas como medio de enseñanza. *El Faro*. II (28), 40-41.

Villareal, F. (1890d). Las proyecciones luminosas como medio de enseñanza. *El Faro*. II (29), 52-54.

Weeden, B. (2008). *The Education of the Eye: The history of the Royal Polytechnic Institution 1838-1881*. Cambridge: Granta Editions.

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