

C. Zaragoza *, J.M. Fernández-Novell **

Young students turn the history of science into an educational theatre

Abstract

Most primary and secondary school students do not relate scientific terms like density, gravity and atom to Archimedes, Newton and Rutherford, respectively. Moreover, they rarely associate science with the history of science. We considered that “science theatre for young audiences” could be a stimulating way by which to present science and the life stories of prominent scientists to students. In this regard, we developed a theatre play called “The History of Science”. After two performances, we filmed the play, thereby acquiring an effective audiovisual method to teach science and the history of science to young people in secondary school classes. We propose this theatrical activity as a reference model for other science disciplines.

(1) Introduction

Posed with questions like “Can you tell me something about Archimedes?”, “what do you know about Galileo?”, most students in Spanish secondary schools¹ are not able to respond.² The heart of the problem lies in their lack of interest in science.³ The loss of interest in science by young people is also observed around Europe. Therefore, teachers must stimulate curiosity in this subject and also increase the general knowledge of this field among their students. Teaching the history of science is dynamic, exciting and motivating work because it implies imaginative communication to teach science and its history.

To motivate students, we wrote and produced a play to learn about several periods of science history. With students as actors, we then used this play as a lesson on chemistry and physics. The play was based on short stories⁴ about the exceptional lives of scientists such as Archimedes, Galileo, Newton, Pasteur and the circumstances of the periods in which they lived (political, religious, social, ...). It also covered important events in the world of science,⁵ e.g. the discovery of metals and fire in Prehistory or explanations about the fundamental roles of the theories proposed by Archimedes, Galileo or Rutherford, emphasizing their great contribution to society.

* Department of Education, Government of Catalonia. IES Can Vilumara (Spain).

** Department of Education, Government of Catalonia, IES Isaac Albéniz (Spain) and Department of Biochemistry and Molecular Biology, University of Barcelona (Spain); email: jmfernandeznovell@ub.edu.

¹ J.M. Fernández-Novell and C. Zaragoza. “Tot ignorant Galileo” [“Not understanding Galileo”] *L’espiral* 18 (2000), p. 10–11.

² J.M. Fernández-Novell. “La ciencia ¿puede ser atractiva para todos?” [“Could science interest everyone?”], *La Vanguardia* (11. 14. 2004), p. 34–35.

³ M. Martínez, B. Gros, T. Romaña. “The problem of training in Higher Education”, *Higher Education in Europe*, vol XXIII (1998), n. 4, p. 483–495.

⁴ Leopoldo de Meis and Diucênio Afonso Rangel. *O método científico*. (2002) 3^a edição. Rio de Janeiro ed. Do autor. Universidade Federal do Rio de Janeiro.

⁵ See Josep M. Fernández-Novell, Carme Zaragoza and Josep Fernández Zaragoza. “Història de la Ciència 1” [“The History of Science 1”], *L’espiral* 26 (2004), p. 14–15. And also, Soledad Esteban Santos “Introducción a la Historia de la química” [“Introduction to the History of Chemistry”]. Universidad Nacional de Educación a Distancia. Madrid 2001.

(2) Materials and Methods

What is a Creative Drama? One possible definition of creative drama is “some dramatic performances which have the understanding of the participants as the objective”.⁶ Although we are not playwrights we used some information from Internet.⁷ The play “The History of Science” reflects our wish to communicate a message about learning science. Basically, we subscribe to learning this discipline in the context of its history.

The drama portrayed through this “Educational theatre” essentially derives from the characters, scientists and period we focused on.

Six topics were prepared:

- First steps. Stone and Metal Ages. Fire, superstition and religion
- Science in Greece: Archimedes and Aristotle.
- The alchemists: Raymond Llull and gold.
- Science revolution: Galileo Galilei and The Spanish Inquisition.
- Science and apples: Newton.
- Scientific method. Lavoisier.

The performance was given by 3 female and 3 male students from our Secondary School class (specifically chemistry and physics).

Make-up was done by one of the actresses (Figure 1). She gave a healthy flush of colour to lips, eyes, or cheeks, and the effects were truly remarkable. She also helped to prepare the costumes, which added a touch of realism to the period in question.

To set the scene, decorations and props (Figure 2) were used to draw students into the period and also into the personality of the scientist in question. Drawings were also made to bring scientists’ lives closer to spectators. Pictures were projected onto a screen by Power point. Set requirements were also established by the team, and only basics were used for each scene.



Figure 1

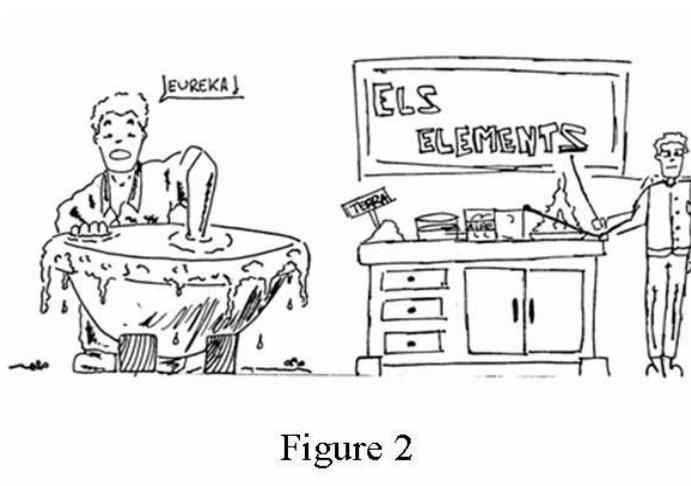


Figure 2

Each act was divided into several scenes and each was completed by its characters and following the requirements of the set (as seen from the topic “First steps” in Table 1).

⁶ See: www.creativedrama.com (A resource for educators, students, artists, and interested parties in creative drama and theatre. Book lists, play information, theatre games).

⁷ See: www.staircase.org/structures (Improvisational Theatre Structures through hard work, dedication, and, most importantly, believing in the art of making dreams come true); www.artslynx.org/theatre/thed.htm (these Theatre Education links provide a wealth of information for the theatre teacher, theatre student, theatre scholar); www.teachingarts.org/theatre/ (site very interested in play righting program, as static as this site is, there is much information helpful to art educators.)

Table 1.
First steps: 3 scenes

Scene 1: live and die.

Characters: a prehistoric man, a prehistoric woman and death.

Set requirements: wigs, bones, animal furs, vegetables, and fruits, a death mask, a sickle and a cloak.

Focus: First metals, flint knives and hunting

Scene 2: magic and superstition.

Characters: a witch doctor and 2 neutral prehistoric characters.

Set requirements: wigs, bones, animal furs, wizard's wand and sounds and effects of thunder and lightning to evoke fear.

Focus: science's view-point: superstition and craftsman.

Scene 3: beyond fire.

Characters: 3 neutral prehistoric characters.

Set requirements: wigs, bones, animal furs, card-stones, some branches and a toy that makes what looks like fire.

Focus: Discovering fire, cooking and a new defence.

(3) Results

After checking the resources available for the educational experience, students and teachers together (team) could then start. Secondary school "chemistry" students spent a lot of extra time outside the class preparing the script and set requirements. They used some biography and books on "The History of Science"⁸ for all purposes and a general science book.⁹ Students practised the play until they felt comfortable interpreting their roles.

Actors most greatly appreciated the opportunity to work in a science-theatre and considered it a valuable experience that they would repeat. They increased their background knowledge of science, and also valued personal interaction between the team: student-student, student-teacher and performers-audience as well; however, most did not feel comfortable presenting the play in public because they were unaccustomed to making such performances.

The play was presented to the educational community in the IES Isaac Albéniz's theatre and the implicit spontaneity of a theatrical performance proved to be exciting for the performers (secondary school students) and audience alike.

After two performances, we observed an increase in young students' interest in "The History of Science" and also in the interest of some teachers for this subject. For this reason, we decided to film the play, thereby acquiring an effective audiovisual tool through which to disseminate certain events in "The History of Science".

The film has been shown in several secondary school classes. Compulsory secondary education covers children up to the age of 16 (four levels) and high secondary school students (16–18 years old).

⁸ On this point, see M. Lozano Leyva. *De Arquímedes a Einstein. Los diez experimentos más bellos de la física*. ["From Archimedes to Einstein"] (2005), Chapter I and III. Random House Mondadori, S. L. ed. Barcelona; Isaac Asimov. *Breve historia de la química*. (1975), Chapter I and II. Alianza Editorial. Translation from "A short History of Chemistry. An introduction to the ideas and Concepts of Chemistry" (1965) by Educational Services Incorporated. Dounleday & Co., Inc., New Cork; and W. F. Bynum, E. J. Browne and R: Porter (1986), *Diccionario de la historia de la ciencia*. Editorial Herder. Barcelona. Translation from "Dictionary of the History of Science"

⁹ See Isaac Asimov. *Nueva guía de la Ciencia*. Plaza & Janés Editores, Barcelona 1985. Translation from "Asimov's new guide to science". Basic Books, Inc. New York 1960; Isaac Asimov. *La búsqueda de los elementos*. Plaza & Janés Editores, Barcelona 1986. Translation from "The search for the elements". Basic Books, Inc. New York 1962; and R. Taton, *Historia general de las ciencias*. Ed. Destino. Barcelona 1989. Translation from "Dictionary of Scientific Biography" (New York).

When “The history of science” film was included in the activity of school, the science’s vision of the students changed. Furthermore, beforehand, each act¹⁰ was explained and story-related questions were asked to maintain young students’ attention, a few examples were:

“About first steps, 5000–6000 years BC: Where did prehistoric men and women live? What did they wear? What did they eat? About Greece: What did the logical thinking represent? Could you say any differences between Archimedes and Aristotle? About the Alchemists: When did Raymond Lull live? Why was not alchemist a dark period? About Galileo Galilei: What were the geocentric and the heliocentric Sun Systems? Who was Copernicus? What was The Spanish Inquisition? About Newton: a new science vision was starting, what are the gravity and its relationship with an apple? And, about Lavoisier: what kind of differences do you can explain between alchemist and chemistry? What important is the experimentation in any research process?”

Figure 3 shows Archimedes (or Aristotle) explaining some scientific principles to the presenter in front of his astonished pupils and also the audience. Furthermore, we can imagine in Figure 4 a Galileo Galilei’s presentation / discussion about the heliocentric Sun System when he was asked by The Spanish Inquisition.

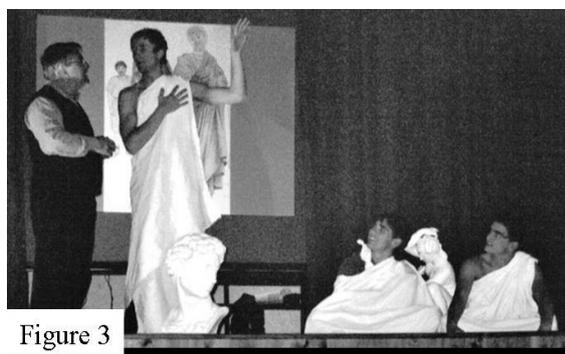


Figure 3

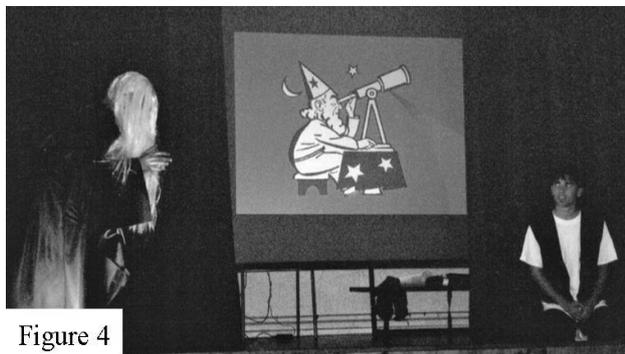


Figure 4

To evaluate the audience’s opinion about the film and the knowledge acquired about science and “The History of Science”, we prepared a questionnaire. This was completed at the end of each session by students in the first level of compulsory secondary school studies (12–14 years old) in the second level (14–16 years old) and, in the end, in high secondary school (16–18 years old) (each level saw the play in separate sessions).

The questionnaire was done on an anonymous basis, students were asked about their appreciation of the content of the film. Results from the questionnaire presented in Table 2 and table 3 reinforced our first impression that the film favoured a new vision of science and its history and increased the scientific interest of young students.

Table 2 shows that most of the students liked the film and also understood it. However, four out of ten considered that they had not learned the topics. Similarly, they also appreciated initial explanations given and questions posed by the presenter and 9 out of 10 students in the audience considered that their knowledge of science had been enhanced by the film.

¹⁰ This **Synopsis** is the basis of understanding our work.

Title: The History of Science.

Age range: The performers were 16 to 18 years old.

Characters: Roles per act, 2F (two female), 4M (four male), and 2N (two neutral).

Actors: M. Rosa Jiménez, Cristina Vegas, Ibar Carty, Dídac Jiménez, Ramón Montilla, Noelia Tarifa, Carme Zaragoza and Josep M. Fernández-Novell.

Make-up: M. Rosa Jiménez.

Decoration and props: Josep Fernández Zaragoza.

Format: 6 topics requiring 6 acts with intermission.

Each act usually lasts 5–6 minutes. The play is based on short stories about the scientists’ lives, emphasizing their contribution to society. The 6 themes covered were as follows: First steps, Archimedes and Aristotle, The alchemists, Galileo, Newton and Lavoisier.

Table 2. A theatrical performance using “The History of Science”.		
Student feedback from “The History of Science” film.	Yes	No
I liked the play/film.	95 %	5 %
I have understood the film.	95 %	5 %
I feel that I have learned the topics covered in the film and the presenter’s explanations.	60 %	40 %
My knowledge of science has increased thanks to the film and the presenter’s explanations.	90 %	10 %
I am interested in studying “The History of Science:” as a part of my science classes.	50 %	50 %

Finally, 50 % of these students expressed interest in the subject of “The History of Science” as part of their science classes. On the basis of students’ answers, we maintain that the “The History of Science” is indispensable for teaching science to our secondary school students. However, “The History of Science” is not included in secondary school curricula in Spain,¹¹ neither is it covered in science textbooks.¹²

Table 3. A theatrical performance using “The History of Science”.		
Fill in this form related to the film:	The most common answer	Other answers
What would you add to the film?	Nothing (72 %)	<i>More music</i> <i>Some scientists</i>
What would you remove from the film?	Nothing (80 %)	<i>Aristotle</i> <i>Alchemists</i>
Make a short summary about 1 scientist:	Galileo	<i>Newton</i> <i>Archimedes</i>
Make a short summary of 1 scientific finding:	Heliocentric Sun System	<i>Gravity</i> <i>Fire</i>
Name 2 scientists that you would add to the film:	Einstein	<i>Edison, Darwin,</i> <i>Fleming</i>
Name 2 scientific findings that you would add to the film:	Medicines	<i>Genes, Electricity,</i> <i>Atomic bomb</i>

¹¹ See: www.mec.es/educa/sistema-educativo; www.xtec.es/estudis/eso/curriculum_eso.htm.

¹² See C. Zaragoza and J. M. Fernández-Novell. “Bridging the gap between secondary school and ‘The History of Science’: an educational experience,” in: M. Kokowski (ed.), *The Global and the Local: The History of Science and the Cultural Integration of Europe. Proceedings of the 2nd ICESHS (Cracow, 6–9 September 2006)*, p. 160–165 (below: chapter 7), and also Grapí, P., “The convenience of history of science in chemistry textbooks at the beginning of the XIXth century”. *A reflection from Lavoisier and Fourcroy’s positions* (2005). In: *Actes de la I Jornada sobre la història de la ciència i l’ensenyament Antoni Quintana Mari. Societat Catalana d’Història de la Ciència i de la Tècnica*, p. 69–73.

The answers reflected in Table 3 indicate that most of the students would not change the plot, three out of ten would add music and some scientists (Einstein, Edison, Darwin,...), but only two out of ten would remove Aristotle or the Alchemists.

Furthermore, Galileo and his heliocentric Sun System were the topics most chosen (55%) when students were asked to make a small summary of one scientist and one scientific finding. In addition, Newton, apples and gravity were chosen by 30% of students and Archimedes, density and gold were chosen by 15%.

Einstein was the most requested addition as a scientist, probably because 2005 marked the centenary of his most important publications. A few students named other scientists such as Edison (electricity), Darwin or Fleming.

On the other hand, the discovery of new medicines was the most requested addition to findings, such as new medicines for AIDS, diabetes or cancer diseases. Other findings also requested, but only in a few questionnaires, were new genetic results related to the discovery of novel pharmaceutical products, electric power, and the atomic bomb (which may be related to cold fusion energy).

(4) Conclusion

This experience is an approach to make science and its history more exciting. In this context, associating a scientist with his / her discovery boosts the scientist's image; the play can emphasize his / her contribution to Physics, Chemistry, Mathematics and Astronomy, Biology, Medicine, ... and show the historical context in which discoveries were made, together with some of their consequences for society. The film increased students' curiosity and this was also accompanied by an increase in general motivation to learn science.

The impact of this experience on the school community has been considerable and it could become a new reference model for other schools and also for other scientific subjects. By means of student performances of plays on "The History of Science" in the classroom, teachers could open up a new communication channel by which to explain, for instance, the essential role of a law of physics or our fundamental responsibility from the climate.

In conclusion, although a number of secondary school science teachers do not appreciate the role of "The History of Science" in science curricula, we propose that activities such as associating theatre / film with science and "The History of Science" in the classroom effectively increase student awareness and knowledge of science.

The promotion of "The History of Science" among young people is crucial if we are to increase their interest in general science and its history.¹³

¹³ Acknowledge: Special thanks go to M. Rosa Jiménez and Cristina Vega for preparing the film, Josep Fernández Zaragoza for drawing the decoration. Thanks also go to teachers and students from our secondary schools IES Isaac Albéniz and IES Can Vilumara for their input. Tanya Yates is thanked for her help in the preparation of the English manuscript.