**Università degli Studi di Milano-Bicocca**
**Dottorato di Ricerca in Società dell'Informazione**
**Ciclo XXIV**

**Centro QUA_SI**
*Qualità della vita*
*nella Società*
*dell'Informazione*


# "A TRULY LIBERAL" PRACTICAL EDUCATION

## Science communication and citizenship from the age of steam to the Knowledge society: a lesson of modernity from the works and ideas of Joseph Priestley and the Birmingham Lunar Society.


**CHIARA CECI**
matricola 724770

**Tutor: Prof. Paolo Maria FERRI**

**Prof. Stefano MORIGGI**

*"If we choose one man as a type of intellectual energy of the Eighteenth century*
*we could hardly find a better than* JOSEPH PRIESTLEY *[...].*
*His versatility, eagerness, activity, and humanity;*
*the immense range of his curiosity in all things, physical, moral, or social;*
*his place in science, in theology, in philosophy, and in politics;*
*his peculiar relation to the Revolution and*
*the pathetic story of his unmerited suffering may make him*
*the hero of the Eighteenth century"*[1].

[1] Harrison, Frederic (1892) *Scientific Correspondence of Joseph Priestley*, New York privately printed.

**INDEX**

# 1. Introduction

*"Education is, as a rule, the strongest force*
*on the side of what exists and against fundamental change:*
*threatened institutions, while they are still powerful,*
*possess themselves of the educational machine,*
*and instil a respect for their own excellence*
*into the malleable minds of the young"*[2].

For the past eight years I have been working in the field of formal and informal science education developing and delivering outreach and science communication activities such as exhibitions, science café, festivals and other events. I have read and heard about theories and best practices in science communication. I have been lectured about "a new wave" in the field and I have been part of the expanding world of Science and Technologies Studies.

I have seen scientists and philosophers, communicators and journalists at work in the their activities of promotion of science and technology, hoping to inform the public and some of them actually believing that their effort would make a difference in the fostering of a Scientific Citizenship. Recently one of the most important Italian scientists, Carlo Alberto Redi, has published a book to explain his opinions as well as his frustrations on this theme. He talks about many bioethical issues and he states that to deal with many of them, as a society, we must give priority to

[2] Russell, Bertrand (1961) *The Basic Writings of Bertrand Russell,* George Allen and Unwin, p. 401.

science education in order to frame the debate on science and society with a balanced and science-based approach[3]. I have experienced these same feelings and opinions myself many times. This is also why, being part of that world of practitioners and having a deep passion for theories and strategies in science communication, I have always been interested in understanding the effectiveness of my job. It has been pointed out[4] that there is some gap between practitioners and STS researchers. By means of an historical and philosophical research I tried to unite my experience as practitioner along with my research's attitude and I hoped to bring a small contribution to some of the most important questions in the field: Why are we communicating science? Can we really foster science citizenship? And what is it, anyway?

I started this research to better investigate the role of science education and communication in building what I shall call "Scientific Citizenship": an interested, informed and critical attitude towards science and technology.

My research is part of the broad area of Science and Technology Studies, an industry where scientists, sociologists, philosophers and historians try to investigate the relationship between science and

---

[3] Redi, Carlo Alberto (2011) *Il biologo furioso. Provocazioni d'autore tra scienza e politica*, Sironi Editore, p. 100.

[4] Miller, Steve (2008) *So where is the theory? On the relationship between science Communication Practice and research,* in D. Cheng et all. (ed.), *Communication Science in Social Contexts*, Springer, p. 276.

society. Some try to place scientific controversies in their social context, some are focusing on museum studies, some on policy, some on media studies. In a STS perspective, thus, there are many ways to look at the problem of education and scientific citizenship. For this research I have decided to "go back to history".

In this work I will look at the **lives and works of Joseph Priestley and other members of the Lunar Society of Birmingham**. I have studied their letters, biographies and works in order to better understand **their ideas about science and education**. I have been working on various primary sources in many archives across Great Britain and I have framed them in my work along with secondary material from the XIX and XIX centuries, as well as with modern works on science education and science communication.

**Joseph Priestley was a premium science communicator**, and his role in the development of science as part of public culture has been fundamental. He aimed to adapt the subject "to the use of every class of reader", his "personal design was to promote discoveries in the science"[5]. His approach to formal and informal education was very practical and he always promoted experiments and first-hand experience to truly understand phenomena. Along

[5] Priestley, Joseph (1768) *Familiar Introduction to the Study of Electricity,* J. Johnson, p. A3.

with the other members of the Lunar Society, he actively promoted this approach to science and education.

I did not look back to history to learn a lesson, I did it to see how it could provide me with a new perspective. I was looking for "a way into the remote mental world of the Eighteenth century", and as I expected there I found there "some affinity with contemporary issues"[6]. I turned to history because I wanted to talk about real flesh and blood people, wishing to see my ideas embodied in them. From their stories and their ideas I learnt much and they made me refine my ideas on science education and citizenship.

Sometimes it is wise to have a historical perspective to think about modern problems; moreover history of science has become a narrative and "reflective" technique, it is used to built a conceptual frame in which one can grow his own ideas and philosophy about science, technology and education. This work analyses the history of an idea in a typical Anglo-Saxon tradition and, thus, it involves interdisciplinary history of science researches.

The analysis of some unit-ideas shows us how they have remained relatively unchanged over the course of time, how they have recombined in new patterns and how they have gained expression in new forms in different historical eras.

---

[6] Darnton, Robert (2003) *George Washington's False Teeth. An unconventional guide to the Eighteenth century*, cit., p. XII.

Embarking in a study on the Enlightenment I wanted to use an "methodology" used at the time, so I decided to deal with my themes reflecting on them as David Hume would have done. Even though today he is mostly known as a philosopher for over sixty years, he "dominated the interpretation of English History. He was the first of philosophical historians"[7] and, "in placing the machinery of progress firmly into a social context, looked at history more profoundly"[8]. History and historiography were key disciplines in the Scottish Enlightenment[9]: they were not only a way to reconstruct the past, but also **a fruitful channel of communication and reflection**. In his essay *On the study of history*[10] David Hume considers three good reasons to study History: firstly, it amuses and entertains; secondly, it deals with the truth and increases one's stock of knowledge; and, thirdly, it has the power to engage the faculty of will in the direction of virtue. History is not only theoretical, it has a practical justification[11]: therefore, following this approach in this work, **I have "commuted" from the Eighteenth century to the present,**

---

[7] Hugh, Trevor-Roper (2010) *History and the Enlightenment*, Yale University Press, p. 120.

[8] *Ivi*, p. 128.

[9] Broadie, Alexandre (2001) *The Scottish Enlightenment, The Historical Age of the Historical Nation,* Birlinn, p. 43.

[10] Hume, David (1836) *Two short Essays on the Study of History and on General Reading, etc.*, Adam W. (ed.), Blair Adam Press.

[11] Broadie, Alexandre (2001) *The Scottish Enlightenment, The Historical Age of the Historical Nation,* cit., pp. 47-48.

**adopting the intellectual stance of the time and using it to interpret today's issues.**

Recently, Eric Schmidt, chairman of Google, appealed to history[12] while talking about new media and education for a new perspective to look at the problem and urged a return to "the glory days of the Victorian era … [A] time when the same people wrote poetry and built bridges"[13]. I share this view and put it into practice in this research.

I have been inspired to study the Eighteenth century as that was an "information age"[14]as well, where science and technology were the changing forces, just like they are today. That "age of improvement" has so many similarities with what we are living today in the fast changing reality of the knowledge society. People were fascinated with the changes and the novelties of their times but at the same time they were horrified by them[15]. The Enlightenment is historically settled between two different centuries, the age of balance and the age of progress[16]. In this

---

[12] Schmidt, Eric (2011) *Television and the Internet: shared opportunities*, MacTaggart lecture, 26 August.

[13] http://www.guardian.co.uk/commentisfree/2011/sep/01/eric-schmidt-google-art-science

[14] Darnton, Robert (2003) *George Washington's False Teeth. An unconventional guide to the Eighteenth century*, cit. p. 25.

[15] Briggs, Asa (2000) *The age of improvement, 1783-1867*, Longman, 2nd edition, p. 1.

[16] *Ibidem*.

period we see "the formative changes in the structure of the English economy, the shape of English society and the framework of government"[17]. In the background we see "the new economic power unleashed by the development of a coal and iron technology"[18] and "in the foreground the problems posed by its use"[19].

**The Enlightenment holds a special place in the history of science communication and education.** Science was changing rapidly and so was communication. The scientific, industrial and social revolutions were driving forces for deep change in men's lives. We are living a similar time, shaped by fast change and innovation, and this time communication has become fast and pervasive. "It sometimes helps to look at the world from the perspectives of those living in the Eighteenth century"[20], those were the times when the universe of science became vast[21], and in an effervescent scientific scene numerous scientific discoveries were made, new technologies invented, and, most importantly to this work, new ideas and practices in science communication and

---

[17] *Ibidem.*

[18] *Ibidem.*

[19] *Ibidem.*

[20] Emerson, Roger L. (2009) *Essay on David Hume, Medical men and the Scottish Enlightenment*, Ashgate, p. 1.

[21] Burns, William E. (2003) *Science in the enlightenment, an encyclopedia*, ABC Clio, p. XI.

education were carried on. Somehow a barrier was broken and science found a real audience. New practitioners, textbooks, societies, amateurs and specialisations appeared, and almost suddenly science had become a social issue. Joseph Priestley and the Lunar Men embody it all and are a perfect case study for those who want to learn from their experience and get a different point of view on science, technology, education and society.

We might perceive it as very different from our reality, but the Eighteenth-century world was "much like our own, where intellectual life is not always isolated from the seduction of adventure, where even enlightened doctrines of reason and reasonableness cannot sensibly be divorced from the personal rationalisation of their proponents"[22].

Far from adopting a presentist approach, my purpose is **to project some questions against an Eighteenth century background and thus see them under a new light**. I think the story I have managed to reconstruct is an interesting way to better understand the nature of the relationship between technoscience and education, and I believe it offers an interesting perspective for modern practitioners and academics working in this field.

[22] Stewart, Larry (1992) *The Rise of Public Science. Rhetoric, Technology, and Natural philosophy in Newtonian Britain, 1660-1750*, Cambridge University Press, p. xv.

*Science, technology and society and the Enlightenment*

Interest and concern about the relationship between science and the public date back to the Seventeenth century, when science began to develop as the central social institution and, eventually, to separate from laypeople. Attempts to popularise science are older than that, though. Scientists have always wanted to communicate their ideas to other scientists and to the public, and to teach the world their discoveries. Science and communication have always been part of the same process.

It was in that "unconventional period"[23] that a clear concern to show science to society appeared. New channels of communication between scientists and non-scientists were created and there was a new call for science education. Opportunities for the popularisation of science were being created and science was beginning to have a place among the general public.

It was not until the second half of the Nineteenth century, alongside the professionalisation of science, that the interest in promoting science to broader publics gained more momentum, reflecting the idea of democratisation of the scientific knowledge. As scientific knowledge continued to expand throughout the Twentieth century, the idea of communication of science became embedded all over the world: scientists, teachers, journalists and

[23] Briggs, Asa (2000) *The age of improvement, 1783-1867*, cit., p. 1.

other communicators tried to make science accessible to a broad range of people. Modern media and new technologies have had an important role in reaching broader ranges of publics. Today science communication has assumed many different formats and what was traditionally done through books and lectures to the public is now done through many channels such as the Radio, TV and more recently the Internet.

However, large scale communication of science such as exhibitions, museums and botanical gardens, books, journals and magazines were already very popular among the general public in the Enlightenment.

In this period we see the rise of the English middle class, the carriers not only of free trade but of the very idea of improvement itself[24]. "The facts of improvement were so striking that they made men dream dreams: the word 'improvement' itself, which now sounds sober, respectable, and emotionally threadbare, was capable then of stimulation daring fights of imagination"[25].

The XVIII century was the Age of Enlightenment, a progressive and (mostly) secularly minded intellectual movement of Europe and North America. The Enlightenment was a richly textured movement that impacted on most areas of the cultural life of the

---

[24] *Ivi*, p. 3.

[25] *Ivi*, p. 2.

time. It had been preceded by an era of scientific revolution, and it was born in this new Newtonian world that modern science. It was in the Eighteenth century that science gained a real social importance that would never leave her again. This importance has grown more and more and has led us to a society deeply immersed and dependent from its science and technology.

**The XVIII century was one of fundamental shifts in European education,** in which scientific and technical education would assume a more central role[26]. Beyond the sheer intellectual quality of thinkers and scientists of the time, in fact, we must recognise that those men were also **great communicators and teachers, who spent a great deal of energy disseminating their ideas**.

Britain, along with France, was the most technologically innovative society of the time[27] and in this fertile environment I was inspired by the ideas and works of a group of Englishmen from the Midlands, the Lunar Society of Birmingham. So-called because it met on a day near a full moon to enable its members to go home after sunset, the Lunar Society was a highly informal organisation

[26] Burns, William E. (2003) *Science in the enlightenment, an encyclopedia*, cit., p. 82.

[27] *Ivi*, p. 272.

of men interested in new development in science and technology, its education and its impact on society.

England was the "workshop of the world"[28], where "every facility seems at hand"[29]. England was rich in resources and had a good position for trade but "the value of resources depends upon their usefulness, and their usefulness in turn depends upon changes in knowledge, in technique and in taste"[30].

Among others "three technical advances were of the utmost importance: the mechanisation of the textile industry; the emergence of a new technology of coal and iron; and the introduction of steam power. Behind these advances there was a long history of experiment and innovation"[31], and the Lunar Men were both behind some of these innovations and playing a fundamental role in the diffusion of some others. Steam provided adequate power to manufacture the increased volume of material and freed industry from dependence on fixed location[32]. "In 1782 Watt patented a 'sun and planet motion' steam engine transforming the up-and-down motion of the piston into a rotary motion. From this time on it was possible to use steam engines as the means of

---

[28] Briggs, Asa (2000) *The age of improvement, 1783-1867*, cit., p. 17.

[29] *Ibidem*.

[30] *Ibidem*.

[31] *Ibidem*.

[32] *Ivi*, p. 21.

motive powers in factories. Necessity was certainly the mother of this invention. An year earlier, Boulton had written to Watt, 'the people in London, Manchester and Birmingham are steam mill mad. I don't mean to hurry you but [...] I think we should determine to take out a patent for certain methods of producing rotative motion"[33]. By continuing to hold the key patent until the 1800s, "Boulton and Watt were at the centre of the new industrial scene, selling, in Boulton's picturesque phrase, 'what the world wants - Power'"[34].

*XVIII century science communicators*

Back in the 1700s there were different means of communication and a different knowledge about science, but in the heart of the English Midlands these people deeply believed in science, education and public knowledge as a mean to promote a better society. I will need to frame the historical, social and religious background to see the modernity of their opinions, and looking at the work of these people I will be able to gain a new angle for modern reflection about the same issues.

Having already declared my debt to Hume, I must also say that some of the ideas I will be discussing in this work grew first of all

---

[33] *Ibidem.*

[34] *Ibidem.*

in the great cultural movement that was Scottish Enlightenment. "During a period of a few decades on either side of 1760, Scotland was home to a creative surge whose mark on western culture is still clearly discernible"[35]. It was a time of work of genius and some of this genius flew down to England, where this great influence fostered the ideas and people I will be dealing with in this work.

I was drawn to this historical period also because it was **an age of criticism, of critical reflection and analysis**. All elements that I believe fundamental for a "truly liberal" education and a mature citizenship. I wished to look into these "enlightened-Lunar" ideas and the way these thinkers put them into practice to bring some of this "light" back to my present research.

The literati of the Enlightenment were not only men of theory. They did not live in an ivory tower and looking over the world from it. They were strongly connected with society and it can not be denied that these thinkers did change the society.

The Enlightenment saw a great expansion in the volume of scientific popularisation. Science was popularised for many reasons and in many ways but surely the Eighteenth and early Nineteenth centuries were the golden age of the professional "lecturer" or "demonstrator". Well before the modern science festivals were established, these men offered courses or demonstrations on the

---

[35] Broadie, Alexandre (2001) *The Scottish Enlightenment, The Historical Age of the Historical Nation,* cit., p. 1.

open markets. Scientific popularisation was not merely an affair of reading texts or viewing experiments and demonstrations. Popularisers encouraged the performance of experiments at home as "rational amusement"[36].

Some scientists distrusted popularisation because it gave people a superficial knowledge which they confused with real science[37]. But many scientists wrote popular books and Joseph Priestley himself was one of them. He viewed the wide dissemination of scientific knowledge as a mean of advancing society generally by dispelling superstition and liberating humanity from illegitimate authority, intellectual and institutional. And women, whose education became a central issue for the Lunar Men, were an important part of this new audience for science popularisation. Joseph Priestley was a brilliant chemist, fiery minister, radical politician, diligent historian and a passionate teacher. He represented the apotheosis of the Eighteenth-century enlightened man.

I dived in an era full of philosophers, men of letters, people committed to science and philosophy but also to the cause of engagement and education. The public intellectual role of people like Joseph Priestley resembles what present science communication studies ask to scientists today. After research and

[36] Burns, William E. (2003) *Science in the enlightenment, an encyclopedia*, cit., pp. 233-234.

[37] *Ivi*, p. 234.

teaching, communication has been stated to be the third mission of Universities and a stronger call to engage with the public has been the protagonist of many STS studies and project in the past few decades.

*What is Scientific Citizenship?*

As already stated, in this research I am going to use a historical case to draw a **lesson of modernity about Science Education and Citizenship**. I have declared that with the expression Scientific Citizenship I picture an interested, informed and critical attitude towards science and technology. And towards life and knowledge in general. I should clarify, though, that the same expression, along with Science Citizen, is used with other meanings and aims. In many public engagement programs, for example, people are asked to take part in some science project (data collection for example) and this is called Citizen-Science approach.

Citizens' involvement in public discussions about science is a key element in nowadays science and society relationship. Citizenship is a word that is more and more used in reports, projects and engagements statements. There is sometimes a slight difference in what the term is used for and I should clarify my use.

*Citizenship* alone is a word and concept that has acquired many uses and meanings, and it is not in the aims of this work to look into that. It is a concept with a complex and controversial pedigree and when associated with science it carries even more difficulties related to its definition. *Citizenship* could be defined as a series of rights and responsibilities related to the individual as a member of a political community, including civic, political, social and economic rights and duties. I would refer to this concept in terms of relationships and behaviours. *Citizenship* describes the relationship between citizens and the state, and the need for them to understand political, economic and social processes, institutions, laws, rights and responsibilities of our democratic system.

Increasingly, citizenship has been used to describe responsibility in terms of behaviour e.g. corporate citizenship, environmental citizenship, consumer citizenship. Aspects of citizenship – from voter turnout to volunteering, from economic capability to cultural change, from crime to social exclusion and from understanding multiple identities to redefining ourselves as a global community – impact on all areas of our lives as some of the most challenging issues of the 21st century. And most of these issues are science and technology-related.

**Citizenship life skills** are about a person's ability to understand and participate in the institutions, science, economics, politics, laws, rights and responsibilities of civic and civil society. Citizenship education, taught successfully, aims to give people the knowledge, confidence and skills to become active citizens, acquiring the skills that enable us to participate in the decisions that shape our future.

To foster a Scientific Citizenship means **to equip (young) people with knowledge, skills and understanding to play an active, effective part in society as informed, critical citizens who are socially and morally responsible.** To give them the confidence and conviction so that they can act with others, have influence and make a difference in their communities (locally, nationally and globally). An *Informed Citizenship* implies a degree of understanding of the key relationships, rights and responsibilities involved in being a citizen, as well as having the skills to exercise those rights and responsibilities in an informed and effective way. Being able to stay informed, to filter information, to discuss and to build one's opinion are essential to be able to speak up and be part of the discussion and maybe also the decision process. People need to be part of these discussions and they can only if prepared to do so.

We can all agree that Democracy needs informed citizens able to discuss about scientific issues. **In a world deeply involved with science and technology, science education and science communication have a fundamental role in fostering scientific citizenship in the Knowledge society.**

All these ideas that democracy and society need a learned and informed citizenship are, obviously, not new, and that is why in this work I will analyse how this idea was at the very base of many works and activities in the English Enlightenment.

It is interesting to state if Scientific Citizenship is only a question of Scientific Literacy or it is a question of general attitude. Robin Millar and Jonathan Osborne made a case for a move forward teaching for "scientific literacy" as they claimed that "our future society will need a larger number of individuals with a broader understanding of science, both for work and to enable them to participate as citizens in a democratic society"[38].

There is a broad discussion in literature about this. I believe it is both, but the latter should be revalued and enhanced in education and communication. How we manage to grow a new scientific attitude to foster Scientific Citizenship is still an open question. I found interesting answers in the work and ideas of Joseph Priestley and other members of the Lunar Society of Birmingham. They promoted a "truly liberal education", a "practical education" and we could use some of that enlightened attitude to reconsider some of our activities and ideas.

The greatest rule in **education** for Priestley was that is **should promote free thinking and a critical attitude**, as proclaimed by

[38] Millar, Robin & Osborne, Jonathan (1998) *Beyond 2000*, King's College, p. 8.

the Royal Society's motto, *Nullius in verba,* do not take anybody's word for it. Bertrand Russell has written a lot on this issue and he managed to wonderfully describe the educational ideas I have found in the Lunar Men. For him too the prevention of free inquiry is "unavoidable so long as the purpose of education is to produce belief rather than thought, to compel the young to hold positive opinions on doubtfulness and be encouraged to independence of mind. Education ought to foster the wish for truth, not the conviction that some particular creed is true"[39]. And "if the object were to make pupils think, rather than to make them accept certain conclusions, education would be conducted quite differently: there would be less rapidity of instruction and more discussion, more occasions where pupils are encouraged to express themselves, more attempts to make education concern itself with matters in which pupils feel some interest"[40]. In accordance with a Lunar attitude he declared that "passive acceptance of the teacher's wisdom is easy to most boys and girls. It involves no effort of independent thought, and seems rational because the teacher knows more than its pupils; it is moreover the way to win the favour of the teacher unless he is a very exceptional man. Yet the habit of passive acceptance is a disastrous one later in life"[41]. Priestley would have agreed with him.

[39] Russell, Bertrand (1961) *The Basic Writings of Bertrand Russell,* cit., p. 406.

[40] *Ibidem.*

[41] *Ivi*, p. 410.

He knew how important it was for the students to develop their own ideas, making their own mistakes. As I will point out analysing his life and work, a liberal practical education was what he wanted for his students. "At Warrington, the most famous and successful Dissenting institution of education, free familiar conversation, associated with intellectual freedom, was the main pedagogical framework"[42]. Along with practical activities. The Laboratory was a cultural space and a fundamental element for science[43] and education.

Critical knowledge and a practical approach. These are the key elements for a truly liberal practical education. Priestley knew it 250 years ago and today we can only be inspired by his work and try to put these ideas into practice. Precisely. He provided his students with the first mechanical and chemical set used in didactic context. We should do the same with the technology we have.

In this work I will first examine the life of Joseph Priestley (chap. 2) as he is the main character in this research, then I will reconstruct the story of the dissenting academies (chap. 3) and of the Lunar Society of Birmingham and the heritage left by its incredible

---

[42] Cohen, Michèle (2009) *"Familiar conversation": The role of the 'Familiar Format' in Education in Eighteenth and Nineteenth-Century England, 1760-1800*, in Hilton, Mary and Shefrin, Jill (eds.), *Educating the Child in Enlightenment Britain: Beliefs, Cultures, Practices,* Ashgate, p. 109.

[43] Vaccari, Valentina (2008) *Joseph Priestley e la Lunar Society: i laboratori e la pratica sperimentale*, Franco Angeli, p. 13.

members (chap. 4). This historical part will provide the arguments for the rest of my work. I will then present a case study of practical education in the Lunar Society (chap. 5) and I will present Joseph Priestley's educational works (chap. 6) in order to analyse his great role as a leading educationalist of his time. All the historical and philosophical element of my research will be used in the last chapter (chap. 7) to draw a lesson of modernity from the ideas and works of Joseph Priestley and other men of the Lunar Society of Birmingham.

## 2 - Life of Joseph Priestley

Joseph Priestley was born on 13 March (O.S.[44]) 1733 at Fieldhead, a small village, near Birstall, only few miles from Leeds, right in the heart of the West Riding wool industry. His father, Jonas Priestley, like his father Joseph before him, was a cloth dresser; with his first wife, Mary, he had six children, and Joseph was the eldest. When he was only one year old he was sent to live with his maternal grandfather, Joseph Swift, a tenant farmer at Shafton, near Wakefield, as Priestley himself tells in his *Memoirs*: "My mother having children so fast, I was very soon committed to the care of her father and with him I continued with little interruption until after my mother's death"[45]. After this sad event, in 1740, he returned to Fieldhead: "I was taken home, my brother taking my place, and was sent to school in the neighbourhood"[46]. The year following Mary's death his father remarried and he was sent away to be brought up by his father's elder sister, Sarah, "But being without a mother, and my father incumbered with a large family, a sister of my father, in the year of 1742, relieved him of all care of me, by taking me entirely to herself, and considering me as her own child,

---

[44] O.S. (old system) is the dating system that preceded the adoption of the Gregorian calendar in 1751. Priestley's date of birth will then be 24 March.

[45] Priestley, Joseph (1970) *Memoirs*, in *Autobiography of Joseph Priestley*, Lindsay, Jack (ed.), Adams & Dart, p. 69.

[46] *Ivi*, pp. 69-70.

having none of her own. From this time she was a true parent to me, till her death in 1764"[47]. His aunt and her farmer husband, John Keighley, lived in Heckmondwike, Yorkshire and when the child arrived, at 9 years old, they informally adopted him. When his uncle died in 1745 leaving Sarah with moderate wealth, she continued to care for Joseph as if he was her own son. She noticed the great intelligence of the child and, wanting for him the best possible education, she hoped he could become a Minister one day. "I was sent to several schools in the neighbourhood, especially to a large free school, under the care of a clergy man, Mr. Hague, under whom, at the age of twelve or thirteen, I first began to make any progress in the Latin tongue, and acquired the element of Greek. But about the same time that I began to learn Greek at this public school, I learnt Hebrew on holidays of the dissenting minister of the place, Mr. Kirby; and upon the removal of Mr. Hague from the free school, Mr. Kirby opening a school of his own, I was wholly under his care"[48]. Latin and Greek were necessary to enter any university level instruction and they were fundamental if Joseph wanted to become a minister. His aunt and all his family were Calvinist and being of a dissenting faith, Joseph knew that he would not be going to one of the two Universities controlled by the

[47] *Ibidem*.

[48] *Ivi*, p. 70.

Established Church, Oxford and Cambridge, but he would be attending one of the Dissenting Academies. Joseph studied as hard as he could to be ready for that moment, but when he was 16 he became seriously ill and, while he was obliged to drop out of school and "was left to conduct my studies as well as I could"[49], his faith became stronger and he got closer to the belief of some members of minor sects that arose from the reformation, called the "Socinian", or "Unitarian". They denied the concept of the Trinity and God is, to them, a simple divine being; one's salvation depends on following the scriptures, the only real source of truth, and the example settled by Jesus Christ, who is, to them, only a man. The young Priestley was now embracing these beliefs and that caused a lot of arguing with his aunt and other people close to him who held a more traditional faith[50]. Nevertheless Priestley was very determined to keep these new ideas for his own belief and showed his great strength of character, a feature that would stay with him for all his life. His tenacious character kept him going during the three years when he was too sick to attend schools. He taught himself French, Italian, Dutch, he kept his interest in the other languages, ancients or modern, and "I attended two days in the

[49] *Ibidem*.

[50] David L. Wykes, *Joseph Priestley, Minister and Teache*r, in Rivers, Isabel & Wykes, David L. (eds.) (2008) *Joseph Priestley, Scientist, Philosopher and Theologian*, Oxford University Press, p. 23.

week upon Mr. Haggerstone[51], a dissenting minister in the neighbourhood [...] Of him I learnt geometry, algebra and various branches of mathematics, theoretical and practical. At the same time I read, but with little assistance from him, 'Gravesend's Elements of Natural Philosophy', 'Watt's Logic, 'Locke's Essay on Human Understanding', etc, and made such a proficiency in other branches of learning [...]"[52]. Priestley's bad health - and to some extent his new "radical" ideas - made his aunt decide that he would be better suited in a trade position somewhere with a better climate, so for some time a commercial career was expected from the young man especially as Priestley was so proficient in so many languages and was already helping an uncle with his business letters. They believed that he would go to Lisbon to work for this uncle, "but getting better health, my former destination for the ministry was resumed"[53].

In 1752, at 19 years old, he had had a prolonged and valid education and was ready for a university level studies; thus, thanks to Mr. Kirkby and some other good connections, Priestley was enrolled as the first student at the newly established Dissenting

---

[51] Rev. Haggerstone had been trained under professor MacLaurin at Edinburgh. Colin MacLaurin was a brilliant mathematician and natural philosopher, professor of Mathematics at Glasgow and Edinburgh. He was friend and disciple of Isaac Newton and this connection shows us the Scottish influence on Priestley's education and proves us how he firstly was introduced to Newton's works and ideas.

[52] Priestley, Joseph (1970) *Memoirs*, in *Autobiography of Joseph Priestley*, cit., p. 72.

[53] *Ivi*, p. 70.

Academy at Daventry. He would have gone to the prestigious Northampton Academy[54], but the previous year its famous founder and tutor, Rev. Doddridge had died and his successor, Caleb Ashworth, moved the academy to Daventry where he was minister as this was the common practice at the time for the Dissenting Academies (see chap. 3). Here he received the finest, most liberal and most enlighten education available in the country at that time. The plan of study, as in all the Dissenting Academies, was exceedingly favourable to free inquiry and in this lively environment Priestley could also benefit from the presence of a well developed science curriculum: "Three years, viz. From September 1752 to 1755, I spent at Daventry, with that particular satisfaction with which young persons of generous minds usually go through a course of liberal study, in the society of others engaged in the same pursuits, and free from the cares and anxieties which seldom fail to lay hold on them when they come out into the world. In my time at the academy was particularly favourable to the serious pursuit of truth, as the students were equally divided upon every question of much importance [...] all these topics were the subject of continual discussion. Our tutors also were of different opinions; Dr. Ashworth taking the orthodox side of every question, and Mr. Clark, the sub-tutor, that of heresy, though always with the greatest

[54] David L. Wykes, *Joseph Priestley, Minister and Teacher*, cit., p. 26.

modesty. Both of our tutors were young, at least as tutors, and some of the senior students excelling more that they could pretend to do, in several branches of study, they indulged us in the greatest freedom, so that our lectures had often the air of friendly conversations on the subjects to which they related. We were permitted to ask whatever questions, and to make whatever remarks we pleased; and we did it with the greatest, but without any offensive, freedom. The general plan of studies, which may be seen in Dr. Doddridge's published lectures, was exceedingly favourable to free inquiry, as we were referred to authors of both sides of every questions, and were even required to give an account of them. It was expected that we should abridge the most important of them for our future use. The public library contained all the books to which we were referred"[55].

He had learnt a great deal in those three years and when he left Daventry he was an accomplished scholar: he had been undertaking a lot of independent works and, beyond his theological studies, he was trained in philosophy and history, mathematics and science, and mastered six ancient and three modern languages[56].

Having completed his training in 1755 at Daventry, Priestley was soon nominated assistant minister at Needham Market, Suffolk.

---

[55] Priestley, Joseph (1970) *Memoirs*, in *Autobiography of Joseph Priestley*, cit., pp. 75-76.

[56] *Ivi*, p. 9.

The congregation was really small, as was his salary (£40 per annum plus £10 subsidy from the central funds of Presbyterian and Independents), but here he had a lot of time to continue to study many of the subjects he was interested in. He was far from being unhappy at Needham Market but surely he found himself financially insecure and in doctrinal disagreement[57] with much of his conservative congregation. When the disagreement became too strong many of the members of the community stopped following his preaching and his salary consequently fell away. To improve his situation he tried to open a school but none enrolled.

With the situation at Needham Market and an environment almost impossible to preach and teach, he decided to move, and, after having being considered for a position but without receiving the offer at the prestigious Warrington Academy, in 1758 he took a ministry at Nantwich, Cheshire. Nantwich was a centre of local manufacture and few miles to its east ran the road from the Potteries to the bridge over the Mersey at Warrington and to Liverpool. "At Nantwich I found a good-natured friendly people, with whom I lived three years very happily; and in this situation I heard nothing of those controversies which had been the topics of

[57] Priestley was a follower of Arianism, the doctrine of Arius of Alexandria (4th century AD) which denied the eternity of Christ and thus the Trinity. Being an Arian, a Socinian and a Unitarian, Priestley was one of the rational dissenters and maybe too "heretical" for many people.

almost every conversation in Suffolk [...]"[58]. Priestley was now in the heart of the Midland, and here he had found a happy atmosphere and was now earning enough money to buy more books and the equipment to practice his growing interest in science. Priestley taught in rotation to three classes of pupils, mainly divided by age group, for six days a week, everyday from seven in the morning to four in the afternoon, with only an hour break for lunch. After this regular school hours he walked to the home of Mr. James Tomkinson, where he was working as a private tutor, and only at seven his long working day was over.

Priestley educational ideas were soon going to influence the whole education system in the Dissenting Academies. Here the curriculum was not built around the classics and the training for ministry only, it was very important to teach subjects that could come in handy to all those students who were going to start a career in commerce or industry. Priestley also believed in the importance to talk about modern history and not about what happened thousands of years before, he thought that it would be important to understand the world and its political and economical dynamics.

All this hard work and his impressive success as a tutor soon became well known, and the Warrington Academy was now considering him again for a position. They offered him the

---

[58] Priestley, Joseph (1970) *Memoirs*, in *Autobiography of Joseph Priestley*, cit., p. 9.

tutorship in Languages and Belles Lettres, and he left Nantwich in September 1761. Some of his students followed him to continue their education under this outstanding teacher, and among these there was William Wilkinson, the son of the famous ironmaster Isaac Wilkinson. In his second year at Warrington Priestley would marry William's sister Mary, who he had known for some time. "This proved a very suitable and happy connexion, my wife being a woman of excellent understanding, much improved by reading, of great fortitude and strength of mind, and of a temper in the highest degree affectionate and generous; feeling strongly for others, and little for herself. Also, greatly excelling in every thing relating to household affairs, she entirely relieved me of all concerns of that kind, which allowed me to give all my time to the prosecution of my studies, and the other duties of my station"[59].

In the favourable environment of the Warrington Academy, he lost no time and started to put all his educational ideas into practice even more planning new courses and proceeding with his researches and studies. His broad interests and his monumental knowledge were mirrored in his six years of teaching activities there that contributed to make Warrington the best Dissenting Academy of the time. He continued to work on the series of lectures he delivered to his students, which he would later publish in his books.

[59] *Ivi,* p. 87.

*Portrait of Joseph Priestley, by Ellen Sharples, probably after James Sharples, circa 1797.*



He became a close friend of the secretary (the rector), John Seddon, of the theological tutor, John Aikin and of John Holt, the tutor in mathematics and natural sciences. He also made friends among his students and beyond his brother in law William, the most important relationship was that with Thomas Percival who after Warrington would study medicine at Edinburgh and become a famous physician and Fellow of the Royal Society. Priestley had a very good relationship also with Dr. Aikin's children: his son, John, the well-known writer and physician, and his daughter, Anna Laetitia, the later famous writer and educationalist Mrs. Barbauld.

As it has been pointed out, Priestley's interest in science had always been great, even if until now and in some ways for all his life, science was only a "leisure" activity, and never his main occupation. Joseph Priestley's brother, Timothy, gives us the first account of his scientific interests in the sermon written for Priestley's funeral where he says that his brother "began to discover a taste for experiments when about eleven years of age [i.e. 1744]. The first he made was on spiders, and by putting them into bottles, he found how long they could live without fresh air [...] My brother, when he began to learn astronomy, would be in the fields with his pen and papers; this spread his fame, as it was at the time a science very little known. When he found out any thing new, I was soon acquainted with it: I remember when he was making much progress with electricity, in showing me how to melt steel; when the mettle melted, he called, Oh has Sir Isaac Newton seen such an experiment! And his pleasure on those occasions cannot well be described"[60]. Priestley's interest in science had grown with his attendance of the Dissenting circles, but it was in the Warrington years that it bloomed. That was mainly due to the people he was

[60] Priestley, Timothy (1805) *A funeral Sermon occasioned by the Death of the late Rev. Joseph Priestley*, Alex. Hogg, and Co., pp. 42-43.

now becoming friend with, and with whom he was starting important scientific correspondences. In his Nantwich years his only friends were Rev. Joseph Brereton, the vicar of Acton, who introduced him to astronomy, and William Willetts[61], the dissenting minister of Newcastle-under-Lyme[62]. While in Warrington, though, he started a whole new series of relationships with important scientists and industrialists, and among those there was Thomas Bentley, whom Priestley would often visit in Liverpool, and through him he got to know the members of the Lunar Society of Birmingham. One of these acquaintances was a real blessing for his growing interest in the field of chemistry: Priestley wanted to arrange some public lectures for his students and when he met Matthew Turner, a Liverpool physician and a friend of Bentley's, he could fulfil this desire by hosting Dr. Turner seminars on *Practical and Commercial Chemistry*. He attended himself and learnt a lot. In the meantime his friends and former students (Percival in particular) were trying to secure him some recognition for his important work on history and education and they succeeded when in 1764 he received an honorary doctorate in Law from Edinburgh University, and then became known as Dr. Priestley.

---

[61] Willetts was married to Catherine Wedgwood (1726-1804), sister to the famous potter Josiah Wedgwood.

[62] Priestley, Joseph (1970) *Memoirs*, in *Autobiography of Joseph Priestley*, cit., p. 86.

Every year he used to spend a month in London and in 1765 Seddon wrote a letter of introduction to John Cantor. That December, once in London, Priestley could meet Cantor and make further acquaintances in the scientific world, mainly at the Royal Society. "I was in this situation, when going to London, and being introduced to Dr. Price, Mr. Cantor, Dr. Watson (the physician) and Dr. Franklin, I was let to attend to the subject of experimental philosophy, more that I had done before; and having composed all the lectures I had occasion to deliver, and finding myself at liberty for any undertaking, I mentioned to Dr. Franklin an idea that had occurred me of writing the history of the discoveries in electricity, which had been his favourite study [...] This he readily undertook, and my other friends assisting him in it, I set about the work [...]"[63]. He spent that Christmas with Cantor as a guest, and in this pivotal period in London[64] he started this important project that would lead him to write the history of electricity and to work on some original experiments. In this new environment Priestley was intellectually stimulated like never before, and upon his return at Warrington he really gave a boost to his scientific works and started many correspondences with his new friends and fellows scholars. His new friends sent him all the published works on the subject and

[63] *Ivi*, p. 89.

[64] Walker, W. Cameron (1834) *The beginning of the scientific career of Joseph Priestley*, Isis, vol. 21, n.1, p. 86.

within a few months he had composed the historical part and could move on to the experimental and original section of the work. He kept them constantly updated on his researches and they were impressed by the speed with which he managed to master the subject and the importance of his results. They were so impressed that they sponsored his nomination for the Royal Society, and before Priestley could publish anything on his scientific researches, he was elected Fellow in June 1766, mainly for his literary works[65]. As usual, he presented all his new researches and the material he had been studying in the series of lectures for his students, and everything was later published in *The History and Present State of Electricity, with original Experiments* in 1767. In the same year he left the Warrington Academy and he was appointed Minister at the Mint-Hill Chapel in Leeds, where he would spend almost six years. Here he lived with his family near a brewery and observing the "impure gas" produced in the fermentation he started working on some new researches that were later published in his pamphlet *On Air* (1772). Priestley had found a new field that interested him a lot: "When I started these experiments, I knew very little of chemistry, and had in a manner no idea on the subject before I attended a course of chemical lectures, delivered in the academy of Warrington, by Dr. Turner, of Liverpool. But I have always thought

---

[65] *Ivi*, p. 91.

that upon the whole, this circumstance was no disadvantage to me; as in this situation I was let to devise an apparatus, and process of my own, adapted to my peculiar views"[66]. *On Air* was a huge success and after having produced a larger account of his researches in an article as *Different Kinds of Air* in the Philosophical Transactions of the Royal Society, he was awarded the Copley Medal[67], the greatest scientific acknowledgment of the time.

While in Leeds Priestley went on with his scientific experiments, always only in his free time from his official duty as minister and teacher. He established a public circulating library for the city and published many books on many different subjects. At Leeds he had found a very liberal and friendly congregation and his connection to some of the most important scientists, industrialists and political men of the time helped to establish his reputation.

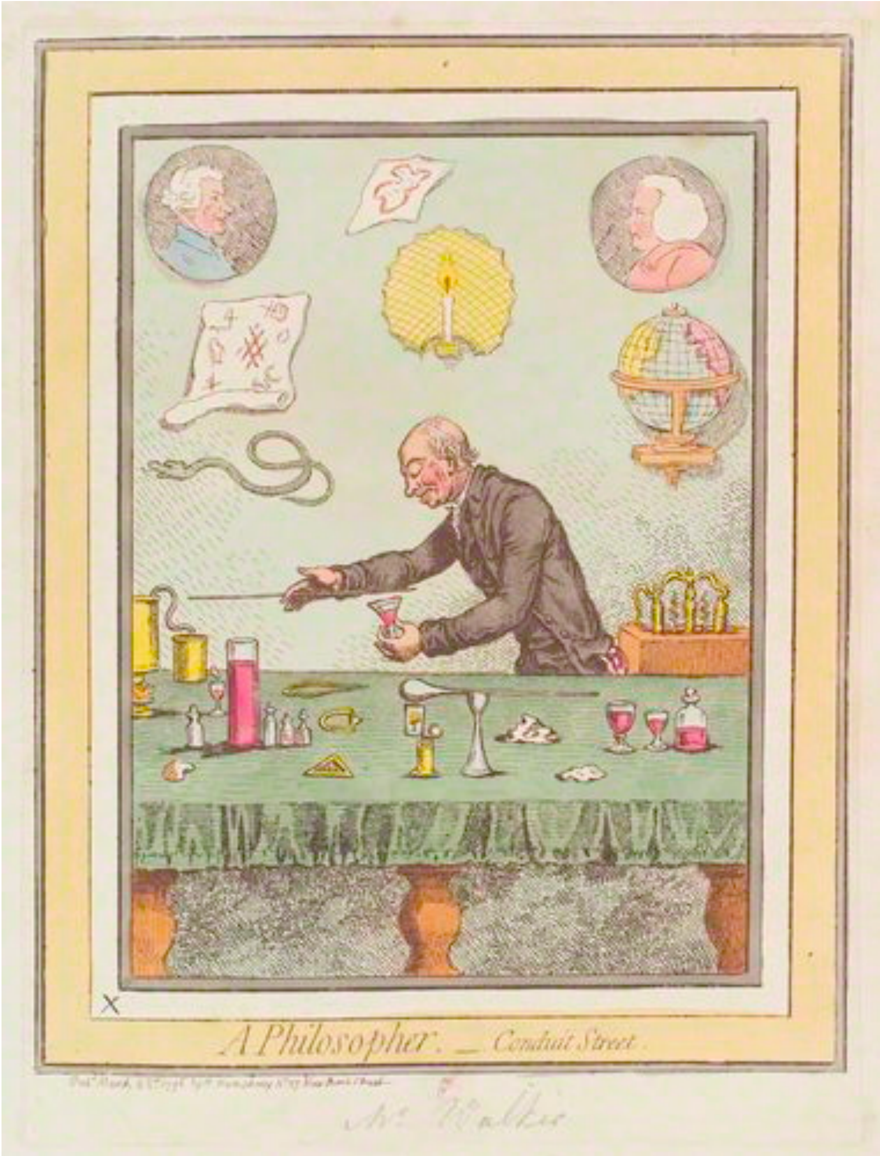
Priestley and his wife now had three children and with the high cost of household management and the expenses for his researches they were always in financial crisis. A solution to their economic problems arrived when he was offered a very good position by Sir Joseph Banks "to accompany Captain Cook in his second voyage to the South Seas"[68], but he was unable to take part to the expedition given the objections of some Anglican clergymen who were an

[66] Priestley, Joseph (1970) *Memoirs*, in *Autobiography of Joseph Priestley*, cit., p. 94.

[67] *Ivi*, p. 95.

[68] *Ivi*, p. 96.

important part of the Board of Longitude and had the direction of the business[69].




*'A philosopher, - Conduit Street', Joseph Priestley (in portrait), by Adam Walker.*
*James Gillray, published by Hannah Humphrey, 28 March 1796*
*© National Portrait Gallery, London*

Soon Priestley found another way to solve his economical problems, and it was his dissenting friend and famous philosopher Rev. Richard Price who helped him. In the summer of 1773, at forty years old, he started working for Lord Shelburne, the later

[69] Thorpe, T.E. (1906) *Joseph Priestley*, J. M. Dent, p. 81.

Marquise of Lansdowne. Working for him Priestley was summering at Calne, near Bowood, the family estate in Wiltshire, and wintering in Shelburne's town house in London, and in this position he spent other six important years of his life. Priestley had few official duties and even if he had some direction to educate Lord Shelburne's sons, there was also a full time tutor, and his main job was to catalogue books and manuscripts and to index the personal papers in the Shelburne library. In 1774 he travelled with Shelburne to Europe and during a month's stay in Paris he met Lavoisier and other French chemists. Under Lord Shelburne he had no financial problems and "he encouraged me in the prosecution of my philosophical enquiries, and allowed me forty pounds for annum for expenses of that kind, and was pleased to see me make experiments to entertain his guests, and especially foreigners"[70]. Priestley had a lot of time to study and work on his experiments and when in London he would attend the informal meeting in a coffee house on Fleet Street and so became a regular member of the "Club of Honest Whigs", so named by Benjamin Franklin, who was soon to leave England (1775) to go back to America where the battle for independence was waiting for him.

In these years Priestley continued to write theological works, which were now stating to make him the leading publicist for the

---

[70] Priestley, Joseph (1970) *Memoirs*, in *Autobiography of Joseph Priestley*, cit., p. 113.

Unitarian cause in England, and so he had officially begun his career as a polemicist in theology and politics. He became somehow unpopular in those circles that did not appreciate his radical and dissenting views and soon this would cause some problems with his patron. The biggest issue was probably linked to the negotiations for independence that were being conducted in those years. Lord Shelburne was conducting them on behalf of the British and on the other side there was Benjamin Franklin, a great friend and confidante of Priestley. Feeling that his position in the matter could be compromised by his librarian and his attachment to the other party, Lord Shelburne offered Priestley a sinecure on one of his estates in Ireland, but Priestley refused and preferred to leave his job at Calne to remain in England, at the heart of political, scientific and religious affairs. His brother-in-law offered him to move to Birmingham and so in 1780 Priestley arrived at Fair Hill, Birmingham, where he became minister at the New Meeting chapel, probably the most liberal congregations of England.

In this new position Priestley was earning half of his previous income (he was now earning 100£ a year) and only thanks to the pension paid by Lord Shelburne (150£ a year) and the generosity of individual patrons (among which some of his industrialist friends, including the potter Josiah Wedgwood) he had time for his scientific researches and he could continue his experiments.

But the brightest side of living in the Midlands again was being part of the most brilliant of provincial intellectual gatherings, the Lunar Society of Birmingham. In his *Memoirs* he writes about this period in Birmingham remembering its importance to him: "I consider my settlement at Birmingham as the happiest event in my life, being highly favourable to every object I had in view philosophical or theological. In the former respect, I had the convenience of good workmen of every kind, and the society of persons eminent for their knowledge of chemistry, particularly Mr. Watt, Mr. Keir, and Dr. Withering. These with Mr. Boulton and Dr. Darwin, who soon left us by removing to Linchfield to Derby, Mr. Galton, and afterwards Mr. Johnson of Kenelworth, and myself, dined together every month, calling ourself the *Lunar Society*, because the time of our meeting was near the full moon"[71]. In these years, along with some of these friends who were fighting for the same causes, he became more and more prominent in religious and political controversies, supporting the causes of American independence and the abolition of slavery, urging the repeal of discriminatory legislation and later supporting the revolutionaries in France.

At the end of the XVIII century the Establishment started to show powerful reactions to non-conformity and radicalism. Being identified as the icon of radicalism Priestley became hated and

[71] *Ivi,* p. 120.

unpopular. There were strong reactions to his opinions and on 14 July 1791 an angry mob destroyed his house, laboratory and chapels in those that are remembered as the Birmingham Riots[72]. His family and him were not longer safe there and were obliged to flee and eventually took refuge in London, "being in some personal danger on this occasion, I went to London [...] There, however, [...] I continued to be an object of troublesome attention"[73].

Once more it was Richard Price who helped him, by resigning from his own position so that Priestley could replace him. Arriving at Hackney in 1791 Priestley found himself again in one of the leader educational institutions. But this time his stay would not be long, as he now had realised that he was no longer safe in England. In late August 1793 his sons Joseph and Henry had sailed to America and soon Priestley had decided to leave with his wife and join his children in Northumberland, Pennsylvania. Once he had received part of the money as compensation for the damages he sustained during the Birmingham Riots, he was ready to leave. In a preface to the sermon delivered to his Hackney congregation on the eve of his departure he wrote: "I cannot refrain from repeating again, that I leave my native land with real regret, never expecting to find anywhere else society so suited to my disposition and habits [...]

[72] David L. Wykes, *Joseph Priestley, Minister and Teacher*, cit., pp. 43-44.

[73] Priestley, Joseph (1970) *Memoirs*, in *Autobiography of Joseph Priestley*, cit., pp. 129-130.

Perhaps I may, notwithstanding my removal, for the present, find a grave [...] in the land that gave me birth"[74].

He sailed from Gravesend on 8 April 1794 and reached America on Wednesday 4 June. Priestley was but one of many people who sought asylum in the United States from political and religious persecution, but he was probably "the first distinguished scientist to do so"[75]. Franklin's death in 1790 had deprived Priestley of his only real American friend, but when he landed at the Old Battery in New York harbour "he had arrived in one country of the western world which had always known him more for his non-scientific works than for his science. In England and in Europe he had, at length, become the scientist whose politics and theology it was impossible to ignore. The political activities which had, since 1789, earned Priestley the hatred of his countrymen, driven him from his home and finally from his country, had temporally focused on European's attention on Priestley, the political philosopher and heretic theologian"[76]. He stayed for one month in Philadelphia and here he was welcomed by president Washington and also by David Rittenhouse, president of the American Philosophical Society[77].

---

[74] Priestley, Joseph (1794) *The Present State of Europe Compared with Ancient Prophesies Gravel Pit Meeting*, 28 February.

[75] Scholfield, Robert E. (1961) *Joseph Priestley's American Education,* in Early Dickensoniana, The Boyd Lee Spahr Lectures in Americana, 1957-1961, Dickinson College, p. 118.

[76] *Ibidem.*

[77] Speck, W. A.(2002) *Joseph Priestley's American dream*, The Historian, n. 73, p.18.

Despite the general warm welcome he soon experienced some more controversy and "the most virulent pamphlet that I have yet seen is just published against me"[78]. Many more followed[79].

Analysing the bibliography of Priestley's works "at least twelve editions of some seven different books by Priestley had been printed in the Colonies or in the United States before he arrived. None of these books were scientific"[80]. The real successes Priestley achieved in America were in the field of education but even so he was offered a chair of chemistry at the University of Pennsylvania which he refused, mainly because his sons and other friends and followers wanted to develop a new community of English liberal dissenters, of which he was to be patriarch. Priestley's sons, Thomas Cooper, and their friends had nearly 700,000 acres of land optioned somewhat north of Northumberland, where they were established. He "had buried himself in a backwoods community, isolating himself from cultured society and from institutions he might otherwise have aided [...] Shortly there was to grow, on the banks of the Susquehanna, an enlightened Utopia, a Pantisocracy of rational Christians, of cultured, liberal Englishmen, of which Joseph Priestley was to be the minister and teacher". This

[78] Graham, Jenny (1995) A *hitherto unpublished letter of Joseph Priestley*, Enlightenment and Dissent, 14, p. 98.

[79] Speck, W. A.(2002) *Joseph Priestley's American dream*, cit., pp. 16-23.

[80] Scholfield, Robert E. (1961) *Joseph Priestley's American Education,* cit., p. 118.

community of poets, saints and scholars never existed though, except in the "naive idealism and homesick longings of Dr. Priestley" and his friends[81]. The colony failed to develop. Even if Priestley had successfully begun soliciting subscriptions to the Northumberland Academy, soon some oppositions to the Academy and to Priestley himself emerged. He had never considered that he could be reviled in America for unorthodox religion and belief in the rights of man[82].

He kept working and updating his bestsellers and only for the presidential campaign in 1800 he wrote some new political works, and very influential ones. Both the opponents[83] for that campaign later declared that Priestley's tracts were an important factor in the election of Jefferson as president[84]. During his ten years in Northumberland and with the election of Jefferson, political favour shone on Priestley and for the first time in his memory the head of the government under which he lived was actually friendly.

Perhaps the greatest impact of Priestley's idea on education was indeed that he had on Thomas Jefferson. Priestley's ideas became important and useful for Jefferson while he was planning the

---

[81] *Ivi*, p. 121.

[82] *Ivi*, p. 126.

[83] The outgoing president John Adams and Thomas Jefferson.

[84] Graham, Jenny (1995) *Revolutionary in exile: the emigration of Joseph Priestley to America 1794-1804*, Transactions of the American Philosophical Society, vol. 85, part 2, pp. 144-149, p. 166.

institution of the University of Virginia. He wrote to Priestley asking for advice on establishing a college on a liberal basis and even if most of Priestley's ideas on curriculum had been published, he was looking for some personal advice on the more practical problems of administration. "In education alone had his work been inadequately developed - and such a development was impossible in an England where dissenting academies were closing under conflict of doctrine and higher education was limited to two Universities bemused with the past. Only in the United States, burgeoning with colleges, could his idea in education have received the trial that they did and only there could his influence have spread so far [...] Priestley's contribution to American education should not be forgotten. It is not small achievement to have inspired the teachers, influenced the curricula or supplied the textbooks for Dickinson, Harvard, Brown, Princeton, Pennsylvania, Columbia, Transylvania, South Carolina and Virginia"[85].

Apart from his political and educational influence, for Priestley the "exile in the United States was the culmination of catastrophe, America represented the end of his life of usefulness. His American years were spent in comparative isolation and his

[85] Scholfield, Robert E. (1961) *Joseph Priestley's American Education,* cit., p. 138.

continued work in science and theology suffered from lack of equipment, intellectual stimulation, and informed criticism"[86].

Confined to his Georgian house in Northumberland[87], away from his country and his circle of friends and colleagues, he was "a distinguished elder statesman of science to Americans"[88]. As consolation for his isolation in his last years of his life, Joseph Priestley could enjoy the friendship and esteem of the third president of the United States: with him he could share a natural affinity and they used to discuss their works. Priestley kept working till the very end even if he was ill; he died in Northumberland on 6 February 1804 at 71 years old, and he is buried there in the Riverview Cemetery.

---

[86] *Ivi*, p. 137.

[87] Priestley's house and laboratory are now a museum and his history and heritage are analyzed in the catalogue of the exhibition *Joseph Priestely in America 1794-1804* (14 sept-12 nov 1994) published by The Trout Galery Emil R. Weiss Center for the Arts Dickinson College.

[88] Scholfield, Robert E. (1966) *A scientific Autobiography of Joseph Priestley (1733-1804),* MIT Press, p. 330.

## 3 - Dissenting Academies and their importance to education in 18th century England

The birth of modern educational ideas in the XVIII century (and Priestley's role with respect to them) must be analysed in the historical and philosophical context of the Dissenting communities and their academies. To work in this interesting and complex frame we need to trace the roots of these communities and academies in the pre-restoration reform ideals. The fundamental principles of modern English education were, as a matter of fact, born well before the Enlightenment, and we should trace their origins back to a Puritan tradition in the first half of the XVII century[89].

In a long and well established tradition, the English education system in the XVIII century was still composed by three levels of study: Elementary school, Grammar school and University. Born within a religious matrix, those institutions had always been under the control and administration of the Church, and their curricula had been designed and carried on for centuries according its dictates. Schools were born attached to cathedrals and the first of this kind dates back to 631 AD[90]. Everything continued almost unchanged until the Elizabethan reform. The main goal of

[89] Parker, Irene (1914) *Dissenting Academies in England*, Cambridge University Press, p. 1.

[90] *Ivi*, p. 2.

education had always been to train new members of the clergy and, apart from the theological studies, most of the classes aimed to teach Latin. Then, with the raise of the middle class, schools started to be attended also by those willing (or in need) to train for a profession. Yet the curriculum had not changed, all the teacher did was to dictate Latin books making sure they learnt the grammar of "the universal language". No other subject was officially taught in grammar schools. Once one reached University, the BA training focused on disputations, and only trained disputants got to learn some real arithmetic, geometry, geography, astronomy or music in their four years Master studies. And only after the completion of this general education they could move to a specialisation in theology, law or medicine[91].

With the Renaissance there was a new interest in the classical literature, and, maybe more importantly, an interest in nature, man's physical world, and then in man himself. Being initially overshadowed by the renewed interest in the classics, the new enthusiasm for a "new learning" associated with the sciences grew little by little. In the Tudors' time it was believed that too much of this "new learning" could help the spreading of Puritanism, and thus the traditional way of teaching was supported. But "tradition

[91] *Ivi*, pp. 9-11.

and authority could not prevent the working out of the great conceptions that had their birth in the Renaissance”[92].

During the reign of Elisabeth I and then during the Stuart reigns a new school system was established with Elementary school, Grammar school and the University level education in Oxford and Cambridge, all closely controlled and managed by the Church of England. This system was destined to last for centuries and in the spirit of conservation and tradition it failed to adapt with the changing times and teaching continued almost unchanged and concerning the same subjects for centuries.

During the Renaissance a new and modern education in natural philosophy and physics became the cornerstone of the “new learning”, but only those who could study freely from the church ‘s control, either at home with tutors or in foreign academies, could pursuit this new education[93]. Despite this, there had been some embryonic movement for educational reforms in the early XVI century, such as the work of Sir Thomas Elyot[94](c. 1490-1546),

[92] *Ivi*, p. 14.

[93] *Ivi*, p. 16.

[94] In 1531 he published a book on education reform *The Boke named the Governour*, written in English rather than in Latin, where he claimed that the concentration on classics and divinity was excessive and denounced the exclusion of other subjects.

Wlliam Gilbret[95] (1538-1583), Richard Mulcaster[96] (1530-1611). But if modern education of those days included any Sciences much is due to the protestant Peter Ramus (1515-1572). His contribution was fundamental to the development of a new educational theory and his "aid to the emancipation of society from the bondage to medieval authority and to the enfranchisement of truth and free investigation"[97]. Ramism started to spread, and with it "the eager to ameliorate social conditions" and the desire "to bring education into line with the social needs of the day and to place it within the reach of every one"[98].

In the second half of the XVI century we see two important streams of thought concerning education: the development of science and the attempt to modify education. Many Englishmen were very interested in pursuing the new curriculum, and the acceptance of Ramus's ideas by many Cambridge scholars was a great advancement, eventually paving the way for the work of later scholars such as Isaac Newton. England was to play a big role in the scientific disciplines, but a change in educational curricula was

---

[95] He prepared a new curriculum, probably for the Inns of Court Academy in London, that included Hebrew, Greek and Latin, philosophy, natural philosophy, law, French, Italian, Spanish and horse-riding. Foster Watson, *The beginning of the teaching of modern subjects in England*. Pitmans, 1909.

[96] Mulcaster, Richard (1581) *Position wherein those circumstances are examined for the training of children either for skill in their booke or health in their bodie*. Mulcaster, Richard (1582) *The elementarie, which entreateth chiefly of the right writing on the English tung*.

[97] Graves, *Peter Ramus*, p. 204 cit. in Parker, Irene (1914) *Dissenting Academies in England*, Cambridge University Press, p. 17.

[98] Parker, Irene (1914) *Dissenting Academies in England*, cit., p. 19.

needed. In the following century these new tendencies were embodied in the fundamental work of John Amos Comenius (1592-1670), the famous Czech educator who advocated an all-encompassing school curriculum, including experimental sciences. His international fame and influence arrived in England and helped the growth of new ideas for the educational reform. The rise of puritanism in the XVI century "saw a strengthening and crystallising into definite shape of the Reformation ideal of the recognition of the worth of the individual. This resulted in the growth in the people of England not only of a desire to exercise their reason in regard to religious questions or even to obtain a measure of control over the government, but also of a firm conviction of the need for universal education"[99]. The formalism of the Church and the education it provided was for some to be maintained as to pursuit the same old classical training, but for others it was time to introduce new methods and disciplines. "Eager in the pursuit of the new knowledge which was rapidly opening out, the Puritans were enthusiastic also in their determination to apply the great principle enunciated by Bacon, that since observation (use of the sense) is the true way to learning

[99] *Ivi*, pp. 23-24.

(and not scholastic philosophy) everyone can, with the aid of the right method, be taught everything"[100].

From the first isolated visions of the XVI century, in the following century we see the first real stirrings of an educational reform. And among those calling for a reform there were Bacon and Comenius, and the leading educational philosopher of the time, John Locke. He had read the educational writings of Montaigne, but he did not know those of Mulcaster or Comenius[101]; he was not a teacher and his work was mainly the result of his own observations and reflections. Locke opposed the scholastic method and the harsh discipline in schools, and favoured an education based on common-sense. In his view knowledge is a product of experience, and the mind of the child is a blank tablet to be filled. Locke laid the bases for a psychological approach, and this "psychological tendency" in education would have been later developed by Rousseau and Pestalozzi[102]. Locke emphasised how important it was to establish a sympathetic relationship between the pupil and the teacher[103], and stressed that the attitude of a parent or a teacher should not be only critic and disciplinarian, but it should resemble that of "a friend

[100] *Ivi*, pp. 24-25.

[101] Baldwin, Bird T. (1913) *John Locke's Contribution to Education*, The Sewanee Review, vol. 21, n. 2, April, p. 179.

[102] *Ivi*, p. 181.

[103] *Ivi*, p. 179.

with more experience"[104]. Locke's views were very influential among his contemporaries, but, most importantly for this research, they would also become very influential for the dissenting community after 1662.

Samuel Hartlib (c. 1600-1662) was another important figure in the development and diffusion of a call for some educational reform. His role in the arrival of Comenius to the country in 1641[105] and his work for the diffusion of Comenius' ideas are just two examples of Hartlib's contribution to the educational reform movement in England. Around 1630 Samuel Hartlib had a very influential circle of contacts and correspondents; this group of people, known as the Invisible College, is considered the precursor of the Royal Society[106]. Among the other members of this circle, and later founders of the Royal Society, there were Robert Boyle, Robert Hooke, Christopher Wren, John Wilkins, John Wallis, John Evelyn and Francis Glisson.

Hartlib and his circle used to meet at the Gresham College in London. They tried to promote an educational reform as, according

---

[104] Locke, John (1854) *On the Conduct of Understanding*, in *The Works of John Locke. With a Preliminary Essay and Notes by J.A. St. John, Esq.*, H.G. Bohn, vol. 1, p. 79.

[105] Turnbull, G. H. (1953) *Samuel Hartlib's Influence on the Early History of the Royal Society*, Notes Rec. R. Soc. Lond., April 1, vol. 10, pp. 101-130.

[106] *Ibidem.*

to them, social improvements would come through education, scientific and technological experiments[107].

In the first half of the XVII century we see a great desire to establish a new education that could give expression to the ideas of Bacon and Comenius. One of the core point of the reform would have been the promotion of the teaching of "real things": "With the conviction that nothing is in the understanding which was not before in the senses, realist proposed to replace the old memory and language training - mere "words" - by a training of the understanding through the cultivation of the power of observation"[108]. The Puritans were the driving force of this reform movement, asking for the introduction of a new method of teaching and for the introduction of new subjects, namely the natural sciences. Pushed by a new social context they also wanted to provide education for more people, believing, as Hartlib expressed many times, that a practical education for the middle class was a matter of deep concern for a state[109].

Under Cromwell dissenters found space to cultivate these ideas, and the Commonwealth was indeed a time of considerable educational activities. "The work done between 1640-1660 was the natural

---

[107] Lawson, John & Silver, Harold (1973) *A social history of education in England*, Methuen, pp. 160-161.

[108] Parker, Irene (1914) *Dissenting Academies in England*, cit., pp. 28-29.

[109] *Ivi*, p. 40.

outcome of the attempts made in those and the preceding years to influence public opinion in the direction of demanding educational reform"[110].

But the wind changed soon, and with the Restoration all doors were closed to reforms. "Probably no event in English history has had so far-reaching and disastrous an effect upon education as the Restoration [...] After the return of Charles II there was the same attempt made to get rid of everything Puritan in the education as in the Church and State"[111]. Restoration was about uniformity, and Puritan ideas about educational reform were casted away. The Conformity legislation of 1662 was trying to restore uniformity in the Established Church of England and there was no tolerance for dissent.

It is in this context that we see the raise of the Dissenting Churches and, along with them, of the Dissenting Academies. The reforming ideas were now embodied in the dissenting way to education, an education that would be different and much broader than that provided by the Established Church. The legislation enacted after the restoration was harshly repressive, and the new laws had two main objectives: to prevent dissenters coming together for worship,

---

[110] *Ivi*, p. 42.

[111] *Ivi*, p. 43.

and to deprive them of higher education so that they would be unable to train a new generation of ministers[112].

English clergy had for a long time been almost exclusively graduates of Oxford and Cambridge and now these universities were barred by the Act of Uniformity to any who would not conform. Most of English and Welsh dissenters found resort in the Scottish Universities where there was no law to exclude them, or moved to continental Europe. But having some fortunate people studying abroad was not a solution to the problem, and soon with great determination dissenters chose a new approach that could provide them with a home-made project for a new University-level education. They would establish their own academies, at first mainly to provide a succession of their ministry, and later to accommodate young men who wished to enter other professions as well[113].

In the field of education dissenters did not confine themselves to catering for their own narrow interests: they promoted schools, Sundays schools, mechanical institutes, adult education and libraries and for the ones already educated they formed societies providing a forum for lectures and discussions. The dissenters' alternative system of education was remarkably effective at educating some of the future industrial, political, cultural and religious leaders, and

---

[112] O'Brien, Padraig (1989) *Warrington Academy 1757-86: its predecessors and successors,* Wigan, p. 5.

[113] *Ivi*, p. 9.

most of them ended up having a powerful influence in society. At first the dissenting academies were the result of an effort to provide education where it was withheld, but later they became a definite and necessary part of the educational system, "unique both in aim and accomplishment"[114]. According to them education should be imperatively liberal and include as many utilitarian subjects as possible and their academies were "the first institutions in England to put into practice the realistic theories"[115] and the ideas of the reformers.

"The Unitarians were deeply concerned in education and their educational ideals, aspirations and practices were an integral part of their character, gave them the confidence and resources to wage their various battles and, not least, did this for their women as well as men"[116]. Their open attitudes and educational psychology allowed them to question old and well established assumptions about women. "They argued that differences between people were not innate but were based on education in its widest sense, encompassing upbringing and formal schooling"[117]. So the dissenters equated male and female intellectual abilities and this egalitarian concept of gender was vital for the enlargement of

---

[114] Parker, Irene (1914) *Dissenting Academies in England*, cit., p. 124.

[115] *Ivi*, p. 134.

[116] Watts, Ruth (1998) *Gender, power and the Unitarians in England, 1760-1860,* Longmans, pp. 7-8.

[117] *Ivi*, p. 8.

opportunities for women, starting from education. They had to be well educated just like men, as it was their moral and spiritual development that would originate their abilities to fulfil their roles as mothers, wives and member of the society. Unitarians played a very important part for the emancipation of women from the late XVIII century onwards[118]. They were not only fighting directly for women's rights, but unitarian men and women were also deeply involved in different humanitarian causes as anti-slavery and all sort of educational reforms.

Thus, in England, where apparently neither the state nor the church had any interest in reforming and expanding the education system, scientific advancement was carried on by the Dissenting academies[119]. These academies were established, at some personal risk, by men whose prime occupation was the ministry. In the first generation of dissenters there were Oxford and Cambridge graduates who had been ejected from the Anglican Church in 1662. They were scholars who considered themselves fitted, and who felt called upon, to engage in this field of education. These early academies had only one tutor and were usually sited within the minister's own home or in hired spaces: some of them would not have a long life, but most academies were "passed" from the tutor

---

[118] *Ivi*, p. 2.

[119] Burns, William E. (2003) *Science in the enlightenment, an encyclopedia*, cit., p. 83.

on a student. Once chosen among other pupils as assistant, the future tutor would then be trained to keep on the tradition: once ready he could leave and establish his own academy or take over a retiring tutor (in this case the academy could also be moved to the home/parish of the new tutor)[120].

The dissenting academies can be divided in three groups: those of the first period (1663-1690) founded by ejected ministers; the ones of the second period (1691-1750) with more than one tutor, that became more "public"; and the third period's ones (after 1750) which started to provide a good education also to those going into business[121]. The first two academies were launched in 1663 one at Coventry and the other at Sheriffhales (near Shifnal) in Shropshire, setting the Midlands as core of the dissenting movement from the start.

Up until the Toleration Act of 1689, at the beginning of William and Mary's reign, just over 20 of these small academies had appeared, and even if by the end of the century almost half of these were already extinct[122] new ones were soon to be established, some of which would play a fundamental role both in education and science. These academies were at first designed to educate for

---

[120] McLachlan, Herbert (1931) *English Education under the Test Act,* Manchester University Press, p. 2.

[121] Parker, Irene (1914) *Dissenting Academies in England*, cit., pp. 57-58.

[122] O'Brien, Padraig (1989) *Warrington Academy 1757-86: its predecessors and successors,* cit., p. 10.

the ministry and they taught Latin, Greek and Hebrew, along with Biblical studies and Theology. Natural Philosophy (Science), Mathematics and Modern Languages were sometimes included and the tuition was in Latin, as customary in universities.

Even if it was only in the academies founded after 1750 that we see the real diffusion of methods and subject innovation in the curriculum, one of the first to introduce new teaching methods and modern subjects was Rev. Philip Doddridge (1702-1751). He was a famous non-conformist and friend of Isaac Newton, and as tutor at the famous Northampton Academy he played a great role in innovating education. In his lessons the working language was English, as he had abandoned the practice of lecturing in Latin; he had included in the curriculum mathematics, natural and experimental philosophy, history, law, commerce and medicine. Doddridge's role and influence on liberal dissenting education in England was great[123] and it was to be inherited in the next generation by Joseph Priestley[124]. In the period 1690-1750 the Dissenting Academies fully realised that the old aims of education were too narrow, and that their doors should be opened not only to those who wanted to enter the ministry, but also to everyone who

---

[123] McLachlan, Herbert (1931) *English Education under the Test Act,* cit., pp. 143-152; Smith, W. Ashley (1954) *The birth of modern education*, Independent Press, pp. 129-144.

[124] Priestley never studied under Doddridge but he surely studied with the curriculum he had proposed, as when he started at Daventry in 1752, the Academy had just been transferred from Northampton by the new tutor after Doddridge's death.

wanted an education. In the middle of the XVIII century in the dissenting academies we see this first real attempt "to bring education into closer touch with life"[125].

Among the academies of the third period one of the most important (also in the perspective of Joseph Priestley's educational role) is the Warrington Academy. At Warrington there was an old educational tradition with Presbyterian ministers. The work of the academy was interrupted in 1714 with the passing of the Schism Act, which declared that no person should teach the young, either in school or college or privately, without conforming to the Church of England and after having obtained a Bishop's license. This could have been a great blow for dissenters, but after Queen Anne died the Act was not enforced and so after a short intermission this important academy, in Sankey Street, Warrington, was resumed.

A century after the restoration and the Claredon's legislation, Warrington was about to become one of the main educational centres of the dissenting community: this was mainly because it was about to offer the best education to the sons of those leading and newly-enriched non-conformist families, to whom many offices and occupation were still barred, that had found new outlets for their talents, mainly in trade, commerce, and manufacturing.

[125] Parker, Irene (1914) *Dissenting Academies in England*, cit., p. 104.

Dissenters were now no longer actively persecuted, and they wanted to improve the status of their academies. With Warrington, among the new institution there were also those of Manchester and Liverpool, all at the centre of the industrial revolution territories, the Midlands[126].

Warrington was well placed geographically in the heart of the Midlands, and it had a very strong non-conformist tradition. For the previously explained nature of these academies, continuity for a dissenting educational centre was difficult to maintain, and sometimes some shift in the doctrinal inspiration of schools could occur. This happened at Warrington, where in the second half of 1700s, there was a drift towards Unitarianism. The first academy of the town had just recently come to an end after almost half a century and the new academy was established, when the Presbyterian minister was succeeded by the Unitarian John Seddon (1725-1770). Originally form Hereford and son of a dissenting minister, when Seddon arrived he was in his thirties and had a lot of energy and enthusiasm. He had studied at the Caleb Rotheram's Academy in Kendal and then at Glasgow University. He fought to find money to have the academy reinstalled in Warrington; and here he became a teacher for some time, and then rector of the school (secretary of the board of Trustees). His intentions were to keep up

---

[126] O'Brien, Padraig (1989) *Warrington Academy 1757-86: its predecessors and successors,* cit., p. 35.

the school and reinforce the tradition that other dissenting academies had established. To promote this new "dissenting" education, as it was happening in many of the cities where a dissenting academy was present, Seddon was also among the founders of the Warrington Public Library (a circulating library).

When the Warrington Academy was launched in 1757 it was intended to have 3 tutors, but as there were only 5 students the first year, they started with 2. John Taylor D.D. (1694-1791), the principal tutor responsible for the course of Divinity, would be very important for Warrington and would leave a big footprint in the teaching approach. The second tutor was John Holt, graduated at Glasgow: he was responsible for teaching Mathematics and Science for fifteen years, "a sort of reasoning automaton whose soul was absorbed by its science"[127]. The first collection of scientific apparatus which the academy possessed was Holt's, and in the preface to *History of Electricity* Joseph Priestley acknowledges him for this reason. In its second year the academy had 23 students enrolled and a third tutor was appointed, Rev. Dr. John Aikin. Joseph Priestley was considered for this position, but he was still young and inexperienced. Only when Taylor died, 3 years after, Priestley was hired at Warrington. Soon he became the most famous of the tutors and gave more than anybody else to give the

---

[127] Mrs. Barbauld definition in O'Brien, Padraig (1989) *Warrington Academy 1757-86: its predecessors and successors,* cit., p. 53.

Academy its unique status. Warrington had also a great production of books (Eyres' Press), some of which were composed by the lessons delivered by the tutors that would become the adopted texts for future courses and for other academies.

Warrington Academy was active for twenty-five years and had 393 students, with an average of just above 15 students per year[128]; 20 students entered medicine after attending Warrington (among which were Thomas Percival and John Aikin, son of the divinity tutor), seven of them are mentioned in the *Dictionary of National Biography* and three became Fellows of the Royal College of Surgeons[129]. After having been the centre of a major progress in higher education, Warrington was closed in 1786 and two new academies were instituted the same year: the Manchester Academy[130] that inherited the library that was at Warrington, and the Hackney New College, that received its collections of scientific apparatus.

The role of Warrington Academy (and of all the dissenting academies) in the introduction and diffusion of science education will be discussed along with Priestley's, but it can be said that it is

---

[128] *Ivi,* p. 85.

[129] Manson, J.S. (1933) *The Warrington Academy (1757-86) and its influence upon medicine and science*, The British Medical Journal, vol. 1, p. 752.

[130] After the closing of the Academy in Warrington, its core was moved to Manchester were it remained until 1803. Then it was moved to York for 37 years and in 1840 it returned to Manchester again until 1853 when it was moved to London to be united with University Hall in Gordon Square and finally in 1889 it moved again to Oxford, where nowadays we can find its descendant in the Manchester College.

"from the soil of free thinking that much of English science has grown"[131] and part of this success can be found in the fact that Dissenting Academies as Warrington succeeded in satisfying "the needs of the upper middle class for a practical modern education"[132].

In the dissenting environment of the Academies we see how the evolution of "the effective teaching of modern subjects and the application of the democratic principle to education awaited the social and educational awakening of the XIX century"[133] and along with this phenomena we see the birth of influential societies, among which there was the Lunar Society of Birmingham.

---

[131] *Bulletin of the Institute of the History of Medicine*, February, 1933, vol. i, n. 2, p. 50 (supplement of the Bulletin of the John Hopkins Hospital, February, 1933, vol. lii, n. 2) cit. in Manson, J. S. (1933) *The Warrington Academy (1757-86) and its influence upon medicine and science*, cit., p. 752.

[132] Parker, Irene (1914) *Dissenting Academies in England*, cit. p. 134.

[133] *Ivi*, p. 136.

## 4 - The Lunar Society of Birmingham

To better place the figure of Joseph Priestley in the cultural and scientific context of his time, it is necessary to deal with the story of the most interesting group of people in XVIII century England and the main intellectual powerhouse of the Industrial Revolution in England: the Lunar Society.

The *Lunaticks*, as they would call themselves, were an atypical society as they were very informal, but somehow they also fitted perfectly in the tradition of the learned society of the time. In the late Georgian Britain, in fact, the associational momentum was moving away from the major centres and new societies were growing in the rising industrial and commercial cities. Most of the provincial learned societies remained generalist bodies and some of the best known were growing in the industrial towns: the Lunar Society of Birmingham is a perfect example of the latter kind. By the end of the XVIII century Birmingham had assumed a very powerful role in the Midlands, both commercially and culturally[134]. Many of the associations which were active in the area had been founded and animated by dissenters: even if the Lunar Society never had any confessional elements it cannot be denied that some of its members were dissenters or were part of that tradition -

[134] Clark, Peter (2000) *British clubs and societies 1580-1800: the origins of an associational world*, Oxford University Press, p. 133.

especially if we consider that Joseph Priestley, the most famous and influential rational dissenter of the time, was a close friend and correspondent of many members, and that he physically joined them once he moved to Birmingham.

"More than any other single group, the Lunar Society of Birmingham represented the forces of change in the late Eighteenth-century England, for the Lunar society was a brilliant microcosm of that scattered community of provincial manufactures and professional men who found England a rural society with an agricultural economy and left it urban and industrial"[135]. This "revolutionary" society has its origins in a network of friendships that emerged in the late 1750s, and its story can help us to set the cultural environment in which it developed the educational perspective we are interested in and whose roots and story we are tracing.

To better perceive its importance, the story of the Lunar Society should be told considering the stories of the relationships among its members as "in spite of their fame as individuals the reputation of the society has been obscured. Theirs was an informal group; it had no officers, kept no records, never published its proceedings"[136], in fact it was only Joseph Priestley that openly

---

[135] Scholfield, Robert E. (1963) *The Lunar Society of Birmingham: a social history of provincial science and industry in eighteenth-century England,* Clarendon Press, p. 3.

[136] *Ivi*, p. 4.

spoke of the society in print[137]. Before the Lunar Society was established, even if they had always been quite informal, some of its members were already somehow associated and this "precursor group" was called the Lunar circle[138]. It was born almost unconsciously from a group of men who became friends thanks to their common interest in science and technology and their desire to share it with each other. Between 1750 and 1765 the blossoms of the Lunar Society can be seen in the relationships among the first three members: Matthew Boulton, Erasmus Darwin and John Whitehust.

**Matthew Boulton (1728-1809)** was born in Birmingham, son of a manufacturer of small metal products. He studied at a private academy at Deritend where he acquired the rudiments of a good ordinary English education. Even though he left school early to follow his father's business[139], he continued with some self-instruction and managed to learn Latin and French, as well as some drawing and mathematics, but "his chief pleasure was in pursuing the study of chemistry and mechanics, in which, as we shall shortly find, he became thoroughly accomplished"[140]. Boulton had an

---

[137] Priestley, Joseph (1970) *Memoirs*, in *Autobiography of Joseph Priestley*, cit., p. 120.

[138] Scholfield, Robert E. (1963) *The Lunar Society of Birmingham: a social history of provincial science and industry in eighteenth-century England,* cit., p. 17.

[139] *Ibidem*.

[140] Smiles, Samuel (1865) *Lives of Boulton and Watt*, John Murray, p. 164.

innate spirit for business and "by the time he was seventeen he had introduced several important improvements in the manufacture of buttons, watch-chains, and other trinkets; and he had invented the inlaid steel buckles which shortly after became the fashion"[141].

When his father died, Boulton had already been managing the family enterprise for years, and now that he had inherited everything he decided to expand it, founding the Soho Manufactory, two miles north of Birmingham. it produced a wide range of goods and, thanks to Boulton's innovations both in design and in techniques, it soon became one of the most famous factories in the country[142]. At Soho Boulton could experiment new techniques of productions, he started many important collaborations and new commercial ventures jointly with some fellow members of the Lunar Society and, as most of them, "besides carrying on the extensive business connected with his manufactory at Soho, this indefatigable man found time to prosecute the study of several important branches of practical science"[143].

---

[141] *Ibidem*.

[142] Factories such as Soho Manufactory were known as *Toy industries*. They produced goods that could be produced in metal, leather or glass such as boxes, hinges, buttons, belt buckles and hooks. Its famous metals were also destined to be associated with the pottery production of his fellow member of the Lunar Society Josiah Wedgwood.

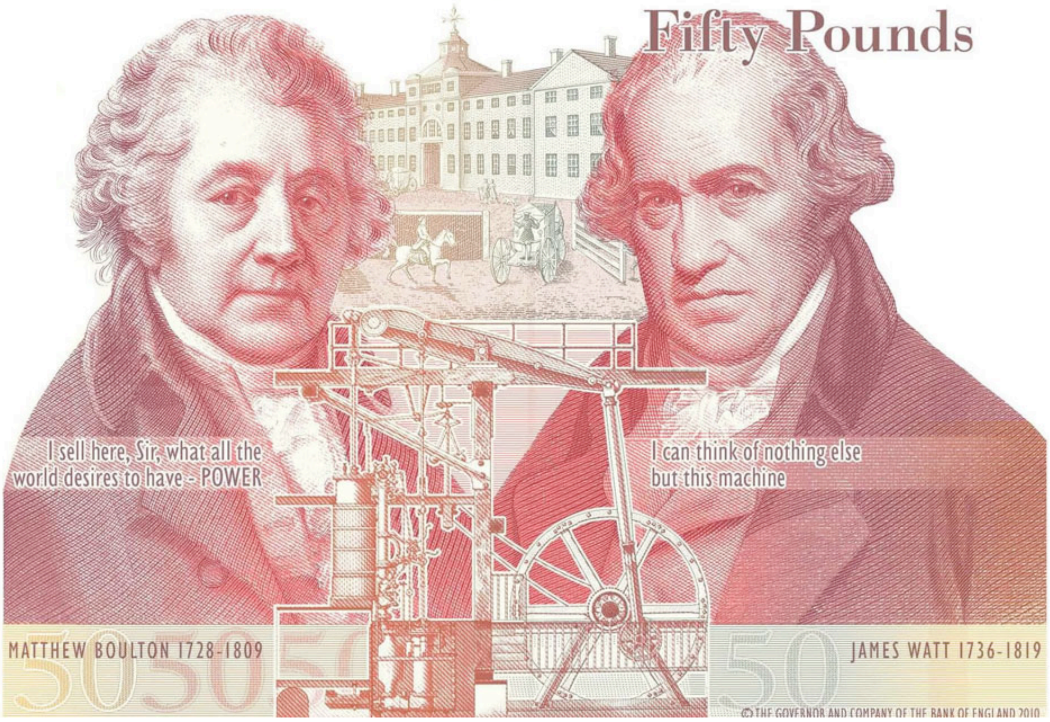
[143] Smiles, Samuel (1865) *Lives of Boulton and Watt*, cit., p. 181.

Boulton would often go to London to get inspiration, to read and draw the "rare works in metal in the British Museum, sending the results, down to Soho. When rare objects of art were offered for sale, he endeavoured to secure them"[144]. He was also inspiring his fellow Lunar friends and he was inspired by them and their intellectual and professional activities. Thanks to Boulton's great commercial ability and his good connections in England and in Europe, he was extremely skilled in promoting his products and those of his friends and business partners.

The most productive connection and partnership was probably that with James Watt. There was always need of power in Boulton's factory, and the dependence from water-power was one of the great defects of his manufacturing establishment. For a long time he had struggled to have enough power, and in case of severe summer droughts he was obliged to connect a horse-mill with the water-wheel. Boulton had started to think about other sources of power and, eight years after they first met, starting in 1766 he engaged a correspondence with Benjamin Franklin about steam power. Boulton had started to study the fire-engine and among those who he consulted there were his friends Franklin and Erasmus Darwin. Just like James Watt in Glasgow, Boulton had a model constructed for experimental purposes, and their ways finally

[144] *Ivi*, p. 171.

encountered when Watt went to visit Soho. "Watt was much struck with the admirable arrangements of the Soho manufactory, and recognised at a glance the admirable power of organisation which they displayed"[145].




*Matthew Boulton and James Watt on the new £50 note.*
*Bank of England/PA*

After that visit Watt started a correspondence with Dr. Small, and thanks to his friendship and encouragement he was led towards Boulton and Birmingham. The collaboration between Matthew Boulton and James Watt would lead to the development of their new model of steam engine. Boulton could now provide more

[145] *Ivi*, p. 185.

power to his factory, and in 1788 he opened the Soho Mint, where the production of coins was powered by steam engines.

We see a first sparkle of a Lunar friendship when Boulton meets the genius of **Erasmus Darwin (1731-1802).** Darwin was born in Elton, in Nottinghamshire, and after studying at St John's College in Cambridge he went to Edinburgh to be trained in medicine. It was here that he first met James Keir, the first of his future Lunar friends[146]. In 1756 Darwin settled as a physician in Nottingham, but after one year he moved to Lichfield where he gained a larger practice, and had much success. He became so famous that King George III asked him to be his personal physician but Erasmus declined, preferring to stay where he had settled rather than moving to London[147]. "Darwin's fame as a doctor depended not on any wonder drugs but on his sympathy with patients, his keen observation of symptoms and correct prognosis"[148]. Darwin had so many interests that he ended up being so much more than "just" a very famous and appreciated doctor: he was a real polymath. He had an amazing scientific insight in many different disciplines such as geology, botany, chemistry, astronomy, meteorology and many of his ideas were pioneering. In 1761, at 29 years old, Darwin was

---

[146] King-Hele, Desmond (1999) *Erasmus Darwin: a life of unequalled achievement*, DLM, p. 16.

[147] King-Hele, Desmond (1977) *Doctor of revolution: the life and genius of Erasmus Darwin*, Faber & Faber, p. 247.

[148] King-Hele, Desmond (1998) *The 1997 Wilkins Lecture: Erasmus Darwin, the Lunaticks and Evolution*, Notes and Records of the Royal Society of London, vol. 52, n. 1, p. 134.

elected Fellow of the Royal Society. He was not just a great scientist with interest and outstanding knowledge and skill in many disciplines: in full accordance with the Lunar spirit he was a practical man and an obsessive mechanical inventor. Many of his machines remained private and secret projects[149], but others were actually realised and gave him some fame: "A speaking machine that astonished anyone who heard it; a mechanical-copying machine as faithful as a modern photocopier; a new method for steering carriages, later used for many years in modern cars; a vertical-axis windmill; a wire-drawn river ferry; and a new type of oil lamp"[150]. One of his other great gifts were words, as Erasmus Darwin was also one of the most admired poets and writer of the time: "Coleridge in 1797 called Darwin «the first literary character in Europe, and the most original-minded man»"[151].

All Darwin's friendships were very deep and lifelong and he had a great social talent, especially with women. After his first wife Mary Howard[152], died he was left alone to raise the three sons that had survived infancy. In order to have help in this he hired a young

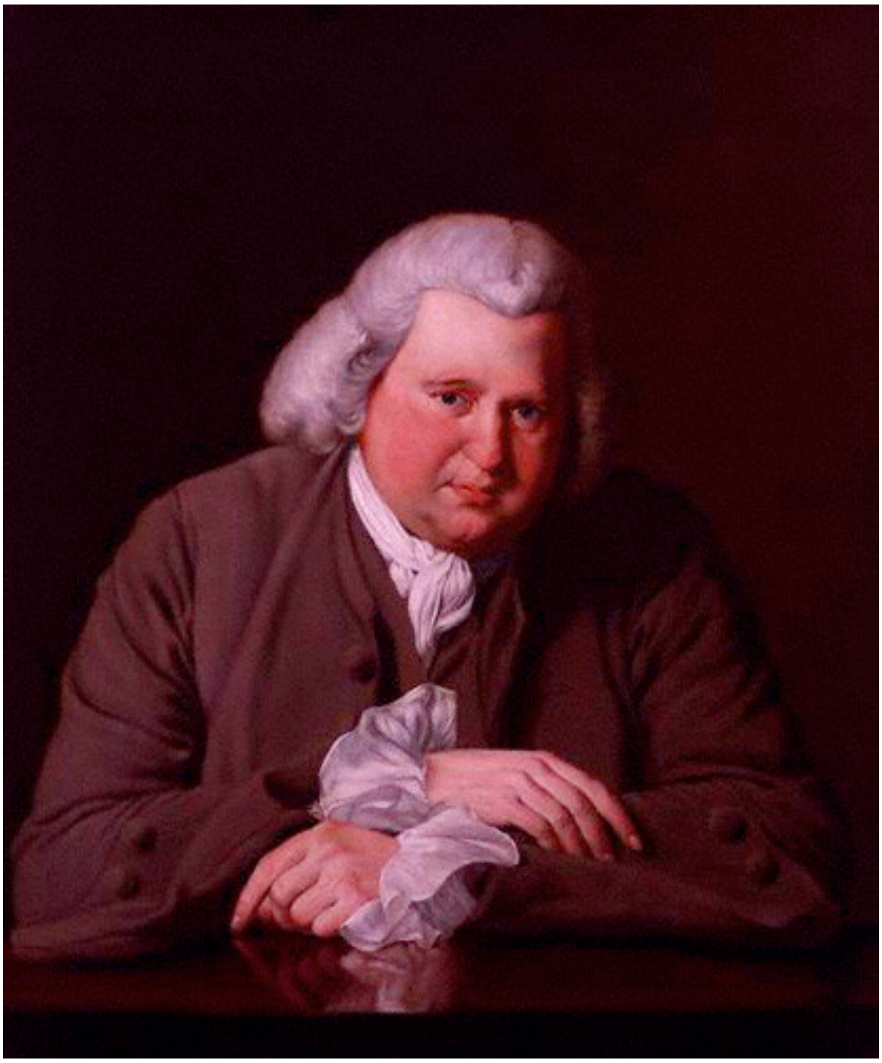
[149] Among these designs which remained only in paper there were: a canal lift, a steam carriage, a steam turbine, a multi-mirrored telescope and even an artificial bird (*ivi*, p. 155).

[150] *Ibidem*.

[151] *Ivi*, p. 156.

[152] Better know as Polly, as Erasmus used to call her.

nursemaid, Mary Parker: with her he soon started a liaison and she gave him two daughters[153].



*Portrait of Erasmus Darwin, after Joseph Wright, 1770*
*© National Portrait Gallery, London*

Later on he married Elizabeth Pole and in their 21 happy years of marriage they had seven children. After his second marriage he moved to Derby : the longer distance and his new wife did not allow Darwin to attend that many Lunar meetings. But he was always in close contact with all his friends and could now

[153] For whose benefit he wrote in 1797 a short book on female education in boarding schools. Darwin, Erasmus (1797) *A plan for the conduct of female education, in boarding schools,* J. Johnson.

concentrate on his great new interest in botany that would culminate with the publication of his important works, both scientifically and literally, such as *The botanic garden* (1791) and *Zoonomia* (1794-1796), where he foreshadows evolutionary ideas. Erasmus Darwin died at 70 in 1802.

**John Whitehurst (1713-1788)** was a clock and instrument maker who was born in Congleton, Cheshire. He had received only a basic formal education and at fourteen he started his apprenticeship and he was taught clockmaking by his father, who also encouraged the boy's general pursuit of knowledge. The high quality of the family clockmaking was well known and there was always good business for them, but in 1734, when Whitehust came of age and had completed his apprenticeship, he left Congleton as it was his brother James that was to stay and work with their father. Whitehust went to Dublin as he was curious to see and learn about a clock "with certain curious appendages", but having not being allowed to see it or to talk to the maker[154] in 1735 he went back to Congleton. The next year he moved to Derby to start his own business.

In the rapidly expanding economy of this city with a higher and higher request of luxury goods, a clock master could easily prosper and, in fact, Whitehust soon obtained considerable employment,

---

[154] Craven, Maxwell (1996) *John Whitehurst of Derby: clockmaker & scientist 1713-88*, Mayfield Books, p. 23.

distinguishing himself by constructing several ingenious pieces of mechanism. His best skills were in clock making, but he was also very good with thermometers, barometers, and other philosophical instruments, and he was also interested in contriving waterworks. He became the person people would refer to when interested in mechanics, pneumatics, and hydraulics, and among these people there were many *Lunaticks*. It was during the 1750s that Whitehurts expanded his circle of friendships beyond the local acquaintances and "by the end of the decade he had formed the three most crucial friendships in his career: Matthew Boulton, Erasmus Darwin and Benjamin Franklin"[155]. Whitehust probably met Boulton and Darwin in Lichfield and they soon started to write each other letters[156]: with the other two, he became a friend of Franklin upon his visit of 1758.

Whitehust made the movement of the Sidereal Clock[157] produced at Soho in 1771, incorporating some of the principles developed by John Harrison for his marine chronometer in 1764. He took part in the works of the building of Kedleston Hall, the home of Sir

[155] *Ivi*, p. 40.

[156] The first letters between Whitehurst and Boulton date 1758 (i*vi*, p. 41).

[157] The mechanism of the clock shows "the movement of the sun in relation to the fixed stars, while the allegorical figure of Science explains the laws of nature on the pedestal and Urania - the Muse of Astronomy - rests above". The first letters between Whitehurst and Boulton date 1758 (*ivi*, p. 150).
The clock failed to be sold at Christie's and by 1796, desperate to sell the piece, Boulton shipped it to St. Petersburg with the hope of selling it to the Empress Catherine the Great. It was returned, unsold, some years later and remained in the Boulton family. It is now on regular display at Soho House.

Nathaniel Curzon, first Lord Scarsdale: here, and later in other houses, he invented and installed new hydraulic apparatuses to move water around and create special effects in the parks and, most importantly, for domestic and agricultural purposes[158]. In 1774 Whitehust started to work at the Royal Mint and he had to move to London, where he sent the rest of his life in scientific pursuits. In 1779 he was elected Fellow of the Royal Society and in his house, in Colt Court, Fleet Street, he was often visited by his friends and important scientists.

The Lunar circle gained new strength between 1765 and 1775, when the three first Lunar men were joined by William Small[159], Josiah Wedgwood, Richard Lowell Edgeworth and Thomas Day.

**William Small (1734-1775)** was the son of a Scottish presbyterian minister. He had studied first at the Dundee Grammar School and then at Marischal College in Aberdeen. He assisted one of his professors, Dr. John Gregory, but never obtained a formal medical training. Son of the Scottish Enlightenment, since 1758 Small worked in Virginia as a Professor of Natural Philosophy at the College of William & Mary, and there he taught Thomas

[158] *Ivi*, p. 79.

[159] Small was probably the one who suggested to start meeting informally in each other's house. Hull, Gillian (1997) *William Small 1734-1775: no publication, much influence,* Journal of the Royal Society of Medicine, vol. 90, p. 104.

Jefferson[160] (along with Priestley, he would be very important for the development of his educational ideas[161]). In Williamsburg he continued to pursue his interest in medicine and was called Doctor, even without a full medical degree[162]. In 1764 Small came back to England being not too satisfied with the academic experience (mainly because of some problems with the board of trustees of the college) but he still wanted to go back to Virginia after he had bought some scientific instruments for his students. His health, though, was getting worse and worse since during his stay in America he had caught malaria. So he decided not to go back, he sent the instruments he had bought and stayed in England for the rest of his life. In 1765 Small was awarded a MD from Aberdeen and in May that year he arrived in Birmingham. He was first introduced to Matthew Boulton thanks to a letter of introduction written by their common friend Benjamin Franklin[163], and became

---

160 Thomas Jefferson studied at the William and Mary College from 1760 to 1762. Hull, Gillian (1997) *William Small 1734-1775: no publication, much influence,* cit., p. 103.

161 Ganter, Herbert L. (1947) *William Small, Jefferson's beloved teacher*, William and Mary College Quartlerly, iv 3rd ser., vol. 4, No. 4, pp. 505-511.

162 Hull, Gillian (1997) *William Small 1734-1775: no publication, much influence,* cit., p. 103.

163 Small and Franklin probably met when the latter was given an honorary degree at William and Mary College in 1763. For what concerns the acquaintance between Boulton and Franklin, it is to be traced to 1758 when Franklin visited Birmingham in 1758 and the future Lunar men could met him and start with him a relationship that would last in the years. Franklin had arrived in England the previous year, and in his second trip to the country, he was now there as a representative of the Pennsylvania Assembly. Franklin was "personally acquainted with seven of the fourteen persons who became members of the Lunar Society (including six of the nine people of the original Lunar circle); he also knew personally many of the scientific friends of the Lunar Society members". Scholfield, Robert E. (1963) *The Lunar Society of Birmingham: a social history of provincial science and industry in eighteenth-century England,* cit., p. 24.

Boulton's family physician[164]. Their relationship became very strong and they would always rely on each other's advice. Beyond the meetings and the Lunar connection all of the members became real friends, and thanks to some marriages even relatives. Their friendship grew well beyond the gatherings and the correspondences and, like it would happen for Erasmus Darwin and Josiah Wedgwood (and the next generation of their families), it soon became more a brotherhood-like relationship. Erasmus Darwin was very happy with the arrival of Dr. Small, and being primarily a doctor himself they could exchange knowledge also on their main activities. When Small's illness got worst it was Darwin that took care of him and assisted him until he died, at 40 years old. Even if Small's interests were broad and his interest in science wide, he had a great sense of anonymity and privacy, and for these he was the only of the member of the Lunar Society that "neither published nor joined formal scientific organisations"[165]. Despite this, the lasting influence of this great man can be traced in his "constant interest in and encouragement of others. His achievement was surely to help them find themselves a vision of what they could personally achieve. In Jefferson's case this was the

[164] *Ivi*, p. 35.

[165] *Ivi*, p. 36.

birth of freedom, while Watt's inventions heralded the modern world"[166].

Among the first people in the group that enlaced strong business relationships and friendships with the future members of the Lunar group, there was the potter **Josiah Wedgwood (1730-1795).** He was born in a small village in Staffordshire, Burslem, in a family of dissenters and potters. Wedgwood attended three years of schools at Newcastle-under-Lyme until his father died, when Josiah was nine years old. His teacher, Thomas Blunt, was very interested in mathematics and chemistry and the boy was immediately fascinated by the latter[167] especially. In 1744 he started a five years apprenticeship in the family art of pottery under his eldest brother, Thomas. At twelve he suffered from smallpox[168] and that illness left him permanently invalid with a weak knee, a big problem for a potterer who needed to use it on the wheel pedal. Driven by a great personal interest and attitude and because of his physical handicap, Wedgwood started to work on designing pottery rather than making it. Once he finished his apprenticeship, he worked for his brother for three years and learnt a lot, but he had an innate business attitude himself and he was already thinking about putting together

---

[166] Hull, Gillian (1997) *William Small 1734-1775: no publication, much influence,* cit., p. 105.

[167] Meteyard, Eliza (1865) *The life of Josiah Wedgwood: from his private correspondence and family papers*, Hurst and Blackett, pp. 207-208.

[168] *Ivi*, pp. 219-220. Wedgwood, Julia & Herford, C.H. (1915) *The personal life of Josiah Wedgwood: the potter*, Macmillan and C., p. 16.

his own enterprise. Wedgwood first joined a minor pottery in Stoke on Trent, Harrison & Alders, and in 1754 he began to work with one of the greatest potters of the area, Thomas Whieldon[169]. Since this very first business adventure Josiah was showing a great interest in the art and science of experimenting new techniques and materials for pottery-making. His passion for chemistry and practical experiments led him to look for new material and production techniques for his wares, and eventually would lead him to "inventing" those, such as the Wedgwood jasper, that would make him one of the most famous potters of the world. As his formal education had been so limited he kept learning from friends and colleagues: among these was Rev. William Willet, the Unitarian minister of Newcastle-under-Lyme, who had married his sister Catherine in 1754 and was also a great friend and companion in the first science adventures of Joseph Priestley. In 1759 Wedgwood rented from his uncle John some workhouses and a house[170], the Ivy House, and there started his own business, giving birth to new and a great tradition of potters. The year 1762 became fundamental in Josiah Wedgwood's life as it was then that he befriended Thomas Bentley[171]. In an accident occurred on the roads of Warrington he

---

[169] Meteyard, Eliza (1865) *The life of Josiah Wedgwood: from his private correspondence and family papers*, cit., p. 236.

[170] Wedgwood, Julia & Herford, C.H. (1915) *The personal life of Josiah Wedgwood: the potter*, cit., p. 18.

[171] *Ivi*, p. 23.

had injured his already ill leg and was taken to Great Lion inn in Liverpool where he was treated by Matthew Turner, surgeon and experimental chemist[172]. The two men had so many scientific interests in common that they soon became friends and Turner introduced Wedgwood to one of his good friends, Thomas Bentley, a great manufacturer and dissenter who had been among the founders of the Warrington Academy. "The friends smoked their pipes together, and over them discussed every conceivable topic, as the result proved-religion, politics, commerce, canal navigation, art, pottery, chemistry, lathe-turning, logic, and even poetry"[173]. Thanks to this accident Wedgwood had now widened his circle of acquaintances and met again Joseph Priestly, who was now tutor at Warrington. The friendship with this man helped him to learn more about science and challenged him to continue the experiments that he would often share with the other Lunar men, and about which he would receive suggestions and comments. In a typical Lunar attitude, the single was motivated and assisted by his friends, and the circle became the driving force of some of the most important scientific and technological innovations of the period.

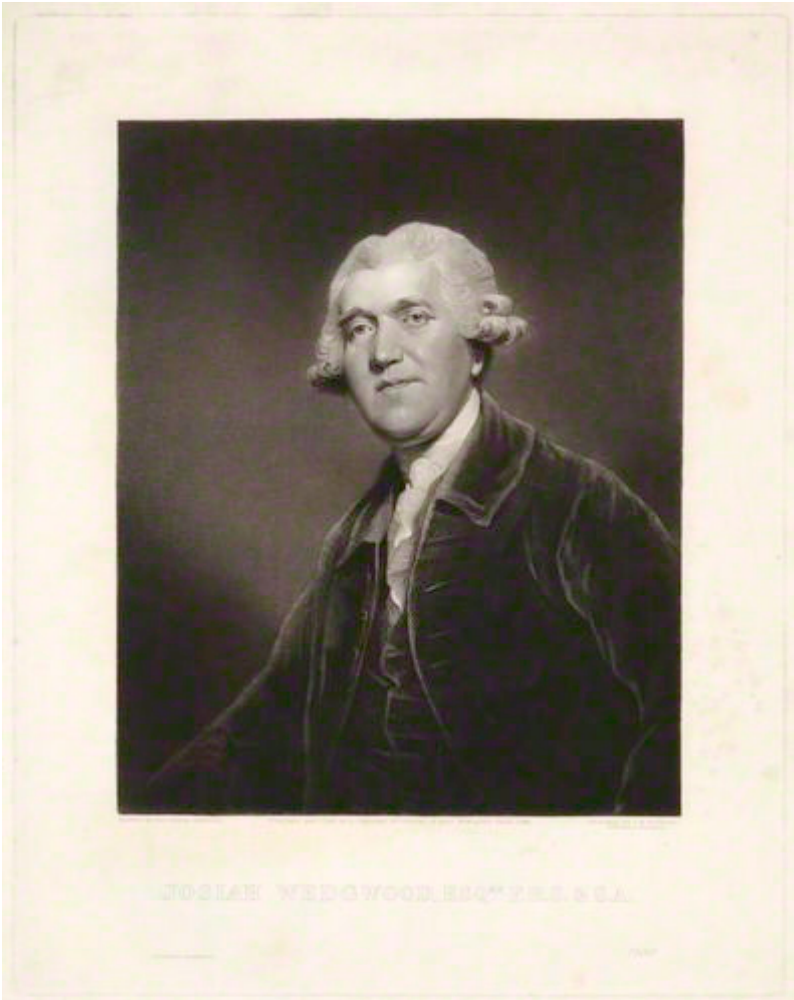
In 1764 a committee for the parliamentary approval of the canal work to connect the Trent and the Mersey rivers was formed in

---

[172] Meteyard, Eliza (1865) *The life of Josiah Wedgwood: from his private correspondence and family papers*, cit., p. 304.

[173] *Ivi,* p. 307.

Staffordshire: Josiah Wedgwood was among the members of this committee, as he had great commercial interest in these canals to provide goods to his factory and to transport his potteries safely.



*Josiah Wedgwood, by Samuel William Reynolds, printed by Brooker & Harrison, published by Robert Sheppard, after Sir Joshua Reynolds, 1841*
*© National Portrait Gallery, London*

But "Josiah Wedgwood brought to the Lunar Group far more than his enthusiasm for canals. As a scientific potter, an artist and a business man, Wedgwood's interests, though widely varied, were always to run parallel with those of at least one other member of the Lunar Society"[174]. Erasmus Darwin had become one of his closest friends, they worked on many different projects together and they found their families destined to be united in a great double heritage.

The first "official" meeting of the Lunar Society was probably that held on 31 December 1775, but only in 1776 they started to meet regularly, probably "as a tribute to Small"[175] that had died the previous year. The *Lunaticks* met every month in the afternoon of the Sunday closest to the full moon: they met for dinner and discussion and, even if "the Lunar Society began at Darwin's house in Linchfield"[176] and they were in turn hosting the meetings, they met more often at Soho House, the home of Matthew Boulton. The Lunar meetings were a moment when they could all sit in the same room and enjoy each other's company. These meetings were probably more a social gathering for them, as the scientific, cultural and commercial matters were mainly discussed in the massive correspondences that they kept with one another. Moreover, they lived relatively close and had many chances to meet other members of the society beyond the monthly meetings.

---

[174] Scholfield, Robert E. (1963) *The Lunar Society of Birmingham: a social history of provincial science and industry in eighteenth-century England,* cit., p. 43.

[175] King-Hele, Desmond (1998) *The 1997 Wilkins Lecture: Erasmus Darwin, the Lunaticks and Evolution*, cit., p. 166.

[176] Probably on 31 Dec 1775. Scholfield, Robert E. (1963) *The Lunar Society of Birmingham: a social history of provincial science and industry in eighteenth-century England,* cit., p. 141. King-Hele, Desmond (1998) *The 1997 Wilkins Lecture: Erasmus Darwin, the Lunaticks and Evolution*, cit., p. 159.

More members were joining the group. **Thomas Day (1748-1789)** was born in London, his father died when he was about a year old, leaving him a great wealth to live on. Day first went to school in Stoke Newington, Middlesex, and later to Charterhouse School. He studied at the Corpus Christi College in Oxford and once he went back to his family estate at Barehill, Berkshire, he met a former student of the same college, Richard Lovell Edgeworth, and they became almost inseparable. They shared a progressive view on education, so they resolved to educate Edgeworth's son, Dick, according to Jean-Jacques Rousseau's ideas. Later they decided to undertake a second project: to train a wife. Day had failed to meet a woman that could be a good wife and embarking in this quite extreme "educational project" he decided to adopt two foundlings and, using Rousseau's maxims, educate them to become a perfect partner. In 1769 he went to an orphanage in Shrewsbury and there Day adopted a 12-year-old girl, whom he named Sabrina Sydney, while from the Foundling Hospital in London he had chosen the 11-year-old Lucretia. He took them to France to educate them in isolation. Unfortunately the girls became ill and deciding to keep only one of them he gave up Lucretia, as he believed she couldn't satisfy him intellectually, and all his hopes were now on Sabrina. Soon after this Day would give up the whole project, Sabrina was placed in a boarding school (and later she eventually married John

Bicknell, the very same friend that some years before had accompanied Day to pick her up at the orphanage). In 1770 Day settled in Lichfield, and after he was introduced to Erasmus Darwin he became acquainted also with the rest of the circle of intellectuals of the Lunar Society. With the other members Day was particularly involved in the antislavery campaign and in 1773 he published the poem *The Dying Negro*, written with John Bicknell, about the horrifying story of a runaway slave. In his poem *The Devoted Legions* (1776) Day argued for the rights of the American colonists, but he gained his real fame as a writer for children. *The History of Little Jack* (1787) became extremely popular, and his *The History of Sandford and Merton* (1783) was a bestseller for over a hundred years. He had started to write for children in response to Edgeworth's complaint of a lack of books for them.

Day died in 1789 after he fell from his horse and was buried at St Mary's Church, Wargrave, Berkshire. These kind of accidents were very common as, in general, at the time travelling was still very uncomfortable. Transportations were among the mutual interests for the Lunar Men, especially because most of them had to be always on the move for their professional activities and some of them, like Darwin, to visit his many patients. Some others, as we have seen in Wedgwood's case, were interested in finding a way to move their goods safely and easily firstly to the factory and then to the stores where they were to be sold. While Wedgwood was leading the lobbying for the construction of the canals, Erasmus Darwin had invented a special carriage to travel more comfortably. He never built the new carriage and it was **Richard Lovell Edgeworth (1744-1817)** who physically constructed it working on Darwin's idea and project.

Edgeworth was born in Bath in a family that owned lands property in Ireland, where he would spend much of his life. He had studied at Warwick before he went to one of the finest schools in Ireland, Drogheda[177]: in 1761 he attended Trinity College in Dublin, but later decided to move back to England and went to Oxford[178]. He married in 1763 and soon after settled at Hare Hatch, near Maidenhead, Berkshire, where he devoted considerable time to his reading and research. There he befriended Thomas Day and through him he met Erasmus Darwin and the rest of the Lunar Men: "Besides my friendship with Mr. Day, I about this time formed an intimacy with Mr. Keir, of Birmingham, a gentleman well known in the literary world. Aand by means of Mr. Keir [...] I became acquainted with Dr. Small, of Birmingham [...] Dr. Small formed a link, which combined Mr. Bolton, Mr. Watt, Dr. Darwin, Mr. Wedgwood, Mr. Day, and myself, together-men of very

[177] Edgeworth, Richard Lovell (1844) *Memoirs of Richard Lovell Edgeworth*, Richard Bentley, p. 37.

[178] *Ivi*, pp. 44-47.

different characters, but all devoted to literature and science. This mutual intimacy has never been broken but by death; nor have any of the number failed to distinguish themselves in science or literature"[179].

Edgeworth had been interested in scientific and technological matters since his youth, "during that time I read some law, and more science. To amuse myself, I made, with indifferent tools, and with the assistance of an indifferent turner, a wooden orrery, that represented the motions of the sun, moon, and earth. I was then destitute of books to assist me, but I calculated the wheel-work accurately, and invented a movement, to represent the obliquity of the moon's orbit, and its change, which I afterwards found to be the same as what is usually employed in this sort of machinery. I never passed twelve months with less pleasure or improvement: no person of my family had any taste for the scientific employments in which I was occupied, and my young wife in particular had but little sympathy with my tastes"[180].

One of Edgeworth's other great interests was education, and he was very concerned about his sons and daughter upbringing. As Day, he was a great follower of Rousseau's theories and "After my return from Ireland in 1765, when I established myself at Hare

---

[179] *Ivi*, p. 116.

[180] *Ivi*, p. 67.

Hatch, I formed a strong desire to educate my son according to the system of Rousseau. His Emile had made a great impression upon my young mind, as it had done upon the imaginations of many far my superiors in age and understanding. His work had then all the power of novelty, as well as all the charms of eloquence; and when I compared the many plausible ideas it contains, with the obvious deficiencies and absurdities, that I saw in the treatment of children in almost every family, with which I was acquainted, I determined to make a fair trial of Rousseau's system"[181]. He helped his friend Day with his Rousseauian experiment with the two girls, and together with his first son, Dick, the two men even visited France in 1771, where they met Rousseau and took up residence in Lyons for two years. Education remained one of his major interests and Edgeworth is renown for his works on this theme. With his daughter, Maria, he published *Practical Education* (1798), a book where they collected their combined wisdom in the bringing-up of children, and later he wrote *Professional Education* (1808).

When Small died, Erasmus Darwin wrote a letter discussing the last days of his friend and patient to another doctor, **William Withering (1741-1799)**, asking him to consider to move to Birmingham and take over Small's practice there: "I am at this moment returned from a melancholy scene, the death of a friend

[181] *Ivi*, p. 111.

who was most dear to me, Dr. Small of Birmingham, whose strength of reasoning, quickness of invention, learning in the discoveries on other men, and integrity of heart (which is worth them all), had no equal. Mr. Boulton suffers an inconceivable loss from the doctor's mechanical as well as medical abilities [...] Now it occurred to me that if you choose that situation your philosophical taste would give you the friendship of Mr. Boulton, which would operate for you what he did for Dr. Small [...] If you should think this prospect worth going to see Mr. Boulton at Soho to inquire further into, I will take care to leave at home a proper letter for you to him if I should not see you"[182]. Withering was born at Wellington, Shropshire, son of an apothecary. In 1762 he went to Edinburgh to study medicine and he used to spend his summer visiting his uncle in Lichfield "where he apparently met Erasmus Darwin"[183]. In 1766 Withering went back home and moved in Stafford where he had a leading role in the foundation of the Stafford General Infirmary[184]. When Darwin wrote him in 1775 suggesting he applied for Small's post, he did so and he was then hired as Physician at the Birmingham General Hospital. With

---

[182] Peck, T. Whitmore P. & Wilkinson, K. Douglas (1950) *William Withering of Birmingham, M.D., F.R.S., F.L.S.,* J. Wright, pp. 1-2.

[183] Scholfield, Robert E. (1963) *The Lunar Society of Birmingham: a social history of provincial science and industry in eighteenth-century England,* cit., p. 122.

[184] Sheldon, Peter (2004) *The life and times of William Withering: his work, his legacy,* Brewin Books, p. 25.

Darwin he shared a great passion for botany, and of course its practical use for medicine, their profession. Once in Birmingham he replaced Small also as Boulton's physician, and naturally became part of the Lunar Society, even if he never really filled the role that was Small's, neither as a friend or as a scientist[185].

While natural history was only starting to be a central issue in the Lunar circle with Withering's and Darwin's works, steam power had always been a great concern for them, and both Darwin and Boulton had started to work on the idea well before they became acquainted with **James Watt (1736-1819)**. Watt was born at Greenock in Scotland and here he obtained an elementary education mainly thanks to his mother who would teach him herself instead of sending him to school[186]. He spent most of his time drawing, or cutting or carving[187], and until he was eighteen he lived at home where "the atmosphere was favourable to the development of his scientific instincts. In his father's workshop[188] he could find a complete outfit of carpenter's tools, and could watch the manufacture of the mechanical parts of ship's tackle or examine and play with the collection of nautical instruments [...] Watt

---

[185] Scholfield, Robert E. (1963) *The Lunar Society of Birmingham: a social history of provincial science and industry in eighteenth-century England,* cit., pp. 124-125.

[186] Marshall, T.H. (1925) *James Watt (1736-1819)*, L. Parsons, p. 32.

[187] Smiles, Samuel (1865) *Lives of Boulton and Watt*, cit., p. 91.

[188] His father, Thomas Watt, was a shipbuilder.

seemed to be attracted by every science in turn. Geometry and mechanics were his first loves, but he passed on to geology, botany and astronomy"[189]. His mother died when he was seventeen and as she was probably what kept him home so long, after her death he was sent to Glasgow to learn the craft of a mathematical instrument maker. Once there Watt didn't find anyone who could teach him, and after one year spent working for an "optician" his skills attracted the attention of Dr. Dick, Professor of Natural Philosophy in the University. He had spotted Watt's first class talent and advised him to go to London and get the best possible training. In 1755 Watt left for London and there began his training as an instrument maker. Once back to Scotland he finally settled at the University of Glasgow as an "instrument maker at the University"[190]. Here he became an educated scientist and established a series of relationships with many scholars: "He was treated by both professors and students as a friend and colleague rather than as an employee"[191]. Here he also became friends with John Robinson, thanks to whom he became interested in the steam engine[192]: "It was in the year 1759 that he first turned his attention

---

189 Marshall, T.H. (1925) *James Watt (1736-1819)*, L. Parsons, p. 36.

190 Scholfield, Robert E. (1963) *The Lunar Society of Birmingham: a social history of provincial science and industry in eighteenth-century England,* cit., p. 62.

191 Marshall, T.H. (1925) *James Watt (1736-1819)*, cit., p. 50.

192 Hart, Ivor B. (1962) *James Watt, pioneer of mechanical power*, Weidenfeld & Nicolson, p. 44.

to steam-engines. The suggestion came from Robinson. He knew that steam-engines were being used to pump mines and was not thinking about ways of improving them, but of possible new uses for the steam"[193]. In the winter of 1763 he had in his hands a working model of the Newcomen engine[194] that had been sent to London to be repaired and that had been recovered to be handed over to him. "At first he was not thinking of theories. 'I set about repairing it,' he says, 'as a mere mechanician'. But when he had finished, although the model was mechanically as perfect as any full-sized engine, it would only make two or three strokes at a time, and then expired. Here was a puzzle of a new kind. It led him away from the purely mechanical aspects of the problem: it became 'science in his hands'"[195]. From the practical experience with this model Watt started a whole series of experiments and reflections to improve the steam engine and he started building his own models. Going from a model to a full scale engine was a long and difficult problem, and a very expensive one. After four years of design and experiment he was almost ready to apply for a patent and he could finish his experiment only with the economical support of Dr. John Roebuck, a physician from Birmingham "who had taken up the

---

[193] Marshall, T.H. (1925) *James Watt (1736-1819)*, cit., p. 66.

[194] In 1712 Thomas Newcomen had invented the first practical device where the power of steam was used to produce mechanical work.

[195] Marshall, T.H. (1925) *James Watt (1736-1819)*, cit., pp. 67-68.

study of chemistry and its application to the processes of industry"[196]. When this partnership came to an end Watt continued to work on his engines thanks to a new partnership, this time with "the greatest industrialist organiser of the century"[197], Matthew Boulton. He knew a lot about Watt's works as he was friend with Roebuck. Boulton was looking forward to meeting Watt as he was interested in steam machines to overcome the problem of low or lack of power with the watermills in Soho. In 1767 when Watt went to visit his factory Boulton was not there and so Watt was welcomed and shown around by Small and Darwin, on Boulton's behalf. The visit inspired Watt greatly and it provided him new friends that would become very important in his future, especially Small who would play a vital role in Watt's inspirations and motivations. "In May 1774 Watt left Glasgow to join Boulton at Soho"[198] and thus Watt actively became part of the Lunar Society. In 1775 "the term of the patent was extended for twenty five years by Act of Parliament, and Boulton and Watt entered on the partnership which was to dominate their lives and, in good measure, the future history of the Lunar Society"[199].

---

[196] *Ivi*, p. 88.

[197] *Ivi*, p. 100.

[198] *Ivi*, p. 107.

[199] Scholfield, Robert E. (1963) *The Lunar Society of Birmingham: a social history of provincial science and industry in eighteenth-century England,* cit., p. 72.

Just after Watt joined the Lunar group, another famous scientist became a member of the society, **James Keir (1735-1820)**. He was born in Stirlingshire in 1735 and he had attended the Royal High School, at Edinburgh, where he continued to study medicine at the University. There he had first met and formed a lasting friendship with Erasmus Darwin. "Although Keir enjoyed his class in chemistry with Andrew Plummer (who also taught John Roebuck, Joseph Blank, William Cullen and James Hutton, the chemical manufacturer and geologist), he was not fond of medicine and did not graduate"[200]. At the age of 22, Keir left the University to join the Army for the Seven Years' War, then he was stationed in the West Indies and later in Ireland. Finding that almost nobody of his fellow soldiers had a great interest for science he understood he had no intention to stay in the Army with such lack of intellectual challenges. From 1767 Keir wanted to join the Lunar Society, thus he left for the Midlands and immediately found many projects of interest with different members of the group[201]. Keir settled at Hill Top, West Bromwich, Staffordshire, and could now devote himself to chemistry and geology. Applying in practice his knowledge he became a successful glassmaker.

[200] *Ivi*, p. 75.

[201] Keir, James (1868) *Sketch of the life of James Keir, esq., F.R.S.: with a selection from his correspondence,* R.E. Taylor, Printed for private circulation, pp. 44-49.

He "managed the Soho factory during Boulton and Watt's frequent and lengthy absences on the promotion of the steam engine, lent them money, and carried out what we would call techno-commercial investigation of the situation at Soho, with appreciations of the prospects"[202]. When Joseph Priestley arrived in Birmingham in 1780 Keir and him started to work together, Keir being a valuable assistant. Keir's scientific abilities became officially recognised in December 1785 when he was elected Fellow of the Royal Society. In 1791, after the death of Thomas Day, at the request of his widow, Keir wrote and published a biography of his fellow Lunatick (*An Account of the Life and Writings of Thomas Day, Esq.*): in 1809 he would also write a short memory of another of them, Matthew Boulton.

As for many other members of the Lunar group Keir's sympathy with the French Revolution was well known and in a public dinner on 14 July 1791, along with Priestley, he was exposed to the violent riot against Whigs and Dissenters. Notwithstanding, he displayed "his composure on the death of his wife in 1802 and on the destruction of his house at West Bromwich by fire in 1807"[203]. His good character was much appreciated and when he was introduced to Sir Humphry Davy, while he was visiting Gregory Watt at

[202] Smith Barbara M. D. & Moilliet, J. L. (1967) *James Keir of the Lunar Society*, Notes and Records of the Royal Society of London, vol. 22, No. 1/2, p. 145.

[203] *Ivi*, p. 150.

Birmingham in 1800, and the famous scientist wrote that he was "both amiable and a great men".[204] Keir died at West Bromwich on 11 October 1820, and he is buried there at All Saints Church, Charlemont.

In 1785 Keir was elected Fellow of the Royal Society along with another Lunatick, **Samuel Galton Jr (1753-1832)** (and a month after other three of them, Boulton, Watt and Withering). Galton was born in Birmingham in 1753, the son of a gunmaker, in a family of Quakers. He studied at Warrington Academy and even though he was there after Priestley had left, his father and him both admired his works and supported him financially[205]. With his studies Galton had acquired a good commercial education, and in 1773 his father made him manager of the Steelhouse Lane gun works, becoming an equal partner the next year. The Galtons worked very closely with other manufacturers, such as Boulton and Watt, and through these friendships the young Samuel became a member of the Lunar Society in the 1780s, hosting some of the meetings at his own home in Great Barr. He was one of the most successful businessmen of the group and he was often involved in the commercial activities with other the Lunar Men, including the canal development. The Galtons were criticised as over 100,000

[204] *Ivi*, p. 151.

[205] Uglow, Jenny (2002) *The Lunar Men. The friends who made the future 1730-1810*, Faber and faber, p. 352.

guns a year were sold to slave traders: being a Quaker the nature of his business was a serious issue for his family, both on a question of principle and of practice.

As he had become particularly close to Priestley and their wives were best friends, after the events that were going to push Priestley to exile, Galton and his wife "took in Mary Priestley immediately after the riots, courting danger himself"[206]. He was so worried for his friend Joseph attending other Lunar meetings that he would carry a pistol in his pocket in case they might be attacked again and they would need to defend themselves[207]. He lived until 1832, just in time to be the only Lunar man to see the Great Reform Act.

Between 1780 and 1791 the Lunar Society was in its heyday, especially since **Joseph Priestley** moved to Birmingham. He had been closely associated with the group's activities for over a decade and was a strong advocate of the benefits of scientific societies. Shortly after his arrival, the meetings were moved from Sunday afternoons to Mondays, to accommodate his duties as a clergyman. The society started to be less dependent on Matthew Boulton, and meetings were now held at other members' houses in addition to his.

---

[206] *Ivi*, p. 446.

[207] *Ivi*, p. 447.

The Lunar Men were radical and liberal, loosely allied with the Whigs and mainly dissenters, and, as such, far from being narrow minded, ignorant and puritanical. They had independent views and were people of strong moral fibre who shared a great passion for knowledge, especially for science and technology. It was in this "Lunar environment" that their genius worked and changed the world, and it is within this ideological framework that we can understand the educational thought of Joseph Priestley.

## 5 - "Everything gives way to experiment": a case study of practical education in the Lunar Society

In the lives and works of some of the members of the Lunar Society and the circle of people around them we can see how strongly they believed in the relationship between scientific empiricism and pedagogical practices. The educational experiences of some of the Lunar Men were briefly described in the previous paragraph and in the next I will analyse the educational contribution of Joseph Priestley in detail. To better exemplify the "Lunar" attitude towards education, I will now propose a case study on one of the members, Josiah Wedgwood, and, in particular, I will analyse how the theme of art and beauty was a key feature of his pragmatic and anti-authoritarian idea of education, and how this idea is fostered by the experimental method of modern science and the religious tolerance of the Unitarian circles[208].

In the strictly pedagogical setting of his work *Some Thoughts Concerning Education (*1693), John Locke had the remarked descriptive and poietic superiority of drawing compared to writing. Locke did not hesitate to recommend for the upbringing of a young at least some learning of representation: "When he can write

[208] This case study has been presented in a paper at the Annual Conference of the British Society for the History of Science in Aberdeen (22-25 July 2010) by Chiara Ceci and Stefano Moriggi.

well and quick, I think it may be convenient, not only to continue the exercise of his Hand in Writing, but also to improve the use of it farther in *Drawing*, a thing very useful to a gentleman on several occasions; but especially if he travels, as that which helps a Man often to express, in a few Lines well put together, what a whole Sheet of Paper in Writing would not be able to represent and make intelligible"[209].

In the Eighteenth century the use of image and representation, from pedagogy to science, was increasingly considered as an indispensable supplement to knowledge, and that would lead to more than one consequence. A major issue will be the opening of new horizons and markets for the arts, especially visual ones, thanks to the acquisition of new techniques and new tools developed with advances in scientific research. In the previous chapter we have seen that Erasmus Darwin invented a "copying" machine and a similar example can be found in the works of another member of the Lunar Society, Matthew Boulton. He had developed a "secret" method for a serial and mechanical reproduction performable on any surface for the paintings of the famous Swiss-German artist Angelika Kauffmann[210].

---

[209] Locke, John (1693) *Some Thoughts Concerning Education*, A. And J. Churchill, pp.190-191.

[210] Rossi Pinelli, Orietta (2009) *Le arti, la scienza, la tecnologia*. in *Le arti del settecento europeo*, Einaudi, p. 162.

As already stated by Locke, a travel experience is perhaps a privileged perspective to understand how the practice of "witnessing through images" would have redefined methods and disciplines, besides becoming a teaching urgency. Even professional travellers learned to depict with forms and colours what words could not show: in 1773, for example, students at the Royal Naval Academy of Portsmouth were required to learn to draw. This growing need for "visual data classification"[211] was recommended even by the London Society of Antiquaries to its members leaving for the Grand Tour, it is also a symptom of an aesthetic re-appropriation of observational and experimental practice of modern science. "The hundred-year span between 1750 and 1850 was a shift in the language of science from words to pictures"[212] and Joseph Priestley's charts had an important role in this process[213]. On the one hand, then, science is "rehabilitated" as an image documentary tool, but also as a didactic and pedagogical one. In addition to the above, the case of medicine is emblematic as there we find, for example, the valuable anatomical plates by George Stubbs in support of *An Essay Towards a Complete New System of Midwifery* (1751). On the other hand, the arts increasingly

[211] *Ibidem.*

[212] Wainer, Howard (ed.) (2005) *Graphic Discovery: A Trout in the Milk and Other Visual Adventures*, Princeton University, p. 6.

[213] *Ivi,* p. 39.

use images with a cognitive and classifying valence derived from the observational and experimental practices of modern science. In my opinion, it is in this context that we can frame the relationship between empiricism and beauty (and education) in the Wedgwood family and in the Lunar circle.

The evolution in the methods of analysis and classification of ancient art is indicative of this trend, and also of a certain way to revive serial classical models and actors into precious furnishings, such as the Wedgwood Potteries. Understanding means more and more to reproduce, and reproducing becomes a way to understand. Following this logic, Anne Claude Philippe de Tubières, Count of Caylus prepared his *Recueil d'Antiquités égyptiennes, étrusque, greques romaines et Gauloises* (1767). His analysis of the artistic object presupposed a careful and meticulous reconstruction of techniques and materials that had made its production possible. For Caylus to understanding the art of the past was a way to bring back the practices of artists from other eras to the contemporaries. Josiah Wedgwood borrowed and then bought in 1769 the *Recueil* by Caylus to create his famous six Etruscan vases[214]. Following Caylus' ideas, Wedgwood believed that only testing techniques and materials obsessively he could revive classical myth and art. *Everything gives way to experiment,* imitation is not reduced to a "mechanical" repetition

[214] These vases, with a new black basalt body, were the first ones to be thrown in the new Etruria factory on the 13 June 1769.

of a model, but it becomes real education to beauty through experimentation of techniques and materials.

Imitation becomes education. As Josiah Wedgwood wrote to Erasmus Darwin: "I only pretend to have attempted to copy the fine antique forms, but not with absolute servility. I have endeavoured to preserve the style & spirit or if you please the elegant simplicity of antique forms, & in so doing to introduce all the variety I was able"[215]. Imitation is no longer a mere operation of reproduction, it is the "effort" to understand an era and its forms through its practices, giving them a new life in their modern 'translation'. However, in this "experimental" approach to beauty one must not see only a scientific method for the analysis of the past; it is important to focus on the aesthetic declination of a pragmatic and anti-authoritarian approach, "not with absolute servility", to education and to social life.

The relationship between methodological empiricism and anti-authoritarian education finds an even clearer expression in the debates about teaching that were going on at that time. For example, the controversial case of the Sunday Schools has been subject to divergent historical interpretations.

The Sunday Schools movement was pioneered as a national institution in England by Robert Raikes (1736-1811), philanthropist

[215] Josiah Wedgwood to Dr. Erasmus Darwin, June 1789.

and owner of the *Gloucester Journal.* Raikes was among those who saw the needs of those children whose parents could not provide schooling for and believed that salvation of the future depended largely upon the education of the young generations. Thus Raikes decided to get involved and, convinced that people "are mistaken who consider the lower orders of mankind incapable of improvement, and therefore think that an attempt to reclaim impracticable, or, at least, not worth the trouble"[216], he took up the challenge and institute schools for these poor children.

Raikes was not the first one to create such schools but "he did not content himself, as others did, with establishing a school or schools in his own neighbourhood: by means of his newspaper and other organs of public opinion he recommended the practice far and wide, and never ceased his advocacy till the scheme was generally adopted throughout the land"[217]. Raikes raised Sunday teaching from a fortuitous rarity into a universal system.

King George III had said that it was his "wish that every poor child in my kingdom should be taught to read the Bible"[218] and Raikes' work was going in that direction, also supported by the Sovereign. Thanks to the attention that Raikes managed to raise on the issue

---

[216] Harris, J. Henry (1899) *Robert Raikes, The man and his works*, E.P. Dutton & Company, p. 57.

[217] Gregory, Alfred (1877) *Robert Raikes: Journalist and Philanthropist: A History of the Origin of Sunday Schools*, Hodder and Stoughton, p. 45.

[218] *Ivi,* p. 44.

we can say that the establishment of Sunday Schools is surely the first small part of the great social changes that were to change the face of society over the next quarter of a century.

Sunday Schools were a "long process of acculturation that had gradually changed the character of evangelicalism"[219], and they helped the development of a libertarian education, especially in those cultural contexts where even education and literacy for children (and for women) longed for the status and rigor of a science. Sunday Schools were meant to be not only and not anymore like a rigid religious indoctrination guarantor of the "salvation of the souls", or a pedagogy with the aim of convincing children "that they are rebels, and then to persuade them to lay down the weapons of rebellion", as was announced, for example, by the Red Hill Sunday School.

As many studies have shown, the history of Sunday Schools is marked by a slow but progressive "erosion of the evangelical sense of sin" and "attenuation of the sense of Inherent depravity". With this process we see a secularisation of the message of the Gospel with psychological terms; however, that is mediated by tools and methods of scientific research. William H. Groser's works - *Sunday School Teacher's Manual* (1867) and *Scriptural Natural History. Trees and*

---

[219] Tholfsen, T. (1980) *Moral Education in the Victorian Sunday School*, History of Education Quarterly, v
ol. 20, No. 1, p. 77.

*Plants mentioned in the Bible* (1888) - and his commitment to the Sunday School Union are a focal point of this teaching, educational and moral evolution, shaped within the language and principles of evangelical orthodoxy.

Well before Groser (and Robert Collins) and in most striking contrast with the idea of education understood as theological indoctrination, an alternative conception of teaching and education had grown far from Sara Trimmer's "Catechetical method" (widely adopted also in the Charity Schools) and from Robert Raikes' idea that in the Sunday Schools the "little heathens" had to be thought only in "readings, and in the Church Catechism"[220]. Some clear symptoms of intolerance had already emerged in many British interpreters of the "revolutionary" pedagogy of Rousseau like Blake or Wordsworth: those ideas were incompatible with any catechism[221].

Rousseau's ideas were particularly influential for the Lunar Men and "in the years following the publication of *Emile*, theories of private education prompted particular interest in the English radicals. While the members of the Birmingham Lunar Society, for example, were brought together by their interest in scientific subjects and by the political and philosophical radicalism, many of them also shared

[220] Raikes, Robert (1784) The Gentlemen's Magazine, vol. 54, p. 410.

[221] Richardson, A. (1989) *The Politics of Childhood: Wordsworth, Blake also the Catechistic Method*, ELH, vol. 56, 4.

an active interest in education. Rousseau's interest in the natural had stemmed from his belief that society was inevitably corrupting; his ideal education aimed to foster the natural development of a child rather than shaping him so as to conform to the ways of the world. While most of British radicals did not go as far as Rousseau, their mistrust for society as it was currently constituted carried over into their attitudes towards public education. Thomas Day, Richard Lovell Edgeworth, Joseph Priestley and Erasmus Darwin all produced widely read and influential works on the subject; of them only Darwin came down in favour of public education"[222].

It was in the Unitarians' dissenting rationalism that we see the cultural context in which the strongest antibodies emerged against all forms of authoritarianism: educational, moral and political. In particular it was the Lunar Society that helped to promote, through its members, a "Truly liberal education"[223] as Joseph Priestley wrote; an education with the anti-authoritarian and tolerant mold typical of the scientific enquiry. In this perspective we understand the need for the Lunatiks and other "dissenting" institutions, as the Warrington Academy, to develop a philosophy of education that should be scientific in method and in content. Art, as we have seen,

---

[222] Woodley, Sophia (2009) *'Oh Miserable and Most Ruious Measure': The Debate between private and Public Education in Britain, 1760-1800*, in Hilton Mary and Shefrin Jill (eds.), *Educating the Child in Enlightenment Britain: Beliefs, Cultures, Practices,* Ashgate, Farnham, p. 26.

[223] Priestley, Joseph (1778) *Miscellaneous Observations Relating to Education,* R. Cruttwell, p. 291.

makes no exception to this "not servile" and empirical way to conceive upbringing, at least from the pedagogical insights of John Locke to the "scientific poems" of Erasmus Darwin (*Botanical Garden*, 1791) and Josiah Wedgwood's pottery.

So, in harmony with the empirical approach to history of art and with a "pragmatic" idea of aesthetic education, a pedagogical science was developed in the Unitarian environments, and it was focused to shape future citizens that would be able to live according to what Tholfsen defined "a Palmerstonian vision of mid-Victorian social ideals"[224]. That is "liberty restricted only by justice, and advancement only checked by impossibility". This would become one of the educational purpose of the "secularised" Sunday School, and that was also the spirit that animated the science teaching that had now matured especially among the Dissenters.

The six volumes of *Evening at Home [or in juvenile budget opened: consisting of a variety of pieces for the miscellaneous instruction and amusement of youth* (1792-1796)] written by John Aikin and his sister Anna Laetitia, later Mrs. Barbauld, and *Practical Education* (1798) written by Richard and Maria Edgeworths are two striking examples of an idea of teaching based on dialogue and on the open confrontation. Contaminated by Priestley's educational ideas, they highlight the importance of experiments and that of the contamination among

[224] Tholfsen, T. (1980) *Moral Education in the Victorian Sunday School*, cit., p. 94.

subjects or "promiscuity", as the Edgeworths called it. The key, they said, is that "the mind is opened to Extensive views"[225]. Children are no longer "rebels" to be tamed according to orthodoxy but reasoning subjects whose knowledge has to be stimulated. As we read in *Practical Education*: "Whenever they [the children] ask sensible questions, make just observations, or show a disposition to acquire knowledge, we should assist and encourage them with praise and affection; gradually, as they become capable of taking any part in conversation, they should be admitted into society, and they will learn of themselves, or we may teach them, that useful and agreeable qualities are those by which they must secure the pleasure of sympathy"[226].

It is easy to understand how such an idea of education was closely linked to an idea of reform, not only moral but also social and political. A reform that included a relocation of the cultural and social figure of women. Thanks to the study and learning of sciences and arts, a woman was now destined to emancipation. In addition to Priestley's works and to Edgeworths', Aikin's and Barbauld's, Erasmus Darwin in 1789 had imagined the second part of the *Botanic Garden*, *The Love of the Plants*, like a charming and libertine sentimental botany, a poem able to capture the attention

[225] Edgeworth, Richard Lovell & Edgeworth, Maria (1798) *Practical Education,* J. Johnson, vol. I, p. 435.

[226] *Ivi*, p. 272.

and curiosity of women and to lead them to scientific knowledge. His commitment to a substantial reform for female education culminated in 1798 in his *A Plan for the Conduct of Female Education,* a work he carried on also thinking about his two daughters. This project earned the praise of the feminist Mary Wollostonecraft, and triggered strong conservative reactions, including that of the poet Richard Polwhele - who condemned in his *The Unsex'd Females* (1798) Mrs. Wollostonecraft and other too "enlightened" women, including Anna Laetitia Barbauld, and accused Darwin for the indecency and immorality of this combination of botany, literature and women education.

What Lunatiks and Dissenters theorised in their essays was a reflection of a specific lifestyle that marked their lives and those of their families. Children of friends and colleagues were left to roam free during their meetings even in the laboratory and in the library of Rev. Priestley[227]. This same kind of freedom was later allowed to Charles Darwin and Emma Wedgwood's children, that were often around him when he was working.

When still young, Charles Darwin had the chance to get educated "sympathetically" to this lifestyle in the house of his beloved cousin and future wife Emma. "Life There Was Perfectly free [...]", Darwin wrote in his autobiography, "and in the evening there was

[227] Priestley, Joseph (1791) *A Particular Attention To The Instruction of Young,* Dec. 4.

much very agreeable conversation, not so personal as it generally is in large family parties, together with music"[228]. At Maer Hall where Josiah Wedgwood II had moved the family since he had taken control of the pottery founded by his father, freedom was a practice mediated by education and by civil engagement, in an indissoluble combination of which the famous ceramics were the most evident symbol and result.

Josiah Wedgwood was convinced that a trip to Italy would have been a formative experience for his children. Emma, among the other daughters, kept a personal diary and in those pages words were often accompanied by images, just like Locke suggested. An education to beauty and art that, in Emma's case, also meant singing and music. She had a famous passion for the piano that accompanied her life with daily exercises. Accordingly with what it has been said before, she also performed a constant practice in social and civic engagement to improve literacy and empower lower classes, starting from Sunday Schools. The Wedgwood women did not write treaties on this subjects, but, as Thomas Day and other Lunar associates, what they did write were children's stories[229].

---

[228] Darwin, Charles (1958) *The autobiography of Charles Darwin 1809-1882 (*With the original omissions restored. Edited and with appendix and notes by his grand-daughter Nora Barlow), Collins, pp. 55-56.

[229] Wedgwood, Emma (1985) *My first reading book*, R.B. Freeman.

However, on several occasions they showed the concreteness of the education they were given, putting it into practice in their lives.

As many Lunar members had done, Elizabeth and her sister Emma Wedgwood had started a Sunday School at Maer Hall. And later in her life when she was the wife of Charles Darwin and they lived at Down House, Emma and her husband did not ceased to fund and support education as the only form of personal redemption and social reform. Maria Edgeworth was over seventy years old when she saw the tenderness of the young Emma in which she appreciated the Wedgwood's style, as if she was one of the jasper vase made by her friend Josiah: "Mrs. Darwin is the youngest daughter of Josiah Wedgwood, and is worthy both father and mother; affectionate and unaffected, and, young as she is, full of old times. She has her mother's radiantly cheerful countenance, even now, debarred from all London gaieties and all gaiety but of her own mind by close attendance on her sick husband"[230].

Many of the educational ideas of the Lunar Men, and in particular those of Joseph Priestley can be found embodied in the fundamental traits of a mindset that has given shape to a family like the Wedgwoods, to its values, to its social and business commitments. In this dissenting attitude we identify a pragmatic and anti-authoritarian idea of education: in the rationalist and

[230] Litchfield, Henrietta E. (1915) *Emma Darwin, A century of family letters, 1792-1896*, John Murray, vol. 2 p. 56.

libertarian context of dissenting authors and institutions this idea found an educational opportunity as well as a tool of moral, social and political reform in the experimental method of modern science.

Aesthetic education, as conceived by Josiah Wedgwood, was able to unite theory and practice, and even imitation became a creative and experimental opportunity to understand the past and to rethink the future. Only within this perspective Josiah Wedgwood, Erasmus Darwin, Joseph Priestley and other Lunar Men's abolitionist endeavours become intelligible. The Lunar Society fully embodies the elements of the radical enlightenment movement, especially the set of principles that it represents: "Democracy; racial and sexual equality; individual liberty and lifestyle; full freedom of thought, expression and the press; eradication of religious authority from the legislative process and education; and full separation of church and state"[231]. Many women and men in the Lunar families have witnessed with their lives the close alliance between the growth of knowledge, social reforms and political and religious tolerance. These values could be considered the "dissenting and Lunar" trademarks of the Wedgwoods, just like their potteries.

[231] Israel, Jonathan (2010) *A revolution of the mind. Radical Enlightenment and the Intellectual origins of Modern Democracy*, Princeton University Press, pp. vii-viii.

## 6 - Joseph Priestley, the educationalist

Joseph Priestley's fundamental work on education started well before he became a well known scientist and a revolutionary public figure and his "involvement in education was an integral part of his major preoccupation in life"[232]. As we have seen, Priestley was not alone in the promotion of a "new education" and he found other valid contributors to the cause in other members of the Lunar Society and their families, and in the Unitarian tradition of the Dissenting Academies. Despite this, Priestley played a crucial role in the innovation of the theory and practice of education, especially because teaching, along with preaching, was his main activity throughout his life[233].

Since his own studies at Daventry Priestley had been exposed to the mainstream of liberal thought in education and to Doddridge's educational ideas and its practical application in the new curricula. In his Academy at Northampton Doddridge had abandoned the centuries-long practice of lecturing in Latin, using instead English as the working language, a feature which was quickly adopted by other dissenting academies. Priestley would carry on and would

---

[232] Watts, Ruth (1983) *Joseph Priestley and Education*, *Enlightenment and Dissent,* no. 2, p. 98.

[233] De Berg, Kevin C. (2011) *Joseph Priestley across theology, education and chemistry: an interdisciplinary case study in epistemology with a focus on the science education context*, Science & Education, vol. 20, Numbers 7-8, pp. 805-830.

promote even more with his work; he was convinced that what his pupils needed was first of all to know their own language, and for this reason Priestley started to work on a series of lectures about grammar and use of the English language. This work was published in 1761 in a book titled *Rudiments of English Grammar*.

In his curriculum Doddridge had included mathematics, history, divinity, natural and experimental philosophy (theoretical and experimental sciences), medicine, law and commerce. It is very important to stress that, with the exception of some rare and usually minor contributions by amateurs, natural philosophy was not taught seriously by the universities until the century before Priestley's time, and their inclusion in the curriculum was largely a response to the dynamic drive of individuals of genius such as Boyle, Hooke and Newton. Even when science was somehow included in the curriculum of the universities, it was still not taught in the colleges for a long time and was not part of the BA degree before the 19th century. With all these innovations, Doddridge had managed to make the Academy at Northampton the finest educational centre in the country[234], and his influence on liberal dissenting education in England would be paramount.

As a student in the newly-opened Daventry Academy, Joseph Priestley was academically far ahead of his peers, mainly thanks to

---

[234] Parker, Irene (1914) *Dissenting Academies in England*, cit., p. 101.

his previous studies, and thus he was excused formal from lessons for all of the first year and much of the second. Priestley invested all his time in more study and in those years he was first introduced to chemistry through Boerhaave's *Elementia Chemiae* (1753) and Rowning's *Compendious System of Natural Philosophy* (1734-43)[235]. Chemistry at that time was a kind of black art rich in useful empirical knowledge, but with small theoretical framework: from this first interest, and along with many others, Priestley would soon contribute to the establishment of chemistry as science.

At Daventry Priestley also studied Newton and Locke afresh, but one of the books that he encountered, and which would become very influential in his thoughts, was David Hartley's *Observation on Man* (1749), where the author presented his theories on human psychology. They got Priestley's closest attention and in particular Hartley's theory of association will soon enter the very foundation of Priestley's thought, including his educational views. According to Hartley, external objects affected the senses and ideas originated in that way became "associated" in one's mind. Determining the pattern of experiences, it was then possible to influence the mental development of the child: "The most important application of Dr. Hartley's doctrine of the association of ideas is to the conduct of

[235] Scholfield, Robert E. (1966) *A Scientific Autobiography of Joseph Priestley (1733-1804),* cit., p. 6.

human life, and especially the business of education"[236]. Education thus becomes invested of a key role in the formation of a better human being, and following this idea Priestley would dedicate his life to the pursuit of giving some real contribution to a better educational system.

Having been profoundly touched by these ideas Priestley started a correspondence with Hartley, mainly about the application of his ideas to education. Hartley promised to work with Priestley on this connection for a publication, but he died in 1757[237] and Priestley worked on this project by himself.

In 1755, having completed his studies at Daventry, Priestley was nominated for the post of assistant minister to the nonconformist congregation at Needham Market in Suffolk and here he tried to open the first school of his own. Yet due to local antipathy to his radical belief, no one enrolled and Priestley could only manage to teach a course for adults on the use of *A new and Correct Globe of the Earth*, for which he had bought two geographical globes: "I began with reading about twelve lectures on the use of globes, at half-a-guinea. I had one course of ten hearers, which did something more than pay for my globes; and I should have proceeded in this way

[236] Priestley, Joseph (1774) *An Examination of Dr Reid's Inquiry into the Human Mind on the Principles of common Sense*, J. Johnson, p. XIII.

[237] Gibbs, F. W. (1965) *Joseph Priestley. Adventurer in science and champion of truth,* Nelson, p. 11.

adding my apparatus as I should have been able to afford it"[238]. From his very first experience as a teacher Priestley shows his practical approach and his predisposition in using apparatuses in his lessons.

Priestley's real first ground for teaching was Nantwich, where he moved in 1758. Here he finally managed to open his first school at Sweet Briar Hall, and this time it was a success: he introduced a curriculum that was far ahead of the times both in the teaching methods and in the contents. Priestley was very taken by his job as a teacher and "he found great satisfaction in the work and discovered that a deep-seated desire to share knowledge with others lay at the root of his success"[239]. Some scientific instruments were used in the classroom, and "when parents and friends visited the school they had the novel experience of being entertained with experiment and short lectures given by the pupils themselves"[240]. The school was composed of thirty boys and six girls and it was probably one of the few University-level education schools open to females. Priestley believes that women should receive an education as they would have an important role in society as mothers and wives; clearly referring to John Locke's *Essay Concerning Human Understanding*, he wrote: "Certainly, the minds of women are capable

---

[238] Priestley, Joseph (1970) *Memoirs*, in *Autobiography of Joseph Priestley*, cit., p. 84.

[239] Gibbs, F. W. (1965) *Joseph Priestley. Adventurer in science and champion of truth,* cit., p. 14.

[240] *Ibidem*.

of the same improvement, and the same furniture, as those of men"[241] (the role Joseph Priestley and the whole Dissenting community has played for female education in the XVIII century has been discussed in Ruth Watts' works[242]).

Priestley's enlarged income allowed him to buy a "few books, and some philosophical instruments, as a small air pump, and electrical machine, &c. These I taught my scholars in the highest class to keep in order, and make use of, and by entertaining their parents and friends with experiments, in which the scholars were generally the operators, and sometimes the lecturers too". We see how Priestley, since his first experience as a educator, puts his ideas into practice. He taught and demonstrated scientific principles and wanted his students to become familiar with phenomena by practicing with the apparatuses themselves, and wanted them to show their families and friends how they worked. Practice was the core of Priestley's teaching method, and the outreach of knowledge, even beyond his own pupils, was among his aims. He repeatedly underlined the importance for students to experiment phenomena with personal activities and he confessed that without experiments sometimes he could not really master a subject: "My

---

241 Priestley, Joseph (1817-31) *The Theological and Miscellaneous Works of Joseph Priestley*, Rutt, J. T. (ed.), vol. XV, p. 419.

242 Watts, Ruth (1998) *Gender, power and the Unitarians in England, 1760-1860* cit.; Watts, Ruth (1989) *Knowledge is power - Unitarians, gender and education in the eighteenth and early nineteenth centuries,* cit., pp. 35-50.

own ideas were always confused and embarrassed till I had recourse to this expedient to disentangle them"[243].

He was willing to expand the curriculum by introducing, according to the work of Doddridge, many new subjects and to teach in English rather than in Latin. But for all these new lessons there was a great paucity of textbooks, and soon Priestley realised that while preparing his lectures for his students he was in fact putting together material that could be published and used by other tutors in other schools.

His first work was to complete a series of lectures on grammar, where he omitted all the technical terms trying to give his students the basis for an understanding of plain English and its grammar, so that they could express correctly and fluently in both the spoken and written language. They would copy his lectures for their own use, but after some improvements and additions he published them in a book in 1761. By that time Priestley had left Nantwich and he was working as tutor at the famous Warrington Academy where he finished and published this first series of lessons. In *Rudiments of English Grammar* Priestley deals with many aspects of language and the different components of grammar (orthography, etymology, syntax and prosody). In each section he included definitions, a part with questions and another with the answers, and there were always

[243] Priestley, Joseph (1777) *Familiar Introduction to the Study of Electricity,* cit., p. 10.

practical examples to clarify his explanations. There are chapters on style and composition for written English, but a lot of aspects of grammar are not included, the book surely has to be considered a mere introduction. Priestley wanted it to be a textbook to help the average pupil, even those without any training in French or Latin, to become proficient in their own language: Priestley believed this was the best way to achieve this aim. The book was well received and was reprinted many times in the decades that followed its publication, being adopted by many schools all over the country.

Practice was a philosophical key point of Priestley's teaching even in this first work: in his lessons on English grammar he would always use clear examples drawn from modern literature, employing many extracts from the best English authors. Priestley was persuaded of the importance of usage, especially in a changing world with an ever changing language. In fact "his voluminous writings on chemistry, natural philosophy, theology and politics have overshadowed his contributions to the study of language. In this field, however, as in all others, he was independent and original, and in his 'Rudiments of English Grammar' (1761) he repeatedly insisted upon the importance of usage"[244].

Following this first publication Priestley began to prepare a series of lectures on the *Theory of Language* (1762) where he proposed his

[244] Baugh, Albert C. & Cable, Thomas (1993) *A history of English Language*, Routledge & Kegan Pau, 4th edition, p. 278.

lessons about themes such as oral communication between species (animals and humans) and the evolution of written and spoken language. He believed that these lectures were extremely important for his students and that by learning a clearer usage of language they would not make misleading associations. The production of this work is a typical example of the polymath genius Priestley was, as he completed a work on a book of over 300 pages in a matter of months, doing it as a secondary activity, in whatever spare time he could find: "I insensibly acquired a habit of composing with great readiness; and from this practice I believe I have derived great advantage through life; composition seldom employing so much time as would be necessary to write in long hand anything I have published"[245]. The publication of this second book enhanced his reputation as an educationalist and a grammarian, raising the status of Warrington Academy as a faculty of modern learning.

Priestley had started to put forward another great innovation in his school at Nantwich continuing at Warrington: the introduction of History into the curriculum. Traditionally history was taught only as an element in the wider study of the classics and it was confined to ancient Greece and Rome. Priestley believed that his students ought to know something about modern history, especially that of their own country. As sons of the business and manufacturing middle

[245] Priestley, Joseph (1970) *Memoirs*, in *Autobiography of Joseph Priestley*, cit., p. 22.

class, they would most probably become involved in these enterprises, and some knowledge of historical, political and economical dynamics of the contemporary world would surely be useful for them.

As with the case of the English language, Priestley found that there were not many texts where he could find sources and teaching materials, and thus started his own draft of lectures that would be published much later, in 1788, as *Lectures on History, and General Policy*. The first book Priestley published on a historical subject was instead *An Essay on a Course of Liberal Education for Civil and Active Life* (1765), a major work which he hoped would become a model for educational reform in England. This book is made up of a hundred and eighty lectures and it is devoted to the study of general history in which, apart from the actual European and world history, Priestley wanted to explain why history is so generally pleasing and interesting, what are its uses and, with a great degree of modernity and innovation, he also wrote about the sources. He wanted to teach his pupils the methods to be true and faithful historians, again giving them a practical knowledge of the subject. Priestley insisted that any study of historical records should include poetry, popular ballads, works of fiction and folklore from the period under investigation, because they might provide valuable supporting evidence for the usual forms of records[246]. Until then, the teaching of history had largely been a collection of records of dynasties and monarchs, battles and wars, with some rare social history that could not give any real idea of everyday life at a particular time.

In the Introduction to the book Priestley declares how he worked to prepare this lecture, gathering information from many sources himself: "I must also remind the reader, that all he is to expert from these lectures is a judicious selection, and arrangement, of the knowledge that was to be collected from books which were extant at the time when they were composed"[247]. This statement implies one of the great characteristics of Priestley's work: he was not an expert on the subject, either by training or experience: he only had a little knowledge of history and was introduced to the subject after arriving at Warrington Academy. Still, with the typical "Priestley approach", he mastered the subject over a period of barely two years, during which he consulted every known textbook and treatise that he could access, studying and absorbing the source material at a phenomenal rate, while at the same time he was preparing and delivering lectures on it.

---

[246] Priestley, Joseph (1765) *An Essay on a Course of Liberal Education for Civil and Active Life,* J. Johnson, Lecture VIII, p. 43.

[247] Priestley, Joseph (1788) *Lectures on History, and General Policy,* J. Johnson, p. vii.

The impact of the publication of *An Essay on a Course of Liberal Education for Civil and Active Life* greatly raised Priestley's educational fame. His texts and his teaching methods started to be adopted by liberal educational institutions, namely the other Dissenting Academies, and by many private tutors: this book was reprinted many times and it "had a far-reaching influence on the transformation of educational practice"[248]. Long before he started his scientific works and became famous for those, Priestley had already done more than any other man to modernise the curricula of the Dissenting Academies[249], and he was the most significant writer on educational philosophy between Locke and Spencer[250].

Along with history, in *An Essay on a Course of Liberal Education for Civil and Active Life* Priestley claims the practical importance of teaching other subjects: "Together with the study of history, I would advise that more attention be given to Geography than I believe is generally given to it, particularly to [...] Commercial geography, exhibiting the state of the world with respect to commerce, pointing out the most advantageous situations for carrying it on; and more especially noting those articles in the

---

[248] Simon, Brian (1974) *The Two Nations and the Educational Structure 1780-1870*, Lawrence and Wishart, pp. 56-57.

[249] Elby, Frederick & Arrowood, Charles F. (1934) *The Development of Modern Education*, Prentice Hall, p. 606.

[250] Knox, H. M. (1949) *Joseph Priestley's contribution to Educational Thought*, The Journal of the Institute of Education, London. Studies in Education, pp. 82-89.

Natural History of countries which are, or may be, the proper subjects of commerce. This branch of knowledge is as yet very much confined. We are probably strangers to some of the most useful productions of the earth on which we live, but a general attention once excited to the subject by teaching it to youth in all places of liberal education would be the best provision for extending it [...] a knowledge of chemistry is absolutely necessary to the extension of this useful branch of science"[251].

Around 1763-64, Priestley worked on another major "spare-time project", something that he was working on since the times of Nantwich. As for the apparatuses he used for his science lessons or the globes in the geography ones, he believed that the students were in need of some practical scheme to better display history, and for this reason Priestley had started to work on several teaching aids to improve the effectiveness of his history lectures. The idea of a chart was not original and Priestley was aware of it, as he knew of an earlier French historical chart that was translated into English in 1750 and that probably had inspired him to produce his own when he was at Nantwich. While at Warrington Priestley completed and published *A chart of Biography*[252], a wall chart that measured three feet in length and two feet in width, an early example of the now

---

[251] Priestley, Joseph (1765) *An Essay on a Course of Liberal Education for Civil and Active Life,* cit., pp. 67-68.

[252] Priestley, Joseph (1764) *A Chart of Biography,* J. Johnson.

familiar time-line diagram. Covering the period between 1200 BC to his own time in 1760 AD, Priestley had to use some measure of scientific thinking in devising and constructing the chart. He wanted to depict the whole of history in units of time and for that he had selected from the most reliable sources some facts and some chosen principal characters and the known facts, and put them in. On the chart, lines represented the characters' lives from birth to death and the scheme was then further divided along the width to produce six equal narrow bands extending over the entire length where they were allocated in classes of people (statesmen and warriors; divines and metaphysicians; mathematicians and physicians; artists and poets; orators and critics; historians, antiquarians and lawyers). The chart includes a total of some two thousand names, from ancient Greeks to Priestley's contemporaries: among the great difficulties in completing the chart there was the assignation of the characters to the most appropriate band. The publication of *Chart of Biography* and the accompanying descriptive book, *A Description of a Chart of Biography,* had an immediate success. They were widely introduced, as valuable history teaching aids, into educational institutions throughout the country. Thanks to this work the Edinburgh University conferred to Priestley the degree of Doctor of Laws on 4 December 1764[253].

---

[253] Priestley, Joseph (1970) *Memoirs*, in *Autobiography of Joseph Priestley*, cit., p. 90.

Immediately after its first publication Priestley started to work on a second edition of the *Chart*. The revised chart, published in 1765, contained around two hundred additional names and the handbook was enlarged from twenty-seven to a hundred and twenty pages[254]. He would continue to update the chart from time to time for the rest of his life, adding new names and events in the new editions, the latest published posthumously in 1805.

The chart was a very important teaching aid that Priestley would use in his own lecture theatre, but the published version made his work available to other academies and educational institutions: "This Chart was drawn out to be made use of in an Academical Lecture upon the Study of History, as one of the mechanical methods of facilitating the study of that science. One reason for having it engraved was that those young Gentlemen who attend the class might have an opportunity of providing themselves with a correct copy of it; and it is hoped that the sale of it will enable the author to oblige his pupils, at no great expense to himself"[255]. The chart could provide the students with much relevant information almost at a glance, and Priestley's recourse to visual aids, in the chart and in the general practical attitude, shows us once more his practical and scientific approach to teaching.

---

[254] Priestley, Joseph (1765) *A Chart of Biography*, Mynde.

[255] Priestley, Joseph (1765) *A description of a chart of biography*, William Eyres, p. 4.

Priestley continued with the production of teaching aids publishing *A New Chart of History* in 1769, once more convinced that the Charts would "trace out distinctly the dependence of events to distribute them into such periods and divisions as shall lay the whole claim of past transactions in a just and orderly manner"[256]. Priestley continued to prepare new lectures on History and General Policy and even if they were most likely written in the period covering late 1764 and 1765, they were not published until 1788 (*Lectures on History and General Policy*). This shows how he was continually adding new subjects to the curriculum, always studying new sources and delivering new lectures to his students.

It was in this period that he really got started with his scientific career, and in 1767 he published *The History and Present State of Electricity*, a groundbreaking work that became the educational base for those working in the field for over half a century. For some time Priestley had started to believe that one of the great needs of the time was to have a history of what he called experimental philosophy, meaning all aspects of science that had been investigated in the past and which had stood the test of time, from the earliest recorded research up to his own time. This was a task on a huge scale and it would have needed to be divided according to the topics such as light, alchemy/chemistry, electricity,

[256] Sheps, Arthur (1999) *Joseph Priestley's Time Charts: The Use and Teaching of History by Rational Dissent in late Eighteenth-Century England*, Lumen 18, pp. 141-142.

pneumatics and hydraulics, anatomy and animal life, and plant life. Priestley decided he would consider each branch of science in turn, and he would write and publish about one before moving on to the next. As with his previous works, he would first examine all the known material on the subject, and then eventually include his own original contribution as he became more familiar and involved with the topic. Despite all the difficulties Priestley quickly put together a defined plan of work and started to study and write. He began with a study on electricity.

Priestley had some basic knowledge of the subject and was aware of the work done in the field. Thanks to the introduction of John Seddon he had became acquainted with some of these great scientists, especially John Canton, Richard Price, William Watson and Benjamin Franklin, at the time agent of government of Pennsylvania in Great Britain. In their meetings they would discuss different scientific topics and it was in a visit to London, over Christmas 1765, that Priestley presented them with his idea of compiling a definitive history of science and obtained their approbation and help for the project. His friends soon started to send him all the materials. Priestley began his work in January 1766, proceeding at such a pace that he completed the history before mid-year.

As he got immersed in the subject and brought all the required material together, Priestley also mounted a series of experiments to test certain claims by earlier workers, and not satisfied with this, he launched into his own major program of original experiments which was completed early in 1767. He published the history and account of his researches in a book that was received with universal acclaim in the summer of that year. *The History and Present State of Electricity* became the definitive textbook for researchers well into the XIX century and set the basis for the great advances in electricity subsequently made by researchers such as Volta, Davy and Faraday. Priestley's reputation as a scientist had grown both at home and abroad, and with it the reputation of Warrington Academy as a centre of educational excellence. This work on electricity became enormously important in educational terms, as there were no universities or faculties anywhere with courses on electricity in those days. The only way to acquire state of the art knowledge of this branch of physics was to access the articles that were produced on this subject, usually from learned societies or meeting those natural philosophers who were engaged in electrical research. With this work Priestley changed the situation and disseminated the fruits of scientific endeavour to all who were interested, ultimately leading the subject to be taught in universities and schools. The impact of Priestley's work on scientific education was huge, far-reaching and permanent, and given the general lack of textbooks in those times, this publication was truly educative, in both formal and informal environments. Following this idea he prepared also a popular everyman's guide about electricity, drafting a layman's account of his work on electricity (*Familiar Introduction to the Study of Electricity*, 1768) directed at the educated general public. In the Preface to this work, he stressed the importance of instructing young persons and beginners in the subject, and of presenting the message simply, even if "those of quicker apprehension were irritated by this approach"[257]. In his mind the aim of scientific inquiry was not recognition and glory, but rather continually getting a little nearer "the truth" and making knowledge available to all who would receive it. What he wanted was to help the public gain a scientific education. Priestley's aim in all things, whether religious, social and scientific, was to search for the "truth", and he felt that his mission was to pass knowledge onto others, to educate, not only those that would follow in his footsteps, but the literate laity at large. A "truly liberal education"[258] indeed.

The *Familiar Introduction to the Study of Electricity*[259] (1777) proves once more that **Priestley was a premium science**

257 Priestley, Joseph (1768) *Familiar Introduction to the Study of Electricity,* cit., p. 8.

258 Priestley, Joseph (1778) *Miscellaneous Observations Relating to Education,* cit., p. 291.

259 Priestley, Joseph (1768) *Familiar Introduction to the Study of Electricity,* cit.

**communicator**, and his role in the development of science as part of public culture has been fundamental. He aimed to adapt the subject "to the use of every class of reader", his "personal design was to promote discoveries in the science, by exhibiting a distinctive view of the progress that had been made in it hitherto, and suggesting the best hints that I could for continuing and accelerating that progress"[260].

Priestley's books have been "largely responsible for creating the widespread public interest"[261] in scientific phenomena and the effectiveness of his way of communicating enhanced his reputation as a public figure of science and culture. In the great expanding market of popular science texts, his books found a perfect niche, and he was also very dedicated to the expanding fashion of public scientific lectures.

Priestley was a "dedicated communicator, motivated by the determination to establish experimental facts in the public realm"[262], he wanted to engage the greatest part of the citizenship into experimental sciences and he wanted them to be involved doing some science in practice. All his writings described the experiment in the simplest way so that readers would be encouraged to try themselves. Priestley knew how important it was

[260] *Ivi*, p. A3.

[261] Golinsky, Jan (1992) *Science as Public culture*, Cambridge University Press, p. 74.

[262] *Ivi*, p. 66.

for the natural philosopher to use this kind of simple language, so that it was easily understood by others, and to encourage them to initiate their own research which would perhaps lead to further discoveries[263]. "Priestley's writings were designed to involve a wide and diverse public in the expanding scientific culture of his time"[264], he used a historical and practical rhetoric, and with this approach he felt it was more appropriate to engage the attention, and to communicate knowledge with greater ease, certainty and pleasure. In fact, in the first lines of *The history and present state of discoveries relating to vision, light, and colours* (1772) he reminds once more his strong belief in a great need for science communication and education: "In order to facilitate the advancement of all the branches of useful science, two things seem to be principally requisite. The first is a historical account of their rise, progress, and present state; and the second, an easy channel of communication for all new discoveries. Without the former of these helps, a person every way qualified for extending the bounds of science, labours under great disadvantages; wanting the lights which have been struck out by others, and perpetually running the risk of losing his

[263] Priestley, Joseph (1768) *Familiar Introduction to the Study of Electricity,* cit., pp. 5-7.

[264] Golinsky, Jan (1992) *Science as Public culture*, cit., p. 77.

labour, and finding himself anticipated in the discoveries he makes, which is a great mortification and discouragement"[265].

As we have seen, Priestley's primary aim was to spread knowledge and provide a scientific education to grow liberal minds. All his work pointed in this direction and he continued to pursue this aim also with his chemicals works. His interest in chemistry was awoke by the opportunity to have Matthew Turner lecturing at Warrington where he had been able to organise a series of classes thanks to some common Lunar friends. Priestley himself attended them with interest, learning a lot. It was not until he moved to Leeds, in the Autumn of 1767 that he really began his career as a chemist. Priestley was working on the next part of his history of science, studying the topic of light and vision. This book was only the second of the bigger history of science project, and unluckily the last one of it, as it would not have success after its publication in 1772, so Priestley decided to abandon the overall idea. In Leeds his house was adjoining a brewery and it was studying the waste bi-products of the fermentation process, an impure gas which he termed "fixed air" from which he would make some great chemical discoveries. Even if the experiments were performed in the brewery, sometimes with simple and inadequate instruments, after having improved the experimental procedures Priestley managed to

[265] Priestley, Joseph (1772) *The history and present state of discoveries relating to vision, light, and colours*, J. Johnson, p. I.

isolate the gas from gaseous, liquid and particulate impurities and made some interesting observations which he published in 1772 in *On Air*. In this work he gave details about his experiments and described how he had saturated water with pure "fixed air" producing an effervescent drink, which he called "artificially carbonated water". In 1773 he had prepared a larger and more precise article to be published in the Philosophical Transactions of the Royal Society, *Different Kinds of Air*. This work had such an impact that Priestley was awarded by the Royal Society the Copley Medal, the most prestigious scientific award in Great Britain. Once more his researches were very practical and Priestley was really motivated in showing the use that could be done with his results. He was extremely satisfied to know that The Royal College of Physicians had recommended to the Admiralty the use of his "artificially carbonated water" as it was an antiscorbutic in preventing sea scurvy[266].

After six years in Leeds Priestley became librarian to Lord Shelbourne, and in this period he had a lot of time and resources to continue his experiments. It was here that he discovered and isolated as pure specimens nine gases including oxygen, ammonia, sulphur dioxide and nitrous oxide. He had now attained international status as a scientist and was considered the greatest

[266] Priestley, Joseph (1970) *Memoirs*, in *Autobiography of Joseph Priestley*, cit., p. 95.

chemist of his time. Only while he was working for Lord Shelbourne (1772-1780), and later, when he went to America, he did not teach actively[267]: this once more shows us how the practice of education was fundamental in his life.

Once Priestley moved to Birmingham, in 1780, he had already been in close contact with other important educationalists of the time and fellow members of the Lunar Society. In the previous paragraphs the truly educative matrix of the group was explained: and also thanks to this association Priestley never abandoned his educational thoughts, even when he was concentrating on his scientific researches. Towards the end of his stay with Lord Shelburne Priestley turned his attention to education once again and, although he was heavily engaged in a major series of experiments in biology and chemistry, he published some more educational reflections in *Miscellaneous Observations relating to Education* (1778). In the Preface to this book we read his views on education once more: "The chief and proper object of education is to produce a useful character (not a shining or popular one). Education is the only foundation of real happiness. Some great and valuable men are unpopular! [...] The great end of education if it corresponds to the great end of life, is, by no means, advancement in the world (i.e. good job, rewarding salary and high standard of

[267] David L. Wykes, *Joseph Priestley, Minister and Teacher*, cit., p. 20.

living) but to inculcate such principles and lead to such habits as will enable men to pass with integrity and real honour through life!"[268]. Education through experience was the way to grow a critic and free mind, and teaching was meant to train and prepare students for adult life, for their role of citizens. Experimental philosophy was a key part of education in his ideas, and subjects as anatomy, biology, chemistry and physics were particularly important in preparing students for adult life, especially so that they could enter trade and professions.

In Birmingham Priestley could seal his friendships with the members of the Lunar Society even more and, among them, the strongest educationalists - Day and Edgeworth - were surely influenced by Priestley's work. We see this influence in some passages of their works, such as when Edgeworth writes that "it must be encouraging to those who have children to educate, to observe that knowledge on various subjects, both of literature and science, has been compressed into a compact form, convenient for those who are to learn, and for those who are to teach. In some arts and sciences such simple and expeditious methods of instruction, both analytic and synthetic, have been devised, that would cost a life of labour in the original attainment, may now be acquired by a pupil of common abilities before he is twenty. A boy of seventeen

---

[268] Priestley, Joseph (1778) *Miscellaneous Observations Relating to Education,* cit.

may now, without great labour, know all that the utmost stretch of the abilities of Newton discovered in the course of forty years. This general diffusion of knowledge makes it at once more shameful to be ignorant, and more difficult to excel. The little more (il poco più) is now of arduous attainment"[269].

In some passages of Edgeworth's *Essay on Professional Education,* one of the major educational texts of the time, Priestley is directly quoted for the stress he put on practise in science education: "Instead of forcing books upon his attention at these times of recreation, it will be better to cultivate his former propensities by instructive amusements, that have not the repulsive appearance of lessons. He may see chemical experiments; many of which can be exhibited without expensive apparatus. As Dr. Priestley has said, whoever waits for a complete laboratory, and all the formality of apparatus to try experiments, will never be a chemist"[270].

In Birmingham Priestley resumed his active role as a teacher and played a key role in the management of the Sunday school[271]. He was assisted in this venture by Thomas Wright Hill (1763-1851) who taught, voluntarily, at his chapel in Birmingham and became a disciple and life-long friend of Priestley. After Priestley had gone into exile, Hill bought his own school at Hill Top, Birmingham,

---

[269] Edgeworth, Richard Lovell (1812) *Essay on Professional Education*, J. Johnson, 2nd ed., p. 25.

[270] *Ivi*, p. 247.

[271] David L. Wykes, *Joseph Priestley, Minister and Teache*r, cit., p. 41.

where he was assisted by three of his young sons, among which Rowland, the future postal reformer of the Penny Post.

From what has been pointed out we can say that Joseph Priestley, especially since he was at Warrington, was instrumental in initiating true scientific education, not only throughout England, but eventually throughout the world, and that the Academy can be recognised as the cradle of scientific education: "Warrington Academy initiated scientific education throughout the world. During its whole history there were fewer than four hundred students, but they and their teachers brought about a remarkable change in two separate ways. They were the men, they and their students, and their students in turn, who made the Industrial Revolution, and they did not make it by mechanical skill but because they learned here an intellectual approach which baulked at nothing and looked upon every thing afresh. It was this intellectual attitude which made it great. Secondly it was made possible because these people formed a kind of education which was quite unique"[272].

After the Riots in Birmingham of 1791 and Priestley's move to Hackney he was already thinking about leaving the country, but that did not stop him to promote his educational and civil ideals. In the discourse delivered on April 27th 1791, at the Meeting-House in the

[272] Jacob Bronowski, Presentation to the Warrington Society on 24 October 1957, to commemorate the bicentenary of the opening of Warrington Academy.

old-Jewry in London[273], he preached that "it is the great object of education to form valuable characters, and to prepare men for the most important station in life"[274], but that "places of truly *liberal education* in this country are few indeed, compared to the number of those in which you receive something that is merely called education"[275]. "But colleges and schools are not the only places for education. The world itself is the greater theatre of instruction, as well as of action, and the actual wants and business of the age in which men live, form them for acting a proper part in it [...] few men who have made any great figure in the world have derived much advantage from what we commonly call their *education* [...] Much, however, may be done in the course of education by way of preparing minds of men for improving such opportunities for public usefulness as may occur. Only inspire the mind of youth with the love of truth, and a sense of virtue and public spirit, and they will be *ready for every good work*"[276]. Talking about the mission of the college he said that "I trust it will be the care of all who are concerned in directing the study of youth, to lead them to consider themselves not only as private citizens, and to form them for the proper discharge of their duties as husbands, fathers, mothers, or

---

[273] J. Priestely (1791), *Discourse to the supporters of New College, Hackney.* J. Johnson, London.

[274] *Ivi*, pp. 3-4.

[275] *Ivi*, p. 4.

[276] *Ivi*, pp. 6-8.

even magistrates, but not to forget that they are members of the larger society of mankind, and therefore should feel a real interest in whatever respect general truth, general liberty, and general happiness; and there have lately arisen important situations, which in a most striking manner call for the attention of the friend of the truth, and of the greater interest of mankind; such as, in a manner, compel persons of any enlarged mind, and general benevolence, to look beyond themselves, their own country, and their own times"[277]. Hackney was the last real teaching experience for Priestley even if his final publication on education was written when he had already moved to America, when President Thomas Jefferson[278] had sought his advice on founding a University of Virginia[279]. Jefferson was very impressed by Priestley's works and cultural power and wrote him that his was "one of the few lives precious to mankind, and for the continuance of which every man is solicitous"[280].

The XIX century has been a time of important scientific discoveries and of deep change in the way we look at the world. By the end of that century, "the methods of science had pervaded the

---

[277] *Ivi*, pp. 13-14.

[278] Priestley, Joseph. *Hints Concerning Public Education*. Letter from Priestley to Jefferson, 8 May 1800, in Chinard, G. (1931) *Correspondence of Jefferson and DuPont de Nemours*, John Hopkins University Press, pp. 16-18.

[279] Letter from Jefferson to Priestley. 18 January. 1800. Library, Congress. Mss., Jefferson Paper, pp. 95-99.

[280] Letter from Thomas Jefferson to Joseph Priestley, 21 March 1801.

world to produce a new way of thinking a new power to understand and to control the forces of nature"[281]. The fundamental changes that took place in the educational system during the XIX century were the gradual but unrelenting infusion of the sciences and of other modern studies in the curriculum at all levels, and the gradual but certain diminishing of the studies of the classical languages. "The debate about science and classical studies had different level of debate. The reformers claimed that there were urgent questions that citizens in the XIX century faced that were not being addressed in classical education to equip them for the age in which they lived in. Modern citizens needed experience with those things that would help them in the realities of the present world - a world that was being increasingly dominated by scientific discovery and technological development"[282].

Those who sponsored the "modern" education also claimed that it would have prevented the passive acceptance of authority and that it would have developed an independent judgment. But some classicists saw the study of science as narrowing the mind and they claimed that the purposes of liberal education were the development of one's intellectual faculties.

---

[281] DeBoer, George E. (1991) *A history of ideas in science education,* Teacher College Press, p. 1.

[282] *Ivi*, p. 3.

For Priestley "knowledge was a light and a guide, a right and a weapon"[283], his strong will to deliver public lectures to produce books stemmed from his belief that it was essential to educate the literate public at large, on many disparate topics. Education was the all-important key that would open the door to understanding, which would, in turn, lead to an improved society. Along with other dissenters and liberal educationalists, such as Day and the Edgeworths, Joseph Priestley strongly opposed to education being a function of the state[284]. He feared that there was a danger if the state would use this apparatus to promote uniformity of thought, suppressing free enquiry. Priestley was one of the first tutors to teach experimental science to schoolchildren and his pivotal role as a public figure and author helped the diffusion of his educational ideas. He introduced new teaching styles, produced wall charts as visual aids and had his lectures printed for the benefit of his pupils.

The analysis of Joseph Priestley's life and works demonstrates his deep commitment as a teacher and his great contribution to educational reform in XVIII century[285]. Perfectly fitting in the important part played by the Unitarian network in promoting an enlightened education towards the end of the XVIII century,

---

[283] Uglow, Jenny (2002) *The Lunar Men. The friends who made the future 1730-1810*, cit., p. 71.

[284] Priestley, Joseph (1765) *An Essay on a Course of Liberal Education for Civil and Active Life,* cit., Appendix.

[285] De Berg, Kevin C. (2011) *Joseph Priestley across theology, education and chemistry: an interdisciplinary case study in epistemology with a focus on the science education context*, cit., pp. 805-830.

Priestley's aim in life was then to bring about the cultural and intellectual enlightenment in England, which would improve the life of all people, even the lower social orders, and make them better, more perfect, more God-fearing, citizens. All this could only be achieved through education.

## 7 - Scientific citizenship in the Knowledge society: a lesson of modernity from the Enlightenment

In this final section of my work I would like to draw a lesson of modernity from the historical case I have built in the previous chapters to directly reflect about science education, communication and citizenship.

We have long overcome the "naïve certainty" that *the better you know science, the more you love it*[286]. Rather than on knowing, in the STS researches we are now focused on the attitude and critical spirit towards science and technology. You don't have to love science and agree with everything you are told. The very idea of having a liberal attitude is that you can question it, and eventually make up your mind on a evidence and informed base analysis. Following the idea that *the better you know science, the better you make your choice* science communication becomes a huge and growing social need. In fact, it can be considered one of the founding factors of the modern concept of democracy[287]. Science, thus, plays an important role in the citizen curriculum[288] and without its contribution the very idea of citizenship is incomplete. Many responsibilities of today's pupils

---

[286] Greco, Pietro (2008) *The better you know science, the better you make your choice. The need for a scientific citizenship in the era of knowledge*, Jcom, n.7 (3), pp. 1-2.

[287] *Ibidem*.

[288] Wellington, Jerry (2003) *Science Education for Citizenship and a Sustainable Future*, Pastoral Care in Education, Volume 21, Number 3, pp. 13-18.

as future citizens stem from the key ideas of science, and its formal and informal communication is today a sheer necessity[289].

We want to build knowledge as part of the goal of producing informed and aware citizens, we want **to promote skills of inquiry** and communication and engage everyone **to take action responsibly. The tremendous liberatory power that science offers** is a "combination of the excitement and thrill that comes from the ability to discover new knowledge, and the tremendous insights and understanding of the material world that it provides"[290].

It has been widely argued that contemporary society requires people "who have a better understanding of the working of science enabling them to engage in a critical dialogue about such issue and arrive at considered decisions about the political and moral dilemmas posed by science"[291]. But Dewey and many others have gone further and, in the footsteps of the ideas of the Lunar society, they all believe that science enables people of a critical dialogue about any issue and a scientific, rational approach to any matter of life could allow every citizen to arrive at considered decisions about dilemmas. Science education should rest on scientific contents and

---

[289] D. Cheng et all. (ed.), *Communication Science in Social Contexts*, Springer 2008, p. 3.

[290] Jonathan F. Osborn, *Science for Citizenship*, in *Good practice in science teaching: what research has to say*, Open University Press, 2000, p. 126.

[291] *Ivi*, p. 127.

the social contexts, but should also highlight the scientific approach to inquiry and historical and philosophical elements.

The idea of scientific literacy sees science as "an extension of the quest for reading, writing and numeracy"[292]. The OECD (2003) PISA study directly suggests that scientific literacy is "the capacity to use scientific knowledge, to identify questions and to draw evidence-base conclusions in order to understand and help make decisions about the natural world and the changes made to it through human activity"[293]. So, we commonly refer to scientific literacy as indicating the level of knowledge of science and its methodology that an adult should have to be considered an informed citizen that can actively find and analyse scientifically relevant information, make up an opinion about them and discuss his view. But it is hard to believe that the general population can have such a detailed scientific knowledge across the wide range of disciplines and themes. Then, instead of talking about scientific literacy we should refer to **scientific awareness**, "an understating of what the scientific enterprise is about, what a scientist means by the word "theory" and what is meant to establish a scientific

---

292 Bauer, Martin (2009) *The evolution of Public Understating of Science. Discourse and Comparative Evidence*, Science, Technology and Society, vol. 14 (2), pp. 221-240.

293 *The Pisa 2003 assessment framework* published by the Organisation for Economic co-operation and development.

fact"[294]. In the everyday world being *scientifically literate* (and aware) doesn't mean you have to do well on a test and prove your knowledge in a quiz, but "it means knowledgeably participating in and contributing to worldly affairs where scientific literacy is required"[295].

This is very similar to Priestley's idea of "truly liberal" and practical education: everyone should be able to "base their opinion on facts and observable evidence rather than prejudice and assumptions; they should be willing to change their opinions based on new evidence, understand cause and effect relationships, and appreciate how science is done - in particular understand the role played by observation and experiment in establishing a scientific conclusion, and they should know what the terms "scientific theory" and "scientific fact" mean"[296].

Science communication studies have been trying for decades to overcome the view of science as an interactive duality between a voice "that knows" and a voice "that does not know"[297]. First the passage from a top down to a two way approach, and then the call for dialogue are steps towards the change of this dualistic view of

---

[294] Devlin, Keith (1998) *Rather than scientific literacy, colleges should teach scientific awareness*, A. J. Phys., 66 (7), p. 559.

[295] van Eijck, Michiel & Roth, Wolff-Michael (2010) *Theorising scientific literacy in the wild*, Educational Research Review, vol. 5, issue 5, p. 185.

[296] Devlin, Keith (1998) *Rather than scientific literacy, colleges should teach scientific awareness*, cit., p. 559.

[297] Latour, Bruno (1987) *Science in action*, Harvard University Press, p. 7.

science knowledge ownership. What is sure is that when we deal with science education for the young generations we are dealing with the voice "that does not know yet", and comes to know science in the first instance in schools[298]. And that is where we need to start to foster science citizenship.

Science education has two main purposes: to foster a future population of scientific literate citizens and, secondly, to inspire young students to undertake scientific studies. These ideas underpin science communication events as well as more formal activities. In the *Glasgow Science Centre* manifesto, for example, we read that "a nation whose citizens are interested and educated in science and technology is more prosperous, more successful and has a brighter future. Science drives innovation and economic performance. **It equips the population with ways to make rational judgements, become questioning consumers and responsible citizens**". More and more museums, science centres and other informal education experiences play a leading role in transforming the relationship with science and technology. Most of the institutions involved in science communication activities know their role has become ever more important as science and technology shape our lives and world. The same happens in the field formal education. The aim is to promote active citizenship informed by the world of

[298] Segal, Gilda (1997) *Towards a Pragmatic Science in Schools*, Research in Science Education, 27 (2), pp. 289-307.

science and technology, inspire lifelong appreciation of the importance and impact of science and engineering, encourage young people of all backgrounds to explore and develop their interests in understanding the natural and human-made world[299].

We (meaning science communicators and educators today) might not know it, but we share with Priestley and the Lunar Society of Birmingham this awareness that **science is an indispensable tool for understanding the world,** and that **becoming informed citizen enriches people's lives**. In the age of steam these ideas could not apply to everyone (women and poor were still largely excluded, for example) but today, with the broadening of the concept of citizenship, each one of us must have "a solid base in the understanding of, and appreciation for, scientific concepts and their essential role in the betterment of humankind"[300]. **Science, education, citizenship and democracy are our key words and they have been deeply interwoven, since the XVIII century.**

*A lesson of modernity*

If I had to pick **two essential features of the Enlightenment** - Scottish, French, or English - I would chose **its demand that we think for ourselves** and **its social virtue of tolerance**. As

[299] From the mission of the *Museum of Science*, Boston.

[300] From the mission of the *Aspen Science Centre*.

remarked my Robert Darnton the Eighteenth century is full of civic lessons[301], and indeed the work of many of the Lunar Men is full of this civic spirit, including the educational ones. It was in the Enlightenment that knowledge started to be a crucial element in democracy: "the standards of human rights developed in the Enlightenment and proclaimed in the founding charters of democracy, notably the American Declaration of Independence and the French Declaration of the Rights of Man and of the Citizen"[302]. No wonder that the radical Enlightenment, of which Priestley can be easily recognised to be one of the most important thinkers, is "now widely seen as the current of thought (and eventually political action) that payed the primary role in grounding the egalitarian and democratic core values and ideals of the modern world"[303].

The "enlightened-lunar" spirits shines in those achievements indirectly, and Thomas Jefferson himself owes a great intellectual debt to two Lunar Men, first William Small, his teacher and mentor, then to Joseph Priestley himself, to whom he turned to have educational advice when Priestley had moved to America. According to John Dewey, Jefferson was "the first modern to state

---

[301] Darnton, Robert (2003) *George Washington's False Teeth. An unconventional guide to the Eighteenth century*, W. W. Norton & Company, p. X.

[302] *Ivi*, p. 16.

[303] Israel, Jonathan (2010) *A revolution of the mind. Radical Enlightenment and the Intellectual origins of Modern Democracy*, cit., p. vii.

in human terms the principles of democracy"[304] and the Jeffersonian idea of happiness embodied in the American Declaration of Independence was born in an era where for the first time Technology seemed to bring happiness and richness[305]: science was giving new hope to people and it would have become a leading force in the building of the American dream.

Benjamin Franklin, a even earlier Lunar "honorary member", embodied in full the lunar spirit as he constructed his whole career on **pragmatic wisdom**. In a letter to Priestley he says how scientific reasoning could be helpful in everyday life, in particular "the Weight of Reason"[306] in considering pros and cons. Franklin's "experimental pragmatism à la Bacon is what integrates his scientific, moral an political views and programs", to him, whom Jefferson described as the father of American philosophy[307], "philosophy" meant at once the physical sciences and the moral sciences[308]. The American Enlightenment is "characterised in its thoughts by its profound attachment to experimental empiricism and its equally profound attachment to the humanistic ideal of the

[304] Dewey, John (1939) *Freedom and Culture,* Putnam, p. 155.

[305] Darnton, Robert (2003) *George Washington's False Teeth. An unconventional guide to the Eighteenth century*, cit., p. 102.

[306] Benjamin Franklin to Joseph Priestley, London Sept 19, 1772 in Smyth Albert Henry (ed.) (1905-07) *The writings of Benjamin Franklin*, The Macmillan Company, vol. V, pp. 437-438.

[307] Thomas Jefferson to Jonathan Williams, Monticello, July 3, 1796 in Ford Paul L. (ed.) (1904-05) *The Writings of Thomas Jefferson*, Federal Edition, vol. VII, p. 87.

[308] Koch, Adrienne (1961) *Pragmatic Wisdom and American Enlightenment*, William and Mary Quarterly vol. 18, No. 3, pp. 313-329.

whole man, whose knowledge is not fragmented, not fragmentary, but moral or ethical in its concern for man and his world"[309]. This American pragmatic liberal temper is somehow a Lunar child, and I will claim that that wisdom shines in the core of John Dewey's ideas, especially in his *Democracy and Education*[310].

Today there is still a lot of discussion on the necessity and modes of scientific education but this debate has been going on for centuries. In this work I believe we can trace some inspiration to support modern claims on the importance of **a pragmatic and interdisciplinary science education** especially if we assume that scientific and technological literacy (STL) is expected to indicate and ability to function, or the potentiality to do so, within society"[311] and to support the development of an informed and aware citizenship.

Reading any STS study of the last decade we read about this novelty of science being the centre of many activities in everyday life, the necessity for people to understand and engage with science and technology, the call for scientists to communicate and the duty for governments to foster science formal and informal education.

---

[309] *Ibidem.*

[310] Dewey, John (1916) *Democracy and Education: An Introduction to the Philosophy of Education*, Macmillan.

[311] Holbrook, Jack & Rannikmae, Miia (2007) *The nature of science education for enhancing scientific literacy*, International Journal of Science Education, vol. 29, n. 11, 3 Sept 27 (2), pp. 1347-1362.

These things are, of course, all true. I will just claim that this is nothing really new or specific of our era, and that in the experience of the Lunar Society I see the same necessities, calls and duties.

I wanted to follow Darnton's advice, and take a lesson from the Eighteenth century, a lesson concerning their **pragmatic attitude towards science, education and citizenship**. I explored the documents that at the time (and in the following decades) were discussing the importance of education (in particular science education) for the development of democracy and society, and I found very interesting parallelisms with the present discussion on the very same issues. Many of the writings I have studied are actual calls for action made by scientists whose wish is that people realise the importance of having a sound scientific knowledge and, even more importantly, a sound scientific attitude and critical predisposition towards life. Something very similar to what many modern institutions, communicators, educators and scientists (just like Carlo Alberto Redi[312]) are still doing today.

Towards the end of the XIX century Youmans claimed that the idea of higher education demanded by that present age "while it represents the present state of knowledge, and affords a various cultivation and an harmonious discipline, shall at the same time best prepare for the responsible work of life. For this, the study of

[312] Redi, Carlo Alberto (2011) *Il biologo furioso. Provocazioni d'autore tra scienza e politica*, cit.

languages and mathematics is necessary, but far from sufficient. Other sciences are to be supplied and a curriculum framed, which, conforming to the true logical order of subjects on the other hand, shall equally conform to the order of unfolding the mental faculties on the other, thus reaching an integral discipline through living and applicable knowledge"[313]. Priestley would have agreed with Youmans and so would have with Tyndall when he claimed that as a means of intellectual culture, the study of Physics (or any other science for what mattered) "exercises and sharpens observation: it brings the most exhaustive logic into play: it compares abstracts, and generalises, and provides a mental imagery admirably suited to these proposes"[314]. Science for the Lunar Men, and for many men after them, was not only a matter of new discoveries of law of nature, it was an educational experience in many different ways.

Interestingly enough, I can trace these same ideas in the works and ideas of a great American philosopher and educator, John Dewey. As it was for the Lunar Men, for Dewey science has a social importance, and being a fundamental tool for social transformation, he also highlights the great importance of a major educational change that could built a new modern, industrial and scientific

---

[313] Youmans, Y. E. (1873) *On mental discipline in education*, In *The culture demanded by modern life: a series of addresses and arguments on the claims of scientific education*, Appleton and Company, p. 25.

[314] Tyndall, John (1873) *On the Study of Physics* (A lecture delivered at the Royal Institution of Great Britain), in *The culture demanded by modern life: a series of addresses and arguments on the claims of scientific education*, Appleton and Company, p. 74.

culture[315]. According to Dewey ethics, pedagogy and philosophy (in just one word, *culture*) fall behind the evolution of the scientific thought and a great cultural and moral reform is in order, inspired by scientific method and teachings[316].

One could be very surprised to read *The Public and its Problems*, a book Dewey published in 1927, and to find it incredibly full of modern ideas. In several parts of this work Dewey hints that healthy democratic communities are informed in the fullest possible measure by their entire membership, all members are enabled to speak and are listened to. To retain this concept in the preface to the second edition, in 1946, he presents this social ideas of democracy expressing an interesting point of view for my discussion of science citizenship. He introduces the public debate about the war-use of atomic fission and claims that this issue has moved a lot of discussion on the control on science and its outcomes and that it should be framed within a social discussion[317]. Every citizen is then entitled with an opinion and should be able to express it. This idea of science citizenship is very similar to what we have been discussing since the first chapter of this work, and to what still underpins modern science communication efforts.

---

[315] Alcaro, Mario (1997) *John Dewey. Scienza Prassi Democrazia,* Laterza, p. 134.

[316] *Ivi*, p. 135.

[317] Dewey, John (1927) *The Public and its Problems,* Holt.

According to Dewey **the true cause of all evil lays in the persistence of prescientific belief and behaviours**[318]. Science and Technology have been, are and always will be revolutionary elements in society especially as they provide a powerful intellectual tool for democracy[319]and, for Dewey, **science is social intelligence in action** and it is necessary to completely accept scientific method not only in technology, but in life[320]. This idea is still at the very core of the reasons why we do science communication in the first place and the people responsible for the promotion of knowledge (aware or not) are promoting this idea with their activities.

As I have stated at the introduction of this work, the men of letters of the Enlightenment were strongly connected with society and in Dewey's work we see how he sees three-fold public responsibilities of intellectuals: 1) to identify and maintain citizens' foci on the concrete problems that define publics, thereby facilitating the bringing of publics into being and maintaining them as long as they continue to be useful for solving such problems; 2) to aid in the creation of experimental methods whereby social intelligence and resources might be better directed to those problems' resolutions;

---

[318] Alcaro, Mario (1997) *John Dewey. Scienza Prassi Democrazia,* cit., p. 151.

[319] Dewey, John (1946) *Problems of men*, Philosophical Library cit. in Alcaro, Mario (1997) *John Dewey. Scienza Prassi Democrazia,* cit., p. 153.

[320] *Ibidem.*

and 3) to bring publics to self awareness through the redirection of traditional cultural symbols and the forging of new ones so as to create shared meanings and feelings of common interest[321].

For almost four decades Dewey has confronted his ideas with another great philosopher of his time, Bertrand Russell. Among those of many others, I found in Russell's work a strong idea that links him to Dewey, Priestley and to other enlightened minds of the Lunar Society. Among the greatest improvements **science has brought to society, he sees the denial of an authoritarian principle**, the **fostering of a free and liberal thinking,** and **the need to base every theory on empirical experiences**[322].

In the ideas of Priestley, Dewey, and Russell science education deals with **the attribution of epistemic authority**, but of course it is so much more than just that. It is in science education and communication activities that scientific images are negotiated even if this process is sometimes overlooked by historians and sociologists of science[323].

We share today with these great thinkers the idea that at the heart of science there is the process of enquiry, the method of scientific reasoning. And the application of this type of reasoning is not only

---

321 Stikkers, Kenneth W. (2010) *John Dewey on the Public Responsibility of Intellectuals*, Etica & Politica/Ethics & Politics, XII, 1, pp. 195-196.

322 Russell, Bertrand (2005) *L'impatto della scienza sulla società,* Newton&Compton, pp. 9-10.

323 Rudolph, John L. (2003) *Portraying epistemology: school science in historical context*, Science Education, vol. 8, issue 1, pp. 64-79.

limited to scientific matters, but it represents "the only method of thinking that has proven fruitful in any subject"[324]. Science, as a means of mental discipline, also has great advantage, "in the *incentives* to which it appears from arousing mental activity, its motives to effort being such as the pupil can be made most readily to appreciate and feel"[325].

In accordance with Dewey's thoughts a renown scientist and educator like Joseph Schwab also proclaimed the importance of enquiry, methods and critical thinking and he also claimed that the real authority of science consisted "not in possession of information but in possession of competence in enquiry"[326].

In Priestley theories and practice in education and communication, in Dewey's and Russell's works we see a strong believe that **the tacit social and moral aim of (practical) science education and communication lies in fostering a better informed and engaged citizenship**. And this goes beyond all the other reasons to promote science communication and to reform education. Inquiry is at the very core of it all. Some modern authors stress how "few things in science education are as popular these days as

[324] Dewey, John (1910) *Science as a subject-matter and as a method*, Science, 31: 787, p. 127.

[325] Youmans, Y. E. (1873) *On mental discipline in education.*, cit., p. 50.

[326] Schawb, Joseph (1962) *The teaching of science as enquiry*, in P. F. Brandwein (ed.) The teaching of science, Harvard University Press, p. 48.

inquiry"[327], and, in fact, in science formal and informal teaching there has been, in the Anglo-Saxon educational systems more than in the Italian one, as well as in the field of science communication (the great variety of hands-on activities in science centres and festivals, for example) a rush to inquiry.

Many have argued that people involvement in manipulation, representation and discussion is path to meaningful science learning[328] and that **inquiry-oriented activities built a positive sense of ownership towards knowledge**[329].

I am very interested in the idea that modern inquiry-based activities focus on one hand on the cognitive goals similar to those in the established scientific disciplines and, on the other hand, they have more and more technologically oriented elements.

If scientific issues are presented just as a "mock" version of "the real thing", where students have just to repeat (even if in a very immersive and dialogic way) an experience/experiment, the risk is

---

327 Rudolph, John L. (2005) *Inquiry, Instrumentalism, and the Public Understanding of Science*, Science Education, vol. 89, No. 5, pp. 803-821.

328 Barron, B. J. S., Schwartz, D. L., Vye, N. J., Moore, A., Petrosino, A., Zech, L., Bransford, J. D. & the Cognition and Technology Group at Vanderbilt (1998) *Doing with understanding: Lessons from research on problem and project-based learning*, Journal of the Learning Sciences, vol. 7, pp. 271-311; Lehrer, R. & Schauble, L. (2002) *Investigating real data in the classroom: Expanding children's understanding of math and science,* Teachers College Press; Schneider, R. M., Krajcik, J., Marx, R. W. & Soloway, E. (2002) *Performance of students in project-based science classrooms on a national measure of science achievement,* Journal of Research in Science Teaching, 39, pp. 410-422; White, B. Y., & Frederikson, J. R. (1998) *Inquiry, modeling, and metacognition: Making science accessible to all students. Cognition and Instruction*, 16, pp. 3-118.

329 Rudolph, John L. (2005) *Inquiry, Instrumentalism, and the Public Understanding of Science*, cit., p. 804; Bransford, J. D., Brown, A. L., & Cocking, R. R. (eds.) (1999) *How people learn: Brain, mind, experience, and school*, National Academies Press; Carpenter, T. P., & Lehrer, R. (1999) *Teaching and learning mathematics with understanding*, in E. Fennema & T. A. Romberg (eds.), *Mathematics classrooms that promote understanding,* Lawrence Erlbaum, pp. 19-32.

to provide them with an idea of science as the search of durable knowledge and not to expose them to the complex social and epistemic knowledge negotiations that should be central in the learning experience. The same goes for informal educational experiences and communication activities.

Just like Priestley preached, educational experiences should be oriented to promote the desire of more knowledge, challenging people to look for answer and, more importantly, pushing them to learn how to ask questions. The attitude toward science, technology (and knowledge in general) that I have highlighted throughout this work is, in fact, easy summed up in few words: **to think instrumentally**. Science and culture, or better, science as a part of ONE culture, is first of all a tool. In the "lunar" attitude, just like in the pragmatic ones, ideas are instruments. The recovery of Priestley's and Dewey's ideas and attitudes give us a chance to build an interesting framework where we can think about science, education, communication and citizenship today. This opens up for **greater democratic participation and ownership of knowledge of scientific and technological issues**[330].

The call we can hear from the voices of the Enlightenment and the modern STS researches embraces a multifold change in the way we can foster the building of scientific citizenship. Beyond the

[330] Rudolph, John L. (2005) *Inquiry, Instrumentalism, and the Public Understanding of Science*, cit., p. 812.

widespread argument of continuing in sponsoring more and more science communication activities, this aim must be achieved primarily in schools. A recontextualization of inquiry along with the historical, philosophical and social elements of science and technology in the curricula is in order "to bring about student understating of the instrumental nature of knowledge in the Deweyan sense"[331]. Ideally, this public input will flow in society and will be reiterated by the science communication activities for the general public. Formal education is the first step in a continue path of informal knowledge building experiences that every citizen will encounter in his life. And along the line this attitude will spread and, eventually, embrace policies.

Science education should provide a solid base to build scientific citizenship, and science communication should act as a continuos reinforcement and information source for citizens. And they both should be first of all what science is eventually all about: a way to engage people and tickle curiosity about the wonders of the world we live in. An endeavour full of new and exciting questions, and eventually some mind-blowing answers.

For what concerns informal outreach events I am going to claim that one of the biggest challenge lays in the 'preaching to the

[331] *Ivi*, p. 815.

converted' situations[332]. The potential for science outreach activities to attract audiences that would not otherwise be available to practitioners is the key to a better and larger ST engagement. Science communicators, in fact, deal mostly with members of the "attentive" and "interested" publics but there are some outreach activities that could be excellent opportunities to "preach to the converted", i.e., "to reach a less attentive public that just happens to be in the 'right' social setting, but which otherwise would be very difficult to reach through other means"[333].

"The converted", i.e. the attentive and the interested publics, that would normally attending outreach events, follow scientific news on different media, might bring with them a number of "less converted" and in an almost viral way they could become the key to get to those audiences. The latter are people that constitute the most relevant target group for outreach activities and science communication, they are the real challenge. One of the best social setting for the 'preaching to the converted' situations are museums/ exhibitions, but new media and social networks are just as strong vehicles. People with less interests than the general average would find themselves more exposed to ST issues because they are

---

[332] Entradas, Marta, Miller, Steve & Peters, Hans Peter (2011) *Preaching to the converted? An analysis of the UK public for space exploratio*n, Public Understanding of Science, online 26 July.

[333] Entradas, Marta (2011) *Who's for the Planet, An analysis of the "Public space for exploration" and views of practitioners of science communication on "their publics" and public communication in the UK,* PhD thesis, UCL.

somehow connected to "converted" individuals. They can be more easily exposed to elements they would not look into themselves and in a "republic.com"[334] internet usage this could be a very interesting issue to analyse. It is basically what Priestley used to do with his students and his families when he welcomed them to his classroom and invited them to perform experiments together and engage the "less converted" through his "converted" pupils[335].

This effort Priestley made to 'preach to the converted' gives me an opportunity to move back to the other major issue I have looked in this work, formal education. The question we might ask now is: what kind of science education can prepare students for the kind of scientific literacy necessary for responsible citizenship? Scholars have been talking about this for decades, and those who have the responsibility to decide the school curricula have a lot to discuss about. I am not going to enter in this vast debate, I would just highlight the perspective of the Lunar Society's ideas and experience and of John Dewey's ideas.

I have shown how they were, very modernly, stating that we must make sure that educational goals include socio-scientific decision-making and scientific problem-solving skills. Just like it was in the XVIII century, education today is a need to acquire social skills,

[334] Susnstein, C. (2003) *Republic.com Cittadini informati o consumatori di informazioni?* Il Mulino.

[335] Gibbs, F. W. (1965) *Joseph Priestley. Adventurer in science and champion of truth,* cit., p. 14.

supported by individual skills enabling people to play a responsible role within society. "School science education needs to respond to a changed social context and to help prepare the young people to contribute as citizens to shaping the world in which they will live"[336].

*A "truly liberal" practical education today. Science education for Digital natives*

In this work I have followed "a genuinely experimental empiricism"[337] perspective from the Lunar ideas, to Dewey, to modern approaches. The educational importance of practical, hands-on experiences has been declared for centuries and as Thomas H. Huxley said "however good lectures may be, and however extensive the course of reading by which they are followed up, they are but accessories to the great instrument of scientific teaching - demonstration"[338]. Teach instrumentally and think instrumentally. Taking the Lunar and Deweyan ideas and trying to put them in a present framework, I believe a key step to boost

---

[336] Jenkins, E. (1999) *School science, citizenship and the public understanding of science,* International Journal of Science Education, vol. 21, pp. 703-710.

[337] Dewey, John (1929) *The Quest For Certainty*, Minton Balch And Company, p. 111.

[338] Huxley, Thomas H. (1873) *On the study of zoology* (A lecture delivered before the science classes at the South Kensington Museum), in *The culture demanded by modern life: a series of addresses and arguments on the claims of scientific education*, Appleton and Company, p. 137.

science education today has to do with **the integration between teaching methodology and new technologies.**

One of the most important things to overcome in teaching is the duality between *ready made science* and *science in the making*[339]. Traditionally the first is taught in school and also presented in science communication activities, while the second (including technology, in a broad sense) is almost exclusively left to informal education and hardly find its way in the classrooms.

We can not even start to talk about science literacy or awareness if we do not consider that we are dealing with different young people. Teaching must adapt to the digital natives' needs and technology must be a part of the pedagogical change. This allows education to be reconceptualised as education in pragmatic science, and that could even help to overcome the alienation from science[340].

Many agree that new technologies (and old ones, as well) applied in science education activities (formal and informal) empower the student (and the citizen) to grasp the knowledge with their own hands[341]. The out-of-classroom environment is rich in media, in communication and in creative opportunities, and if students are not given a chance to take it all to the in-classroom environment

---

[339] Latour, Bruno (1987) *Science in action*, cit., p. 13.

[340] Segal, Gilda (1997) *Towards a Pragmatic Science in Schools*, cit., pp. 289-307.

[341] Ferri, Paolo (2011) *Nativi digitali*, Bruno Mondadori; Ferri, Paolo & Mantovani, Susanna (2008) *Digital kids. Come i bambini usano il computer e come potrebbero usarlo genitori e insegnanti*, Etas.

their educative experience could be very dry. All the students today are digital natives[342], and we need to consider this status when planning educational activities. If there is something they will surely be good at is the use of technology, and this same something could be a way to engage them with scientific issues allowing them to add creative components[343].

“Long before they ever get to school, kids have seen a tremendous amount of the world. They’ve watched wars in far-off countries and explorations of distant planets. They’ve seen wild animals up close. They’ve simulated racing, flying, and running businesses. Many have taught themselves to read through the electronic games they play. The world is no longer a dark, unknown place for today’s school kids. Kids are not intellectually empty. Even though some of what they know may be incomplete, biased, or wrong, they arrive at school full of knowledge, thoughts, ideas, and opinions about their world and their universe”[344]. School used to be the real beginning of one’s personal “enlightenment”[345] but today most children have many opportunities to get to know the world very soon, and that is mainly thanks to the great amount of powerful technologies they

---

[342] Prensky, Marc (2001) *Digital Natives, Digital Immigrants*, On the Horizon, vol. 9, Is:5, pp. 1-6.

[343] Prensky, Marc (2005) *Engage me or enrage me*, Educause review, Sept/Oct, p. 62.

[344] Prensky, Marc (2008) *Turning on the lights,* Reaching the Reluctant Learner, Volume 65, Number 6, pp. 40-45.

[345] *Ibidem.*

can master so easily and so quickly. They grow up with already a lot of "lights", literarily thinking of how many screens they get to use everyday (TV, Pc, Nintendo's, Xbox, Playstation, iPad, iPod, iPhone...), but also metaphorically. Since they were babies they are connected around the clock: they were born "to be wired".

The role of educators is to use, build on, and strengthen students' reservoirs of knowledge and skills. Thus they need to adapt to new knowledge and skills these students have today. Kids can use "their connections to the light" to find information quickly, to structure it in new ways, and to communicate with peers around the world in a powerful, 21st-century learning process[346]. What they need is not someone who only is a provider of information, they need explainers, context providers, meaning makers, and evaluators of information. Educators' role is all in this mission.

If we decide that all the lights that surround kids are somehow *detrimental* to their education we are just going to power them down, "they leave behind the intellectual light of their everyday lives and walk into the darkness of the old-fashioned classroom"[347]. We are powering them down physically and intellectually.

Using a very appropriate and Victorian metaphor by Andrew Rasiej, in education we are still "counting horses", while the world has

---

[346] *Ibidem.*

[347] *Ibidem.*

moved on to “counting locomotives”. Why are news tools not an important part of the education process? As a matter of fact new technologies provide teachers and educators a wide range of incredible opportunities to enhance their activities and not only make teaching methods up-to-date and easy to deliver, but also more effective and engaging.

We need to give students the opportunity to use technology in school and find out what/how students want/need to be taught. We have new great tools in our hands, new apparatuses, as Priestley would have said. We will hardly need to teach how to use them (meaning how to operate them), but we will surely will need to guide them on how to use them (meaning how to make a good use and get the best out of them).

Scholars studying the new media-education relationship, like Marc Prensky, are promoting a change in paradigms, from “being taught” to “learning on your own with guidance”. It all sounds like what Priestley said, only now we have new media, new subjects, new contents and a very different society. Like in the Enlightenment, and in every other era, education is about getting prepared for the future. And the future of this generation must start for a liberal, practical and technological education.

I believe the historical researches I have performed and the philosophical reflections I have carried out are relevant in the modern pedagogical framework because the most important changes required to educators are not technological, but rather conceptual.

Priestley thought a lot about what education ought to be, he worked to built a new curriculum where his students could experiment and acquire meaningful, worthwhile, and relevant skills for their future. Back in the XVIII century the future was made of steal and steam, now it's wireless. Still, the actual trends in formal and informal science education prove how practice is still a fundamental element of learning and engaging experience. It is *learning by doing* all over again. With a touch screen instead of an air pump.

**REFERENCES**


Aikenhead, G.S. (1994) *What is STS science teaching?*, in Solomon, J. & G. Aikenhead (eds.), STS Education: International Perspectives in Reform, Teacher's College Press.

Aikenhead, G.S. (2003) *STS Education: a rose by any other name*, in A Vision for Science Education: Responding to the world of Peter J. Fensham, (ed.), Routledge Press.

Alcaro, Mario (1997) *John Dewey. Scienza Prassi Democrazia,* Laterza.

Alsop S., Bencze L. & Pedretti E. (eds.), (2005) *Analysing Exemplary Science Teaching. Theoretical lenses and a spectrum of possibilities for practice,* Open University Press, Mc Graw-Hill Education.

Alsop, S. & Hicks, K. (eds.) (2001) *Teaching Science*, Kogan Page.

Alsop, S. & Ibrahim, S. (2007) *Searching for Science Motive: Community, Imagery and Agency*, Alberta Science Education Journal Special Edition, Shapiro, B. (ed.) Research and writing in science education of interest to those new in the profession), 38 (2), 17-24.

Alsop, S., & Ibrahim, S. (2008) *Visual journeys in critical place based science education*, in Lee, Y-J. & Tan, A-K. (eds.), *Science education at the nexus of theory and practice*, SensePublishers, pp. 291-303.

Alsop, S., Ibrahim, S. & Blimkie, M. (eds.) (2008) *Science and the city: A Field Zine*, Ontario.

Armytage, W. H. G. (1967-8) *The Lunar Society and its Contribution to Education,* University of Birmingham Historical Journal, vol. 67.

Baldwin, Bird T. (1913) *John Locke's Contribution to Education*, The Sewanee Review, vol. 21, n. 2, April.

Barron, B. J. S., Schwartz, D. L., Vye, N. J., Moore, A., Petrosino, A., Zech, L., Bransford, J. D. & the Cognition and Technology Group at Vanderbilt (1998) *Doing with understanding: Lessons from research on problem and project-based learning*, Journal of the Learning Sciences, vol. 7, pp. 271-311.

Barry, Andrew (2000) *Making the active scientific citizen*, paper presented at the 4S/EASST conference "Technoscience, citizenship and culture", University of Vienna, 28-30 Sept.

Baugh, Albert C. & Cable, Thomas (1993) *A history of English Language*, Routledge & Kegan Pau, 4th edition.

Bauer, Martin (2009) *The evolution of Public Understating of Science. Discourse and Comparative Evidence*, Science, Technology and Society, vol. 14 (2), pp. 221-240.

Bauer, M., Allum N. & Miller S. (2007) *What can we learn from 25 years of PUS survey research? Liberating and expanding the agenda,* Public Understanding of Science*,* vol. 16 (1): 79-95.

Beale, Norman (2008) *Joseph Priestley in Calne*, The Hobnob Press.

Bertilsson, Margareta & Elam, Mark (2002) *Consuming, Engaging and Confronting Science: the emerging dimension of Scientific Citizenship,* Science, Technology and Governance, Discussion paper One, March.

Bingle, W. & Gaskell, P. (1994) *Science literacy for decision making and the social construction of scientific knowledge,* Science Education, 78 (2): pp. 185–201.

Boantza, Victor D. (2007) *Collecting airs and ideas: Priestley's style of experimental reasoning*, Studies in History and Philosophy of Science, vol. 38, pp. 506-522.

Bransford, J. D., Brown, A. L., & Cocking, R. R. (eds.) (1999) *How people learn: Brain, mind, experience, and school*, National Academies Press.

Briggs, Asa (2000) *The age of improvement, 1783-1867*, Longman, 2nd edition.

Broadie, Alexandre (2001) *The Scottish Enlightenment, The Historical Age of the Historical Nation,* Birlinn.

Bodmer, W., F. (1985) *The Public Understanding of Science*, The Royal Society.

Burns, William E. (2003) *Science in the enlightenment, an encyclopedia*, ABC Clio.

Cambi, Franco & Striano, Franca (eds.) (2010) *John Dewey in Italia*, Liguori Editore.

Carpenter, T. P., & Lehrer, R. (1999) *Teaching and learning mathematics with understanding*, in E. Fennema & T. A. Romberg (Eds.), *Mathematics classrooms that promote understanding,* Lawrence Erlbaum, pp. 19-32.

Chang, Hasok (2004) *Inventing Temperature. Measurement and Scientific Progress*, Oxford University Press.

Chang, Hasok (2009) *We have never been Whiggish (about Phlogiston)*, Centaurus, vol. 51, pp. 239-264.

Cheng, D. & al. (ed.) (2008) *Communication Science in Social Contexts*, Springer.

Chinard, G. (1931) *Correspondence of Jefferson and DuPont de Nemours*, John Hopkins University Press.

Clark, Peter (2000) *British clubs and societies 1580-1800 : the origins of an associational world*, Oxford University Press.

Cohen, Michèle (2009) *"Familiar conversation": The role of the 'Familiar Format' in Education in Eighteenth and Nineteenth-Century England, 1760-1800*, in Hilton, Mary and Shefrin, Jill (eds.), *Educating the Child in Enlightenment Britain: Beliefs, Cultures, Practices,* Ashgate.

Craven, Maxwell (1996) *John Whitehurst of Derby: clockmaker & scientist 1713-88*, Mayfield Books.

Crosland, Maurice (1987) *The Image of Science as a Threat: Burke versus Priestley and the "Philosophical revolution"*, BJHS, 20, pp. 277-307.

Dalton, Tom E. (1960) *Channing School 1885-1960,* London.

Darnton, Robert (2003) *George Washington's False Teeth. An unconventional guide to the Eighteenth century*, W. W. Norton & Company.

Darwin, Charles (1958) *The autobiography of Charles Darwin 1809-1882* (With the original omissions restored. Edited and with appendix and notes by his grand-daughter Nora Barlow), Collins.

Darwin, Erasmus (1797) *A plan for the conduct of female education, in boarding schools,* J. Johnson.

Davies, D. Elwyn (1988) *Education and radical dissent in Wales in the 18th and 19th centuries,* TUHS 19:2 pp. 92-101.

Davies, Ian (2004) *Science and citizenship education*, International Journal of Science Education, vol. 26, n. 14, pp. 1751-1763.

DeBoer, George E. (1991) *A history of ideas in science education,* Teacher College Press.

De Berg, Kevin C. (2011) *Joseph Priestley across theology, education and chemistry: an interdisciplinary case study in epistemology with a focus on the science education context*, Science & Education, vol. 20, Numbers 7-8.

Devlin, Keith (1998) *Rather than scientific literacy, colleges should teach scientific awareness*, A. J. Phys., 66 (7).

Dewey, John (1897) *My pedagogical creed*, School Journal, vol. 54, pp. 77-80.

Dewey, John (1902) *The school as a social centre*, The elementary school teacher, vol. III number 2, October.

Dewey, John (1910) *Science as a subject-matter and as a method*, Science, 31:787, p. 127.

Dewey, John (1916) *Democracy and Education: An Introduction to the Philosophy of Education*, Macmillan.

Dewey, John (1927) *The Public and its Problems,* Holt.

Dewey, John (1929) *The Quest For Certainty*, Minton Balch And Company.

Dewey, John (1938) *Experience and Education,* Kappa Delta Pi.

Dewey, John (1939) *Freedom and Culture,* Putnam.

Dewey, John (1946) *Problems of men*, Philosophical Library.

Dolin, Jens, Evans, Robert & Quistgaard, Nana, *Teaching and learning scientific literacy and citizenship in partnership with schools and museums*, SETAC, http://www.museoscienza.org/setac/resources.asp.

Durant, Jon (1993) *What is scientific literacy?* in Jon Durant and Jane Gregory (eds.) Science and Culture in Europe, Science Museum.

Durant, J.R., Evans, G.A., Thomas, G.P. (1989) *The public understanding of science,* Nature, 340, pp. 11–14.

Edgeworth, Richard Lovell (1812) *Essay on Professional Education*, J. Johnson, 2nd ed.

Edgeworth, Richard Lovell (1844) *Memoirs of Richard Lovell Edgeworth*, Richard Bentley.

Edgeworth, Richard Lovell & Edgeworth, Maria (1798) *Practical Education*, J. Johnson.

Einsiedel, Edna (2005) *Editorial: Of Publics and Science*, Public Understanding of Science, vol. 16(1): 5-6.

Elby, Frederick & Arrowood, Charles F. (1934) *The Development of Modern Education*, Prentice Hall.

Emerson, Roger L. (2009) *Essay on David Hume, Medical men and the Scottish Enlightenment*, Ashgate.

Entradas, Marta (2011) *Who's for the Planet, An analysis of the "Public space for exploration" and views of practitioners of science communication on "their publics" and public communication in the UK,* PhD thesis, UCL.

Entradas, Marta, Miller, Steve & Peters, Hans Peter (2011) *Preaching to the converted? An analysis of the UK public for space exploratio*n, Public Understanding of Science, online 26 July.

Faraday, Michael (1873) *On the Education of the judgment* (A lecture delivered at the Royal institution of Great Britain), in *The culture demanded by modern life: a series of addresses and arguments on the claims of scientific education*, Appleton and Company, pp. 185-224.

Fensham, P.J. (1985) *Science for all,* Journal of Curriculum Studies, 17, pp. 415-435.

Fensham, P.J. (1988) *Familiar but different: Some dilemmas and new directions in science education,* in P.J. Fensham(ed.), Developments and dilemmas in science education, Falmer Press, pp. 1–26.

Ferri, Paolo (2011) *Nativi digitali*, Bruno Mondadori.

Ferri, Paolo & Mantovani, Susanna (2008) *Digital kids. Come i bambini usano il computer e come potrebbero usarlo genitori e insegnanti*, Etas.

Ford Paul L. (ed.) (1904-05) *The Writings of Thomas Jefferson*, Federal Edition.

Gailbraith D. (1997) *Analyzing Issues: science, technology, & society*, Trifolium Books. Inc.

Ganter, Herbert L. (1947) *William Small, Jefferson's beloved teacher*, William and Mary College Quarterly, iv 3rd ser., vol. 4, No. 4.

Gaskell, J.P. (1982) *Science, technology and society: Issues for science teachers,* Studies in Science Education*,* 9, pp. 33–36.

Gibbs, F. W. (1965) *Joseph Priestley. Adventurer in science and champion of truth,* Nelson.

Golinsky, Jan (1992) *Science as Public culture*, Cambridge University Press.

Goodman, Joyce & Leach, Camilla (1998) *Catherine Cappe (1774-1822) Unitarian education and women's lives*, Faith and Freedom 51:2, Autumn/Winter, pp. 117-128.

Graham, Jenny (1995) A *hitherto unpublished letter of Joseph Priestley*, Enlightment and Dissent, 14.

Graham, Jenny (1995) *Revolutionary in exile: the emigration of Joseph Priestley to America 1794-1804*, Transactions of the American Philosophical Society, vol. 85, part 2.

Greco, Pietro (2008) *The better you know science, the better you make your choice. The need for a scientific citizenship in the era of knowledge*, Journal of Science Communication, n.7 (3).

Gregory, Alfred (1877) *Robert Raikes: Journalist and Philanthropist: A History of the Origin of Sunday Schools*, Hodder and Stoughton.

Gregory, Jane & Miller, Steve (1998) *Science in Public: Communication, Culture and Credibility,* Plenum.

Griffith, William P. (1983) *Priestley in London*, Notes and records or the Royal Society of London, vol. 38, n. 1, pp. 1-16.

Harrington, Maria C.R. (2009) *An ethnographic comparison of real and virtual reality field trips to Trillium Trail: The salamander find as a Salient Event,* in Freier, N.G. & Kahn, P.H. (eds.), Children, Youth and Environments: Special Issue on Children in Technological Environments, 19 (1).

Harris, J. Henry (1899) *Robert Raikes, The man and his works*, E.P. Dutton & Company.

Harrison, Frederic (1892) *Scientific Correspondence of Joseph Priestley*, New York privately printed.

Harrop, S. (1976) *The place of education in the genesis of the Industrial Revolution with particular reference to Stalybridge, Dukinfield and Hyde*, unpublished M.A. thesis, University of Manchester.

Hart, Ivor B. (1962) *James Watt, pioneer of mechanical power*, Weidenfeld & Nicolson.

Hill, M. D. & Hill, Rowland (1822) *Plans for the Government and Liberal Instruction of Boys in Large Numbers Drawn from Experience*, G. and W. B. Whittaker.

Hill, Rowland & Hill, George Birkbeck (1880) *The Life of Sir Rowland Hill and the Penny Postage*, 2voll, T. De La Rue & Co.

Hodson, D. (1998) *Teaching and Learning Science: Towards a Personalized Approach*, Open University Press.

Hodson, D. (2003) *Time for action: Science education for an alternative future,* International Journal of Science Education, 25 (6): pp. 645–670.

Holbrook, Jack & Rannikmae, Miia (2007) *The nature of science education for enhancing scientific literacy*, International Journal of Science Education, vol. 29, n. 11, 3 Sept 27 (2), pp. 1347-1362.

Homer-Dixon, T. (2001) *The Ingenuity Gap: Can We Solve the Problems of the Future?*, Vintage Canada.

Hugh, Trevor-Roper (2010) *History and the Enlightenment*, Yale University Press.

Hughes, G. (2000) *Marginalization of socio-scientific material in science-technology-society science curricula: some implications for gender inclusivity and curriculum reform*, Journal of Research in Science Teaching, 37 (5), pp. 426–40.

Hull, Gillian (1997) *William Small 1734-1775: no publication, much influence,* Journal of the Royal Society of Medicine, vol. 90.

Hume, David (1836) *Two short Essays [by David Hume?] on the Study of History and on General Reading, etc.*, in Adam (W.) of Blair Adam, Two short Essays, etc. 8º vol.

Huxley, Thomas H. (1873) *On the study of zoology* (A lecture delivered before the science classes at the South Kensington Museum), in The culture demanded by modern life: a series of addresses and arguments on the claims of scientific education, Appleton and Company.

Israel, Jonathan (2010) *A revolution of the mind. Radical Enlightenment and the Intellectual origins of Modern Democracy*, Princeton University Press.

Jenkins, E. (1999) *School science, citizenship and the public understanding of science,* International Journal of Science Education, vol. 21, pp. 703-710.

Keir, James (1868) *Sketch of the life of James Keir, esq., F.R.S.: with a selection from his correspondence,* R.E. Taylor, Printed for private circulation.

King-Hele, Desmond (1977) *Doctor of revolution: the life and genius of Erasmus Darwin*, Faber & Faber.

King-Hele, Desmond (1998) *The 1997 Wilkins Lecture: Erasmus Darwin, the Lunaticks and Evolution*, Notes and Records of the Royal Society of London, vol. 52, n. 1.

King-Hele, Desmond (1999) *Erasmus Darwin: a life of unequalled achievement*, DLM.

Knox, H. M. (1949) *Joseph Priestley's contribution to Educational Thought*, The Journal of the Institute of Education, London. Studies in Education, pp. 82-89.

Koch, Adrienne (1961) *Pragmatic Wisdom and American Enlightenment*, William and Mary Quarterly, vol. 18, No. 3, pp. 313–329.

Kumar, D. & Chubin, D. (2000) *Science Technology and Society: A sourcebook or research and practice*, Kluwer Academic.

Latour, Bruno (1987) *Science in action*, Harvard University Press.

Lawson, John & Silver, Harold (1973) *A social history of education in England*, Methuen.

Lehrer, R. & Schauble, L. (2002) *Investigating real data in the classroom: Expanding children's understanding of math and science,* Teachers College Press.

Liu, Xiufeng (2009) *Beyond science literacy: science and the public*, International Journal of Environmental Science and Education, vol. 4, n. 3, pp. 301-311.

Litchfield, Henrietta E. (1915) *Emma Darwin, A century of family letters, 1792-1896*, 2 voll., John Murray.

Locke, John (1854) *On the Conduct of Understanding*, in *The Works of John Locke. With a Preliminary Essay and Notes by J.A. St. John, Esq*. (2 voll.), H.G. Bohn.

Locke, John (1693) *Some Thoughts Concerning Education*, A. and J. Churchill.

Manson, J.S. (1933) *The Warrington Academy (1757-86) and its influence upon medicine and science*, The British Medical Journal, vol. 1, p. 752.

Marshall, T.H. (1925) *James Watt (1736-1819)*, L. Parsons.

McEvoy, John G. (1984) J*oseph Priestley, Scientist, Philosopher and Divine*, Proceedings of the American Philosophical Society, vol. 128, n.3, pp. 193-199.

McLachlan, Herbert (1931) *English Education under the Test Act,* Manchester University press.

McLachlan, Herbert (1934) *The Unitarian movement in the religious life of England 1. Its contribution to thought and learning 1700-1900,* George Allen & Unwin, pp. 71-161.

Meteyard, Eliza (1865) *The life of Josiah Wedgwood: from his private correspondence and family papers*, Hurst and Blackett.

Millar, Robin (1996) *Towards a science curriculum for public understanding.* School Science Review, vol.77 no. 280: 7-18.

Millar, Robin & Osborne, Jonathan (1998) *Beyond 2000*, King's College.

Miller Jon D. (1998) *The measurement of civil scientific literacy*, Public Understanding of Science, 7, pp. 203-223.

Miller, R. (1996) *Towards as science curriculum for public understanding*, School Science Review, 77 (280): pp. 7018.

Miller, Steve (2008) *So where is the theory? On the relationship between science Communication Practice and research,* in D. Cheng et al. (ed.), *Communication Science in Social Contexts*, Springer.

Mulcaster, Richard (1581) *Position wherein those circumstances are examined for the training of children either for skill in their booke or health in their bodie.*

Mulcaster, Richard (1582) *The elementarie, which entreateth chiefly of the right writing on the English tung.*

O'Brien, Padraig (1989) *Warrington Academy 1757-86: its predecessors and successors,* Wigan.

Osborne, J. (2000) *Science for citizenship*, in Good Practice in Science Teaching, Monk, M. & Osborne, J. (eds.), Open University Press.

Parker, Irene (1914) *Dissenting Academies in England*, Cambridge University Press.

Peck, T. Whitmore P. & Wilkinson, K. Douglas (1950) *William Withering of Birmingham, M.D., F.R.S., F.L.S.,* J. Wright.

Pedretti, E. (1996) *Learning about science, technology and society (STS) through an action research project: co-constructing an issues based model for STS education,* School Science and Mathematics, 96 (8), pp. 432-440.

Pedretti, E. (1997) *Septic tank crisis: a case study of science, technology and society education in an elementary school*, International Journal of Science Education, 19 (10), pp. 1211-1230.

Pedretti, E. (2005) *STSE education: principles and practices,* in Aslop S., Bencze L., Pedretti E. (eds.), Analysing Exemplary Science Teaching: theoretical lenses and a spectrum of possibilities for practice, Open University Press, Mc Graw-Hill Education.

Pedretti, E. & Forbes (2000) *From curriculum rhetoric to classroom reality, STSE education,* Orbit, 31 (3), pp. 39-41.

Pedretti, E., Hewitt, J., Bencze, L., Jiwani, A. & van Oostveen, R. (2004) *Contextualizing and promoting Science, Technology, Society and Environment (STSE) perspectives through multi-media case methods in science teacher education*, in D.B Zandvliet (ed.), Proceedings of the annual conference of the National Association for Research in Science Teaching, Vancouver.

Pella, Milton O. (1976) *The place or Function of Science for a Literate Citizen*, Science Education, 60 (1), pp. 97-101.

Prensky, Marc (2001) *Digital Natives, Digital Immigrants*, On the Horizon, vol. 9, Is: 5, pp. 1-6.

Prensky, Marc (2005) *Engage me or enrage me*, Educause review, Sept/Oct.

Prensky, Marc (2008) *Turning on the lights,* Reaching the Reluctant Learner, Volume 65, Number 6, pp. 40-45.

Priestley, Joseph (1764) *A Chart of Biography,* J. Johnson.

Priestley, Joseph (1765) *A Chart of Biography*, Mynde.

Priestley, Joseph (1765) *A description of a chart of biography*, William Eyres.

Priestley, Joseph (1765) *An Essay on a Course of Liberal Education for Civil and Active Life,* J. Johnson.

Priestley, Joseph (1768) *Familiar Introduction to the Study of Electricity,* J. Johnson.

Priestley, Joseph (1772) *The history and present state of discoveries relating to vision, light, and colours*, J. Johnson.

Priestley, Joseph (1774) *An Examination of Dr Reid's Inquiry into the Human Mind on the Principles of common Sense*, J. Johnson.

Priestley, Joseph (1777) *Familiar Introduction to the Study of Electricity,* J. Johnson, (3rd edition).

Priestley, Joseph (1778) *Miscellaneous Observations Relating to Education,* R. Cruttwell.

Priestley, Joseph (1788) *Lectures on History, and General Policy,* J. Johnson.

Priestley, Joseph (1791) *A Particular Attention To The Instruction of Young,* Dec. 4.

Priestley, Joseph (1791) *Discourse to the supporters of New College, Hackney*, J. Johnson.

Priestley, Joseph (1794) *The Present State of Europe Compared with Ancient Prophesies Gravel Pit Meeting*, 28 February.

Priestley, Joseph (1817-31) *The Theological and Miscellaneous Works of Joseph Priestley*, Rutt, J.T. (ed.) 25 voll.

*Priestley, Joseph (1970) Memoirs, in Autobiography of Joseph Priestley, Lindsay, Jack (ed.), Adams & Dart.*

Priestley, Timothy (1805) *A funeral Sermon occasioned by the Death of the late Rev. Joseph Priestley*, Alex. Hogg, and Co.

Raikes, Robert (1784) The Gentlemen's Magazine, vol. 54.

Ready, Kathryn J. (2010) *Dissenting heads and hearts: Joseph Priestley, Anna Barbauld and conflicting attitudes towards devotion within rational dissent,* Journal of Religious History, vol. 34, n. 2, June.

Redi, Carlo Alberto (2011) *Il biologo furioso. Provocazioni d'autore tra scienza e politica*, Sironi Editore.

Reid, David A. (2010) *Rational dissent and the rhetoric of educational philanthropy in the dissenting academies of Lancashire*, Hackney and Exeter, Northen History, XLVII:1, March.

Richardson, A. (1989) *The Politics of Chilhood: Wordsworth, Blake also the Catechistic Method*, ELH, vol. 56, 4.

Richardson, G., & Blades, D. (2001) *Social Studies and Science Education: Developing World Citizenship Through Interdisciplinary Partnerships,* Canadian Social Studies, 35(3).

Rivers, Isabel & Wykes, David L. (ed.) (2008) *Joseph Priestley, Scientist, Philosopher and Theologian*, Oxford University Press.

Roberts, H. P. (1932) *Early Unitarian schoolmasters and schools in Wales*, TUHS 5:2, pp. 157-164

Rose, Norman Francis (2002) *The role of Joseph Priestley as an educationalist in the 18th century*, PhD Thesis, University of Birmingham.

Rossi Pinelli, Orietta (2009) *Le arti, la scienza, la tecnologia*, in *Le arti del settecento europeo*, Einaudi.

Roth,W. M. (2001) *Learning science through technological design*, Journal of Research in Science Teaching, 38, pp. 768-790.

Rudolph, John L. (2003) *Portraying epistemology: school science in historical context*, Science Education, vol. 87, issue 1, pp. 64-79.

Rudolph, John L. (2005) *Inquiry, Instrumentalism, and the Public Understanding of Science*, Science Education, vol. 89, No. 5, pp. 803-821.

Russell, Bertrand (1961) *The Basic Writings of Bertrand Russell,* George Allen and Unwin.

Russell, Bertrand (2005) *L'impatto della scienza sulla società,* Newton&Compton.

Rutt, J.T. (eds.) (1817-1831) *The theological and miscellaneous works of Joseph Priestley,* J. Johnson, vol. XV.

Saunders, E. M. (1984) *A progress: Channing School, 1885-1985,* John Catt Ltd.

Schawb, Joseph (1962) *The teaching of science as enquiry*, in P.F. Brandwein (ed.) The teaching of science, Harvard University Press.

Schmidt, Eric (2011) *Television and the Internet: shared opportunities*, MacTaggart lecture, 26 August, Full text: http://www.guardian.co.uk/media/interactive/2011/aug/26/eric-schmidt-mactaggart-lecture-full-text

Schneider, R. M., Krajcik, J., Marx, R. W. & Soloway, E. (2002) *Performance of students in project-based science classrooms on a national measure of science achievement,* Journal of Research in Science Teaching, 39, pp. 410-422.

Scholfield, Robert E. (1961) *Joseph Priestley's American Education,* in Early Dickensoniana, The Boyd Lee Spahr Lectures in Americana, 1957-1961, Dickinson College.

Scholfield, Robert E. (1966) *A scientific Autobiography of Joseph Priestley (1733-1804),* MIT Press.

Scholfield, Robert E. (1963) *The Lunar Society of Birmingham: a social history of provincial science and industry in eighteenth-century England,* Clarendon Press.

Sheldon, Peter (2004) *The life and times of William Withering: his work, his legacy,* Brewin Books.

Sheps, Arthur (1999) *Joseph Priestley's Time Charts: The Use and Teaching of History by Rational Dissent in late Eighteenth-Century England*, Lumen 18.

Shulman, Lee S. (1986) *Those Who Understand: Knowledge Growth in Teaching*, Educational Researcher, vol. 15, No. 2, pp. 4-14.

Seed, John (1982) *Unitarian ministers as schoolmasters 1780-1850: some notes,* TUHS 17:4, pp. 170-176.

Segal, Gilda (1997) *Towards a Pragmatic Science in Schools*, Research in Science Education, 27 (2), pp. 289-307.

Simon, Brian (1974) *The Two Nations and the Educational Structure 1780-1870*, Lawrence and Wishart.

Smiles, Samuel (1865) *Lives of Boulton and Watt*, John Murray.

Smith Barbara M. D. & Moilliet, J. L. (1967) *James Keir of the Lunar Society*, Notes and Records of the Royal Society of London, vol. 22, No. 1/2.

Smith, W. Ashley (1954) *The birth of modern education*, Independent Press.

Smith, Kenneth Gill (1974) *Willaston School [Nantwich]*, TUHS 15:4 ,pp. 130-136.

Smyth Albert Henry (ed.) (1905-07) *The writings of Benjamin Franklin*, The Macmillan Company.

Solomon, J. (1993) *Teaching Science, Technology & Society*, Open University Press.

Solomon, J. & Aikenhead, G. (eds.) (1994) *STS Education: International Perspectives in Reform*, Teacher's College Press.

*Speck, W. A. (2002) Joseph Priestley's American dream, The Historian, n. 73.*

Stewart, Duncan P. (1952) *The Woolton Mechanics' Institute*, TUHS 10:2, pp. 66-90.

Stewart, Larry (1992) *The Rise of Public Science. Rhetoric, Technology, and Natural philosophy in Newtonian Britain, 1660-1750*, Cambridge University Press.

Stikkers, Kenneth W. (2010) *John Dewey on the Public Responsibility of Intellectuals*, Etica & Politica / Ethics & Politics, XII, 1, pp. 195–206.

Susnstein, C. (2003) *Republic.com. Cittadini informati o consumatori di informazioni?* Il Mulino.

Tarrant, Dorothy (1950) *Unitarians and Bedford College,* TUHS 9:4 , (1950) 201-206.

Tarrant, W. G. & Worthington, Joseph (1927) *University Hall, London* TUHS 4:1, pp. 1-15.

Tholfsen, T. (1980) *Moral Education in the Victorian Sunday School*, History of Education Quarterly, vol. 20, No. 1.

Thorpe, T.E. (1906) *Joseph Priestley*, J. M. Dent.

Turnbull, G. H. (1953) *Samuel Hartlib's Influence on the Early History of the Royal Society*, Notes Rec. R. Soc. Lond., April,1, vol. 10, pp. 101-130.

Tyndall, John (1873) *On the Study of Physics* (A lecture delivered at the Royal institution of Great Britain), in *The culture demanded by modern life: a series of addresses and arguments on the claims of scientific education*, Appleton and Company.

Uglow, Jenny (2001) *The Lunar Men,* J. Johnson.

Uglow, Jenny (2002) *The Lunar Men. The friends who made the future 1730-1810*, Faber and Faber.

Vaccari, Valentina (2008) *Joseph Priestley e la Lunar Society: i laboratori e la pratica sperimentale*, Franco Angeli.

van Eijck, Michiel & Roth, Wolff-Michael (2010) *Theorising scientific literacy in the wild*, Educational Research Review, vol. 5, issue 5, pp. 184-194.

Wainer, Howard (ed.) (2005) *Graphic Discovery: A Trout in the Milk and Other Visual Adventures*, Princeton University.

Walker, G. E. (ed.) (1973) *Willaston School, 1900-1937,* Privately printed.

Walker, W. Cameron (1834) *The beginning of the scientific career of Joseph Priestley*, Isis, vol. 21, n.1.

Watson, Foster (1909) *The beginning of the teaching of modern subjects in England*, Pitmans.

Watts, Ruth (1979) *The Unitarian contribution to the development of female education in the nineteenth century,* University of Leicester, unpublished M.A. dissertation.

Watts, Ruth (1980) *The Unitarian Contribution to the development of female education 1790-1850*, History of education, 9:4, pp. 273-86.

Watts, Ruth (1983) *Joseph Priestley and Education*, Enlightenment and Dissent, no. 2, pp. 83-100.

Watts, Ruth (1987) *The Unitarian contribution to education in England from the late eighteenth century to 1853*, University of Leicester, Ph.D. Thesis.

Watts, Ruth (1989) *Knowledge is power - Unitarians, gender and education in the eighteenth and early nineteenth centuries,* Gender and education, 1:1, pp. 35-50.

Watts, Ruth (1991) *Revolution and reaction: "Unitarian" academies 1780-1800*, History of Education 20:4, pp. 307-24.

Watts, Ruth (1994) *Gentlemen and ladies: educational strategies for developing middle-class élite and the problems they raised*, International Standing Conference for the History of Education Gender Group Conference papers, pp. 1-10.

Watts, Ruth (1994) *Joseph Priestley*, Unesco prospects: quarterly review of education, 24, pp. 1-2.

Watts, Ruth (1995) *Educational and cultural transfer: the case of Unitarian women from the late eighteenth century to 1860*, History of Education Society Bulletin, pp. 11-19.

Watts, Ruth (1995) J*oseph Priestley (1733-1804),* Prospects, Thinkers on Education, UNESCO, vol. XXIV, no. 3, pp. 343-53

Watts, Ruth (1997) *"Unlimited education for all?" Unitarians and education 1800-1860*, Address at Unitarian College Closing Proceedings, 17 June.

Watts, Ruth (1997) *'Rational' religion: Unitarian men and women and the education of the working class, 1800-1860*, unpublished paper International Standing Conference for the history of education, Maynooth, September.

Watts, Ruth (1998) *Changing societies: Unitarians, gender and education in England*, Longmans.

Watts, Ruth (1998) *Gender, power and the Unitarians in England, 1760-1860,* Longmans.

Watts, Ruth (1998) *Some radical education networks of the late eighteenth century and their influence*, History of Education, 27:1 pp. 1-14.

Watts, Ruth E. (1999) *Unlimited knowledge for all: Unitarians and education 1800-1860*, TUHS 22:1, pp. 18-36.

Wedgwood, Emma (1985) *My first reading book*, R.B. Freeman.

Wedgwood, Julia & Herford, C.H. (1915) *The personal life of Josiah Wedgwood: the potter*, Macmillan and C.

Wellington, Jerry (2003) *Science Education for Citizenship and a Sustainable Future*, Pastoral Care in Education, Volume 21, N. 3.

Whewell, William *On the Education of history of science* (A lecture delivered at the Royal institution of Great Britain), in *The culture demanded by modern life: a series of addresses and arguments on the claims of scientific education*. Appleton and Company, 1873, pp. 225-252.

White, B. Y., & Frederikson, J. R. (1998) *Inquiry, modeling, and metacognition: Making science accessible to all students. Cognition and Instruction*, 16, pp. 3-118.

Williams, Jay *Dewey and the Idea of Science Education*, The School Review, vol. 67, n. 2, Dewey Centenary Issues (summer 1959), pp. 186-194.

Woodley, Sophia (2009) *'Oh Miserable and Most Ruious Measure': The Debate between private and Public Education in Britain, 1760-1800*, in Hilton Mary and Shefrin Jill (eds.), *Educating the Child in Enlightenment Britain: Beliefs, Cultures, Practices,* Ashgate, Farnham.

Youmans, Y. E. (1873) *On mental discipline in education*, in *The culture demanded by modern life: a series of addresses and arguments on the claims of scientific education*, Appleton and Company.

Ziman, J. (1994) *The rational of STS education in the approach*, in Solomon, J. & Aikenhead, G. (eds.) (1994). *STS Education: International Perspectives in Reform*, New York: Teacher's College Press, pp. 21–31.

(1932) *Joseph Chamberlain and popular education, TUHS* 5:2, pp. 201-203.