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Cross-National and Comparative History of Science Education: An Introduction

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Science and education are global endeavours, but in spite of the transnational turn of contemporary affairs, their practice has been and still is shaped by national and local forces. Interestingly, the history of science, the history of education and science education research display different levels of involvement with this national diversity.

Most research in the history of science is still characterized by an insufficient conceptualization of the national. Historians of science commonly choose a local or national focus for their research, which is inherent in their training and daily practice. This choice is often more implicit than explicit, and it can contribute to a partial or inaccurate characterization of historical phenomena (Simon and Herran 2008).

The problematization of the national is still an unresolved matter in history of science; as most studies assume a local or national focus without further intellectual discussion or at least the acknowledgement of practical reasons making this a necessary choice. This is a fundamental issue, because evaluating the pertinence of a local, national, international, or transnational perspective (or a combination of several of these) has a major role in the definition of historical questions and the production of historical results (Simon 2012; Cohen and O'Connor 2004).

Moreover, the study of modern science in historical perspective has privileged a set of countries, namely France, Great Britain and Germany since the nineteenth century, together with the USA from the twentieth century, and a centre-periphery model by which science produced in these national contexts radiates elsewhere. The production of scientific knowledge in other countries is often conceived as a process of reception and reproduction. While major advances have been made which counteract this picture, and expand the range of national cases, and provide more sophisticated explanations of the production and circulation of scientific knowledge, overall these trends are still representative of the history of science literature (Simon and Herran 2008; Sivasundaram 2010; Schaffer et al. 2009; Turchetti et al. 2012).

Without denying the importance of these four countries in the making of modern science, this bias in the literature leads to the neglect of science in other national settings

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(Gavroglu et al. 2008). Furthermore, it contributes to understanding present national contexts as compact and homogeneous. However, it is often the case that, in spite of the processes of construction and administration of the nation state launched in the nineteenth century, national contexts can often be quite heterogeneous (Naylor 2010; Chakrabarty 2000). The production of national pictures of scientific practice requires also taking into account the role of practitioners which crossed national borders, and to pay attention to comparative analysis of different national contexts in order to avoid the temptation of national exceptionalism (Simoes et al. 2003; Curtis 2012; Kikuchi 2012; Angulo 2012; Simon 2011).

The field of science education research offers a richer picture in terms of national diversity, favoured by the relevance and practical outcomes that science education has for national governments worldwide. Furthermore, the international science education and history of education communities are characterized by a better balance between different national societies, and a more multidirectional internationalism than their history of science counterparts (Compère 1995; Jenkins 2001; Viñao 2002). While it has been rather standard to think that certain national contexts are more relevant than others for their participation in the production of scientific knowledge, the picture for education is less biased, and includes a broader acknowledgement of the role that science education has had in most if not all national cultures.

In spite of this, there were countries which in the nineteenth century contributed earlier than others to the national expansion of science education. This national set partly intersects with the set of countries considered to have led scientific research, but is not fully contained in it (Simon 2011; Green 1990). The field is still in need of further comparative studies which will offer light on the wider international context of science education in historical perspective. But, what is especially remarkable is that, even national contexts such as France and the German states, which witnessed an early development of science teaching across secondary and higher education, did not grow in isolation. In the nineteenth century international comparisons had a major role in the making of any national policy of educational development in France, the German states and elsewhere. Governments commissioned reports and commissioners went abroad to carry out fieldwork before proposing educational reforms back home.[1] The development of such methods, characterized by their internationalism, gave rise to comparative education as a contemporary academic discipline and has continued to play a major role in the design of educational policies.

International comparison was also a major tool in the work of historically-minded sociologists developed between the 1960s and 1970s.[2] Their work used different national case studies with the aim of elucidating aspects such as the dynamics of social change and their connection with educational structures, the role of education in the processes of professionalization, the mechanisms of scientific and technological development, and the design of new educational policies. These studies have provided a major methodological repertoire for the use of historians of science education, but they also display a number of limitations.

The sociological nature of this work includes a valuable effort of generalization which can be useful for historians, but at the same time it also presents a series of constraints. On

[1] See for instance Johnston (1827), Arnold (1860), Wagner (1864), Demogeot and Montucci (1868), Hippeau (1872), Rabany (1879).

[2] Ben-David (1968) and (1971), Vaughan and Archer (1971), Archer (1979), Ringer (1979), Jarausch (1983).

the one hand, these studies were strongly shaped by their particular aims grounded on the analysis of social change, the political relevance of the nexus between science, technology and education, or the development of contemporary educational policies. On the other hand, their use of international comparisons also contributed to hide the particularities of each national case study. These studies assumed that national contexts were homogeneous and that it was straightforward to think about national "models" or "systems" of education. The main task was then to design appropriate tools and techniques of analysis able to operate comparison between national states which often had different educational structures and historical records about them.

While sharing this interest in comparison in international perspective, the papers included in this special issue provide a historical account which is more free of preassumptions, more open to historical exploration, and more methodologically diverse. This special issue offers case studies ranging from the eighteenth century to the present, dealing with national states such as Spain, Greece, Belgium, Canada, England, France and Poland and contributing to revise the international role of French, German, British and American experiences in the shaping of modern science education. The focus of the papers includes international comparison, analysis of cross-national circulation and appropriation of scientific and educational knowledge, and intra-national comparisons of developments in regions with distinctive educational cultures.

Mónica Blanco investigates the early history of the teaching of calculus through a case study on Padilla's work, the first textbook published in Spain which included this topic. The historical and methodological interest of this study is strengthened by its use of international comparison. Blanco compares Padilla's little known course with that by Bézout, published a decade later and, in contrast, regarded as a major textbook shaping the teaching of mathematics worldwide. Comparison offers us two major outcomes which challenge the traditional historiography in this field. On the one hand, while the impact of French mathematics in eighteenth-century education and research was no doubt very considerable, it was not unique. Moreover, the standard bipolarization of the field, according to French and British contributions, is insufficient. Mathematics teachers in countries such as Spain, clearly peripheral in the historiography of mathematics, made a selective use of these two national traditions, and in addition they were able to produce original work. On the other hand, Spanish initiatives in this field were deemed to have a low acknowledgement for the discontinued and heterogeneous characteristics of the institutional framework of military education in Spain. Thus, Padilla's work was afflicted by more limited channels of communication, both locally and internationally. But what is more relevant is that the success of Bézout's work was connected not only to its scientific and pedagogical qualities, but also to the compact structure of French military education, centralization, and the control over textbooks exerted by the state and examiners such as Bézout.

Konstantinos Tampakis offers in his paper a wide overview of the development of science education in Greece, during the nineteenth century. The formation of the Greek state was subject to changes of political regime dominated by foreign powers, and the training of Greek science teachers took often place abroad. As a result, the development of science teaching in Greece was shaped by Bavarian, Prussian and French practices. However, as is often the case, it was a process of creative appropriation, in which the realities and features of Greek culture led to the development of a distinct national context of science education. Tampakis reviews the development of science teaching in primary, secondary and higher education and situates carefully the patterns in the development of institutions and the production of textbooks in their political context. This case study is

particularly relevant in revealing the complexity of the processes of formation of national cultures of science education. The development of Greek science teaching was the result of the interaction of the ideas of German administrators about education, but also about Greek civilization, the local movements for a Neohellenic Enlightenment, the appropriation of the British monitorial system through its implementation by French educators, the importation and translation of French textbooks and the training of Greek science teachers abroad. The complexity of this process leaves no doubt about the major role of internationalism and the inadequacy of thinking in exclusively national terms.

Sophie Onghena in her study of Belgian science education provides us with a case study which singles out the formation of a national culture of science education through appropriation of foreign experiences. Like in Tampakis' analysis of Greek education, Onghena's account of the Belgian case stresses the impact of French and German pedagogy in the making of science education in a young national state. But she offers a more focused explanation, grounded on the construction of the Belgian national identity through internationalist nationalism. The geographical position of Belgium and the fact of being a bilingual nation favoured the country's capacity to absorb educational ideas and products from its neighbours, France and Germany. Onghena analyses the processes of institutionalization of the teaching of physics and chemistry in the context of secondary education, the development of curricula, the production and use of textbooks, and the provision of scientific instruments in schools. The French experience had a major role in the shaping of experimental science teaching in Belgium. It affected both the francophone and Flemish regions. It was also influential in the development of school examinations, but in this context the Prussian experience had also a central role, in configuring overall a distinctive Belgian approach. The German influence was also important in the development of school science collections. Towards the end of the century, Belgian science education had developed its own distinctive features, through appropriation of different national cultures favoured by an international outlook.

Michelle Hoffman revisits Onghena's focus on a country characterized by national duality, but she takes it further by adding a comparative dimension. Hoffman analyses the development of general science courses in two Canadian provinces, and situates it in relation to a third national context, the USA. Thus she aims at understanding the different roles that the development of general science courses played in the shaping of science teaching in the 1930s. While Ontario developed its own educational schemes, educators were particularly attentive to the development of general science courses in the USA and Britain. Their pedagogical characteristics were considered especially suitable to develop general reasoning skills, knowledge of technological applications and the calling for jobs in industry. The development of these courses in Ontario was however not an inevitable phenomenon, but it grew from a conjunction of economical, political and intellectual aspects. In contrast, in Quebec the development of science education was driven by scientists preoccupied by university recruitment. Thus, there was instead a tendency to develop educational approaches around distinct scientific disciplines. By exploring comparatively the differences in science education development in these two Canadian provinces and asking the question of why general science courses had little success in Quebec, Hoffman contributes to enrich the historiography of Canadian science education. Furthermore, she is able to offer a strong characterization of the driving problems and forces in the development of modern science education which can have exemplary value in international perspective.

Catherine Radtka uses instead comparison to produce a general overview of the development of a scientific concept—temperature—between the twentieth century and the

present. Her study analyzes how temperature was presented in elementary textbooks produced in three countries (France, England, and Poland) in the 1950s, a relevant period for the shaping of contemporary pedagogy, and the 2000s, a more recent period allowing reflection on long term phenomena in the shaping of science and pedagogy. The three national cases represent different political and cultural ideologies which made their way into curricula and pedagogy. These national contexts are also subject to national stereotypes further reinforced by the Cold War, which Radtka's analysis contributes to reconsider. Thus she shows that, interestingly, contemporary English and Polish textbooks favour a theoretical presentation of the notion of temperature, while French textbooks tend to integrate temperature merely as a concept used in everyday life. These diverging tendencies contrast with a greater homogeneity in the 1950s, when the textbook presentation of temperature was characterized by an inductive perspective in different countries. This homogeneity is in contrast with standard cultural and political pre-conceptions on countries such as France, England and Poland during the Cold War. Vice versa, the current heterogeneity challenges the expectations of the outgoing political and educational processes of European unification. In addition, the concept of temperature is not dissociated from its material culture and this study contributes to characterize how the cultural status and the pedagogical role of thermometers have changed in the last half century.

The papers in this special issue contribute to unveiling the complexity of the national in the study of science and education, and its inseparable connection to international comparison and cross-national circulation of knowledge. Furthermore, they warn us against the inaccuracies of considering the national framework as inevitable, and they encourage us to practice a more honest and explicit characterization of the geographical, political and cultural boundaries of our research case studies. While comparative and cross-national studies still require further work, this special issue is a step in this direction. In this context, the history of science education undoubtedly offers an excellent ground for the development of new approaches able to enrich both the history of science and the history of education and to inform current developments in science pedagogy and science education policy.

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