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Teaching about Medicines under a Historic-Intercultural Approach: Lessons from the Classroom

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Abstract

The introduction of History and Philosophy of Science (HPS) in school science has been advocated by science educators and curricular reforms for some decades, but the way this HPS inclusion is usually done is traditionally connected with a view of science as solely a Western product of the 17th century Enlightenment. Nevertheless, recent debates in the field of Post/Decolonial Science are challenging this historical view by promoting an intercultural model for the analysis of scientific development throughout our history. This model involves the understanding of science as the product of exchanges between different people and cultural traditions, transforming a local historical narrative into a global one. This work presents initial results from a qualitative classroom-based experience that employed this historic-intercultural model to teach regular topics from the English curriculum. This intervention was carried out in collaboration with a secondary school science teacher in London/UK, and involved the development and teaching of a teaching-learning sequence (TLS) on Medicines (4-5 hours) that incorporated historical cases and discussions about NOS under this historic-intercultural model. Participant students (n=27) were aged 12-13, and data was collated through teacher's interviews, classroom observations, students' diaries and concept maps. Using this "Medicines" TLS as a case study, the potentialities and hindrances of this historic-intercultural model will be analysed regarding curricular and the participant teacher's perspectives, and its impacts on students' views about NOS.

Keywords: *history of science, intercultural science, nature of science, classroom-based research, secondary school science*

1. Introduction: an overview on HPS and Science Education

The inclusion of History and Philosophy of Science (HPS) in school science has been advocated by several science educators and historians[1],[2],[3], and explored by different curricular reforms in recent decades. The possibilities offered by HPS have been systematised by several authors, with Matthews[2] highlighting its impacts on students' motivation, humanisation of science, and understanding of the scientific enterprise as dynamic. Similarly, Höttecke and Silva[1] summarised the contributions from HPS after an extensive review of the field: learning about science as a process, promoting conceptual change, learning about nature of science (NOS), fostering public understanding of science, and students' positive attitudes towards it. Here, there is an important examination of the potential of HPS to humanise scientists by showing that scientific work is carried out by regular people working in a community, which is also connected with the external public, dynamic, fallible and negotiated[3],[4],[5].

Nevertheless, this potential of HPS to challenge traditional views about scientific work has been recently questioned[4],[5], especially regarding which HPS is being advocated. According to Sarukkai[5] the "explicit emphasis on the figures of Western Enlightenment" (p.1996) by HPS can portray a specific image of science, scientific work and community that only foster a biased humanisation of science. The author is referring to the ways in which HPS have been traditionally introduced into school science, being very often connected with a specific idea of modern science as solely a Western product of the 17th century Enlightenment.

Recent debates in the field of Post/Decolonial Science are challenging this perspective by advocating an intercultural model for scientific development throughout History, which is based on the "Global History of Science" field[6],[7]. The argument here is that modern Western Science is a product of exchanges between different cultures, and of the circulation of diverse types of knowledge around the world, all promoted by historical and geographical contexts such as the trade in the Silk Road, and the European colonising/imperialist projects. Thus, an intercultural model of HOS being applied into school science would involve the understanding of science as the product of these exchanges, transforming a local historical narrative into a global historical narrative.

According to Sarukkai[5], this model can bring a more diverse view of science to science lessons, challenging traditions in HPS that "led generations of students in non-Western societies to believe that

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their cultures have had no contribution to the science of the modern world" (p.1996). Additionally, this approach can also foster the learning of NOS, since it involves aspects such as collaboration, negotiation and adaptation of scientific knowledge, exploitation of and power-struggle regarding natural resources, ethical, economical and political aspects of science, etc.
In this scenario, this paper presents the initial results from an empirical experience that employed this historic-intercultural model to teach the topic of "Medicines" from the English National Curriculum. A Teaching and Learning Sequence (TLS) about this topic was developed and taught aiming at incorporating intercultural discussions about NOS into school science through the use of HPS, and at answering the following questions: Can the study of the contributions of different cultures to modern science be successfully integrated into science learning through HPS? In which ways can this type of activity promote a wider understanding of NOS?

2. Methodological aspects

This investigation was carried out at a secondary state and multicultural school in London/UK in collaboration with one science teacher, and involved the development and teaching of a TLS about Medicines (4-5 hours of teaching) that incorporated discussions about NOS under a historic-intercultural model. The TLS was taught as a substitute of the one usually employed by the participant teacher. Participant students (n=27) were aged 12-13, and were enrolled in one of this teacher's science classrooms.
Data was collated through audio-recordings of my meetings with the teacher during the preparation of the TLS, classroom observations during the teaching of the TLS, interview with the teacher at the end of the TLS, students' diaries written at the end of each lesson and students' concept map developed at the of the TLS. Data analysis was carried out as a qualitative case study, focusing on the epistemological and pedagogical conditions for the development and implementation of the TLS, and on its impacts on students' understandings about NOS. In order to address these dimensions of the development and implementation of the TLS, this study explored three different levels: Curriculum; Teaching/Pedagogy; Students (as seen in table 1).

Table 1. Levels of analysis of the development and application of the TLS on Medicines

Level of analysis	Period	Main focus	Data generation
Curriculum	Pre-teaching of the TLS	Development of the TLS (how curriculum expectations and HOS/NOS teaching can be bridged)	- Researcher's self-reflection - Interview with the teacher (pre-TLS)
Teaching/ Pedagogy	During and after-teaching of the TLS	Application of the TLS (how the TLS is being taught and teacher's perceptions of the experience)	- Researcher's field notes - Teacher's recordings - Interview with the teacher (post-TLS)
Students	During the TLS	Students' engagement with the TLS (interest in and learning of content and NOS)	- Researcher's field notes - Students' NOS diaries - Students' group concept map

3. Findings and discussions

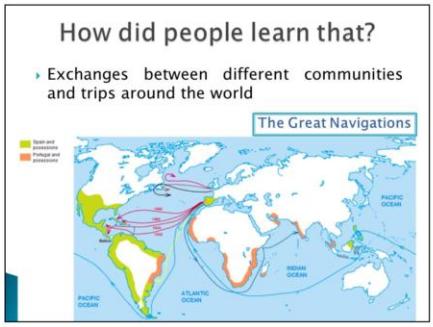
3.1 The curriculum level – the TLS on Medicines

This level of analysis was informed by the question "how can curriculum expectations and HOS/NOS teaching be bridged?"
The first relevant aspect here is the choice of "Medicines" as the topic to be explored under an historic-intercultural approach. According to the English curriculum for the participant students' age group, the teaching of this topic should encompass drug trials and animal testing, so its own nature is connected to NOS. Furthermore, the availability of a sound scholarship about the History of medicines, uses of natural resources (Natural History), and drug development and trials made the process of translating historical knowledge into a TLS for secondary school science easier.
This scholarship was then translated into a simplified but historically accurate and meaningful account of this global history, being transformed into a TLS on Medicines. The challenge here was to develop a TLS that included not only intercultural discussions about HOS/NOS, but also the content expected by the official specifications. To connect these two dimensions, the TLS emphasised the development and circulation of medical knowledge, enabling the explicit exploration of aspects related to NOS, such as:

• Socio-cultural aspects and controversies in the production of scientific knowledge;
• The importance of natural resources for the production of scientific knowledge and its consequences (including environmental issues and intellectual property);
• The collaborative and collective nature of the scientific work;
• The relationship between science, ethics, economy, politics.

Additionally, this TLS was also able to explore the expected scientific concepts part of the official curriculum, and extra concepts (stages of drug development and vaccines). The whole TLS consisted of a lesson plan, a set of slides to be used during the lessons, and materials/guides/handouts for the proposed activities/homework. It was expected to last four lessons (four hours), each one regarding a core idea: Lesson 1 - natural resources and medicines; Lesson 2 - artificial drug development and biodiversity; Lesson 3 - drug testing; Lesson 4 – vaccines.

- Talk about how knowledge about medicines from different cultures (for instance the willow tree bark and the Amazonian viper) were shared and collected throughout the centuries by people travelling around the world.
- Exemplify that by talking about the Silk Road, an ancient network of trade routes that ran from China through India and Persia, arriving in Africa and south Europe (now Turkey – Istanbul). It was the centre of commerce between these communities between around 120BCE until 1450CE (remember Marco Polo), when the Great Navigations expanded other sea routes and contacts with the Americas (next slide about Great Navigations). It was through this route that most of Chinese and Indian traditional medicine arrived in Europe, alongside Islamic and African knowledge.



- Same idea from last slide, now exemplifying the new trade and colonisation routes created by the Great Navigations – also known as the "Age of Discovery" or the "Age of Exploration" (exploration of African Atlantic coast starts with the English and Portuguese in early 1400s; then the Indian Ocean in 1488, culminating with Christopher Columbus landing in the Americas in 1492).
- Highlight that the expansion of European domains also expanded scientific knowledge, specially in the fields of Zoology and Botany (new species), helping the creating of new medicines. Most of this knowledge is acquired through the contact with the native people in these new lands.
- Highlight the collective aspect of scientific knowledge, how it's more than just 5 or 10 people working on a specific topic, but in fact the culmination of years of knowledge exchange between different communities/traditions, and that not everybody is always recognised by their contributions (until nowadays) -> think about why that's the case.

Fig.1. Example of slides used at the Medicines TLS (Lesson 1)

3.2 The teaching/pedagogy level

This level of analysis informed by the question "how was the TLS being taught and what were teacher's perceptions of the experience?"
An interesting aspect of the teacher's work with this TLS was the amount of time dedicated to an explicit exploration of the examples employed during the lessons. With this TLS, she dedicated a good time to discussions about these examples, aided mainly by the use of the follow-up questions. This more contextualised and in-depth approach promoted a pathway for discussions about NOS and for connections with socio-scientific contexts and people's lives, such as access to scientific knowledge and advances, economy and ethics in science, etc.
For instance, when talking about industrialised and natural medicines bought in famous high street shops in England (lesson 2), she not only presented some brands as examples, but also carried out a discussion about prices of conventional and herbal medicines in these shops, that is, about who the public for these type of medicines is, comparing that with use of herbal medicines in rural, poor areas. Another example was her discussion about obesity in Botswana (lesson 3). After students worked on this task (figure 2), the teacher introduced the question of biodiversity and social justice in the case of a plant used in commercial drugs to fight obesity in rich countries that was harvested in a country (Botswana) devastated by hunger.

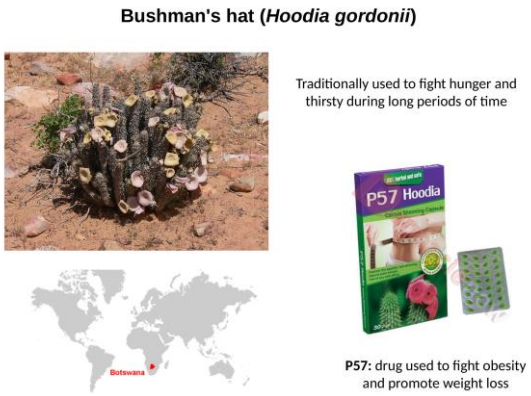


Fig.2. Example used during task 3 (biodiversity and drug production)

The teacher's impressions about the experience of working with TLS were generally positive. During the experience, she seemed satisfied with the current results, especially with students' engagement and questioning, and also noted how even students considered by the school as part of the low abilities group were also participating and interested in the lessons.

3.3 The Students' level

The student's level of analysis focused on engagement with the proposed discussions and learning of NOS.

Regarding their engagement, students were so interested in the tasks and questions being proposed that usually more than half of them volunteered to participate in the discussions. They were involved in talking about their previous and out-of-school knowledge, giving their opinions, asking for extra information about NOS, etc.

Another important aspect of this TLS was to promote students' discussions about NOS through a different approach towards HOS, which was investigated through classroom observations, concept maps developed at the end of the TLS (figure 3), and diaries written at the end of each lesson guided by the question "what did you learn today about how science and scientists work?" (figure 4).

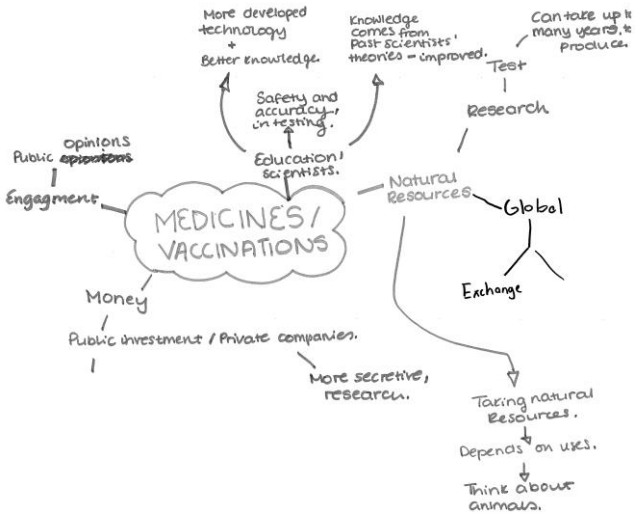


Fig.3. Group concept map on Medicines (after the TLS)

• "Scientists learn from each other to improve their knowledge." • "I learnt more about global and ancient medicine and how medicine has grown due to trading." • "I learnt that people from different countries shared cures for illness. This helps in science as today scientists can study the cure and create new ones." • "I learnt that there are many cures but we do not know what they are due to deforestation."	• "It takes long to process the drugs and it comes from many different places." • "I learnt how long it takes for drugs to be released and how long of a process it is." • "You have to back up your discovery with evidence to be believed." • I learnt why scientists would fake results and why people think vaccines are dangerous." • "I learnt that people have many different views on vaccines."

Fig.4. Examples of quotes about NOS from students' diaries (during the TLS)

When analysing students' concept map (figure 3) and diaries (figure 4), we can see how different ideas about NOS were operated by the students during their thinking about Medicines: the use of natural resources (through research and global exchanges); knowledge-related ("education, scientists"), public engagement ("public opinions") and ethical aspects behind Medicines production; the collaborative nature of scientific enterprise – all ideas that were part of the TSL and explicitly discussed during the lessons observed. Looking closer, we can see students' thoughts about how money is related to science and the question of public and private investments and of secretive research; how medicines development is dependent on natural resources and how it can have impacts on nature ("think about animals"); how this process is based on long-term and costly research; how testing is an important part of this development to ensure safety and accuracy, and also how previous knowledge, and exchange of knowledge between different people is also relevant to the development of better and safer drugs; how this whole process is also subject to the influence of public opinion and ethical decisions.

4. Final thoughts

The results from this experience seem promising for those interested in using different perspectives about HOS to teaching about NOS. More especially, students' high interest in a TLS about Medicines that employed a global/intercultural approach towards the history of medical knowledge show how new ways of discussing scientific development and NOS can indeed incorporate more culturally-sensitive and post-colonial topics. By adopting this intercultural model, talking about science and its nature in the case of this TLS became an intrinsic part of the lesson and, with the help of a contextualised work and follow-up questions, NOS aspects were explored by the teacher in a explicit way without losing sight of the scientific content.

It is important to remark here, however, that the historical work involved in developing the TLS was not easy, since the intercultural nature of this study exposed how the field of HOS is still grasping with the Global History model. Even if the historical scholarship about Medicines can be considered well developed and abundant, it still lacks this global perspective that connects the construction of scientific knowledge. Therefore, new forms of integrating HOS into school from a global perspective still need to be explored by Historians of Science and Science Educators, especially if we want to promote more creative, intercultural and NOS-related science teaching possibilities.

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