

Michael Matthews and the development of History, Philosophy and Science Teaching: thirty years after ‘the present rapprochement’

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ABSTRACT

The potentialities of the interplay among Science, Science Education, History and Philosophy of Science have been acknowledged since the XIXth century. Nevertheless, the institutionalization of History, Philosophy and Science Teaching (HP&ST) as a modern discipline and research field was only achieved in the end of the 1980s and beginning of the 1990s. In this perspective, it is hard to find someone that has contributed to their field as much as Michael Matthews has been doing for HP&ST. In this paper, I aim to discuss the genesis and development of HP&ST, highlighting the protagonist role that Michael Matthews has been playing for 30 years. The main source for this discussion is Matthews’s recently published autobiography History, Philosophy and Science Teaching: A Personal History and some of his previous works. The central assumption of this text is that a research field is constituted by two important dimensions: its conceptualization (the set of philosophical, theoretical, axiological, methodological conceptions that constitute the field), and its institutionalization (the set of means that allow the concrete implementation and diffusion of research and knowledge). In the case of HP&ST, Michael Matthews has been a central figure in the development of both dimensions. Throughout this paper, I discuss Michael Matthews’s initial philosophical influences, his work to institutionalize HP&ST (creating IHPST, Science & Education, and HPS&ST Newsletter) and his philosophical approach to HP&ST, conceiving it as an important mean to enhance Science Education in the context of a liberal, cultural, and humanistic education. In 2022, we will be celebrating 30 years of

Science & Education and, consequently, of Michael Matthews's seminal paper History, philosophy, and science teaching: The present rapprochement. I hope that this discussion works, firstly, as an invitation for HP&ST researchers to dive into Matthew's account on the history of the field, which illuminates many of the important issues and debates of our discipline. Secondly, this paper is intended to be a call to remember and reinforce the original perspectives and reflections that Michael Matthews's proposed to HP&ST: the appreciation of the Enlightenment tradition, the value and importance of liberal education, the necessity of philosophical rigor, and the conception of HP&ST as an essentially cross-disciplinary research field.

KEYWORDS

History and Philosophy of Science, History and Philosophy of Mathematics, HP&ST

RÉSUMÉ

*Les possibilités offertes par l'interaction entre la science, l'enseignement des sciences, l'histoire et la philosophie des sciences sont reconnues depuis le XIXe siècle. Néanmoins, l'institutionnalisation de l'histoire, de la philosophie et de l'enseignement des sciences (HP&ES) en tant que disciplines ou domaines de recherche modernes n'a été réalisée qu'à la fin des années 1980 et au début des années 1990. Dans cette perspective, il est difficile de trouver quelqu'un qui ait autant contribué à son domaine que Michael Matthews ne l'a fait pour HP&ES. Dans cet article, nous discuterons la genèse et le développement de HP&ES en soulignant le rôle joué par Michael Matthews au cours des trente dernières années. Notre principale source est l'autobiographie récemment publiée de Matthews *History, Philosophy and Science Teaching: A Personal History*, ainsi que certains de ses travaux antérieurs. L'hypothèse centrale de ce texte est qu'un champ de recherche est constitué de deux dimensions principales : sa conceptualisation (l'ensemble des conceptions philosophiques, théoriques, axiologiques, méthodologiques qui composent le champ), et son institutionnalisation (l'ensemble des moyens qui permettent la mise en œuvre et la diffusion de la recherche). Dans le cas de HP&ES, Michael Matthews a été une figure centrale du développement de ces deux dimensions. Tout au long de l'article, nous discuterons les influences philosophiques initiales de Michael Matthews, son travail pour institutionnaliser HP&ES (créant l'IHPST, *Science & Education* et la *HPS&ST Newsletter*) et son approche philosophique vis à vis de HP&ES, le concevant comme un moyen important d'améliorer l'enseignement des sciences dans le contexte d'une éducation ouverte, culturelle et humaniste. En 2022, nous célébrerons les 30 ans de *Science & Education* et, par conséquent, de l'article fondateur de Michael Matthews *History, Philosophie, and Science Teaching: The present rapprochement*. J'espère que ce propos sera perçu, d'une part, comme*

une invitation pour les chercheurs HP&ES à se plonger dans le récit de Matthew sur l'histoire du domaine, qui éclaire une grande partie des enjeux et débats importants de notre discipline, et, d'autre part, comme un appel à se souvenir pour les renforcer pour aller plus loin, des perspectives et des propositions originales que Michael Matthews a proposées à HP&ES, telles que l'appréciation des tradition iluministe, la valeur et l'importance de l'éducation libérale, la nécessité de la rigueur philosophique ou encore la conception de HP&ES comme un domaine de recherche essentiellement interdisciplinaire.

MOTS-CLÉS

Histoire et philosophie des sciences, Histoire et philosophie des mathématiques, HP&ES

INTRODUCTION

History and Philosophy of Science (HPS) have been an integral part of Science itself and Science Education for a long time (Videira, 2007). Many prominent scientists have dedicated a significant effort either to develop historical accounts of science development or to promote philosophical reflections on the metaphysical and epistemological grounds of their own research programs (Bohr, 1928, 1999; Boltzmann, 1974; Heisenberg, 2000). Moreover, the defense of historical and philosophical reflection in Science Education may be found in different didactical proposals over the last centuries, such as Ernst Mach's textbook on Mechanics (Mach, 1902).

Despite these long connections, the consistent conception and institutionalization of a specific research field called History, Philosophy and Science Teaching (HP&ST), dedicated to discuss the interplay among these academic disciplines, is a much more recent achievement. More specifically, it can be traced back to the final years of the 1980s and the first years of the 1990s. In this perspective, it is hard to find someone that has contributed to the genesis and development of a research field as much as Michael Matthews has been doing for HP&ST.

In 2022 we will be celebrating thirty years of *Science & Education* foundation and, consequently, of Michael Matthews's seminal work *History, philosophy, and science teaching: The present rapprochement* (Matthews, 1992b)¹, which has widely impacted Science Education. In this paper, my goal is to present a general reconstruction of HP&ST development and the central role that Michael Matthews played in this process. The main source for this discussion is Michael Matthews's recently published autobiography

¹ Moura (2021) has called my attention to this fact.

History, Philosophy and Science Teaching :A Persona Story (Matthews, 2021). Of course, I do not intend to cover all aspects that the book brings about. Instead, I aim to present a short analysis of Matthews's account, stressing how his efforts have contributed to the institutionalization and the theoretical development of HP&ST. I hope that this paper also works as an invitation for those interested in HP&ST to read prof. Matthews's autobiography. Besides being an uplifting narrative of a personal trajectory, it also allows a deeper understanding of the philosophical and historical context that shaped HP&ST genesis and development.

Considering HP&ST as a modern research field, the paper is organized in order to highlight Michael Mathews's contributions in two different dimensions: first, to the institutionalization of the field, which encompasses the creation and strengthening of official institutions, specialized journals and communication means of a specific community; second, to the theoretical conception of the field, which embraces a clear defense of the objectives, methods and theories that constitute the field.

The paper is structured as follows: first, I briefly introduce some historical aspects of Matthews's life and the philosophical influences that led him towards the foundation of HP&ST. Then, I generally sketch the process of institutionalization of HP&ST, highlighting the foundation of the International History, Philosophy and Science Teaching Group (IHPST), the creation of *Science and Education*, and Matthews's ongoing work at the HPS&ST Newsletter. In the sequence, I introduce some of Matthew's theoretical defenses and contributions to HP&ST, aiming to summarize what I consider some of the brickstones of the field. Finally, I present some final remarks.

MICHAEL MATTHEWS' PERSONAL TRAJECTORY TOWARDS THE FOUNDATION OF HP&ST

The interconnection between HP&ST history and Michael Matthews's own trajectory is very impressive. Some of Matthews's questions and concerns, already present in his undergraduation, became important philosophical issues in his future perspectives (in a revisited and deeper way). In this section, I intend to briefly outline some of Matthews's early philosophical influences in order to connect with the subsequent development of the field. In the preface of his autobiography, he says:

In this book, issues and topics are picked out in as much as I have made contributions to them. Inevitably, it is an opinionated treatment. The conviction, however, is that my own personal story of progress from youthful philosophically-interested Catholic adolescent and undergraduate science student, through a commitment to liberal education, and finally being a contributor to HPS&ST research-might have

some value to others and perhaps illuminate some fundamental issues in the field (Matthews, 2021, p. vii)

Matthews was born in a Catholic family and studied in a prestigious Christian school. His engagement with the Christian doctrine led him to important philosophical inquiry in the time of the church reform in the second Vatican Council (1962-1965). The transformations in the church, referring to social sensible topics, such as contraception, brought about the tension between the Natural Law doctrine present in many arguments of the Christian philosophy and social or cultural perspectives about the Christian morality, according to which such issues could not be object of universal claims:

Clearly, the positive side of commitment to Natural Law was that it allowed, indeed commanded, rejection of the laws and commands of dictatorial, unjust regimes; it provided a non-political, trans-historical, philosophical court of appeal. In Nazi Germany, Stalinist Russia, Mao's China, and so many other places, this emboldened and gave comfort to the brave. But the theory did depend on identification of, and agreement about, what was natural in the natural law and, counter-wisely, what in natural law might be accounted for by culture and historic circumstance? (Matthews, 2021, p. 15)

It is interesting that the tension between natural law and sociological perspective that already took Matthews's attention in his catholic trajectory was also present in the cultural environment of that period in general. Years later, a similar debate would take place, a conflict between objectivist *versus* constructivist standpoints in the field of Philosophy and Sociology of Science, an episode that is deeply connected with the beginning of HP&ST.

Michael Matthews obtained a science degree and teacher training at Sydney University, completed a double-honours degree in psychology and philosophy, a master's degree in history and philosophy of science, and a master degree and PhD in Education. During his studies, Matthews had a significant training in Philosophy of Science and Philosophy of Education, a path that would eventually lead him to HP&ST.

In the philosophy of science course, Matthews got in touch with the grounds of logical empiricism, which provided important elements for understanding the nature of science:

Logical Empiricism's programme of explicating and understanding key scientific concepts such as law, theory, observation, reduction, explanation, and so on, and its concern with clear and unambiguous writing, left a lasting impression. 'Write clearly' was the Sydney philosophy department's mantra (Matthews, 2021, p. 41).

Matthews (2021) also discusses some of the chief claims of logical empiricism and his relation to them:

1. Science seeks the truth; it endeavours to find out how the physical, social, and personal worlds work and are constituted.
2. Ultimately, though not immediately, empirical testing and evidence are determinate for scientific truth claims.
3. Statements that, in principle, were non-empirical (theological and traditional metaphysical) were meaningful but were neither true nor false.
4. Science is unified, although there are different *methods* employed across natural sciences and across social sciences, there is a unified family of *methodology* involved in all science.
5. The methodology of science needs to be rational and reasonable, it cannot be subservient to politics, religion, commerce, or other external factors.
6. Science depends upon adherence to both cognitive and personal values.
7. Science is universal: there are no 'local' sciences; the truths of science are equally true across cultures.
8. Science methodologically assumes a naturalistic (but not physicalist) world view.
9. A naturalistic world view is the only correct one: supernatural, transcendental, idealist, and orthodox religious world views are mistaken; the world and its causal processes are not the way such views maintain.
10. Science is part of the Enlightenment tradition; this tradition has had a positive benefit to the world; the social, political, and educational requirements of science need to be defended and extended.

At the time I was convinced of all of these theses. Fifty-plus years later, with suitable refinements being made as my own studies in HPS progressed, I continue to be, with the exception of #3, so committed. For this third thesis, it is more defensible to simply allow different kinds of truths e.g. mathematical, moral, literary, scientific (Matthews, 2021, p. 41).

The adherence to logical empiricism description of science reappears in different forms in Matthews's work. Moreover, his philosophical formation allowed him to submit many of popular Science Education claims to a rigorous inquiry and to sustain a firm position against obscurantist writing and superficial ideas : « «Now reading the postmodern avalanche of unintelligible sentences and excruciating verbiage in Education, the era of logical positivism seems positively luminous » (Matthews, 2021, p. 43).

In the course on Philosophy of Education, on the other hand, Matthews was deeply influenced by liberal education. According to this perspective, education is an end in itself, not being subdued to commercial, utilitarian, political interests. Matthews stresses

that, in a liberal education, someone is introduced to the main paradigm examples of the various forms of knowledge in order to think with their concepts and logic. For Science Education, liberal education has a direct impact:

An immediate implication is that teachers, then students, come to have knowledge or appreciation of the history and philosophy of the different domains they teach and are learning; the epistemology and methodology of the domains. They need to know, for instance, if there are truth criteria for a domain (History, Art, Maths), and if so, what they are (Matthews, 2021, p. 54).

In the next sections, Matthews's trajectory in the institutionalization and conceptualization of HP&ST is discussed. Throughout his history, it is possible to realize how these first philosophical influences were kept alive in his work and important debates of the field.

THE INSTITUTIONALIZATION OF HP&ST

Modern disciplines are not simply a collection of independent studies and writings. First, they encompass specific theories, methods, and problems that are the objects of concern and interest of a specific community - what we may call the theoretical conception of the field. Nevertheless, they are also formed by a concrete network of scientists, institutions, specialized journals and communication means that allow the knowledge production to undergo a very strict process of review, debate, and diffusion inside the scientific community - what we may call the institutionalization of the field.

In this sense, for a modern research field to be founded, it is necessary to conceive it theoretically and provide the institutional means for it to exist. More specifically, this institutionalization may encompass three processes: (i) creation of specific institutions, associations or groups, responsible for assembling a community, shaping its identity around specific research problems, theories and methods; (ii) foundation of specialized journals, in which papers can be evaluated and read by specialists; (iii) creation of communication means that promote the diffusion of ideas and works, and that aid to sustain the identity of the community. In this section, I discuss how Michael Matthews has strongly contributed for these three processes in HP&ST field.

The beginning of IHPST

In 1987, Michael Matthews went to Tallahassee, Florida, USA, where David Gureder, a researcher on Galileo, was working. At that time, Jaakko Hintikka (1929-2015), editor

of *Synthese Journal*², invited Matthews to guest edit a special issue on HP&ST. Not only Michael Matthews accepted that challenge, but he was also able to gather a great number of significant papers on the subject, which had to be distributed over 6 issues in different journals (including *Synthese*).

This first step allowed the formation of a movement around the research on HP&ST and, in 1989, the first conference of the subject was held in Tallahassee, assembling about 200 participants from 30 countries. This meeting may be considered the beginning of the International History, Philosophy and Science Teaching Group³. Michael Matthews was its foundation secretary and newsletter editor.

As Matthews widely discusses, this period was heated by the conflicts and debates of *Science Wars*, in which scientists, philosophers and sociologists discussed the possible interpretations and conceptions about the nature of science and the scientific knowledge. This tension was translated into the HP&ST community and conference, which promoted a wide-open debate on the subject. During all these years, Michael Matthews himself was engaged in the constructivism-objectivism debate, holding a firm position against the constructivist philosophy and pedagogy, as we will discuss in the next section. This tension led to a break in the field in 2006, when Keneth Tobin and Wolff-Michael Roth founded *Cultural Studies of Science Education*, and many constructionism-friendly HP&ST researchers migrated to cultural studies.

Despite being created in 1987, IHPST was only formalized in 2007, and Michael Matthews was elected founding president. During this time, IHPST has been the most important international HP&ST group, joining the research community in biannual conferences since 1987, altogether with biannual regional conferences. It is a group committed with the enhancing of science education through the discussion with philosophy of science and philosophy of education as it is described in its website:

The group is concerned to promote the betterment of school and university science and mathematics education by making them informed by the history, philosophy, and sociology of science and mathematics. It has a particular interest in bringing these spheres of knowledge into teacher-education programmes. The group through its activities promotes:

- The utilization of historical, philosophical, and sociological scholarship to clarify and deal with the many curriculum, pedagogical and theoretical issues facing contemporary science education.
- Collaboration between the communities of scientists, mathematicians, historians,

2 *Synthese* is a philosophy journal focusing on contemporary issues in epistemology, philosophy of science, and related fields (<https://www.springer.com/journal/11229>)

3 <https://ihpst.clubexpress.com/>

philosophers, cognitive psychologists, sociologists, and science educators, and school and college teachers.

- The inclusion of appropriate history, philosophy, and sociology of science courses in science teacher-education programmes.
- The dissemination of accounts of lessons, units of work, and programmes in science, at all levels, that have successfully utilized history, philosophy, and sociology.
- Discussion of the philosophy and purposes of science education, and their place in, and contribution to, the intellectual and ethical development of individuals and cultures.
- Nowadays, IHPST has about 200 active associates from the following countries: USA, Canada, Mexico, Colombia, Argentina Brazil, South Korea, Israel, Portugal, Sweden, Greece, Lebanon, UK, Netherland, Denmark, Australia, Germany, France, Spain, Taiwan, Italy, Russia, Ireland, Switzerland⁴.

The foundation of Science & Education

One of the main consequences of the Tallahassee conference and the creation of IHPST was Kluwer Education editor's invitation for Michael Matthews to transform the group Newsletter into a specialized peer reviewed journal: *Science & Education - Contributions from History, Philosophy and Sociology of Science and Mathematics*. Besides founding *Science & Education* in 1992, Michael Matthews held the position of chief editor for 25 years.

In his first editorial, Matthews presented the main features and objectives of the journal, which, in great extent, dialogued with the ideals that inspired IHPST creation and that would become Michael Matthews's standpoints for the next years. First of all, it should be emphasized that *Science & Education* is the first specialized journal on the topic:

Science & Education: Contributions from History, The publication of Philosophy and Sociology of Science and Mathematics is a landmark in science and mathematics education: for the first time a specialised journal will promote contributions that historical, philosophical and sociological studies make to practical and theoretical issues in these two important areas of educational endeavour (Matthews, 1992a, p. 1).

As it will be discussed in the next section, one of the main HP&ST claims is that Mathematics and Science Education would be strongly enhanced if there was a more intense and concrete debate among science education, mathematics education, philosophy of science and philosophy of education. Consequently, HP&ST is essentially a cross-disciplinary field:

4 This information was gently provided by prof. Andreia Guerra, the current IHPST president.

Science & Education hopes to become a cross-disciplinary forum. The members of the editorial committee are drawn from philosophers of science, philosophers of education, historians of science, cognitive psychologists, scientists and mathematicians, science and mathematics teachers, and educators. (...) One major division that Science & Education seeks to overcome is that between researchers in mathematics education and researchers in science education (Matthews, 1992a, p. 2).

Beyond that, Michael Matthews also presented a clear commitment to making *Science & Education* capable of including authors whose first language is not English:

For financial, historical and practical reasons the medium of the journal is English. Every effort will be made to publish non-English authors, and to seek translations of good and relevant research in other languages; as well as to provide information about curricula and other developments in the non-Anglo world. The editorial committee is drawn from fifteen countries and will seek out local research that falls within the scope of the journal (Matthews, 1992a, p. 3).

The very inclusive and wide-open perspective held by Michael Matthews also allowed HP&ST to be a field in communication with other traditional movements in Science Education, such as STS (Science, Technology and Society):

These STS courses, in England, Holland, Canada and the US, deal explicitly with political and ethical issues, and such discussion depends upon notions such as justice, equality, distribution of goods, responsibility and the like - all of which are illuminated, or at least clarified, by philosophical analysis, and by reference to the considerable debate surrounding the history of these ideas (Matthews, 1992a, p. 4).

The sociological dimension that STS discussion brings up also triggers the arguments around the Science Wars, a matter that was present since the creation of IHPST and has always concerned Michael Matthews:

Multicultural education is another instance. Here the calls for inclusion of ethnic science in the curriculum are frequently made in the name of Kuhnian relativism, and the contention that the epistemology of western science and mathematics is but one among a number of equally valid epistemologies. This is an argument with enormous practical ramifications, and it deserves more critical analysis than it often receives in curriculum and policy debates. Another example is the current spread of constructivism. Constructivism is on its way to being a new orthodoxy in both science and mathematics education. It is laden with ontological and epistemological

commitments, yet many of these are made on faith, or in disregard of the philosophical analyses that bear upon them. Without appreciation of the history and philosophy of science, constructivism is intellectually superficial, and an easy target for critics: it runs the risk of repeating the mistakes of discovery learning (Matthews, 1992a, p. 5).

Despite Michael Matthews's clear criticism against constructivism what is even more important is the open and outspoken call for debate. *Science & Education* was not conceived to be a dogmatic journal or a space for indoctrination, but a forum for discussion and dialogue. This intellectual and epistemological position of the editor is also clear in the first volume where we may find Suchting's (1992) paper *Constructivism deconstructed*, as well as von Galserslfed (1992) detailed answer: *Constructivism reconstructed: a reply to Suchting*.

By providing this open space for debate, Michael Matthews reinforces that HP&ST is not a field only concerned about providing the "right answers" but about encouraging researchers, teachers and students to ask more questions and to think about the different possibilities these questions may provide:

The educational task is not so much to provide the answers but to get the students to see that there are questions; and having seen the questions to try to answer them as honestly and thoroughly as is possible with the realisation that their own answers are likely to be disputed and that they can learn from such criticism (Matthews, 1992a, p. 8).

Since the foundation of *Science & Education* in 1992, the journal has been consolidated as the most important specialized journal on the topic. Some numbers that can corroborate such claim are given in Matthews's autobiography:

In 2009, there were 65,000 article-downloads from the publisher's website with, interestingly, 21% of the downloads being from China (23% from USA). By the end of my editorship in 2015, the downloads were edging towards 100,000 pa. In 2019, at the end of my successor's (Kostas Kampourakis) editorship there were 162,000 article downloads pa. With Asia-Pacific having 27%, Europe 27%, and North America 26% (Matthews, 2021, p. 141).

Also, after leaving *Science & Education* editor position, Michael Matthews edited a 25th birthday celebration handbook, containing an important collection of the main contemporary perspectives on HP&ST:

To celebrate the 25th 'birthday' of the journal Springer asked me to edit an

International Handbook of Research in History, Philosophy and Science Teaching. This was prepared over a three-year period and published in 2014 (Matthews, 2014). There were 3 volumes, 76 chapters, 2,544 pages, and 125 authors from 30 countries contributed. The Subject Index had 2,000 entries, the Name Index had 3,600 entries, and there were 10,200 References. A truly comprehensive, and mega time-consuming, work (<https://www.springer.com/gp/book/9789400776531>) (Matthews, 2021, p. 140).

A detailed discussion about Michael Matthews's editorship may be found in his autobiography and in a special paper on the subject (Matthews, 2015).

HPS&ST Newsletter

Besides editing *Science & Education* for 25 years, Michael Matthews has also been editing the *HPS&ST Newsletter*⁵ since the foundation of IHPST in 1989. Unlike *Science & Education*, which is a specialized peer reviewed journal, the *Newsletter* is a monthly publication destined to communicate about events, publications, position essays, integrating the HP&ST community. As Michael Matthews (2021) stresses, Paulo Maurício in Lisbon and Nathan Oseroff-Spicer in London have significantly contributed to the *Newsletter*. In 2021, still committed with the original endeavor of making HP&ST community accessible for researchers all over the world, Michael Matthews added new assistant editors from different continents to make the information about the community more integrated.

MICHAEL MATTHEWS'S PHILOSOPHICAL APPROACH TO HP&ST

The protagonist role of Michael Matthews in the institutionalization of HP&ST was briefly described in the last section. Nonetheless, a research field is not only defined by its institutional aspects but also by its theoretical and philosophical propositions. In other words, it answers questions like the following ones: What is HP&ST? What are its main claims, problems, questions, methods, theories, and objectives? Which elements differentiate HP&ST from other research fields and distinguish good and bad research in HP&ST? In this section, the contribution of Michael Matthews to the conceptualization of HP&ST will be presented.

My starting point to discuss Michael Matthews's contribution to the conception of the HP&ST field is the set of papers he published in the six special editions resultant of the Synthese invitation in 1989. In these works, Matthews (1989a, 1989b) recalls that it

5 The newsletter is accessible at <http://www.hpsst.com/hpsst-newsletter.html>

has been thirty years since the last major reforms in science Education. In the 1950s and 1960s, the Russian sputnik motivated a wide reform in science education in America, according to which the objective of education should be to create "little scientists". This perspective motivated the notion of "science as inquiry", in which students should be submitted to investigation practices, organized under a naïve inductivist conception. Some examples of inadequate description of science are the following:

Comprehending the nature of science is equated with specific steps in the scientific method, and understanding the nature of technology is synonymous with the definition "technology is applied science". History of science is merely the presentation of summaries of famous scientists, and there is little or no recognition of technology as a significant force shaping human society. We suggest that all of these examples are inappropriate and inadequate (Bybee, Ellis, & Matthews, 1992, p. 327).

In the final years of the 1980s there were already enough results to consider that this educational perspective had failed: "In spite of new curricula, better trained teachers, and improved facilities and equipment, the optimistic expectations for students becoming inquirers have seldom been fulfilled" (Welch et al. 1981, p. 33 apud Matthews, 1989a). Addressing the dramatic situation of science education in the US and the failure of the inadequate science representation in the educational context, Michael Matthews defends that "It is apparent that the curricula and the teaching processes would have benefited if philosophers and historians had from the outset been more engaged in the reform task" (Matthews, 1989b, p. 2). This may be recognized as one of the first claims of HP&ST, i.e., science education would be significantly enhanced if there was a proper discussion with disciplines such as history and philosophy of science.

This claim is supported by the notion that every didactic activity in science education always introduces some representation of science. We do not decide whether introducing a philosophical view of science or not, but we decide if we are going to be aware of the perspective introduced and if we are going to make it as consistent as possible.

This paper describes an attempt to introduce philosophy and history of science to pre-service science teachers. I argue briefly for the view that science in the schools cannot be taught without implicitly assuming a particular philosophy of science. Therefore, both philosophy and history of science are necessary components of under graduate science education courses (Matthews, 1990b, p. 93).

Therefore, Matthews does not argue in favor of substituting "scientific topics" for

“philosophical or historical” ones. Every Physics teacher speaks about Galileo, Newton, Kepler, Einstein, Joule. Moreover, every science teacher speaks about law, theory, postulates, derivation, observation, measurement, and so on. In these frequent situations, the teacher has an opportunity to discuss not only the technical subject that is being studied but also to provide a wider discussion about what science is, how it progresses and why we should trust science. The teacher can also use the historical episode to discuss not only the answers provided by science but also the questions originally made. Thus, HP&ST is proposed in terms of offering a liberal, cultural education, by widening the aims of science education, in which the student is able to understand science as a historical and cultural process (Matthews, 2021).

The present rapprochement

The first paper of Science & Education is Michael Matthews’s (1992b) *History, philosophy, and science teaching: The present rapprochement*, and, in my opinion, it is the most important landmark in the conceptualization of HP&ST as a research field. As pointed out by Moura (2021), this paper had a significant impact in the international community. Its Spanish and Portuguese translations, published in *Enseñanza de las ciencias* and *Caderno Brasileiro de Ensino de Física* respectively, have more citations than the original publication in English.

As the title suggests, Michael Matthews starts the paper discussing the recent Science Education reforms (in the end of the 1980s), which started to take the historical and philosophical dimensions of science into account. In this presentation, HP&ST is introduced as an important mean to enhance Science Education and to conceive it in terms of not only technical or disciplinary goals, but also as an opportunity for students to understand their own culture, history and society. The present rapprochement is dyed by the ampliation of the purposes of science education, influenced by a liberal perspective on education.

Michael Matthews has not only presented the curriculum reforms in detail but also discussed the main critiques to the introduction of history of science in science education, and sketched some possible relations between HP&ST and psychology of learning. At the end, Matthews proposed six topical issues that should concern science education and that would benefit by philosophical attention: Feminism, Constructivism, Ethics, Metaphysics, Idealization, and Rationality. The paper introduces the general aspects of the field, its main critiques and perspectives. Even after thirty years, it is completely contemporary and it is still an important reading for everyone interested in HP&ST.

Some of Matthews’s claims along the last 30 years

Michael Matthews’s autobiography, as he explains, is not a presentation of the HP&ST

state of the art nor a review of his own propositions in the field, but a personal story. Nevertheless, many of Matthews's standpoints, propositions and studies are addressed in the book and in the referenced literature.

While reading the book, as someone deeply engaged with science education and HP&ST, it is unavoidable to reflect about which lessons we can learn from Matthews's account. In this section, I would like to summarize some of the main messages that I learned through the reading. Of course, these topics do not end the discussion present in the book nor in Matthews's wide list of publications. Probably, other readers (or Matthews himself) could highlight other issues.

1) HP&ST becomes fundamental in a liberal education.

The influence of the liberal education philosophy in Matthews's conceptions is clear along all his autobiography. As already discussed in this paper, liberal education aims to provide a more general education, in which the student may understand science as a historical and cultural process as well as its role in society. This proposal overcomes the technicist perspective that was hegemonic in the education reforms of the 1950s and 1960s. Aiming to provide a wide, cultural, humanistic education, which offers the appropriate tools for students to understand their realities and to act ethically in the world, Science Education may significantly benefit from History and Philosophy of Science.

Historical and philosophical discussions are means to enhance Science Education and to make it more capable of achieving the purposes of a liberal education. This first claim, present along all of Matthews's trajectory, makes us remember that we always must make clear what the purpose of Education is. Proposing historical and philosophical approaches in a technicist perspective, for instance, would only reinforce a fragmented conception of science and would not contribute to a better education. Philosophy of Education is fundamental to pave the path for HP&ST.

2) Science Education is always philosophical.

A second message that is diffused through all the text, and that is explicitly stated in Matthews (1990b) is that science education is always philosophical. Every pedagogic instruction is committed to some epistemological perspective. By proposing HP&ST, one aims to make this philosophical discussion explicit and consistent. When Philosophy of Science is ignored, it is easier to defend superficial or contradictory ideas. HP&ST perspective, on the other hand, makes the philosophical discussion about the "features of science" (Matthews, 2012) explicit. So, one is not substituting scientific topics for philosophical or historical one, but only enhancing science education, making it deeper and more reflexive.

3) *Our enlightenment heritage should be brought back to the spotlight.*

The influence of the enlightenment spirit in Matthew's trajectory is also explicit throughout his autobiography. The defense of the liberal education and his commitment to logical-empiricist description of science are some examples already mentioned. Besides, Matthews presents a detailed section about Enlightenment and Education. Some of the raised issues are the commitments of Enlightenment (universalism, objectivity, rationalism, empiricism, scientism, anti-revelationism, naturalism, utilitarianism, optimism, independence) (Matthews, 2021, p. 142).

Nowadays, when we face anti-vaccine and climate change denial movements, the values of enlightenment should be brought back to the spotlight of Science Education and HP&ST. In some sub-fields of Science Education, words such as rationalism and empiricism seem to be X-rated. The role of science in the solution of some crucial contemporary challenges is a fundamental topic for Science Education, and the Enlightenment tradition may bring important insights about that discussion. Michael Matthews has developed many studies on Ernst Mach, one influent physicist and enlightenment thinker (Matthews, 1990a, 2016) and also discussed the development of the Enlightenment Project by Mario Bunge (Matthews, 2019a, 2019b).

4) *Cross-disciplinary dialogue is necessary in HP&ST.*

Typically, science teachers and researchers in the science education field have not a formal training in History and Philosophy. Matthews highlights that many of the researchers in HP&ST have to learn the subject themselves or from other science education researchers. Philosophical and Historical discussions, though, may demand deep and rigorous analysis and debate – otherwise one may get stuck in superficial ideas or be simply repeating jargons. Many of different trends in science education, unfortunately, fit exactly in this situation. A more rigorous training in Philosophy and History would be beneficial for the researchers of the field. Also, the complexity of the issues addressed by HP&ST make it essentially a cross-disciplinary field. An intense and effective communication among historians, philosophers and educators would contribute for establishing a deeper analysis of contemporary topics.

5) *Write good philosophy, write clearly.*

Not only the philosophical superficiality but also the intentional practice of obscurantist writing is a challenge. Many times, this obscurantist writing is also associated to the defense of ontological and epistemological claims that could not be supported after a deeper philosophical analysis. Unfortunately, this conception of philosophical writing is widespread in different academic fields, including Science Education. About this topic, Matthews comments:

The damage done to the minds of students who are subject to one, two, three, or more years of reading texts such as those above, is inestimable. I saw the effects with my own eyes within days of arriving in Auckland. If that is the academic norm, if that is how you are supposed to learn to write, then what possible chance is there that university education can contribute to people writing clearly, being able to judge sense from nonsense, good advice from gobbledegook, and appreciate the difference between sound and unsound arguments? Minimal chance (Matthews, 2021, p. 176).

A more detailed discussion on obscurantist writing and a criticism against the philosophical and pedagogical problems of constructivism may be found in the autobiography (Matthews, 2021).

6) *Education is not indoctrination.*

Matthews also stresses the difference between education and indoctrination:

The teacher may have strong opinions on various HPS issues, but the point of education is to develop the students' minds, which means giving students the knowledge and wherewithal to develop informed opinions about HPS, and the interest and motivation to seek out such knowledge. (Matthews, 2021, p. 277).

Indoctrination is the practice that aims to make students to think exactly like the teacher. Instead of broadening students' minds and comprehension, indoctrination sharpens the discussion towards a specific pre-established view. In a 1998 paper, Matthews says:

We look back on these examples and realize that something was wrong. It is not just that the positions (logical empiricism, inductivism, and dialectical materialism) are now seen as flawed, but we think that something else was amiss. This problem is still with us (Matthews, 1998a, p. 167).

The problem still with us is the intention of convincing others that our epistemological standpoint should be "the epistemology". If we consider that when students agree with the teacher's perspective (in a controversial topic, such as nature of science), they are getting a more sophisticated view, this is indoctrination. On the other hand, education should provide informed perspectives about reality so students can develop their own standpoints. Hanson comments on this topic: "There is not one nature of science..... When teachers intentionally argue for a specific perspective (as discussed in the quote by Matthews above) on such a controversial issue then this is a self-evident case of indoctrination" (Hansson, 2018, p. 294).

Some important research topics

Along his academic trajectory, Michael Matthews has devoted his time to research important topics on HP&ST. Many of these studies are described in his autobiography. Specially, Michael Matthews highlights his studies about Science and Worldviews, the history of the pendulum, and the recent studies on Feng-Shui.

Pendulum Studies (1995-2005)

One of the main interests of Michael Matthews was the history of pendulum. About this, he wrote:

In 1994, returning to UNSW from Auckland, I was able to turn back to my Shimony inspired pendulum studies. Utilising the wonderful resources of the UNSW library (in the days before everything was available online), I wrote a comprehensive book on the history, philosophy, and pedagogy of pendulum motion. The book *Time for Science Education: How the History and Philosophy of Pendulum Motion can Contribute to Science Literacy*—had 1,300 references and was published in 2000 (Matthews, 2000; <https://www.springer.com/gp/book/9780306458804>). All references were available in the wonderful UNSW library, and without the relentless pressure to publish, I was able, in my own time, to read them all. It is oft asked: How could 1,300 papers be written about the pendulum? The answer I give is: ‘read the book and see’ (Matthews, 2021, p. 193).

Besides the book just mentioned, Matthews also published a series of papers discussing the history of the pendulum and its implication for science education (Matthews, 1998b, 2001a, 2001b; Matthews, Gauld, & Stinner, 2004). In all these works, Matthews stresses the centrality of the pendulum in many prominent scientist studies, becoming an important figure of the scientific revolution and significantly impacting our culture and society.

Science and Worldviews (2008-2010)

In 2009, Michael Matthews edited a special issue on Science & Education about Science and World views (<https://link.springer.com/journal/11191/volumes-and-issues/18-6>). Afterwards, this special issue led to the publication of the book *Science, Worldviews and Education* (Matthews, 2009).

Feng Shui: Science or Pseudoscience? (2012-2020)

Matthews’s interest on Worldviews and Science led him to explore the philosophical, epistemological, historical, cultural aspects of eastern traditional medicine and their implication for Science Education:

Feng shui–informed Traditional Chinese Medicine (TCM) is a multi-billion dollar, international growth industry. Yet there was almost no extant discussion of the educational opportunities and responsibilities afforded by feng shui for science teachers. I believed such an investigation would be a fitting contribution to the HPS&ST research programme (Matthews, 2021, p. 224).

Matthews's studies on Feng Shui led to the publication of a book on the subject and a special issue on Science & Education (<https://link.springer.com/journal/11191/volumes-and-issues/30-6>).

FINAL REMARKS

We have been facing very challenging and extreme situations around the world in the last years. In this scenario, the COVID pandemic has made the importance of scientific endeavor even more evident in the contemporary society. Moreover, it has also made explicit that the understanding of what science is and how it works is still something strange to our mainstream culture. Fakenews, post-truth, science denial, anti-vaccine movement are just some examples of how obscure our times can be.

In this sense, Michael Matthews's thirty-year claims are more contemporary than ever. Our heritage from the Enlightenment project is exactly what provided vaccines, information about climate change, and possible solutions to the different contemporary problems. Education (and not indoctrination) is what allows students to develop a mature and independent perspective about the current status of knowledge and about how to act ethically with the best available information. In a liberal, humanistic, cultural education, one can pave the grounds for the development of this epistemic attitude. In this perspective, History and Philosophy are important tools and means to enhance Science Education, making it consistent with the aims of a liberal education.

Unfortunately, many of the contemporary movements and trends in Science Education are directed towards the defense of specific worldviews and political commitments instead of allowing students to develop their own intellectual independency. Superficial ideas and philosophical claims are not exception. Michael Matthews's trajectory is an example of resistance to such movements and doctrines. His theoretical propositions and many HP&ST studies provide a wide range of subjects and ideas to inspire future works and movements in the field. Again, I hope that the present paper works as an invitation for other researchers to read Matthews's autobiography, in which many important studies and claims are discussed in detail.

Besides Matthews's studies, his own academic and professional trajectory is also an example of important aspects to be considered. First, his own formal education in

Philosophy of Science and Philosophy of Education recalls us about the importance of rigorous education in these fields and sustaining a concrete cross-disciplinary dialogue with philosophers and scientists. Moreover, Matthews has been doing a significant effort to institutionalize HP&ST. Improving and widening this community must be an important commitment if we want to concretely impact contemporary education. The organization of institutions, journals and communication means is necessary to the diffusion of knowledge and, thus, it is part of the scientific activity.

In this paper, I have tried to briefly summarize some of Matthews's contributions to the institutionalization and conceptualization of HP&ST and share some of my personal reflections inspired by his autobiography. Certainly, many important aspects and episodes are missing and a complete discussion of Matthews's contribution to HP&ST would deserve many other papers. I hope, however, that this text motivates a wider debate about the identity of HP&ST and its role in the contemporary society. In this case, Matthews's trajectory is undoubtedly an important reference for us to think about the field during the next 30 years or more.

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