HPS&ST Newsletter
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Introduction

The HPS&ST Newsletter is sent monthly to about 11,000 emails of individuals who directly or indirectly have an interest in the contribution of history and philosophy of science to theoretical, curricular and pedagogical issues in science teaching, and/or interests in the promotion of innovative, engaging and effective teaching of the history and philosophy of science. The newsletter is sent on to different international and national HPS lists and international and national science teaching lists. In print or electronic form, it has been published for 40+ years.

The Newsletter, along with RESOURCES, OBITUARIES, OPINION PIECES and more, are lodged at the website: HERE

The newsletter seeks to serve the diverse international community of HPS&ST scholars and teachers by disseminating information about events and publications that connect to concerns of the HPS&ST community.

Contributions (publications, conferences, Opinion Piece, etc.) are welcome and should be sent direct to the editor: Michael R. Matthews, UNSW, **m.matthews@unsw.edu.au** .

John Heilbron (1934-2023): History in Physics Education

John Heilbron died in Padua, Italy, on November 5, 2023, at the age of 89. His scholarship extended from the history of early modern

European astronomy and natural philosophy to the revolutions of twentieth-century physics.

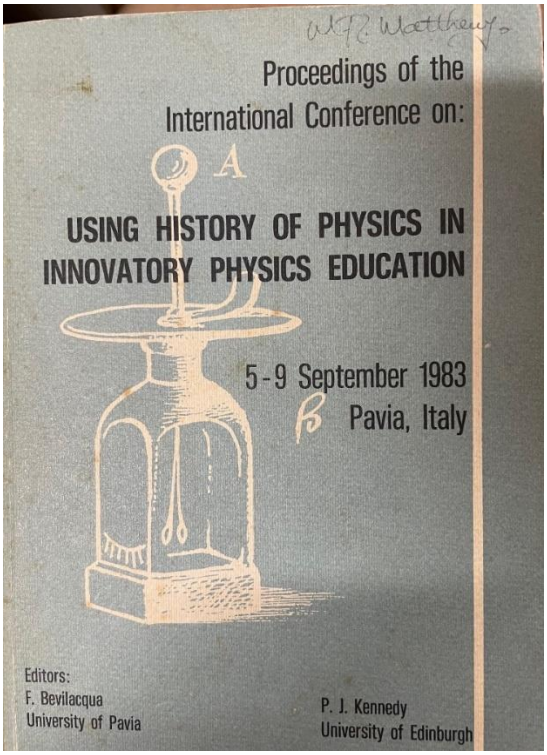
Like no other historian of physics of his era, he held the entire sweep of his field's history in view. The author of more than twenty books, many additional book-length studies, and crucial resources for the discipline, he received the profession's highest book prize, the Pfizer Prize, from the History of Science Society for his study *The Sun in the Church: Cathedrals as Solar Observatories* and was the recipient of the Society's most prestigious award, the Sarton Medal.

Obituaries:

University of California, Berkeley HERE
The Guardian HERE
Jim Baggott HERE

Heilbron had wide academic and cultural interests, including a concern with education. Forty years ago, in September 1983 he contributed to the first 'History of Physics and Physics Teaching Conference' which was held at Pavia University and organized by Fabio Bevilacqua (Pavia) and Peter Kennedy (Edinburgh). Ninety participants attended from 25 countries.

Heilbron's talk was titled: 'The Virtual Oscillator as Guide to Physics Students Lost in Plato's Cave'. It was reproduced in *Science & Education* 1994, Vol.3 No.2, 177-188, HERE



The 330 pp Proceedings were roneoed (pic above). Other contributors included:

Walter Jung
Lewis Pyenson
Salvo D'Agostino
Gerd Buchdahl
David Edge
Samuel Goldberg
Anthony French
Jürgen Teichmann
Harry Collins
Steven Shapin
Maurice Ebison
Bernadette Bensaude-Vincent

These were all internationally recognized historians of science; all had a concern with a better understanding of the history of science and utilizing history for the more engaging and productive teaching of science.

This 1983 conference led to the formation of the European History of Science Society's *History and Education* group, which held subsequent conferences in Munich (1986), Paris (1988), Madrid (1992), Szombathely (1994) and

Bratislava (1996). All conferences produced printed Proceedings. Copies are rare, however Fabio Bevilacqua and the newsletter editor, Michael Matthews, have originals.

Some papers were reproduced in *Science & Education:*

Jung, W.: 1983/1994, 'Toward Preparing Students for Change: A Critical Discussion of the Contribution of the History of Physics to Physics Teaching'. *Science & Education* 1994, 3(2), 99-130. HERE

Jung, W.: 1986/1993, `Cognitive Science and the History of Science', *Science & Education* **2**(1), 31-56. HERE

Buchdahl, G.: 1983/1993, 'Styles of Scientific Thinking'. *Science & Education* 2(2), 149-167. HERE

Pyenson, L.: 1993, 'The Ideology of Western Rationality: History of Science and the European Civilizing Mission', *Science & Education* 2(4), 329-344. HERE

Many in the European group contributed to the formation of the International History, Philosophy and Science Teaching Group at a 1989 conference in Tallahassee.

17th International History, Philosophy and Science Teaching Conference 2-6 September 2024 - Buenos Aires, Argentina

Conference e-mail: ihpst2024@gmail.com

Conference Theme: **Trusting school science again**

Conference Chair: Agustín Adúriz-Bravo, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires

Invited Speakers

2024 Springer Lecturer: **Cyrus Mody,** Maastricht University, The Netherlands
HERE

2024 Latin-American Lecturer: **Olimpia Lombardi,** CONICET, Argentina
HERE

Important Dates

Submission of proposals: Until 20th May 2024

Early registration: Until 30th June 2024

Ordinary registration: From 1st July 2024 until the first day of the Conference

Registration fee:
IHPST members: early (till June 30) USD165; after July 1, USD200
Non-members: USD260 & USD320
Argentina participants: USD20 discount on above.

Conference details: **HERE**

8th Panhellenic Conference on Philosophy of Science, Dec. 5-7 2024

The Department of History and Philosophy of Science of the National and Kapodistrian University of Athens organises the 8th Panhellenic Conference on Philosophy of Science to be held in Athens on December 5-7, 2024.

The thematic sections of the conference include all areas of philosophy of science (general philosophy of science, philosophy of special sciences), as well as areas of philosophy (metaphysics, epistemology, ethics, philosophy of language, philosophy of mind, history of philosophy, political philosophy) to the extent that they are related to issues concerning science.

Keynote Speakers:

Stéphanie Ruphy (Ecole normale supérieure (ENS Paris) - Université PSL)
James Ladyman (University of Bristol)

Abstracts for contributed papers should be between 500 and 700 words, not including references (up to 5 references can be included). The allocated time for delivering contributed papers will be 30 minutes, including discussion. Submissions of a symposium proposal must include a general description of the topic and its significance (between 500 and 700 words) and summaries (up to 250 words) for each contribution. Symposia will be allocated 2 hours, and can include 3 to 5 talks. They can have any format.

Deadline for submission of abstracts: 30 June 2024 Notifications of abstract acceptance: August 2024

For submission guidelines and to submit your abstract : **HERE**
For questions about the conference, please contact: phos@phs.uoa.gr

Fourth World Conference on Physics Education, 26-30 August, Krakow

The **4th WCPE** is organized by the Faculty of Physics, Astronomy and Applied Computer Science, Jagiellonian University, Kraków, Poland, in cooperation with the International Research Group on Physics Teaching (GIREP vzw), The International Conference on Physics Education (ICPE), and the Faculty of Physics and Astronomy, University of Wrocław, Poland.

Keynote Speakers:

Marisa Michelini, University of Udine, Italy
Paula R. L. Heron, University of Washington, United States of America
Claudio Fazio, University of Palermo, Italy
Lama Jaber, Florida State University, United States of America
Magdalena Kersting, University of Copenhagen, Denmark
Andreas Mueller, University of Geneva, Switzerland
Thomas Schubatzky, University of Innsbruck, Austria

Details: **HERE**

27th International Congress of History of Science and Technology, Dunedin, June 29-July 5, 2025

The 27th International Congress of History of Science and Technology will be held from **29 June - 5 July 2025** at the University of Otago in Dunedin, New Zealand.

Symposium Proposals due by 1 May 2024.
Standalone Papers due by 1 December 2024.

The International Congress of History of Science and Technology (ICHST), held every four years, is the world's premier meeting for history of science and technology. The 27th Congress will

be held as a hybrid in-person and online event at the University of Otago's Dunedin campus in June-July 2025. Delegates registered for virtual participation will be able to both present and attend online. The Congress will bring together a diverse group of the world's leading scholars and students in the fields of history of science, technology, and medicine as well as related disciplines. It will be the first time the Congress has been held in Australasia and only the second time in the Southern Hemisphere.

The **theme** of the 27th ICHST is "Peoples, Places, Exchanges, and Circulation."

Details **HERE**

 # OPINION PAGE

Quantum dialectics: When quantum mechanics posed a threat to the Marxist doctrine of materialism, communist physicists sought to reconcile the two*

JIM BAGGOTT

Jim Baggott is a freelance science writer. He holds a BSc in chemistry from the University of Manchester and a DPhil from Oxford University. He worked as a postgraduate research fellow at Oxford and at Stanford University in California before returning to England to take up a lectureship in chemistry at the University of Reading. After five years of academic life he decided on a complete change of career and worked in the oil industry for 11 years before setting up his own independent business consultancy and training practice.

He maintains a broad interest in science, philosophy, and history, and writes on these subjects in what spare time he can find. He was awarded the Marlow Medal by the Royal Society of Chemistry in 1989 and a Glaxo Science Writer's prize in 1992. His book *Mass: The Quest to Understand Matter from Greek Atoms to Quantum Fields*, won the 'Cosmos' Prize for Science Writing in 2020. He is co-author (with the late John L. Heilbron) of *Quantum Drama: From the Bohr-Einstein Debate to the Riddle of Entanglement.*

* This essay appeared in Aeon Magazine 23 May 2024.

THE QUANTUM REVOLUTION in physics played out over a period of 22 years, from 1905 to 1927. When it was done, the new theory of quantum mechanics had completely undermined the basis for our understanding of the material world. The familiar and intuitively appealing description of an atom as a tiny solar system, with electrons orbiting the atomic nucleus, was no longer satisfactory. The electron had instead become a phantom. Physicists discovered that in one kind of experiment, electrons behave like regular particles – as small, concentrated bits of matter. In another kind of experiment, electrons behave like waves. No experiment can be devised to show both types of behaviour at the same time. Quantum mechanics is unable to tell us what an electron *is*.

More unpalatable consequences ensued. The uncertainty principle placed fundamental limits on what we can hope to discover about the properties of quantum 'wave-particles'. Quantum mechanics also broke the sacred link between cause and effect, wreaking havoc on determinism, reducing scientific prediction to a matter of probability – to a roll of the dice. We could no longer say: when we do *this*, *that* will definitely happen. We could say only: when we do this, that will happen with a certain probability.

The Copenhagen School: Subjectivism and Idealism?

As the founders of the theory argued about what it meant, the views of the Danish physicist Niels Bohr began to dominate. He concluded that we have no choice but to describe our experiments and their results using seemingly contradictory, but nevertheless complementary, concepts of waves and particles borrowed from classical (pre-quantum) physics. This is Bohr's principle of 'complementarity'. He argued that there is no contradiction because, in the context of the quantum world, our use of these concepts is purely symbolic. We reach for whichever description – waves or particles – best serves the situation at hand, and we should not take the theory too literally. It has no meaning beyond its ability to connect our experiences of the quantum world as they are projected to us by the classical instruments we use to study it.

Bohr emphasised that complementarity did not deny the existence of an objective quantum reality lying beneath the phenomena. But it did deny that we can discover anything meaningful about this. Alas, despite his strenuous efforts to exercise care in his use of language, Bohr could be notoriously vague and more than occasionally incomprehensible. Pronouncements were delivered in tortured 'Bohrish'. It is said of his last recorded lecture that it took a team of linguists a week to discover the language he was speaking. And physicists of Bohr's school, most notably the German theorist Werner Heisenberg, were guilty of using language that, though less tortured, was frequently less cautious.

It was all too easy to interpret some of Heisenberg's pronouncements as a return to radical subjectivism, to the notion that our knowledge of the world is conjured only in the mind without reference to a real external world. It did not help that Bohr and physicists of Bohr's school sought to shoehorn complementarity into other domains of enquiry, such as biology and psychology, and attempted to use it to resolve age-old conundrums concerning free will and the nature of life. Such efforts garnered little support from the wider scientific community and attracted plenty of opprobrium.

Albert Einstein famously pushed back, declaring that, unlike quantum mechanics, God does not play dice. He argued that, while quantum mechanics was undoubtedly powerful, it was in some measure incomplete.

In 1927, Bohr and Einstein commenced a lively debate. Einstein was joined in dissent by the Austrian physicist Erwin Schrödinger, who devised the conundrum of 'Schrödinger's cat' to highlight the seemingly absurd implications of quantum mechanics. But although both Einstein and Schrödinger remained strident critics, they offered no counter-interpretation of their own. Despite their misgivings, there was simply no consensus on a viable alternative to complementarity.

Ideological Objections to Copenhagen I: Lenin's Materialism

Complementarity also fell afoul of the principal *political* ideologies that, in different ways, dominated human affairs from the early 1930s, through the Second World War, to the Cold War that followed. Both Bohr and Einstein were of Jewish descent and, to Nazi ideologues, complementarity and relativity theory were poisonous Jewish abstractions, at odds with the nationalistic programme of *Deutsche Physik*, or 'Aryan physics'. But the proponents of *Deutsche Physik* failed to secure the backing of the Nazi leadership, and any threat to complementarity from Nazi ideology disappeared with the war's ending. Much more enduring were the objections of Soviet communist philosophers who argued that complementarity was at odds with the official Marxist doctrine of 'dialectical materialism'.

Vladimir Lenin, who had led the Bolshevik Party in the October Revolution of 1917, was a dogmatic advocate of the materialist worldview

expounded by the German philosophers Karl Marx and Friedrich Engels, authors of *The Communist Manifesto*, first published in 1848. The world according to Marxism consists of objectively existing matter in constant motion, bound by laws. Such laws govern different levels of existence that we attempt to describe through different scientific disciplines that are not necessarily reducible one to another. For example, sociology – regarded as an empirical science – is not reducible to physics and is therefore bound by its own laws of human social and economic behaviour.

Marx and Engels observed that such behaviour breeds functional contradictions within an organised society. To survive, people submit to exploitative relationships with the means of economic production and those who own them. Distinct classes emerge: masters and their slaves, lords and their serfs, business owners (the bourgeoisie) and their low-wage workers (the proletariat).

These functional contradictions are ultimately resolved through inevitable class struggle resulting in irreversible changes in social organisation and the means of production. The classical antiquity of Greece and Rome had given way to feudalism. Feudalism had given way to capitalism. And capitalism was destined to give way to socialism and communism, to the utopia of a classless society. But the necessary changes in social organisation would not happen by themselves. The path led first through socialism and the 'dictatorship of the proletariat', supported by an autocratic state that would eventually no longer be needed when the communist utopia was realised. For Lenin, the ends justified the means, which included the violent repression of bourgeois capitalist and counter-revolutionary forces.

In Marxist philosophy, the method of studying and apprehending both social and physical phenomena is dialectical, and the interpretation of natural phenomena is firmly materialistic. It was not enough just to interpret the world, Marx claimed. Philosophers must also seek to change it, and this could not be done in a world built only from perceptions and ideas. Any philosophy that sought to disconnect us from material reality, by reducing the world to mere sensation and experience, posed a threat to Marxism.

In *Materialism and Empirio-Criticism* (1909), Lenin had berated the physicist Ernst Mach and his Russian followers, and the German philosopher Richard Avenarius, who had formulated the positivist doctrine of empirio-criticism. The philosophy of positivism was anathema, as it sought to reduce knowledge of the world to sensory experience. Lenin argued that such thinking led only to a subjective idealism, or even solipsism. To him, this was just so much 'gibberish'.

Complementarity looked just like the kind of positivist gibberish that Lenin had sought to annihilate. A reality accessible only in the form of quantum probabilities did not suit the needs of the official philosophy of Soviet communists. It appeared to undermine orthodox materialism. Nevertheless, an influential group of Soviet physicists, including Vladimir Fock, Lev Landau, Igor Tamm and Matvei Bronstein, promoted Bohr's views and for a time represented the 'Russian branch' of Bohr's school. This was not without some risk. Communist Party philosophers sought their dismissal, to no avail, largely because they could not agree on the issues among themselves.

Ideological Objections to Copenhagen II: Stalin's Materialism

The situation in the Soviet Union changed dramatically a few years later. As his health declined, Lenin had tried to remove the Communist Party's general secretary, Joseph Stalin, whom he deemed unfit for the role. But Stalin had been quietly consolidating his position and had placed loyalists in key administrative posts. After a brief power struggle following Lenin's death in 1924, Stalin became supreme leader. In 1937-38, he tightened his grip by unleashing a reign of terror, known as the Great Purge, in which many of the old Bolsheviks who had fought alongside Lenin in 1917 were executed. Although the total death toll is difficult to determine, a figure of 1 million is not unreasonable. Physicists were not exempt. Bronstein was arrested, accused of terrorism offences, and executed in February 1938.

Stalin put his own stamp on the political ideology of Soviet communists in his short text titled

Dialectical and Historical Materialism (1938), a formulation of Marxist philosophy that would be adopted as the official Communist Party line. Those intellectuals who resisted the official doctrine now faced real risks of losing more than just their jobs.

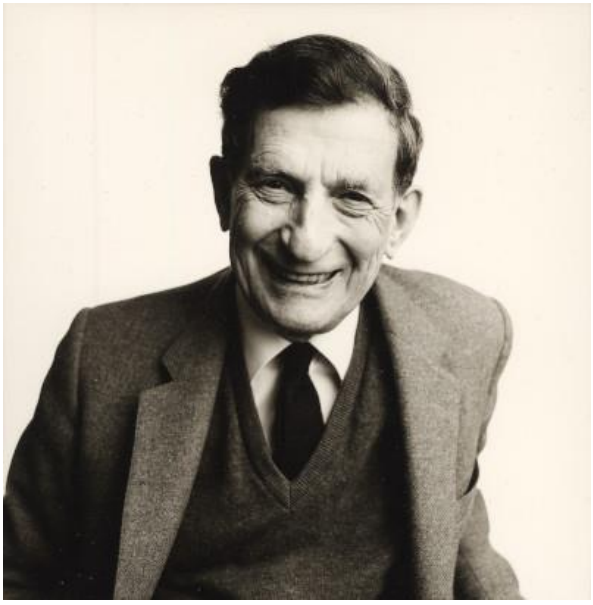
The distractions of the Second World War meant that little changed for physicists until Andrei Zhdanov, the Party's philosopher and propagandist-in-chief, who was thought by many to be Stalin's successor-in-waiting, specifically targeted the interpretation of quantum mechanics in a speech delivered in June 1947.'The Kantian vagaries of modern bourgeois atomic physicists,' he proclaimed, 'lead them to inferences about the electron's possessing "free will", to attempts to describe matter as only a certain conjunction of waves, and to other devilish tricks.' This was the beginning, writes the historian Loren Graham, 'of the most intense ideological campaign in the history of Soviet scholarship' (HERE). An outspoken commitment to complementarity became positively dangerous.

Soviet physicists scrambled to defensible positions. Fock retreated from complementarity as an objective law of nature, and criticised Bohr for his vagueness. Others sought ways to 'materialise' quantum mechanics. Dmitry Blokhintsev, a student of Tamm's, favoured a statistical interpretation based on the collective properties of an 'ensemble' of real particles. In such an interpretation we are obliged to deal with probabilities simply because we are ignorant of the properties and behaviours of the individual material particles that make up the ensemble.

Einstein had used this conception in the opening salvo of his debate with Bohr in 1927. Yakov Terletsky who, like Tamm, had studied under the Soviet physicist Leonid Mandelstam, favoured a 'pilot-wave' interpretation of the kind that had initially been promoted by the French physicist Louis de Broglie before it was shot down by Bohr's school in 1927. In this interpretation, a real wave field guides real particles, and probabilities again arise because we are ignorant of the details.

David Bohm: The Marxist Materialist

As the 1930s progressed towards world war, many Western intellectuals had embraced communism as the only perceived alternative to the looming threat of Nazism. Numbered among the small group of Jewish communist physicists gathered around J Robert Oppenheimer at the University of California, Berkeley was David Bohm. As Oppenheimer began to recruit a team of theorists to work on the physics of the atomic bomb at the newly established Los Alamos National Laboratory in early 1943, Bohm was high on his list. But Bohm's communist affiliations led the director of the Manhattan Project, Leslie Groves, to deny him the security clearance necessary to join the project.



Bohm was left behind at Berkeley and joined with his fellow communist and close friend Joseph Weinberg in teaching the absent Oppenheimer's course on quantum mechanics. His long discussions with Weinberg, who argued that complementarity was itself a form of dialectic and so not in conflict with Marxist philosophy, encouraged him to accept Bohr's arguments, although he was not free of doubt. In his textbook *Quantum Theory* (1951), derived in part from his experiences teaching Oppenheimer's course, Bohm broadly adhered to Bohr's views.

Bohm had by this time moved to Princeton University in New Jersey. Einstein, who in 1933 had fled from Nazi Germany to Princeton's Institute for Advanced Study, asked to meet with him sometime in the spring of 1951. The meeting re-awakened the Marxist materialist in Bohm. As Einstein explained the basis for his own misgivings, Bohm's doubts returned. 'This encounter with Einstein had a strong effect on the

direction of my research,' he later wrote, 'because I then became seriously interested in whether a deterministic extension of the quantum theory could be found.' Was there, after all, a more materialistic alternative to complementarity? 'My discussions with Einstein … encouraged me to look again.' Although there is no documented evidence to support it, Bohm later claimed he had also been influenced 'probably by Blokhintsev or some other Russian theorist like Terletsky'.

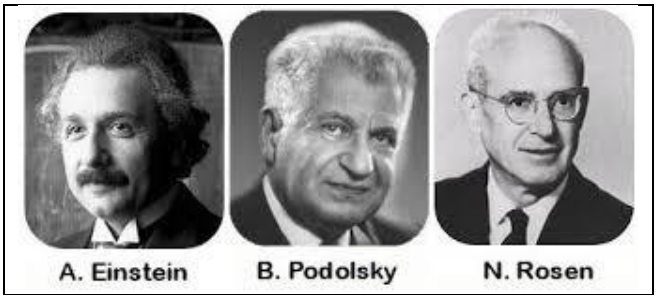
But Bohm's relationship with Weinberg had by now returned to haunt him. In March 1943, Weinberg had been caught betraying atomic secrets by an illegal FBI bug planted in the home of Steve Nelson, a key figure in the Communist Party apparatus in the San Francisco Bay Area. This evidence was inadmissible in court. In an attempt to expose Weinberg's betrayal, in May 1949 Bohm had been called to testify to the House Un-American Activities Committee, set up by the House of Representatives to investigate communist subversion in the US. He pleaded the Fifth Amendment, a standard means of avoiding self-incrimination, which only raised more suspicion.

Bohm was arrested, then brought to trial in May 1951. He was acquitted (as was Weinberg a couple of years later). Now caught in the anti-communist hysteria whipped up by Joseph McCarthy, Bohm lost his position at Princeton. Only Einstein tried to help, offering to bring him to the Institute. But its new director – Oppenheimer, now lauded as the 'father of the atomic bomb' and increasingly haunted by the FBI's interest in his own Leftist past – vetoed Bohm's appointment. Bohm left the US for exile in Brazil, from where he published two papers setting out what was, in effect, a re-discovery of de Broglie's pilot-wave theory. The theory sought to restore causality and determinism to the quantum world and was firmly materialist. Oppenheimer rejected Bohm's efforts as 'juvenile deviationism'. Einstein, who had once toyed with a similar approach and might have been expected to be sympathetic, declared it 'too cheap'.

Under a barrage of criticism, Bohm gained support from the French physicist Jean-Pierre Vigier, then assistant to de Broglie in Paris. He was just what Bohm needed: a resourceful theorist, a man of action, a hero of the French Resistance during the war, and a friend of the president of the Democratic Republic of Vietnam, Ho Chi Minh. Invited to join Einstein in Princeton, Vigier's communist associations had led the Department of State to forbid his entry into the US. He worked with Bohm on another variation of the pilot-wave theory and persuaded de Broglie to rekindle his interest in it, sounding alarm bells among the Bohr faithful: 'Catholics and communists in France are uniting against complementarity!'

The Einstein-Podolsky-Rosen (EPR) Thought Experiment

But Bohm's mission to restore materiality to quantum mechanics amounted to more than demonstrating the possibility of a deterministic alternative. In 1935, working with his Princeton colleagues Boris Podolsky and Nathan Rosen, Einstein had set up a stubborn challenge, a last throw of the dice in his debate with Bohr. In the Einstein-Podolsky-Rosen (EPR) thought experiment, a pair of quantum particles interact and move apart, to the left and right, their properties correlated by some physical law. Schrödinger invented the term 'entanglement' to describe their situation. For simplicity, we assume that the particles can have properties 'up' and 'down', each with a 50 per cent probability.



We have no way of knowing in advance what results we're going to get for each particle. But if the particle on the left is found to be 'up', the correlated particle on the right must be 'down', and vice versa. Now, according to quantum mechanics, the entangled particles are mysteriously bound together no matter how far apart they get, and the correlation persists. Suppose the particles move so far apart that any message or influence sent from one cannot get to the other even if it travels at the speed of light. How then does the particle on the right 'know'

what result we obtained for the particle on the left, so that it can correlate itself?

We could assume that when they are sufficiently far apart the particles can be considered separate and distinct, or 'locally real'. But this conflicts with Einstein's special theory of relativity, which forbids messages or influences from travelling *faster* than light, as Einstein himself explained: 'One can escape from this conclusion only by either assuming that the measurement of [the particle on the left] (telepathically) changes the real situation of [the particle on the right] *or by denying independent real situations as such to things which are spatially separated from each other*. Both alternatives appear to me entirely unacceptable.' (Emphasis added.) Particles that do not exist independently of each other are said to be 'nonlocal'.

Einstein was known for his pacifist and Leftist inclinations. Podolsky was Russian-born, and Rosen was a first-generation descendant of Russian émigrés. Both of Einstein's assistants were sympathetic to the Soviet cause. Six months after the publication of the EPR paper, Rosen asked Einstein to recommend him for a job in the Soviet Union. Einstein wrote to the chairman of the Council of People's Commissars, Vyacheslav Molotov, praising Rosen for his talents as a physicist.

Rosen was at first delighted with his new home, and soon he had a son. 'I hope,' Einstein wrote in congratulation, 'that he too can help in furthering the great cultural mission that the new Russia has undertaken with such energy.' But by October 1938 Rosen was back in the US, having discovered that his research did not prosper in the people's paradise.

Podolsky had earned his PhD at the California Institute of Technology and had returned to the Soviet Union in 1931 to work with Fock and Landau (and the visiting English theorist Paul Dirac) at the Ukrainian Institute of Physics and Technology in Kharkiv. From there, he joined Einstein at the Institute in Princeton in 1933. Ten years later, a prospective atomic spy assigned the codename 'Quantum' by Soviet intelligence attended a meeting at the Soviet embassy in Washington, DC and spoke with a high-ranking diplomat. Quantum was seeking an opportunity to join the Soviet effort to build an atomic bomb and offered information on a technique for separating quantities of the fissile isotope uranium-235. He was paid $300 for his trouble.

In Russian Foreign Intelligence Service (SVR) files made public in 2009, Quantum was revealed to be Podolsky.

Bohm examined the EPR experiment in considerable detail. He developed an alternative that offered the prospect of translation from a thought experiment into a real one. With the Israeli physicist Yakir Aharonov, in 1957 he sought to demonstrate that real experiments had in fact already been done (in 1950), concluding that they did indeed deny independent real situations to the separated particles, such that these cannot be considered locally real.

Entanglement is a Real Phenomenon

This was far from the end of the matter. Befuddled in his turn by Bohrian vagueness and inspired by Bohm, the Irish physicist John Bell also pushed back against complementarity and in 1964 built on Bohm's version of EPR to develop his theorem and inequality. The experiments of 1950 had not gone far enough. Further experiments to test Bell's inequality in 1972 and in 1981-82 demonstrated entanglement and nonlocality with few grounds for doubt.

It began to dawn on the wider scientific community that entanglement and nonlocality were real phenomena, leading to speculations on the possibility of building a quantum computer, and on the use of entangled particles in a system of quantum cryptography. The 2022 Nobel Prize in Physics was awarded to the three experimentalists who had done most to expose the reality of entanglement and its promise of 'a new kind of quantum technology'. The projected value of the quantum computing industry is estimated to be somewhere between $9billion and $93 billion by 2040. I doubt there is any other example in history of such a high-value industry constructed on a physical principle that nobody understands.

Conclusion

Marxism powered many objections to Bohr's complementarity, and so helped to shape the

development of postwar quantum mechanics. Soviet physicist-philosophers lent their support by finding positivist tendencies in Bohr's teaching in conflict with dialectical materialism. Some sought an alternative materialistic interpretation. Podolsky and Rosen both admired the Soviet Union and in different ways sought to contribute to its mission. Bohm laboured at a time when there was little appetite for what many physicists judged to be philosophical, and therefore irrelevant, foundational questions. It says much about Bohm's commitment that he resisted the temptation to leave such questions to play out in the theatre of the mind. The Marxist in Bohm sought not only to show that a materialistic alternative was possible, but also to find a way to bring the arguments into the real world of the laboratory.

It was not enough just to interpret the world. Bohm also sought to change it.

This essay is dedicated to the memory of my colleague, co-author and friend, John Heilbron, who died on 5 November 2023.

Invitation to Submit Opinion Piece

In order to make better educational use of the wide geographical and disciplinary reach of this *HPS&ST Note*, invitations are extended for readers to contribute opinion or position pieces or suggestions about any aspect of the past, present or future of HPS&ST studies.

Contributions can be sent direct to editor. Ideally, they might be pieces that are already on the web, in which case a few paragraphs introduction, with link to web site can be sent, or else the pieces will be put on the web with a link given in the Note.

They will be archived, and downloadable, in the OPINION folder at the HPS&ST web site **HERE**.

Varia

- Vale, Mary Terrall (1952-2023) **HERE**
- Vale, John Heilbron (1934-2023) **HERE**
- Subrena E. Smith, *Why philosophy is so important in science education* **HERE**
- Michael R. Matthews, *Thomas Kuhn and Science Education*, *Science & Education* Vol.33 No.3, **HERE**
- Schickore, J. & Newman, W. R. (Eds.) (2024). *Elusive Phenomena, Unwieldy Things: Historical Perspectives on Experimental Control.* Dordrecht: Springer. [**Open Access**]
- Eight HPS&ST books downloadable gratis **HERE**
- *Science & Education* Open Access articles (148) **HERE**

Featured Book

Bernard J.T. Jones, Vicent J. Martínez & Virginia L. Trimble *The Reinvention of Science: Slaying the Dragons of Dogma and Ignorance*, World Scientific, London, 2024.
ISBN: 9781800613607
492+viii pages

Throughout the history of science, different thinkers, philosophers and scientists postulated the existence of entities that, in spite of their not being visible or detectable in their time, or perhaps ever, were nevertheless useful to explain the real world. We started this book by looking at a handful of these entities. These included phlogiston to account for fire; the luminiferous ether for propagation of radiation; the homunculus to provide for heredity; and crystalline spheres to carry the wandering planets around the earth. Many of these erroneous beliefs had held up progress, just as dragons drawn on the edges of a map discouraged exploration. This pattern of science evolution continued through the centuries up to the present day.

The book evolved into a more extensive history of how science evolved through controversy, suppression, and the desire to maintain the status quo. Our story passes from the Babylonians and Greeks through the Middle Ages, the renaissance and the scientific revolution to almost current events.

We discuss the evolution of our world, the controversy about the extinction of dinosaurs, and open questions in contemporary science such as dark matter, black holes and the origin of the Universe, including how we understand the subatomic world of elementary particles.

Most of the chapters deal with astronomy, cosmology and physics, but there are brief ventures into geosciences (continental drift), biosciences (the homunculus), atmospheric physics (Heaviside layer), paleontology (the extinction of dinosaurs), and computer science (artificial intelligence).

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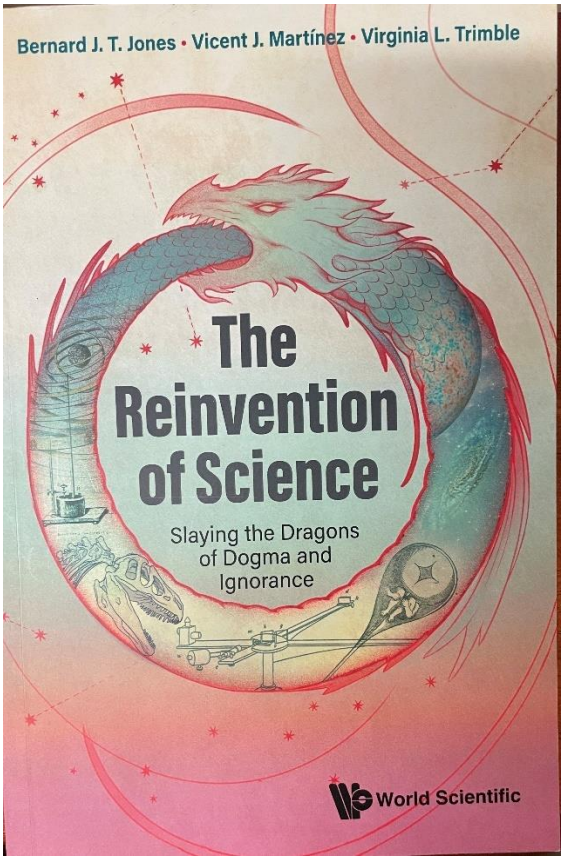

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  - Machines Reinventing Science

Chapter One ‘Ether and Atoms’ is available at the HPS&ST site **HERE**

AUTHORS OR PUBLISHERS of suitable HPS&ST books who would like an appropriate Preface, Introduction or First Chapter of their book featured in the newsletter, and placed in the RESOURCE folder of the HPSST website, should contact newsletter editor Michael R. Matthews

Recent HPS&ST Research Articles

Aizenman, J., King, C., Kling, T. et al. (2024). A Liberal Arts Curriculum that Situates Science While Promoting STEM Graduation. *Sci & Educ*, 1-21. https://doi.org/10.1007/s11191-024-00532-0

Baddour, R.I., BouJaoude, S. (2024). Exploring the Nature of Science Conceptions of University Science Professors Using the Family Resemblance Framework. *Sci & Educ*, 1-25. https://doi.org/10.1007/s11191-024-00535-x

Beck, P.T.L., Cornand, R., De Turck, W. et al. (2024). Replicating the Fontana-Ingenhousz Eudiometer: Incorporating Historical Experiments in Undergraduate Chemistry

Education. *Sci & Educ*, 1-27. https://doi.org/10.1007/s11191-024-00533-z

Danielson, R. W. et al. (2024). Conceptual contamination: Investigating the impact of misinformation on conceptual change and inoculation strategies. *Journal of Research in Science Teaching*, 1–26. https://doi.org/10.1002/tea.21963

El-Hani, C.N., Ludwig, D. (2024). Intercultural Education as Dialogue Between Knowledge Systems: Elements of a Theoretical Framework. *Sci & Educ*, 1-48. HERE

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Galili, I. (2024). The Observer Concept in Science as a Basis for Its Further Curricular Application Within the Discipline-Culture Paradigm. *Sci & Educ*, 1-31. https://doi.org/10.1007/s11191-024-00521-3

García-Méndez, S., de Arriba-Pérez, F. & Somoza-López, M.C. (2024). A Review on the Use of Large Language Models as Virtual Tutors. *Sci & Educ*, 1-16. https://doi.org/10.1007/s11191-024-00530-2

Garofalo, S.G., Farenga, S.J. (2014). Science Teacher Perceptions of the State of Knowledge and Education at the Advent of Generative Artificial Intelligence Popularity. *Sci & Educ*, 1-20. https://doi.org/10.1007/s11191-024-00534-y

Guerrero, G., & Sjöström, J. (2024). Critical scientific and environmental literacies: a systematic and critical review. *Studies in Science Education*, 1–47. https://doi.org/10.1080/03057267.2024.2344988

Hagiopol, C., Leru, P.M. (2024). Scientific Truth in a Post-Truth Era: A Review. *Sci & Educ*, 1-34. https://doi.org/10.1007/s11191-024-00527-x

Jenner, R.A. (2024). Lineage Thinking in Evolutionary Biology: How to Improve the Teaching of Tree Thinking. *Sci & Educ*, 1-18. https://doi.org/10.1007/s11191-024-00531-1

Lee, GG., Mun, S., Shin, MK. et al. (2024). Collaborative Learning with Artificial Intelligence Speakers: Pre-service Elementary Science Teachers' Responses to the Prototype *Sci & Educ*, 1-29. https://doi.org/10.1007/s11191-024-00526-y

Liu, R., Liu, C. & He, P. (2024). Chinese Grades 1–9 Students' Views of the Nature of Science: Do They Differ by Grade Level, Gender, and Parents' Occupation? *Sci & Educ*, 1-27. https://doi.org/10.1007/s11191-024-00519-x

Matthews, M.R. (2024). Thomas Kuhn and Science Education, *Science & Education* 33(3), 609-678. HERE

https://doi.org/10.1007/s11191-022-00408-1

Msambwa, M.M., Daniel, K., Lianyu, C. et al. (2024). A Systematic Review Using Feminist Perspectives on the Factors Affecting Girls' Participation in STEM Subjects. *Sci & Educ*, 1-32. https://doi.org/10.1007/s11191-024-00524-0

Örnek, F., Alaam, S. (2024). Five Essential Features of Scientific Inquiry in Bahraini Primary School Science Textbooks and Workbooks. *Sci & Educ*, 1-49. https://doi.org/10.1007/s11191-024-00523-1

Vicente, J.J., Franco-Mariscal, A.J. & Oliva, J.M. (2024). Enhancing Argumentation and Decision-Making of Preservice Early Childhood Education Teachers Through Role-Playing on Animal Experimentation. *Sci & Educ*, 1-33. https://doi.org/10.1007/s11191-024-00529-9

Ward, Z. B., & Creel, K. A. (2024). To Hedge or Not to Hedge: Scientific Claims and Public Justification. *Philosophy of Science*, 1–19. https://doi.org/10.1017/psa.2024.17

Recent HPS&ST Related Books

Girten, Kristin M. (2024). *Sensitive Witnesses: Feminist Materialism in the British Enlightenment*. Redwood City, CA: Stanford University Press. ISBN: 9781503633032

"Kristin M. Girten tells a new story of feminist knowledge-making in the Enlightenment era by exploring the British female philosophers who asserted their authority through the celebration of profoundly embodied observations, experiences, and experiments.

"This book explores the feminist materialist practice of sensitive witnessing, establishing an alternate history of the emergence of the scientific method in the eighteenth century. Francis Bacon and other male natural philosophers regularly downplayed the embodied nature of their observations. They presented themselves as modest witnesses,

detached from their environment and entitled to the domination and exploitation of it.

"In contrast, the author-philosophers that Girten takes up asserted themselves as intimately entangled with matter—boldly embracing their perceived close association with the material world as women. Girten shows how Lucy Hutchinson, Margaret Cavendish, Aphra Behn, Eliza Haywood, and Charlotte Smith took inspiration from materialist principles to challenge widely accepted "modest" conventions for practicing and communicating philosophy.

"Forerunners of the feminist materialism of today, these thinkers recognized the kinship of human and nonhuman nature and suggested a more accessible, inclusive version of science. Girten persuasively argues that our understanding of Enlightenment thought must take into account these sensitive witnesses' visions of an alternative scientific method informed by profound closeness with the natural world." (From the Publishers)

More information HERE

Haufe, Chris (2024). *Fruitfulness: Science, Metaphor, and the Puzzle of Promise*. Oxford, UK: Oxford University Press. ISBN: 9780197666395

"Some ideas seem to possess a disproportionate ability to lead to new insights, new discoveries, new ideas, and even entirely new ways of thinking. Such ideas are said to be fruitful. Looking across the history of science and mathematics, we see creative minds preoccupied with the search for ideas of this kind. More precious than truth, but far less plentiful, fruitful ideas provide those in pursuit of knowledge with a seemingly bottomless well of innovation from which to draw as they attempt to solve new problems and to refine solutions to old ones. Seasoned researchers have a nose for these ideas. They often know in an instant that some way of approaching a problem will eventually result in a solution to it and to a whole host of other problems, all of which suddenly seem related.

"In *Fruitfulness*, Chris Haufe explains how these ideas are detected and developed into large-scale frameworks for research. He argues for a philosophical perspective on scientific knowledge that places the search for fruitfulness at the heart of the scientific enterprise. This perspective demands a fundamental shift in our thinking about scientific theories, conceiving of them as metaphors to facilitate research instead of increasingly correct descriptions of nature." (From the Publisher)

More information HERE

Stengers, Isabelle (2023). *Virgin Mary and the Neutrino: Reality in Trouble* (A. Goffey, Trans.). Durham, NC: Duke University Press. ISBN: 978-1-4780-2520-7

"In *Virgin Mary and the Neutrino*, first published in French in 2006 and here appearing in English for the first time, Isabelle Stengers experiments with the possibility of addressing modern practices not as a block but through their divergence from each other. Drawing on thinkers ranging from John Dewey to Gilles Deleuze, she develops what she calls an "ecology of practices" into a capacious and heterogeneous perspective that is inclusive of cultural and political forces but not reducible to them.

"Stengers first advocates for an approach to sciences that would emphasize the way each should be situated by the kind of relationships demanded by what it attempts to address. This approach turns away from the disabling scientific/nonscientific binary—like the opposition between the neutrino and the Virgin Mary. An ecology of practices instead stimulates an appetite for thinking reality not as an arbiter but as what we can relate to through the generation of diverging concerns and obligations." (From the Publisher)

More information HERE

Jones, B. J. T., Martínez, V. J., & Trimble, V. L. (2024). *The Reinvention of Science: Slaying the Dragons of Dogma and Ignorance*. London, UK: World Scientific. https://doi.org/10.1142/q0394

"Throughout the history of science, different thinkers, philosophers and scientists postulated the existence of entities that, in spite of their not being visible or detectable in their time, or perhaps ever, were nevertheless useful to explain the real world. We started this book by looking at a handful of these entities. These included phlogiston to account for fire; the luminiferous ether for propagation of radiation; the homunculus to provide for heredity; and crystalline spheres to carry the wandering planets around the earth. Many of these erroneous beliefs had held up progress, just as dragons drawn on the edges of a map discouraged exploration. This pattern of science evolution continued through the centuries up to the present day.

"The book evolved into a more extensive history of how science evolved through controversy, suppression, and the desire to maintain the status quo. Our story passes from the Babylonians and Greeks through the middle ages, the renaissance and the scientific revolution to almost current events. We discuss the evolution of our world, the controversy about the extinction of dinosaurs, and open questions in contemporary science such as dark matter, black holes and the origin of the Universe, including how we understand the subatomic world of elementary particles.

"Most of the chapters deal with astronomy, cosmology and physics, but there are brief ventures into geosciences (continental drift), biosciences (the homunculus), atmospheric physics (Heaviside layer), paleontology (the extinction of dinosaurs), and computer science (artificial intelligence). The authors present a sequence of how mistakes and fallacies have been purged from our quest to understand nature. The way these changes have come about are skillfully set in their relevant historical contexts." (From the Publisher)

More information HERE
Chapter One of book available HERE

Jordanova, Ludmilla (2024). *Defining Features: Scientific and Medical Portraits, 1660-2000*. Chicago, IL: The University of Chicago Press. ISBN: 9781780231532

"Portraiture as a genre is receiving increased attention at the same time that public curiosity about science is reaching unprecedented levels. Published to coincide with a major exhibition at the National Portrait Gallery, London, from 14 April – 17 September 2000, and the Sainsbury Centre for Visual Arts, University of East Anglia, from 27 September – 10 December 2000, *Defining Features* brings portraiture and science together.

"Ludmilla Jordanova's lucid text reflects on the nature of the relationship between art, science, medicine and technology by focusing on a selection of portraits that spans more than three centuries. Illustrated with likenesses of such notable personalities as Edward Jenner, Marie Curie, Charles Darwin, Albert Einstein and Dorothy Hodgkin, and encompassing a variety of media from paintings and medals to bookmarks and key rings, Defining Features charts changing attitudes towards medical practice and scientific investigation, as well as exploring how notions of gender, heroism, popularization and celebrity have affected the public's understanding of how researchers do their work." (From the Publisher)
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More information HERE

McPherson, Lionel K. (2024). *The Afterlife of Race: An Informed Philosophical Search*. Oxford, UK: Oxford University Press. ISBN: 9780197626849

"The ideology that underlies the concept of race has a long history. For centuries that ideology has spun supernaturalist and scientistic stories about ostensibly natural differences between different groups. The concept of "race" is in scientific decline, but the intertwined ideology and rhetoric behind it live on, and indeed prosper.

"In this groundbreaking fusion of philosophy and color-conscious politics, philosopher Lionel K. McPherson enlists sweeping historical and empirical evidence to challenge fascination with the race concept. His lively, incisive analysis illuminates why social lineage matters far more than any "race" thing ever could, and why race ideology-rhetoric is more

a distraction from gross injustice than a primary source. The Western label "black" was merely a figurative description for African peoples and African ancestry. The idea of continental races came later—with philosophers, theologians, and eventually scientists adding some important but elusive racial factor to visible continental ancestry.

"McPherson argues that the race concept's main business was to sponsor absurd pretexts for Western slavery and colonialism, and their active legacies of nonrepair. Rejecting endless debate about the possible nature of race, he unpacks how color categories in America are a caste device that marked Europe-identified (white) freedom versus Africa-identified (black) enslavement. This caste reframing paves the way for a de-raced account of Black American national specificity and political solidarity, distinct from flat blackness. The Afterlife of Race concludes with a vision of tangible justice and social equality for descendants of American slavery: color aside, Americans of conscience would finally prioritize dismantling their country's foundational caste division, with its entrenched wealth and well-being chasm between White and Black America." (From the Publisher)

More information HERE

Mindell, David P. (2024). *The Network of Life: A New View of Evolution.* Princeton, NJ: Princeton University Press. ISBN: 9780691228761

"In *The Network of Life,* David Mindell explains why the conventional narrative of evolution needs to evolve. Ever since Darwin, evolution has largely been thought to work like a family tree in which species are related through a series of branching events. But, today, a growing knowledge of the ways species share genetic materials in a process known as horizontal evolution has revealed that evolution is actually a network of shared genealogy in which species are more interconnected than previously thought. In this book, Mindell presents this new narrative of life's evolution and its profound implications for all life on Earth.

"*The Network of Life* describes the drivers of horizontal evolution—interbreeding and genetic recombination, the merger of species, horizontal gene transfer, and coevolution. The network view of evolution that emerges supports a new symbiotic theory of health, which holds that the future health of humans, other species, and our shared environments depends on evolution and adaptation across life's network.

"Difficult times lie ahead for many of Earth's species as climates and habitats transform. At the same time, new and altered life-forms are arising and spreading in association with human activities. We are also learning to reshape and create life by mimicking the mechanisms of horizontal evolution, and we are coevolving with technology as we enhance our bodies, brains, and life spans. *The Network of Life* shows why and how increasing our knowledge of horizontal evolution can provide critical lessons as we navigate our looming challenges." (From the Publisher)

More information HERE

Petersen, Arthur C. (2024). *Climate, God and Uncertainty: A Transcendental Naturalistic Approach Beyond Bruno Latour*. London, UK: UCL Press. ISBN: 9781800085954

"*Climate, God and Uncertainty* brings together the philosophical approaches of pragmatism and (neo-) Kantianism in transcendental naturalism. The new approach is based on combining an expansive concept of "nature" with an emphasis on the separate ontological status of transcendental values. This book moves beyond Bruno Latour's thought to understand what climate change means for philosophical anthropology and wider culture.

"Referring mainly to works by Latour, William James, and Heinrich Rickert, this book develops a cultural philosophical approach called "transcendental naturalism." This approach reinterprets the interface between science and politics in the context of climate change, highlighting, for instance, issues such as the religious disenchantment of nature, the scientific disbelief in a plurality of value-laden perspectives, and the disregard for non-modern

worldviews in politics. In developing its argument, the book makes a methodological intervention on the sort of naturalism that guides both Latour's work and a large part of the academic field called 'science and religion.'" (From the Publisher)

More information HERE

Schickore, J. & Newman, W. R. (Eds.) (2024). *Elusive Phenomena, Unwieldy Things: Historical Perspectives on Experimental Control.* Dordrecht: Springer. [**Open Access**]

"This open access book provides a historical treatment of scientific control in experimentation in the longue durée. The introduction distinguishes four related strands in the history of experimental control: the development of practices to stabilize experimental conditions; the career of the comparative design; the unfolding of methodological discussions about control practices and designs; and the history of the term "control". Each chapter brings these distinctions to bear on specific historical episodes. The focus is on experiments with complex, elusive phenomena such as perception and learning, irregular movements, and unobservable elements. Such experiments bring control issues to the fore because they are difficult to design and stabilize and often controversial.

"Together, the chapters show that the local context shapes what exactly is controlled, how control can be accomplished, and how controls are justified. They also show that control strategies and methodological ideas often remain stable for a long time and change only gradually. This book, as well as the volume on analysis and synthesis in experimentation by the same editors, contains contributions by an array of experts from multiple disciplines, making it suitable for historians and philosophers of science and students alike." (From the Publisher)

More information and downloadable book file HERE

Authors of HPS&ST-related papers and books are invited to bring them to attention of the Newsletter's assistant editor Paulo Maurício (**paulo.asterix@gmail.com**) for inclusion in these sections.

PhD Award in HPS&ST

ABSTRACT: RESEARCH ON TEACHING THE HISTORY OF SCIENCE THROUGH AN INTERDISCIPLINARY APPROACH

MUHAMMET EMIN MISIR,
Doctoral Dissertation
muhammetemin@sakarya.edu.tr

Supervisor: Prof. Dr. Canan LAÇİN ŞİMŞEK
Sakarya University, Türkiye, 2023

The main aim of this research is to evaluate the contribution of teaching the history of science with an interdisciplinary approach to understanding the nature of science among science teachers. In addition to this aim, the study also examined the contribution of the practices carried out within the research scope to participants' knowledge levels in the history of science, their perspectives on the instructional value of the history of science, their comprehension of scientific concepts, their technological competencies, and their general knowledge.

Designed as a convergent parallel mixed-methods study to achieve this aim, this research took place within the scope of the course, 'Historical Development of Scientific Thoughts', lasting for one semester. Implicit and history of science approaches were adopted in teaching the nature of science. Twelve science teachers participated in the research. Quantitative and qualitative data collection tools were applied before and after the implementation of the study. Quantitative data collection tools included the Reconceived Nature of Science Scale, the Instructional Value of Science History Scale, and the Technological Pedagogical Content Knowledge (TPACK) Scale.

Qualitative data collection tools comprised semi-structured interviews, an open-ended questionnaire on 'How does a scientist conduct

research?', a table for collecting knowledge level about era and civilizations of history of science, an Associated Scientists Word Cloud to detect interactions among scientists, a World Silent Map, and a Same Period Occurrences Information Form to determine awareness of events occurring in the recent past. Participants prepared documentaries based on a chosen scientist and the historical development of a scientific concept according to predefined criteria within the scope of the course.

According to the t-test results, there was a significant difference between pre-test and post-test total scores in the Reconceived Nature of Science Scale. Significant differences were found only in the Scientific Practices sub-dimension of the scale. No significant differences were found in the dimensions of Purpose and Values, Method and Methodological Rules, Scientific Knowledge, Social and Institutional Aspects, and Educational Practices. However, qualitative analysis revealed that participants developed understandings of all dimensions. Furthermore, the analyses of the applications conducted within this course positively influenced participants' knowledge levels in the history of science.

Additionally, the t-test analysis of the results from the Instructional Value of Science History Scale, a quantitative data source, found significant results favoring the post-test. Interview findings also indicated that participants appreciated the inclusion of science history in the curriculum. It was concluded that participants held positive views regarding understanding scientific concepts through the method of science history.

The analyses indicated that both quantitative TPACK and qualitative interviews showed an increase in participants' technological competencies. Moreover, through the interviews, it was observed that interdisciplinary practices of the science history course enhanced participants' general cultural knowledge and facilitated gains in conducting literature reviews, conducting research in libraries, and scriptwriting, among other skills.

We welcome publishing details of all PhDs awarded in the field of HPS&ST. Send details (name, title, abstract, supervisor, web link) to editor: m.matthews@unsw.edu.au

Integrated History and Philosophy of Science, 10th conference, California Institute of Technology, Pasadena, California, 27-29 March 2025

The Committee for Integrated History and Philosophy of Science invites the submission of abstracts for individual papers and "lightning talks" for &HPS10, the 10th conference in the series *Integrated History and Philosophy of Science*. We seek contributions that genuinely integrate historical and philosophical analyses of science (i.e., the physical sciences, life sciences, cognitive sciences, and social sciences) or that discuss methodological issues surrounding the prospects and challenges of integrating history and philosophy of science.

For information about the Committee for Integrated History and Philosophy of Science and previous conferences, see http://integratedhps.org/.

Keynote speakers: Lydia Patton (Virginia Tech), Marius Stan (Boston College)

All proposals (whether for a contributed paper or lightning talk) should contain a title and an abstract of up to 700 words (including references).

Please submit your abstracts to https://app.oxfordabstracts.com/stages/75646/submitter

Deadline for abstract submissions: **11:59 pm Anywhere on Earth (UTC -12) 18 August.** Notification date: **31 October, 2024.**

Please direct any inquiries to Uljana Feest (feest@philos.uni-hannover.de) or Dana Tulodziecki (dtulodzi@purdue.edu)

Coming HPS&ST Related Conferences

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June 26-28, 2024, Singapore National Institute of Education, STEM conference
Details **HERE**

July 1-5, 2024, History and Pedagogy of Mathematics Conference, University of New South Wales, Sydney.
Details: **HERE**

July 4-14, 2024, International Congress on Mathematical Education, Sydney
Details HERE

July 8-10, 2024, Science in Public, annual conference, University of Birmingham.
Details: HERE

August 1-8, 2024, 25th World Congress of Philosophy, Rome
Details **HERE**

August 28-30, 2024, European Network for Philosophy of the Social Sciences (ENPOSS), 13th Conference, University of Bergen, Norway
Details: **HERE**

September 2-6, 2024, International History, Philosophy and Science Teaching Group
Details: **HERE**

September 16-20, 2024, Eighth International Conference on the History of Mathematics Education (ICHME-8), Warsaw
Details: Organiser Karolina Karpinska

September 17-19, 2024, Forum on Philosophy, Engineering and Technology, Karlsruhe Institute of Technology
Details: **HERE**

October 28-30, 2024, Conference on Philosophy of Technology, Maastricht University, the Netherlands
Details: either darryl.cressman@maastrichtuniversity.nl or massimiliano.simons@maastrichtuniversity.nl

September 4-7, 2024, 11th European Society for History of Science conference, Barcelona
Details **HERE**

December 5-7, 2024, 8th Pan-Hellenic Conference on Philosophy of Science**,** Athens
Details: **HERE**

March 6-10, 2025, US Philosophy of Education Society, PES, annual conference, Baltimore.
Details: **HERE**

March 27-29, 2025, Integrated History and Philosophy of Science, 10th conference. CIT Pasadena, CA
Details: **HERE**

June 29-July 5, 2025 International Congress of Science and Technology, Dunedin, New Zealand
Details: **HERE**

HPS&ST Related Organisations and Websites

IUHPST – International Union of History, Philosophy, Science, and Technology
DLMPST – Division of Logic, Mathematics, Philosophy, Science, and Technology
DHST – Division of History, Science, and Technology
IHPST – International History, Philosophy, and Science Teaching Group
NARST - National Association for Research in Science Teaching
ESERA - European Science Education Research Association
ASERA - Australasian Science Education Research Association
ICASE - International Council of Associations for Science Education
UNESCO – Education
HSS – History of Science Society
ESHS – European Society for the History of Science
AHA – American History Association
FHPP APS - Forum on History and Philosophy of Physics of the American Physical Society
HAD AAS - Historical Astronomy Division of the American Astronomical Society.
ACS HIST – American Chemical Society Division of the History of Chemistry
GWMT - Gesellschaft für Geschichte der Wissenschaften, der Medizin und der Technik
ISHEASTME – International Society for the History of East Asian History of Science Technology and Medicine
EASE - East-Asian Association for Science Education
BSHS – British Society for History of Science
EPSA - European Philosophy of Science Association
AAHPSSS - The Australasian Association for the History, Philosophy, and Social Studies of Science
HOPOS – International Society for the History of Philosophy of Science
PSA – Philosophy of Science Association
BAHPS - Baltic Association for the History and Philosophy of Science

BSPS – The British Society for the Philosophy of Science
SPSP - The Society for Philosophy of Science in Practice
ISHPSB - The International Society for the History, Philosophy, and Social Studies of Biology
PES– The Philosophy of Education Society (USA)

The above list is updated and kept on the HPS&ST website at: **HERE**

HPS&ST related organizations wishing their web page to be added to the list should contact assistant editor Paulo Maurício: paulo.asterix@gmail.com

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