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ABSTRACT

Proceedings from the first three History and Philosophy of Science and Science Teaching Conferences are examined to identify the profile of papers in science content areas. Those papers with a chemistry education emphasis are investigated more closely. Results indicate that papers with physics content dominate. Chemistry and biology content were addressed at about the same frequency. The chemistry topics covered in the papers include air pressure, equilibrium, atomic theory, and periodicity. Student cognition and language in science are the least studied areas among those covered while sociology of chemistry and teacher cognition are examples of domains that have not been addressed. (DDR)

REFLECTIONS ON THE PROCEEDINGS FROM HPSST CONFERENCES: A PROFILE OF PAPERS ON CHEMISTRY EDUCATION*

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INTRODUCTION
Three major conferences focusing on the role of history and philosophy of science (HPS) in science education have been held over the last six years in Tallahassee, Florida (1989), Kingston, Ontario (1992) and Minneapolis, Minnesota (1995). Subsequent conferences in Calgary, Alberta and Pavia, Italy have been scheduled to take place in 1997 and 1998 respectively. The trend in occurrence of these conferences as well establishment in 1992 of a new journal, *Science & Education* suggest an increasing interest in the exploration of issues related to how science education can be informed by HPS.

In this paper, I present an investigation of the proceedings from the first three conferences. I trace papers included in the proceedings with respect to content areas (such as physics, biology and mathematics) and in particular, explore the territory of those papers with chemistry content. Identification of particular trends in the literature is an important aspect of research in education. Information on how HPS has been applied to chemistry education can point to the status of our current understanding of such application. It can also demonstrate potential deficits in the literature where more research effort can be invested in the future.

BACKGROUND
The role of content in learning has received considerable attention since mid-1970s as a result of research on students' alternative conceptions of natural phenomena and scientific principles (Fensham et al., 1995). Furthermore, it has been argued that distinction of content areas is important since learning and teaching of different content areas might vary (White, 1995). Duit (1994) have noted several trends in research into

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students' conceptions in particular science content areas. 66% of the studies on students' conceptions dealt with physics content, 20% with biology content, and 14% with chemistry content. Duit (1994) speculates on why physics dominates:

> One reason appears to be that cognitive psychologists have often chosen physics examples when they carried out their research in a science domain. Maybe the assumption that physics is more mathematically and hence logically structured than the other sciences (which is a dubious assumption) has been a major factor. (p. xxvii)

Research in chemistry education is not only an understudied area in science education but also it has focussed on relatively classical examples such as the mole concept (Duncan and Johnstone, 1973), entropy (Campbell, 1980) and chemical equilibrium (Gussarsky and Gorodetsky, 1985). Given this profile, it is important to note the status of the application of HPS to chemistry education within the broader context of content areas as well as within the territory of particular chemistry topics.

PAPERS ON CONTENT AREAS

The primary purpose of this study was to situate those papers with chemistry content within the larger context of content areas. To this end, the number of papers devoted to science content areas and mathematics were traced in the abstracts of the proceedings from the first three conferences. Only papers with exclusive and particular emphasis on content areas were selected. In other words, papers which dealt with *general* science issues such as epistemology and pedagogy in science were not taken into consideration. (This means that papers with either no specific content area focus or with multiple coverage of content areas where emphasis was not on content *per se* were excluded.)

Table 1. summarizes the number of papers with physics, chemistry, biology, mathematics and geology content. The 'biology' category includes papers on environmental biology (1 paper in Vol. I of 2nd conference), marine science (1 paper in Vol. II of 3rd conference) and paleontology (1 paper in Vol. I of 3rd conference). The 'physics' category includes papers on astronomy and engineering topics as well as those on heat energy (with more physics than chemistry emphasis). The 'math' category includes statistics (1 paper in Vol. I of 2nd conference).

Some of the papers presented at the first conference appeared in the 'Conference Journals': *Educational Philosophy and Theory*, *Interchange*, *Studies in Philosophy and Education* and *Synthese*. The number of papers published in these journals are included collectively in **Table 1**. The emphasis on papers ranged from teaching and curriculum to epistemology and linguistics around the particular topic under investigation.

RESULTS

More than half (57%) of the papers on content areas in all three conferences were devoted to physics. Chemistry and biology occupied about the same number of papers (19% and 18% respectively). Twelve percent of papers were on mathematics and only 1 paper dealt with geology content. Papers with chemistry content accounted for 3-8% of all papers. **Table 2**. illustrates the frequency of papers in each proceeding as well as the conference journals. The number of papers was about the same between the first and second conferences while, between the second and the third conferences, there was an increase of 31%. Although the number of papers on chemistry quadrupled between the first and second conferences, it stayed the same between the second and third conferences. **Tables 3-5** in the *Appendix* summarize the titles of papers with chemistry content.

Table 1. Number of papers on content areas

Title of proceeding	Physics	Chemistry	Biology	Math	Geology
The History and Philosophy of Science in Science Teaching	2	-	1	2	-
Conference Journals	3	1	-	1	-
More History and Philosophy of Science in Science Teaching	8	2	1	-	-
History and Philosophy of Science in Science Education Volume I	5	4	4	3	-
History and Philosophy of Science in Science Education Volume II	8	4	1	2	-
Third International History, Philosophy, and Science Teaching Conference Volume I	18	2	8	4	1
Third International History, Philosophy, and Science Teaching Conference Volume II	13	6	3	1	-
Total	57 (52%)	19 (18%)	18 (17%)	13 (12%)	1 (1%)

Table 2. Frequency of papers with chemistry content

Title of proceeding	Total number of papers	Number of papers devoted to chemistry topics	% of papers devoted to chemistry topics
The History and Philosophy of Science in Science Teaching	73 37 (Vol I) 36 (Vol II)	2	~ 3 %
Conference Journals	36	1	~ 3 %
History and Philosophy of Science in Science Education	103 53 (Vol I) 50 (Vol II)	8	~ 8 %
Third International History, Philosophy, and Science Teaching Conference	135 70 (Vol I) 65 (Vol II)	8	~ 6 %

SUBJECT-MATTER OF PAPERS WITH CHEMISTRY CONTENT

The papers can be classified in *three* broad categories based on their emphasis on education, philosophy and history:

I. Papers with emphasis on education:

These papers constitute 48% (9 of 19) of papers with chemistry content and address the following issues:

- use of HPS in curriculum
- teaching of particular HPS themes (e.g. demarcationism); of particular topics (e.g. air pressure); of HPS (e.g. background to the atomic theory)
- student cognition (e.g. conceptions of states of matter)
- design of instructional innovations (e.g. interdisciplinary contexts for chemistry instruction)

II. Papers with emphasis on philosophy:

These papers account for 26% (5 of 19) of the papers with chemistry content and address the following issues:

- use of models (e.g. in producing explanations--exemplified with 'atom')
- use of explanations (e.g. in knowledge construction--exemplified with 'combustion')
- role of language in science (e.g. semantics of 'energy')

III. Papers with emphasis on history:

These papers account for 26% (5 of 19) of the papers and address the following issues:

- historical cases around principles (e.g. Le Chatelier's), theories (e.g. atomic theory)
- nature of science (e.g. use of history in nurturing appreciation of science, exemplified with the development of the Periodic Table)

Finally, at the level of content, the following topics were covered:

- Atomic theory
- Periodic law/Periodic Table
- Le Chatelier's principle
- States of matter
- Air pressure
- Combustion
- Chemical reversibility
- Isomerism

CONCLUSIONS

The results indicate that papers with physics content dominate. This is not surprising given the trends observed by Duit (1994). However, given the same trends it is interesting to note that chemistry and biology content were addressed at about the same frequency. The chemistry topics studied in the papers are typical and conventional (e.g. air pressure and equilibrium) although some are fundamental and central to chemistry (e.g. atomic theory and periodicity). Overall, the papers on chemistry account for a small number of papers in the proceedings. Student cognition and language in science are the least studied areas among those covered while sociology of chemistry and teacher cognition are examples of domains which have not been addressed.

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APPENDIX

Title and author of papers with chemistry content

Table 3. Papers on chemistry in the proceedings of the *first* conference

Title of proceeding	Date and place of publication	Title and author of paper
The History and Philosophy of Science in Science Teaching	1989 - Science Education and Department of Philosophy, Florida State University, Tallahassee, Florida (Don Emil Herget, Editor)	none
Interchange (proceeding makes reference to those papers that were part of the conference and appeared in this journal)	(Michael Matthews and Ian Winchester, Editors)	• History in the chemistry curriculum (George B. Kauffman)
More History and Philosophy of Science in Science Teaching	1990 - Science Education and Department of Philosophy, Florida State University, Tallahassee, Florida (Don Emil Herget, Editor)	• The history of atomic theory with its societal and philosophical implications in chemistry classes (Jutta Luhl) • Akeroyd and Spargo on Kauffman's 'history in the chemistry curriculum' (F. Michael Akeroyd)

Table 4. Papers on chemistry in the proceedings of the *second* conference

Title of proceeding	Date and place of publication	Title and author of paper
History and Philosophy of Science in Science Education- Volume I	1992- The Mathematics, Science, Technology and Teacher Education Group and The Faculty of Education, Queen's University, Kingston, Ontario (Skip Hills, Editor)	• Developing an appreciation of the nature of science using the history of the periodic law in a secondary school chemistry course (David M. Betts) • Sequence of models of 'gas' and 'atom' adequate for producing explanations: Three examples inspired on the history of chemistry (M. Calvet, I. B. Barrisant Andreu, L. Rivera, I. B. Vergaguer, M. Izquierdo) • An immaculate conception: Le Chatelier and equilibrium (Stephen Demeo) • Study of some conditions involved in the construction of the concept of 'chemical reversibility' (Pere Grapi)

Table 4 (continued). Papers on chemistry in the proceedings of the *second* conference

Title of proceeding	Date and place of publication	Title and author of paper
History and Philosophy of Science in Science Education- Volume II	1992- The Mathematics, Science, Technology and Teacher Education Group and The Faculty of Education, Queen's University, Kingston, Ontario (Skip Hills, Editor)	• Teaching the social and philosophical background to atomic theory (Jutta Luhl) • Teaching about air pressure: A role for history and philosophy in science teaching (Michael R. Matthews) • Explanations on combustion: Their analysis and evolution (T. Morato, N. Solsona, M. Izquierdo) • Pupils' conceptions around changes of state of aggregation of matter (J. Rafel, C. Mans, P.J. Black)

Table 5. Papers on chemistry in the proceedings of the *third* conference

Title of the proceeding	Date and place of publication	Title and author of paper
Third International History, Philosophy, and Science Teaching Conference- Volume I	1995- International History, Philosophy, and Science Teaching Group in cooperation with University of Minnesota's College of Education; History of Science and Technology, Institute of Technology; Minnesota Center for Philosophy of Science, College of Liberal Arts; and Continuing Education and Extension/University College; and the Bakken Library and Museum, Minneapolis, Minnesota (Fred Finley, Douglas Allchin, David Rhees, Steve Fifield, Editors)	• Explanation and know-how in the construction of knowledge and implications for science education: The case of the supposed isomerism of the hydrocarbon ethane (Roger T. Cross) • Science or pseudoscience: Does science education demarcate? The case of chemistry and alchemy in teaching (Sibel Erduran)

Table 5 (continued). Papers on chemistry in the proceedings of the *third* conference

Title of the proceeding	Date and place of publication	Title and author of paper
Third International History, Philosophy, and Science Teaching Conference- Volume II	1995- International History, Philosophy, and Science Teaching Group in cooperation with University of Minnesota's College of Education; History of Science and Technology, Institute of Technology; Minnesota Center for Philosophy of Science, College of Liberal Arts; and Continuing Education and Extension/University College; and the Bakken Library and Museum, Minneapolis, Minnesota (Fred Finley, Douglas Allchin, David Rhees, Steve Fifield, Editors)	• Physical and chemical change: The long history of the iron filings and sulfur experiment (W.P. Palmer) • Creating a context for chemistry (A. Truman Schwartz) • 'Energy-talk': The struggle for suitable words (Clive Sutton) • The electrical atom: A series of lessons for high school teachers (Richard P. Swanson) • Teaching the second law of thermodynamics (Carlo Tarsitani) • The explanatory power of our models: A philosophical analysis with some implications for science education (Andrea Woody)

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