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AUTHOR Sensenbaugh, Roger
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ABSTRACT

This annotated bibliography contains 33 items from the ERIC database concerning the use and misuse of metaphor in science education. The items date from 1977 to 1988 and are grouped into fire categories: overview, science education, writing in the sciences, children's learning, and computer terminology. (RS)

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Use of Metaphor in Science Education

by Roger Sensenbaugh

Metaphor can be a powerful tool in learning difficult or unfamiliar concepts, especially in science and science-related fields, but it can also be misused. Metaphor is like a rubber band: stretch it too far and it breaks. Overusing a simple metaphor or using incorrect metaphors can lead to deep-seated misconceptions. Documents in the ERIC data-base reflect both aspects of metaphor by describing its powerful role in reasoning and creativity, in transmitting concepts from teacher to learner, in presenting difficult concepts to a more general audience and in science education, while also warning of its potential for misuse.

The first section of this *FAST Bib* presents an overview of the role of metaphor in many forms of discourse, especially scientific and technical. The remaining sections deal with specific issues concerning the use of metaphor in science education, writing in the sciences, the cognitive processes of children, and computer terminology.

Abstracts for some of the articles cited here have been abbreviated to conform to the *FAST Bib* format. The ED numbers for sources included in *Resources in Education* have been included to enable the user to go directly to microfiche collections, to order from the ERIC Document Reproduction Service (EDRS), or to go to *RIE* for the full abstract on those sources not available through EDRS. The citations to journals are from the *Current Index to Journals in Education*, and these articles can be acquired most economically from library collections or through interlibrary loans. Reprint services are also available from University Microfilms International (UMI) and from the Original Article Tearsheet Service (OATS) of the Institute for Scientific Information.

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Overview

Gibson, Walker, ed. *New Students in Two Year Colleges: Twelve Essays.* National Council of Teachers of English, Urbana, IL, 1979. 136p. [ED 163 503]

Intended for college English teachers, the essays in this collection deal with the teaching of reading and writing to the "new" types of students who are presently attending two-year colleges. One essay argues that all metaphor, in science, literature, and all forms of discourse, functions as a source of real power over the world of things and the self.

Miall, David S. "Metaphor and Transformation: The Problem of Creative Thought". Technical Report No. 300. Center for the Study of Reading, Urbana, IL, 1983. 44p. [ED 237 958]

Argues that a useful place to begin research on the creative processes of scientists and artists is with the response to metaphor.

Ortony, Andrew, ed. *Metaphor and Thought.* Cambridge Univ. Press, 1979. 501p. [ED 182 771]

Raises questions in a series of 21 essays about the viability of the traditional distinction between the literal and the metaphorical, including metaphor in science and the educational uses of metaphor.

Stanford, Barbara Dodds; Stanford, Gene. *Thinking through Language. Book Two.* National Council of Teachers of English, Urbana, IL., 1985. 114p. [ED 260 435]

Provides training in analytical skills as well as systematic development of intuitive skills by exploring three kinds of relationships and connections: comparisons (especially metaphor and analogy); whole/part relationships; and the creation of new relationships.

Wallenstein, Barry. "Why is Poetry Difficult?" 1977. 22p. [ED 144 055]

Argues that poetry, with its highly metaphorical expressions and compacted form, is much like scientific language, which uses numbers and symbols as tools to get at truths that ordinary discourse is unable to describe.

Science Education

Bell, Beverley, ed. "Teaching about Animal, Plant, Living. Part 1. Learning in Science Project. Working Paper No. 31." Science Education Research Unit, University of Waikato, Hamilton, New Zealand, 1981. 27p. [ED 236 014]

Presents a guide for teaching activities produced as a result of a Learning in Science Project investigation which showed that children often have quite different meanings for the words "animal," "plant," and "living" than do scientists. Includes contrasting scientists' meanings for these words with the metaphoric and everyday use of the words.

Gamble, R. "Cognitive Momentum," *Physics Education,* v21 n1 p24-27 Jan 1986.

Discusses several aspects of the relationship between teaching and learning with regard to learning hierarchies, stage theory, and the abundant use of metaphor.

Gentner, Dedre. "The Structure of Analogical Models in Science," Bolt, Beranek, and Newman, Inc., Cambridge, Mass., 1980. 102p. [ED 193 011]

Argues that analogical models can be powerful aids to reasoning and proposes a structural characterization of good science analogy using a theoretical approach in which complex metaphors and analogies are treated as structure mappings between domains.

Kyle, Benjamin G."The Mystique of Entropy," *Chemical Engineering Education,* v22 n2 p92-97 Spr 1988.

Illustrates qualitative and metaphoric applications of entropy in the areas of cosmology, the birth and death of the universe; life and evolution; literature and art; and social science.

Hewson, Mariana G. A'B.; Hamlyn, Daryl. "Cultural Metaphors: Some Implications for Science Education," *Anthropology and Education Quarterly,* v16 n1 p31-46 Spr 1985.

Considers implications for the learning of orthodox scientific theories of heat by considering the persistence of a cultural metaphor for heat in the Sotho people of Southern Africa.

Pines, A. Leon. "Teaching Scientific Concepts: The Use of 'Bottom Up' and 'Top Down' Strategies Combined with the Use of Metaphors." Paper presented at the regional convention of the National Science Teachers Association, 1979. 19p. [ED 178 353]

Discusses the nature of the development of conceptual relationships and the structure of concepts. Presents topics with regard to the importance of combining metaphors with two alternative approaches to learning—rote learning and inductive learning.

Rachelson, Stanley Eugene. *An Identification of the Characteristics of Hypothesis Generation in Scientific Inquiry with Applications to Guided Imagery and to the Science Curriculum Improvement Study and Essence Curricula.* Ph.D. dissertation, University of Georgia, 1977. 200p. [ED 139 649]

Investigates the use of guided imagery as an instructional strategy for science teaching to foster the characteristics of the hypothesis generating component of scientific inquiry. Concludes that hypothesis generation is performed by the right cerebral hemisphere and that this generation is synthetic, imaginative, timeless, intuitive, metaphorical, and sudden.

Writing in the Sciences

Anderson, Philip M. "Language Development and Aesthetic Modes of Thought." Paper presented at the Annual Meeting of the National Council of Teachers of English, 1986. 9p. [ED 288 190]

Argues that metaphorical thinking exercises are relevant in scientific and technical writing.

Anderson, Philip M.; Sunstein, Bonnie S. "Teaching the Use of Metaphor in Science Writing." Paper presented at the 38th Annual Meeting of the Conference on College Composition and Communication, 1987. 25p. [ED 281 204]

Describes a freshman writing assignment which encouraged students to use metaphors to think their way through scientific topics, improving their writing skills in the process. Reading material was chosen for its use of metaphors to explain scientific topics. States that students found metaphors made a fluent connection between their personal experience and a scientific model.

Bump, Jerome. "Metaphor, Creativity, and Technical Writing," *College Composition and Communication*, v36 n4 p444-53 Dec 1985.

Explores the use of metaphor and personification in the "classics" of scientific and technical writing, and the current resistance to creativity in scientific writing. Suggests familiarizing students with the role of metaphor in scientific creativity.

Friedman, Alan J. "Contemporary American Physics Fiction," *American Journal of Physics*, v47 n5 p392-95 May 1979.

Discusses the works by six contemporary American novelists that illustrate the current state of "physics fiction." The discussed examples of physics fiction ranged from the fluent and frequent inclusion of the casual, to the elaborate systems of physics metaphors.

Grunig, Larissa Schneider. "Parsimony vs. Redundancy: Competing Principles in Scientific and Technical Writing," *Technical Writing Teacher*, v13 n2 p171-86 Spr 1986.

Reports on a study of the use of metaphor and analogy in scientific writing to determine whether the author's analogical style affected the media attention a brochure received and whether it improved the reader's understanding of the content.

Lott, Clarinda Harriss. "Alternative Shapes in Expository Writing." Paper presented at the 38th Annual Meeting of the Conference on College Composition and Communication, 1987. 9p. [ED 282 248]

Current writing in the sciences challenges the idea that mature exposition is impersonal and unpoetic. Argues that from Bertrand Russell to Lewis Thomas, scientific writing is filled with subjective observation and metaphorical language. Presents suggestions for freshman composition instructors to help students avoid impersonal and unpoetic language.

Molino, Jean. "Metaphores, modeles et analogies dans les sciences (Metaphors, Models, and Analogies in the Sciences)," *Langages*, n54 p83-102 Jun 1979.

Written in French, this article challenges the contention of science that scientific language eliminates figurative language and, instead, demonstrates the relationship of metaphor, models, and analogy to scientific concepts.

Roesler, Glenn R. "Of Fallacies, Ferris Wheels, and Figurative Language: Metaphor in Science and Technical Writing," *Journal of Teaching Writing*, v6 n2 p283-91 Fall-Win 1987.

Assesses the unaccepted use of figurative language in science and technical writing, focusing on objections to metaphor's imputed ambiguity. Proposes that metaphor play a stronger role in conceptualization of scientific and technical ideas.

Worsley, Dale. "Visualization and Objective Observation," *Teachers and Writers Magazine*, v19 n5 p1-3 May-Jun 1988.

Presents some examples (using metaphor and simile) of the way language can express clear visualization and objectivity.

Children

Ault, Charles R., Jr. "Intelligently Wrong: Some Comments on Children's Misconceptions," *Science and Children*, v21 n8 p22-24 May 1984.

Examines the misconceptions of children as indicative of imaginative and perceptive thinking. Presents anecdotes that illustrate the split between realist and relationalist thinking, and the confusion between fact and metaphor in citations from literary works.

Johnson, Virginia. "Fun, Fantasy, and Feeling," *Science and Children*, v15 n4 p21-2.

Gives two science activities designed to stimulate the right brain function and to motivate elementary students, using metaphors.

Kohl, Herb. "Insight: Limits and Symbols," *Teacher*, v98 n2 p22-24 Sep 1980.

Suggests that metaphorical physical examples can sometimes help children understand psychological situations, particularly those concerned with limits, more effectively and with less embarrassment than a direct discussion of behavior. Presents an example which relates pliability or brittleness in an object to the limit of a person's tolerance.

Smith, Deborah C. "Cognitive Processes and Students' Misconceptions in Science." Paper presented at the Annual Meeting of the Northeastern Education Research Association, 1984. 22p. [ED 255 366]

Describes several categories of misconceptions and examines a common elementary science lesson on the water cycle, focusing on places where children might go wrong in their understanding.

Solomon, Joan. "Children's Explanations," *Oxford Review of Education*, v12 n1 p41-51 1986.

Building on the work of Piaget, this article examines how children explain scientific phenomena using simile and metaphor. Demonstrates the difficulty children have in constructing explanations which contain sufficient "semantic distance" to be effective. Contends that comparison as explanation may bid for a place among the basic "processes" of science education.

Solomon, Joan. "Children's Explanations." 1985. 13p.
[ED 257 675]

Examples of explanations students give during science lessons are used to demonstrate that the use of metaphor and simile is one of a number of very different modes of explaining.

Watts, D. Michael. "A Constructive Alternativist View of Children's Science." Paper presented at the 4th International Congress in Personal Construct Psychology, 1981. 23p. [ED 230 365]

Explores the complex structure and organization of ideas and meaning that children bring with them to their science lessons. Suggests that children are more concerned with construing situations and events and that, in their flow of language, they fail to limit the implications of their words or appreciate the metaphors of physics.

Computer Terminology

Holz, Josephine R. "Trends in Popular Magazine Depictions of the Computer." Paper presented at the 75th Annual Meeting of the Eastern Communication Association, 1984. 23p. [ED 243 159]

Examines the metaphors or analogies that involved the attribution of human characteristics to computers appearing in popular magazines from the 1940s through 1969.

Kilpatrick, Jeremy. "Reflection and Recursion," *Educational Studies in Mathematics*, v16 n1 p1-26 Feb 1985.

Explores how the computer as a metaphor affects our understanding of the processes of learning and teaching. Describes reflection and recursion in mathematics and their roles in thinking and learning.

Nilsen, Don L. F. "Live, Dead, and Terminally Ill Metaphors in Computer Terminology, or Who Is More Human, the Programmer or the Computer?" *Educational Technology*, v24 n2 p27-29 Feb 1984.

Discusses the metaphors and personification present in terminology which describes the computer and its functions, and asserts that computers are becoming so personified there is little difference between terms associated with humans and computers. Also suggests that programmers are becoming less human.

Peelle, Howard A. "Computer Metaphors: Approaches to Computer Literacy for Educators." International Council for Computers in Education, University of Oregon, Eugene, OR, 1984. 49p. [ED 240 704]

Examines various metaphors educators might use to help students develop computer literacy. Concludes that educators must think about how to go beyond metaphor to a more substantial understanding of computer science and information theory.

Weiner, E. Judith. "Computational Considerations for the Processing of Explanatory Literal Analogies and Expressive Metaphors," *Computers and the Humanities*, v21 n2 p91-101 Apr-Jun 1987.

Presents a model of the structure of logic considered necessary for computer processing of metaphorical language. Formally states and diagrams

the algorithm for metaphors, isolating domain distance, predicate inequality, and hyperbole as particularly important factors. Distinguishes explanatory literal analogies from expressive metaphors, concluding that their relation to one another is more important than the relation between metaphors and similes.

ERIC Clearinghouse on
Reading and Communication Skills
Indiana University
Smith Research Center
2805 East Tenth Street
Bloomington, IN 47408
(812) 855-5847

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