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 five categories: overview, science education, writing in the sciences, children’s learning, and computer terminology. (RS)
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 misuse. 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. Reproduction 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


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, function as a source of real power over the world of things and the self.


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

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.


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 metaphoric 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**


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.


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


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.


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.


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.


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.


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


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


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. Students found metaphors made a fluent connection between their personal experience and a scientific model.


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.


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.


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.


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.


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.


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.


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

Children


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.

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


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.


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.


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.


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.


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**


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


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.


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.


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.


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.