DOCUMENT RESUME

ED 406 144 SE 059 770

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TITLE Excellence in the Science Curriculum.
PUB DATE 97
NOTE 16p.
PUB TYPE Reports - Research/Technical (143)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Curriculum Development; Educational Objectives; *Educational Philosophy; *Educational Psychology; Elementary Secondary Education; Excellence in Education; Existentialism; *Problem Solving; Program Improvement; Public Schools; Realism; *Science Curriculum; Standards; Teaching Methods
IDENTIFIERS Experimentalism; Idealism; Missouri

ABSTRACT

Science teachers need to select tenets from the philosophy of education which stress student attainment of vital context, abilities, and attitudes. This paper discusses diverse schools of philosophical thought in terms of how each might relate to improving the science curriculum. For example, a science teacher who is a realist emphasizes that one can know the real world, in whole or part, as it truly is. The mind then does not modify or change what is being perceived; hence, specific objectives of instruction can be determined by science educators for students to achieve. Experimentalists stress a problem-solving approach in the curriculum. They emphasize that individuals cannot know the real world as it truly is; however, individuals obtain experiences from this reality. Thus in the science curriculum, problem-solving is the focus. Idealists believe that one can receive ideas about the real world only. In idealism mental development becomes of the utmost importance, therefore depth teaching is needed to cultivate the intellect in guiding student achievement in science. Decision-making opportunities in science are important for existentialists. Problem-solving can encompass all these philosophies and should be a major tenet of education to emphasize in the teaching of science. Contains 18 references. (PVD)

EXCELLENCE IN THE SCIENCE CURRICULUM

Each person lives in a world of science. The natural environment affects all of us. It operates in terms of scientific theories, principles, and laws. Pupils in the public school setting need to achieve relevant goals in science. These goals should be attainable, meaningful, and possess purpose for the learner. The Show Me Standards (1996) list the following science objectives for pupil achievement in Missouri schools:

In science, students in Missouri public schools will acquire a solid foundation which includes knowledge of

1. properties and principles of matter and energy
2. properties and principles of force and motion
3. characteristics and interactions of living organisms
4. changes in ecosystems and interactions of organisms with their environment
5. processes (such as plate movement, water cycle, air flow) and interactions of Earth's biosphere, atmosphere, lithosphere, and hydrosphere
6. composition and structure of the universe and the motions of objects within it
7. processes of scientific inquiry (such as formulating and testing hypotheses)
8. impact of science, technology and human activity on resources and the environment.

Each of the above named objectives should be emphasized within a related, designated unit of study. The objectives might also be written more precisely, if desired, so that it can be measured if a pupil has/has not achieve each stated end of instruction. There are states in the United States that mandate measurably stated objectives. Other states have a more open-ended approach in allowing leeway in writing objectives. I recommend that objectives not be written so precisely that facts only are emphasized on tests to appraise pupil achievement. The following objective stresses pupils memorizing facts: the pupil will list in writing the names of ten arthropods. Then too, objectives can be so broadly stated that they become meaningless such as "The pupil will learn science." This objective certainly lacks clarity in terms of what will

be taught and evaluated to determine pupil achievement.

To improve the quality of life for each person, a problem solving approach should be emphasized in ongoing lessons and units in science. With problem solving, change occurs from what is to what should be in science.

Diverse schools of philosophical thought will be discussed and how each might relate to improve the science curriculum.

Realism in the Science Curriculum

A science teacher who is a realist emphasizes that one can know the real world, in whole or in part, as it truly is. The mind then does not modify or change what is being perceived. Tillman, Berofsky, and O' Connor (1971) wrote, "Most people when they think about the objects of perception, would say that they perceive a world of objects which is external to them and which exists independently of their perception of it. This view is called realism."

Since the external world is perceived the way it is in actuality, specific objective of instruction can be determined by scientists and science educators for pupils to achieve. Each objective must be relevant and is a part of the whole that can be known by the learner. Thus in geology, biology, chemistry, physics, and astronomy, among other academic disciplines, measurably stated objectives of instruction need to be emphasized in teaching and learning in the science curriculum. With quality learning opportunities selected by the science teacher, pupils either achieve or do not achieve the specific objective(s) as a result of instruction. Measuring pupil achievement in learning stresses what pupils have learned what was stated in each objective. Realists desire observable results in learning from pupils. The results are verifiable regardless of which teacher is appraising learner progress. The verification principle is very important to teachers of science who adhere to realism as a philosophy of instruction.

Skinner (1979) was a leading advocate in stressing precise objectives for pupil attainment. Reinforcement is emphasized to reward correct/ good responses in learning. Observable, measurable results

are obtained from what pupils have achieved. Guesswork is not involved, but per cents, standard deviations, quartile deviations, grade equivalents, and percentile ranks emphasize how well each pupil is doing in the area of science instruction. Numerical results of pupil achievement in science is wanted by the realist teacher. Scores from tests; objective evaluations of science experiments and demonstrations performed by pupils; ratings given to learner performance as well as responses to questions, oral reports, port folios and related papers written in which interobserver reliability is in evidence, present data as to how well pupils are achieving. These procedures qualify as objective means of appraising learner progress.

Mager (1972) stressed the importance of writing objectives so they are operationalized. Objectives are then specific and clear to teachers, pupils, and other interested persons. Learning opportunities may be chosen and aligned with the stated objectives. Appraisal procedures used to determine pupil achievement are also aligned with the objectives. Quality validity and reliability are then in the offing. A pupil reveals if he/she attained or did not attain a stated objective. The realist science teacher wishes to know if pupils individually are or are not achieving objectives of instruction. The results may then be reported to parents in a very precise way.

Prior to instruction, the teachers may announce to pupils which objectives will be emphasized in the science lesson or unit. The pupil knows exactly what will be expected in terms of knowledge or skills to be obtained. The involved pupil should have more confidence in learning when realizing what the instructor's expectations are. The science teacher might desire to arrange the objectives in an ascending order of complexity. A logical sequence follows since the teacher sequences objectives in science for the pupil to achieve.

Advantages given for emphasizing realism as a philosophy of instruction are the following:

1. teachers may realize how successful they are in teaching since results form pupil learning are clear and observable.

2. objectives, learning activities, and evaluation procedures are

interrelated in that the learning activities and the evaluation procedures must harmonize with the stated objectives. Thus, for example, it becomes easier to choose learning activities than otherwise would be the case due to the harmony needed between these activities and the stated objectives.

3. effective schools research states that pupils achieve better if there is a clear relationship between the learning activities and the evaluation procedures with that of the objectives of science instruction (Edmonds 1982).

Disadvantages given for emphasizing realism as a philosophy of education stress the fragmented knowledge that pupils may learn since each objective achieved emphasizes parts of a whole. The teacher controls the science curriculum since he/ she determines the objectives, learning opportunities, and evaluation procedures; pupils are not involved here in decision making. The products of instruction in science are emphasized, leaving little room for processes such as abstract thinking which is rather difficult to measure.

Examples of precise objectives for pupils to achieve in science are the following:

1. The pupil will write a paragraph indicating seven animals involved in a food chain.

2. The pupil will make a drawing showing ten animals in a forest food web and their interactions.

3. The pupil will list in writing the names of five parasites and their respective hosts.

4. The pupil will define each of the following: producers, consumers, decomposers, symbiosis, and an aquatic/land community.

Experimentalism in the Science Curriculum

Experimentalists stress a problem solving approach in the curriculum. They emphasize that individuals cannot know the real world as it truly is. Individuals, however, obtain experiences of this reality. With experiences, changes occur in one's thinking and believing. A changing world makes for problematic situations. Problems need

identification and solutions sought. In the science curriculum, pupils with teacher guidance select a problem within an ongoing lesson or unit of study. The problem needs to be adequately delimited so that meaning and understanding is involved. An hypothesis is developed directly related to the stated problem. Information from a variety of sources is used by learners to arrive at a tentative solution. Experimentalists believe all knowledge to be tentative, not absolute.
The result might well involve changing and modifying the original hypotheses. The new hypothesis is then tried out in a concrete situation (Geiger 1955). Problem solving may be used in all curriculum areas and in life itself. Knowledge here is used to solve problems and is not an end in and of itself. The practical and the utilitarian are emphasized within the framework of problem solving: knowledge secured from a variety of sources has an application dimension. Knowledge then is useful to solve problems in a changing world, science included (Ediger 1995).

Experimentalists emphasize that school and society are one, not separate entities. Since groups in society select and solve problems, pupils in committees also need to be involved in cooperative learning stressing problem solving. School and society are one, not separate entities. Dewey (1915) is still very widely recognized as a leading advocate of experimentalism in teaching and learning. In integrating the learner with the self as well as with the societal arena, he advocated four characteristics of pupils which have wide implications for the teaching of science. These are that pupils possess the social impulse in that they desire to work together with others in the curriculum; the constructive impulse in which learners like to learn by doing, not being passive individuals; the investigative and experimentation inclination whereby pupils desire to learn by discovery rather than being told and lectured; and the creative or expressive impulse, rather than have rigid formal expectations for achievement.

Advantages given in emphasizing experimentalism as a philosophy of teaching science are the following:

1. pupil interest in science becomes paramount when they with

teacher assistance identify problem areas. Interest in learning makes for effort in achieving.

2. very young pupils in early primary grades may be involved in problem solving experiences (Ediger 1994).

3. problem solving is useful in all curriculum areas and in life itself when problems are selected and solutions sought.

Disadvantages of using experimentalism as a philosophy of education include problem selection being too difficult as well as problem solving may not be a favorite style and way of learning for a few pupils. Also motivation may be lacking for some pupils to identify and solve problems.

The following are examples of possible problems for pupils to solve:

1. How do animals adapt to their natural environment?

2. How do cells differ in size and shape to fulfill their unique functions? How are cells similar in features possessed?

3. How do unicellular and multicellular organisms differ from each other?

4. Which life processes do all living things perform?

Pertaining to John Dewey's philosophy of experimentalism, Meyer (1949) wrote:

All of this, of course, depends upon in no small way on thinking. For Dewey, however, thinking becomes significant only when applied to life situations. It is, he has said, "an instrumentality used by man in adjusting himself to the practical situations in life." Or to phrase it more simply, human beings think in order to live. Because of this stimulus, which has its basis in biology and sociology, it is impossible -- it is absurd-- to interpret life in a systematic and and abstract way. Since, moreover, Dewey holds that life is in constant flux, it is impossible to solve problems with any degree of finality for the problems of tomorrow will be different from those of today.

As for the problem of knowledge, Dewey believes that knowledge and true experience is functional. What is this thing for? What is its use? Is a coal mine a physical deposit or does it have function? and if so, what is it? Such are the questions that help to give meaning to one's experience; but such questions cannot be answered without antecedent

action. Action must precede knowledge. Whatever knowledge we possess has resulted from our activities, our efforts to survive, to obtain food, shelter, and clothing. Only that which which has been organized into our disposition so as to enable us to adapt to our environment to meet our needs and to adapt our aims and desires to the situation in which we exist is really knowledge.

Idealism in the Science Curriculum

Idealists believe that one can receive ideas about the real world only. Thus one cannot know the real world as it truly is independent of the observer. Mental development in idealism becomes of utmost importance since an idea centered world is in evidence. Mind is real and needs development. As a leading idealist still quoted widely presently, Horne (1932) stressed the importance of the use of reason and rational thought in arriving at truth. Concepts and generalizations or universals such as justice, truth, goodness, ethics, and beauty have always existed and can be discovered by human beings. These universals are a priori, to an idealist, in that they have existed prior to human experience.

A subject centered curriculum in science is of paramount importance. In science lessons and units of study, pupils should achieve vital concepts, and generalizations. Depth teaching is needed to cultivate the intellect in guiding pupils achievement in science. A multimedia approach in leaning is needed to assist pupils to achieve abstract ideas in science. The abstract to an idealist is superior to the concrete and semiconcrete in learning. The concrete and semiconcrete facets of learning in science are salient to the degree that learners attain the abstract such as vital facts, concepts, and generalizations in ongoing lessons and units of study. Since reading and writing, in

particular, stress abstract learnings, they should not be minimized in the science curriculum.

To emphasize a subject centered curriculum as idealists recommend, an academically inclined teacher needs to teach in a scholarly way so that objectives stressing intellectual goals are attained by pupils. Blanchard (1964) wrote

> The aim of thought from its very beginning, we saw, was at understanding. To understand anything meant to apprehend it in a system that rendered it necessary. The ideal of complete understanding would be achieved only when the system that rendered it necessary was not a system that itself was fragmentary and therefore contingent , but one that was all- inclusive and so organized internally that every part was linked to every other by intelligible necessity.

Advantages given for emphasizing idealism as a philosophy of teaching science include the following:

1. pupils are to achieve significant subject matter. Idealism emphasizes the acquisition of vital content in science that pupils need to attain. Uses made of knowledge in science need to emphasize what is just to all, what is truthful, what is good in its application, what will truly stress ethical dimensions, and that which has beauty in its aesthetical areas.

2. many pupils may be motivated to learn when an academic approach to learn science is stressed. This might be especially appealing to the gifted and talented learners in science. All pupils need motivation to achieve and learn in science.

3. the abstract in idealism is preferred to the concrete and semiconcrete; relevant concepts, and generalizations, and other universals emphasize abstract goals in science teaching. Idealist advocate wholeness in knowledge, not fragmentation. Knowledge is related in all of its manifestations.

Disadvantages given for idealism as a philosophy in teaching and learning include minimizing a hands on approach in learning science since the focal point of teaching is to have pupils develop well intellectually; placing emphasis upon universals much more so than specifics – the latter is salient in pupils arriving at conclusions such as

in science experiments; and integrating of knowledge to the point where science as a discipline is not as clearly defined as it might be. Idealists tend to stress that which goes beyond the five senses. Thus metaphysics and the a priori are salient to an idealist.

Quality sequence in science might be slighted when abstract phases of learning are more prized more highly than the concrete and semiconcrete. Most educators presently recommend a sequence of concrete, semiconcrete, to the abstract in teaching- learning situations. Quite similar in sequence, Bruner (1968) advocated using manipulative materials such as objects and items; followed by iconic materials such as audiovisual materials which are one step removed from the manipulative phase; and then symbolic activities which stresses the abstract including reading and writing.

Objectives in science, according to idealism as a philosophy of education, might well stress the following universal topics:

1. monerans such as bacteria and blue green algae. Monerans are prokaryotes in that they have no true nucleus. They consist of producers, consumers, and decomposers. A few move around whereas others are stationary.

2. protists, such as paramecium, euglenas, diatoms, and cribaria. Protists are unicellular and have a true nucleus. With a true nucleus, protists are eukaryotes, and are producers as well as consumers.

3. fungi, such as mushrooms and bread molds. Most fungi are multicellular. Since fungi do not contain chlorophyll, most are decomposers with a few being consumers.

4. plants, such as mosses, liverworts, ferns, and seed plants. Plants are eukaryotes and are producers. Plants do not move from one place to another.

Pertaining to idealism, Bigge (1982) wrote:

The heart of idealism is the belief that basic reality consists of ideas, thoughts, minds, or substantive selves, not physical matter. Since priority is given to minds, minds have bodies, but bodies do not have minds. Idealism carries with its view the idea of subsistence (the superexistence) of God, who also is basically mind or self. The universe

is an expression of intelligence and will; its order is due to an eternal, spiritual reality. For idealists, people are good-active substantive minds; they are absolutely real selves endowed with free will or genuine moral choice. This philosophy has ancient roots; it dates back to Socrates (469-399 BC) and Plato (427-347 BC).

Idealism really is idea-ism. The source of this title is based on Platonic thought. For Plato, ideas only are genuinely real; they consisted of immaterial essences. That which people perceive is a shadow of reality; each thing that they perceive gets its existence from its Thingness; an idea. A book is a book because of its being more or less an imperfect replica of Bookness. a woman is a woman because she is a replica of Womanness. Plato's assumed world of "eternal verities" consisted of the True, the Good, and the Beautiful.

We can trace the development of idealism by listing some of the leading philosophers who have contributed to this position and stating a leading idea that each has contributed to this philosophy. Socrates believed that children are born with knowledge already in their minds, but they needed help to recall this innate knowledge. Plato contributed to the idea of Ideas, which are the universal forms of all existing things and are the essence of reality. St. Augustine (350-430) held a dualistic (mind-body) force of goodness.

Existentialism and the Science Curriculum

Existentialists believe that one exists first and then finds his/her purposes in life; there are no standards to guide human beings other than those developed by the human race. Most existentialists advocate that people are condemned to be free with no a priori standards in life. Individuals then make or break themselves due to the kind of society wanted. Each person chooses and makes choices continually. To be human is to choose. If a person permits the self to have someone else makes one's own decisions, then the individual ceases to be human.

Combs (1972) stresses that the way individuals perceive a situation will assist in determining how the individual will behave. Perception is unique to the individual. Each person decides upon what is true, judges what is good, and decides upon plans of action. The science curriculum then must provide opportunities for pupils individually to decide what to learn, that is the objectives of instruction. The pupil needs to be heavily involved in selecting learning opportunities as well as methods of

determining progress. The teacher is a guide and encourages pupil learning. The teacher, however, does not lecture nor determine the science curriculum for the individual pupil. A learning centers approach in teaching science may then be emphasized. Here, there are an adequate number of centers with quality tasks for learners at each center. There needs to be more tasks than what a pupil can complete so that individual sequential choices may truly be made. A psychological, not logical, science curriculum is then in evidence. Each pupil may select tasks based on personal needs, interests, and purposes. The choice to be made is up to the individual pupil. If tasks do not meet personal needs of the involved learner, he/ she might plan with the teacher what has merit and value to the pupil. A contract system might also be implemented in which the pupil with teacher guidance selects tasks to put into a contract for completion. The learner himself/ herself is responsible for choices made. The individual perceives what is good and has quality. Knowledge is subjective, not objective to the existentialist. For example, in a values clarification session, the pupil determines what is moral in terms of uses made of science and technology; the teacher has a difficult position as a stimulator and of one who encourages pupil learning. Being humane in an absurd environment is a major goal for pupil achievement in existentialist thought and thinking.

Within an existentialist science curriculum, through pupil/teacher planning a learner may select topics such as the following to pursue:

1. How do pesticides and herbicides help or hinder the natural environment? This question pertains to curbing insets and weed growth for the raising of farm crops versus possible contamination of soil and water.

2. How does one deal with animals in a humane way? This question stresses what to do with surplus dogs and cats roaming an area, as well as using animals for food and for scientific experiments.

3. How can the natural environment be used for development so that adequate numbers of jobs are available for workers versus the destruction of natural habitats for wildlife?

4. How can the needs of individuals be met as well as those in the societal arenas? This raises the question of the individual versus the larger group in a community, state, nation, and the world.

Alston and Brandt (1978) write the following direct quote of Jean Paul Sartre, a late leading existentialist:

Man is nothing else but what he makes of himself. Such is the first principle of existentialism. It is also what is called subjectivity, the name we are labeled with when charges are brought against us. But what do we mean by this, if not that man has a greater dignity than a stone or table? For we mean that man fist exists, that is, that man first of all is the being who hurls himself into the future and who is conscious of imagining himself being in the future. Man is at the start a plan which is aware of itself, rather than a patch of moss, a piece of garbage, or a cauliflower; nothing exists prior to this plan; there is nothing in heaven; man will be what he will have planned to be. Not what he will want to be. Because by the word "will" we generally mean a conscious decision, which is subsequent to what we have made of ourselves. I may want to belong to a political party, write a book, get married; but all that is only a manifestation of an earlier, more spontaneous choice that is called "will." But if existence really precedes essence, man is responsible for what he is. Thus, existentialism's first move is too make every man aware of what he is and to make the full responsibility of his existence rest upon him. And when we say that a man is responsible for individuality, but that he is responsible for all men.

The Psychology of Education

Principles of learning from the psychology of learning give direction to the science teacher in teaching-learning situations in ongoing lessons and units of study. Ediger (1994) lists the following criteria upon which educational psychologists agree should be followed by teachers;

1. meaningful learning experiences should be provided pupils in the curriculum.
2. interesting content and skills should be offered in lessons and units of study.
3. purpose needs to be established within pupils for learning.
4. quality sequence for pupil learning is a must.
5. rational balance among knowledge, skills, and attitudinal objectives is important in the instructional arena.

In Summary

Science teachers need to select tenets form the philosophy of education which stress pupils attaining vital content, abilities, and attitudes. In reviewing the different philosophies of education discussed in this paper, the following is salient from each philosophy:

1. clarity in objectives of science instruction, carefully selected, as recommended by realists. However, it is important to avoid fragmenting knowledge obtained by pupils.

2. problem solving procedures as recommended by experimentalist. Life in society emphasizes the importance of being able to solve personal and social problems.

3. major concepts and generalizations, as universals in science, advocated by idealists.

4. decision making opportunities in science as recommended by existentialists. Each person needs to learn to make decisions.

I believe that a problem solving philosophy encompasses the other three philosophies. I recommended problem solving as a major philosophy of education to emphasize in teaching science due to its relevance in the curriculum and in life itself. Problems abound and need solutions. Knowledge acquired then is instrumental or useful in problems to be solved which are selected by pupils with teacher guidance.

Ediger and Rao (1996) wrote the following in summarizing different psychologies of teaching:

Comparisons were made among the following models in teaching science:

1. problem solving with teacher guidance.
2. behaviorism with its predetermined precise objectives for student attainment.
3. humanism and its emphasis upon students selecting sequential activities from among alternatives.
4. the structure of knowledge with key concepts and generalizations identified by academicians in their respective areas of specialization. Science teachers assist students to achieve these structural ideas inductively using methods and procedures of scientists in a science laboratory setting.
5. stimulus- response learning of students in which a specific

response is associated with a precise stimulus.

The writers advocate a problem solving approach be utilized in teaching science. From a stimulating learning environment in science, students with teacher guidance identify and solve vital problems. Problem solving skills are useful in all academic areas, as well as in the societal arena. Behaviorism, humanism, the structure of knowledge, and stimulus- response learning may be emphasized within the framework of problem solving situations. Subject matter in science may then be utilized in the problem solving science curriculum.

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SE059770

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