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AUTHOR	Kuhn, David J.
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ABSTRACT

This paper is concerned with the question of how the value systems of individuals may be clarified and applied in the science classroom and in the real world outside. Science teaching is considered as occurring on three levels: the fact level, the concepts-process level, and the values level. The fact level was often stressed prior to the 1960s, the concepts-process level received added attention during the 1960s, and the values level will gain increasing importance in science teaching during the 1970s. Value education in the sciences must be built on the sound understanding of science concepts and processes. It will require innovative strategies, a new perspective on science education, and different roles for teachers. A number of strategies, including simultations, role playing, sensitivity modules, values continuums, and the use of attitudinal surveys are described. Appropriate teacher behaviors in the classroom (e.g., asking evaluative questions and promoting a classroom climate conducive to value exploration) are also examined. Science education must make the exploration of value systems paramount in order to produce a scientifically literate and aware citizenry capable of making proper decisions on such questions as population control, radioactive fallout, pesticide usage, and industrial effluencts. (Author/JR)

Value Education in the Sciences:

The Step Beyond Concepts and Processes

David J. Kuhn
University of Wisconsin-Parkside
Kenosha, Wisconsin 53140

A number of major curriculum projects have been produced in K-12 science education in the past decade. These programs represent a major improvement over the fragmented and disjointed efforts that were undertaken in the name of science education before that time. These programs provide a sound conceptual and science process base for the understanding of scientific phenomena. They represent a landmark in the improvement of science education in the schools. Many of these curricula also provide an excellent cognitive undergirding for the exploration of social problems.

This potential, however, is largely unrealized. In this age of new realities, a new direction in science education is needed. This effort need not and should not discard the curriculum efforts of the past; it should build upon them. Students must be prepared to cogently explore the social implications of science. The child affects his environment and is affected by it. As a case-in-point, the "drug culture" has certainly not exempted children; the popular press has been filled with tragic cases of twelve-year olds who died or who were seriously impaired by drug usage. On the positive side, many children have also participated successfully in community environmental action programs.

The long-term benefits of an emphasis on the social implications of science are even more important than any immediate effect. Stevenson's comment that "the child is the father of the man," should be posted in every classroom. This concept is self-evident, but too often, it is forgotten. One of the purposes of science education is to prepare the citizen to function well in relating science to the present and future concerns of society. Carin points to a general design of this type of program and the need for it:

"....science for the elementary school child has meaning only in a humanistic and social context. This means that teachers need to change the present science curriculum to include this broader picture of science in society. This need not lessen or dilute the strengths, concepts, and processes of the current science programs. It does mean, however, placing the science content and processes within a cultural context that also demonstrate greater concern for the betterment of society." (1, p.29)

Many eloquent calls have been made for such programs. There seems to be a general consensus that these designs should be put into practice in the day-to-day classroom. However, the classroom teacher's position might be paraphrased in Harry Truman's phrase, "the buck stops here." It is clearly time to deal with the concern of the implementation of value education in the day-to-day classroom.

What knowledge, skills, and materials does the science teacher need to carry out this challenge? These seem to be some general areas that require attention: He needs to understand what his values are and how they can affect his science teaching. He must realize that his classroom behaviors can have a dramatic effect on the value education of students. He must be aware of the fact that all of the classroom materials that he uses have a value component. In summary, he must work to provide the kind of open classroom environment where the student can explore his value systems concerning the social implications of selected scientific questions.

Where does the science teacher begin? He begins by rethinking his concepts of values. What are values and how are they developed? The term, values, has almost a built-in ambiguity. It is defined in several different ways. Rogers suggests that "valuing is the tendency of a person to show preference." (13, p. 241) Raths, et al, state that "out of experiences may come certain general guides to behavior. These guides tend to give direction to life and may be called values." (11, p. 27)

Inlow defines values as "determiners in man that influence his choices in life and that thus decide his behavior." (8, p.2)

Rogers suggests that values are initially developed in the child in the course of his interaction with his environment. He says that gradually the locus of valuing is shifted from the child to external factors and forces. (14, pp. 243-244) He states that many values are introjected on us by the school, church, or parents. He argues for an emphasis on the individual's understanding the nature of the valuing process. He stresses also a need to return the locus of valuing to the individual. (15, p. 249)

The value systems of an individual play a major role in his attitude toward social issues, e.g., environmental pollution. The child voices his values openly, e.g., we should not drink soda in non-returnable containers because they contribute to pollution. The values of the child seem clear-cut, if somewhat simplistic. The child often points out inconsistencies between an adult's announced values and his related behaviors, e.g., Dad, why did you throw your cigarette package out of the car window? Didn't you say littering contributes to pollution? Clearly, value systems are important, even to the small child. We argue that value education should be an integral part of his K-12 science experiences in school and that science teachers must be prepared to provide this experience.

Students need opportunities to explore their values about societal concerns. Those issues involved are complex. But, the time-honored approach of introjection of values either by precept, example, or regulations is no longer appropriate. The student should be able to develop his value systems in the science and society area. It is essential that the classroom atmosphere be non-judgemental. If it is not, children will be reluctant to express their values. It is particularly important that the teacher refrain from expressing his values until the children have expressed their value-orientation. This exercise of restraint is most difficult for many teachers. But it is a model that must be fostered. The non-directive teacher can lessen teacher talk in lieu of productive student talk and thus increase the potential for value exploration.

Values clarification is another important component of values education in the science classroom. An excellent handbook of strategies for clarifying values has been developed by Simon, et al. (19) The handbook contains seventy-nine strategies for clarifying values. The exercises include value clarification exercises for children as well as for teachers. Many of the exercises may be adapted for use in science education. Two of the exercises that this writer has found useful in science teaching are described briefly below.

A rank order technique may be used for values clarification. It could be used in this way. The teacher gives the class three (or four) alternative choices according to their preferences, e.g., which would you spend more money on? Space exploration, poverty programs, defense, or ecology. Next, the teacher asks the students to give their rankings. After students have given their rankings, the teacher may give her rankings. More discussion may follow. This situation requires the students to look deeper into themselves and make value judgements (20, pp. 58-60).

The values continuum is a useful technique to aid students in identifying and displaying their values. The scenario for its application might go something like this: An issue is chosen, e.g., recycling resources and discussed briefly to be certain that all children have the necessary background information. The values continuum is placed on the blackboard or transparency, e.g.,

Returnable Rod . . . . No-Deposit Nola

Rod never eats or drinks from a non-returnable container.	Nola uses only throw-away containers. She feels that returnable containers create too much of a mess, and besides, they make extra work.

The teacher asks the students to write their initials on the continuum at the spot where they wish to place themselves. Each student who wishes to participate makes his position known and briefly tells the meaning of his position. After the students have made their contributions, the teacher may wish to indicate his position. Ideally this activity will produce a good spread of opinion and subsequent discussion may be used to further develop the topic.

Values clarification may be also enhanced by role playing. Students, for example, may play the roles of various participants in a hearing to require a major local industry to regulate their effluents to lessen air pollution. Students may play various roles, e.g., industrialist, ecologist, town council president, mayor, "Friends of the Environment" member, etc. For a role playing experience to be meaningful, the teacher must provide the proper background information and provide time for a thorough discussion after the role playing activity is completed. Role playing provides a fertile path to values development and action based on these values on the part of the child.

The value clarification may also help the science teacher to realize that his value orientation may be markedly different from the students in his classes. The teacher may be a product of a system that stressed the rigors of modern science. He may have reveled in the collection of quantitative data, the setting up and using of sophisticated equipment and the exploration of theoretical models of scientific phenomena. But many of the students in his classes don't! Huston's study (6) suggested that the value orientations of chemistry teachers strongly favored the theoretical over the humanistic approach while the chemistry students orientation was exactly the reverse. The message is certainly evident: value education in science is the wave of the future as far as students are concerned.

How can you be certain that value education is having a beneficial effect on students? An ultimate test of the effects of value education is in the change of student behavior that it may evoke. The student's actions based on his values are referred to by Vivian and Henderson (21) as index behaviors. If he espouses the belief that littering is harmful to the environment, then we would not expect him to throw candy wrappers on the school lawn. Teachers should observe index behaviors of students. It will help them to determine how deeply the student prizes the value that he expresses. This process will also make the science teacher more sensitive to values held by individual children. This experience may also cause the teacher to re-examine his own behavior to determine if they are in conflict with his espoused values. It is particularly disconcerting to the child to note a value conflict between the verbal exposition and the day-to-day actions of an adult, e.g., a parent or teacher.

The value systems that children bring to the science classroom are not uniform, in fact, they may be markedly different. Rowe provides a number of cogent and humane insights into the value systems of inner-city children. She suggests that "pregnancy, birth, death, waste, violence are part of the daily experience of many inner-city children." (16, p. 31) It is understandable that they react somewhat differently than children from affluent backgrounds to the same curriculum materials.

Rowe describes the contrasting reactions of inner-city and suburban children to a SCIS aquarium unit. She relates their reactions to death in the aquarium. Through several touching and dramatically realistic anecdotes, she implicitly argues for a humane, relevant, science teaching that is sensitive to the differing values systems of students. Rowe's vivid description of her interaction with a Harlem fourth grade boy who was mistakenly labeled as mentally retarded underlies the theme. The boy observed mealworms in a shoebox. He related the mealworms interaction to fighting and the box as their "prison". Her report of the rest of interaction subtly underlines a desperate need for a change in science teaching priorities:

> "Just then a neighboring boy stuck his pencil in at one of the worms and received a whack on the arm. "I don't want my worms hurt." He turned to me, "I don't like to hurt things. I don't like to fight. Do you like to fight?" I told him the truth. "No, I'm mostly too scared."
>
> "I don't like to fight." he said. "Some people think we should get out on the street and fight, but I don't like to. I'd rather go to the parks and look at the cracks."
>
> Then he began to tell me how the insects changed from fall to winter and what happened in spring. And he knew it all in amazing detail. Soon he switched to telling about the cockroaches in his apartment. He knew them too--where they hid and had their young, what they ate, when they would come and go.
>
> Eventually the regular teacher took over the class and began the authorized ritual so familiar in some classrooms: "What did we learn?"
>
> The boy looked up startled. He shrugged, crossed his arms and slumped in his seat--gone again." (17, p. 33)

This vignette also suggests that value education requires planning. It will not occur in any effective manner unless it is built into the curriculum. What are some viable curricular approaches to value education in the sciences? Harmin, et al, suggests a sound approach to science teaching that will encourage value exploration. The nucleus of this paradigm is that science may be taught on three levels: the knowledge level, the concept level, and the values level. They describe the benefits of the pedagogical strategy as follows:

> "values issues must become a part of the teaching of science--so much a part of it that almost no topic in any science class will be taught without some opportunity to consider the values implication of that content. "Just the facts, Ma'am," must be banished from anything to which we give the name, science teaching. The factual approach may have sufficed in an earlier, less complex and confusing world, but today, with nuclear holocaust just outside the window and the polluted atmosphere already seeping in, we simply cannot afford to train a generation of students who know the how and why of scientific phenomena, but do not have a process for inquiring into the values issues raised by the topics they study." (5, p. 17)

A brief outline of a unit typically taught in many schools on "Pond Life" follows. A few facets of each of the three levels are indicated. No attempt is made to be comprehensive, but only to contrast the net effects of the various types of instruction. It is also realized that there is a considerable degree of interdependence and mutual support in the three types of instruction.

Knowledge Level

The facts level has traditionally been emphasized in science courses in the elementary school. This is an albatross that must be shed. A selected amount of essential and relevant information is needed, but only in appropriate context that will make it meaningful for the elementary school child. It largely centers in on Spencerian phase, "Which knowledge is of the most worth?"

Topic - Life in Pond Water

1. Name four protozoans.
2. What is a producer?
3. Name these environmental factors that might affect the amount of living organisms in pond water.
4. What do daphnia eat?
5. List four plants found in pond water.

These statements and questions are typical of the trivia that often clogs science education programs. This type of information level emphasis if carried to excessive extremes will most certainly "turn off" students' interest. It also may create a cognitive dissonance that will make further exploration of the topic less educationally productive.

Concept Level

The emphasis on science concepts and processes is characteristic of the federally funded science curricula developed in the last decade, e.g., SAPA, ESS, and SCIS. Good teaching in science education has been generally characterized by the development of basic concepts, e.g., population, by inductive, concrete, experience-based teaching strategies. A parallel concern has been the use of science processes, e.g., inference in the investigation of scientific questions. This model of science teaching has been a much desired goal of many teachers. It has often been articulated at meetings and in-service workshops. Yet, some teachers have not been able to successfully put this model into practice. However, it is a desirable approach to science education, but it is not sufficient to meet all the challenges of a new era of social concern.

The concepts listed below represent examples of the major unifying concepts of the discipline that could be sequentially developed in units on "Life in Pond Water." They provide the learner with the requisite cognitive structure that will permit a cogent exploration of values. Value education clearly requires a conceptual base.

Topic - Life in Pond Water

1. Population
2. Food Chain
3. Food Web
4. A Biological Community
5. An Aquatic Ecosystem

Values Level

The values level of science teaching gives students the opportunity to set up evaluative standards or value structures. Then he can determine how closely a scientific idea or object meets these standards or values. The questions listed are used as illustrative examples of this type of interaction.

Topic - Life in Pond Water

1. What can you do to stop the pollution of ~~ponds in~~ your area?
2. What can you do to stop the filling of a small pond to create more land for a housing project?
3. How does water pollution affect your family?
4. Suppose as a result of water pollution you had to cut your usage of water to one-fourth of normal. How would you ration the reduced supply?
5. How could water pollution in a pond affect the food that you eat?

The values level of instruction places an emphasis on students opinions and judgements. It stresses valuing as a process to be fostered in the student. This level of instruction in science education is seldom reached. Yet, it is vital that children have an opportunity to explore the value-laden issues that affect our lives, e.g., air pollution, crowding, urban blight, etc.

This level of instruction can also be expressed behaviorally. Student behavioral objectives can be expressed at these same three levels of instruction. Merrill (10) has reported an effort to develop this type of curriculum planning in a California school district. It is important to state behavioral objectives in the values domain in a non-directional way. The student should not be forced to "mirror" a set of presented value systems. We should not be upset that all the students do not express the values that we strongly hold.

What is significant is that skills in the use of the valuing process be acquired. This approach to valuing is new to most science teachers. A concern of science curriculum designers has been the development of skills in the use of science processes, e.g., inference. Yet, valuing has not been "seen" in terms of a set of skills to be developed and enhanced. The value process skills used in this interaction need to be more precisely defined so that these skills may receive more careful attention.

Values are formed within the individual in the valuing process. Values change as new information and new or modified concepts interact with valuing process skills. A major bypass mechanism of this process has afflicted science teaching: the tendency of science teachers to introject their cherished values on students. Many contemporary science students have evolved, in turn, at least a partial defense mechanism to introjection: It is their rejection of the values that many adults including parents and teachers try to introject upon them. An awareness of this situation underlines the futility of any other approach, but an emphasis on valuing as a process.

Value education is also enhanced by the use of appropriate teaching material. It is our assumption that all science materials may be used in value education, i.e., they all have a values component. But clearly some materials are much more value laden than others. The Environmental Studies materials (3) are excellent examples of materials that provide students with the type of activities and free flexible learning environment in which value exploration is nurtured.

The classroom behavior of the teacher is another major factor in value education. A useful technique for the analysis of classroom teaching is the Flanders Interaction Analysis (4). This analysis allows the investigation of how often the teacher accepts student feeling, praises or encourages student actions, criticizes or justifies his authority, lectures, etc. These behaviors have an important bearing on the potential for value education. A teacher who lectures most of the time does not provide much opportunity for value exploration. If he does no[illegible]pt student feelings or if he frequently is critical of students, the students will be reluctant to expose their values.

The questioning behavior of the science teacher is also an important factor in value education. Most teachers ask questions that are classified at the memory level by Sander's (18), e.g., What is a carnivore? This type of questioning behavior does little to enhance value exploration. The teacher questions that will aid value exploration involves analysis, interpretation and evaluation. Evaluative questions are a particularly rare occurrence in the science classroom; yet they should naturally occur in the study of science.

The evaluative question should have a personalizing effect on the science and society related issues that are studied. The question, What can you do to combat air pollution?, may stimulate a new level of value exploration. This value examination will not be automatically precipitated by a basic experiment or films about air pollution. The truism that questioning skill is basic to the teaching process, is indisputable; the evaluative question is equally important to value education in the sciences.

This idea is generally accepted, but has been implemented only in rare instances in the classroom. The studies of Lochheed, et al, (9) provide a sobering reminder of the usual situation. Their studies of over 14,000 examination questions asked by science teachers indicated that nearly 90% of the questions were of the knowledge level type and none of the questions were in the evaluative category.

Value education in the science requires a complete metamorphosis in our approach to science teaching. We must realize that value exploration has a vital place in science education. It cannot be left to the humanist or social scientist. It has implications for curriculum development, material selection, teaching style and many other aspects of science teaching.

It also has personal implications for each of us as teachers. The science education literature provides us with some useful guidance in this regard. Hutchinson's study (7) suggests that chemistry curricula have become more theoretical and abstract in the last decade. Davenport (2) suggests that this type of course in unattractive to a large percentage of students. Ratney (12) points to a direction in chemistry teaching that we also espouse. His comments may apply equally well to the other sciences:

> "Tell a class that chemists are mounting an assault on the unknown and it will yawn; show how the atomic theory is as mighty an intellectual achievement as Shakespeare's plays and it will tune you out. But show how chemistry helps fight disease, hunger, poverty and pollution, and then, maybe students will come and listen." (12, p.246)

In the light of this situation, we must abandon our current attempts at teaching values. We can not simply implant our values on the young. The valuing process must be emphasized. We must make a serious committment to the preparation of the student for an effective involvement in the social concerns of the unforeseen future. Many aspects of science teaching should be channeled in this effort. If we move in this direction, we give the student a legacy that he can use and expand on throughout his life.

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