Moral Issues and Social Policy in Science Education: Closing the Literacy Gap

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Introduction

The development of our students as rational beings, capable of informed policy judgments with respect to science and society, has been proposed as a major goal in science education for many years. To think that this capacity is not part of what it means to be scientifically literate would entail envisioning science education divorced from its social function. The goal was made explicit in the National Science Teachers Association’s (NSTA) Committee on Curriculum (1971) recommendations and has been identified and reaffirmed by present members of NSTA a decade later (Kahle & Yager, 1981). It is less clear, however, how this goal may be implemented in the science curriculum, what a new rationale for this curriculum entails, and what atmosphere our classrooms would take on as science educators strive to achieve a more complete realization of scientific literacy. The aim of this article is to develop a more thorough rationale for the implementation of an interdisciplinary approach to science education. This rationale will entail arguments stressing the need for educational reform and will summarize the most viable approaches and important considerations in responding to that need.

Understanding the Need for Reform in Science Education

A Progressive Perspective

The idea that science education should concern itself with moral and ethical issues is not new. In fact, that notion can be found in American education as early as 1910 in Dewey’s progressivism:

Science has as yet had next to nothing to do with forming the social and moral ideals for the sake of which she is used . . . (Science) has remained a servant of ends imposed from alien tradition . . . science must have something to say about what we do, and not merely about how we may do it most easily and economically . . . When our schools truly become laboratories of knowledge-making, not mills fitted out with information hoppers, there will no longer be the need to discuss the place of science in education. (Dewey, 1974, p. 192)

Dewey’s contention was that science is frequently presented as “ready-made knowledge” of fact and law rather than as a method of thinking, a method of inquiry into
any subject matter. Dewey maintained, therefore, that science teaching suffered because the method of science was not emphasized.

The need to discuss the place of science is most evident when one begins to identify trends in science education by reading the current literature. Current educators are envisioning science not as an isolated subject; rather they are understanding science in its relation to other areas of life (Sabar, 1979; Champagne & Klopf, 1982; Jacobson, 1982; Kahle & Yager, 1981). This theme is becoming widespread such that a new conception of the science paradigm (which is not unlike Dewey's progressivism) is taking root; one that conceives science education as being interdisciplinary, and demands making means-to-ends decisions relevant to the worth of life. Something that Bronowski once wrote of science seems, at last, to be grasped by science educators:

Science is not a mechanism but a human progress, and not a set of findings but the search for them. Those who think science is ethically neutral confuse the findings of science, which are, with the activity of science, which is not. (1972, pp. 63–64)

It is necessary that science education be incorporated into the progressive educational view. The progressive position equates subject matter with meaningful experience; it is sound pedagogy that students be exposed to aspects of science through their own familiarity with its social applications. Events are selected by the teacher so that they relate to those of earlier experiences and grow creatively in subsequent experience (Dewey, 1977). The moment the sciences are extended into the social realm one finds that questions of ethical theory make their appearance. Problems of moral complexity will now confront science educators and their students. Science education would now become interdisciplinary inasmuch as questions and issues of policy, obligations, rights and duties, to mention but a few, would necessarily arise. For example, questions about codes of professional ethics, research, and experimentation with specific subject groups would include other disciplines such as ethics (e.g., utilitarianism, deontology) and law. Students need experience in dealing with topics that are not part of the immediate subject matter at hand. They will now be confronted with having to assess and evaluate their attitudes, beliefs, and ethical positions related to the subject matter. This type of collateral learning plays a major role in sparking the student's interest and desire to continue learning.

The Interdisciplinary Curriculum

A progressive approach to science education incorporates a social dimension based on an interdisciplinary curriculum. At the onset of the seventies, Karplus (1971) had predicted, quite correctly, that an interdisciplinary science education trend would occur. In a review of the literature, Sabar (1979) describes various curricula that stress an integrated approach to science. For example, the Educational Development Center has recognized the need for an interdisciplinary approach. A unit named Energy, People and Their Environment has been developed which stresses social and environmental decisions (policy) for high school students. Sabar (1979) further points out that in recognizing the need to provide preservice and inservice teachers at the secondary level with familiarity with the societal ramifications of science, the American Association for the Advancement of Science has compiled a listing of college programs that are oriented to the ethical and values implications
of science and society. Another evolving group with international roots called Science-Technology-Society Educators have recognized the importance of alternative interdisciplinary courses in science and have developed courses and material to aid educators in meeting the challenges of the interdisciplinary trend (e.g., see Lewis, 1981).

In the last decade, the interdisciplinary thrust has become more evident than in past years. Specifically, the transition to an interdisciplinary approach with more emphasis on social policy, values, and ethical theory and less emphasis on science content is the theme which most commonly depicts an orientation to the aims of science education. Although it is clear that a thrust still exists toward expanding the science curricula, it is less clear as to the development of its rationale, and how that rationale relates to a new notion of scientific literacy.

In order to achieve a working definition of scientific literacy, it is necessary to include ethical components in the science curriculum. To the extent that a major aim of responsible scientific teaching is for the student to become aware of the multiple consequences that may arise from the decisions made on a social problem, the pursuit of ethical issues becomes legitimized. Scientific literacy includes more than informing a person in science content; it demands that people be informed citizens so that they can apply the scientific process to social problems (James, Schmidt, & Conley, 1974). The fact that most important scientific and technological-based decisions have an impact on society is also recognized by Barman and Rusch (1978), Stahl (1979), and Bybee (1979). Iozzi, Cheu, and Maul (1979) and Champagne and Klopfer (1982) also support this notion of a scientifically literate citizenry; that it would involve a public whose people are responsible decision makers, effective problem solvers, and whose judgments are cognizant of future impacts. Inasmuch as there exists a science-based technology which penetrates our culture, the application of scientific knowledge to problems that are meaningful (relevant) to students would necessarily involve their decisions on social issues and concerns (Robinson, 1976). In turn, some traditional content must be lost to interdisciplinary topics. However, such discourse would be more useful to a wide range of students in terms of long range goals of science education (James, Schmidt, & Conley, 1974). It would not be too soon to develop a science curriculum based on an interdisciplinary approach at the secondary level and carry it through into early college courses. Students intending to major in science could still gain concepts necessary for advanced study in upper level college courses.

It should be evident that a strong case has been proposed for a progressive, interdisciplinary science curriculum with its emphasis on ethical issues pertinent to social policy. Furthermore, the notion of combining moral issues and ethics with the science curriculum is not as incompatible as one might initially suspect. Indeed, the methods of scientific reflection and inquiry and moral and ethical endeavors are quite congruous. Kohlberg and Mayer stress this point:

According to the progressive, there is an important analogy between scientific and ethical patterns of judgment or problem-solving, and there are overlapping rationales for intellectual and ethical education. In exposing the child to opportunities for reflective scientific inquiry, the teacher is guided by the principles of scientific method which the teacher himself accepts as the basis of rational reflection. Reference to such principles is non-indoctrinative if these
principles are not presented as formulae to be learned ready-made or rote patterns grounded in authority. Rather, they are part of a process of reflection on ethical or value problems. (1972, p. 475)

A common pedagogical goal of science educators, therefore, should be the embodiment of scientific literacy in the public. Such a public will inevitably be confronted with policy judgments in society, which can only be made in an effective, rational manner if individuals have had practice and experience in making those kinds of decisions. They must be able to determine which facts of a given situation are relevant, and be sensitive to the repercussions that may follow their decisions. In an interdisciplinary science curriculum, students would be given the experience of policy thinking. For this to occur, the student must be engaged in a process of reflective thinking: the kind of thinking that is used in metaethics and normative ethics is also used in scientific reflection. It is the ability to synthesize information pertinent to a problem while eliminating the extraneous variables. Put differently, it is the rational calculation of means to ends. As a result, an overall logical consistency is established in the process of ascertaining a resolution to the problem. The hallmark of a good educator may be one who can establish the importance of such discourse to the student.

Responding to the Needs of Science Education

The Moral Atmosphere of the Classroom

This section addresses issues surrounding the implementation of an interdisciplinary approach to science education. Specifically, the form a science curriculum would take to intertwine science content with ethical issues? What should the atmosphere of the classroom be like? What is the role of the teacher? What are some viable examples of this approach?

In order for progressive science education to be effective, certain conditions should be present; for example, peer interaction, especially during dissonant or conflict situations. Competing interests and claims often exist when policy thinking is practiced among students. It is necessary, therefore, to create an ethical atmosphere in the classroom to foster consensus in defining and discussing problems. The democratic environment probably is the most successful approach:

Morality means a decision of what is right where there is a conflict between the interests and claims of two or more people. Justice means fairness in deciding the conflict, giving each person his due and being impartial to all. Democracy is a form of government designed so that the decision-making process will be considered fair by all. (Kohlberg et al., 1974, p. 10)

Dewey's (1966) major propositions entail the concept of democracy. However, Dewey envisioned democracy as more than a form of government, but also included a moral experience among people. It is a way of associated living through shared communication and social experiences in a collective pluralistic society. Furthermore, democratic education, in its ideal form, safeguards against indoctrination, providing freedom for the student to take part in decisions and recognizing basic rights of communication.
In a democratic environment, the teacher will have to extend responsibility to the students in order that they recognize that they, as individuals, are liable for the welfare of the group, as much as the group is responsible to and for each individual (Kohlberg et al., 1974). Hence, it will be necessary for students to establish some form of social contract. This will include students consenting to rules and principles which will guide the resolution of dilemmas and problematic situations. If the educational climate is constructed so as to stimulate the moral growth of the student, then the following elements of experience should be provided for them: role-taking opportunities, intellectual stimulation, responsibility, cognitive-moral conflict, peer interaction, and a democratic communicative environment. The use of moral dilemmas in the classroom may be an effective means in providing these elements of experience (Kohlberg et al., 1974; Kohlberg, Wasserman, & Richardson, 1975).

Some Viable Approaches for Classroom Implementation

Galbraith and Joné's (1976) have outlined the teaching processes involved when presenting moral dilemmas to students. Their processes would be best applied at the secondary level in a way that would be useful to one with little or no experience in this area. A general outline which science educators may readily adapt to their needs is presented with concrete classroom strategies to illustrate the precise roles of the teacher and the student. In following this outline as a basic approach to using moral dilemmas in the classroom, students should be exposed to cognitive-moral conflicts and levels of reasoning different than their own. Berkowitz, Gibbs, and Broughton (1980) have suggested that as little as one third of a stage disparity in moral reasoning between discussants provides optimal moral growth. The teacher acts as a facilitator in this process, thereby encouraging the natural stage development of the student. There are probes which the teacher, as a catalyst, should be prepared to use. The probes can reflect different levels of reasoning. Some of these probes are: (1) clarifying probes, to make sure what kind of reasoning is being conveyed, (2) general probe, used to elicit responses about the dilemma, (3) issue-specific probe, used to focus students' attention on a specific issue, (4) stage-higher probe, used to confront a student with a problem that cannot be adequately solved by his/her predominant stage of moral reasoning, and (5) role-taking probe, which is used to encourage students to make claims about a moral dilemma based upon different perspectives of individuals or events involved in that particular dilemma.

Hence, the teacher has an important role in the progressive science classroom. The teacher must be able to sensitize students to various techniques or courses of action in order to solve problems that the students might not otherwise be able to fully comprehend and tackle on their own (Baker & Doran, 1975). This will encourage students and add to their self-confidence which in turn may promote creativity and innovation in assessing and diagnosing problems and their solutions. The major hurdle for the teacher is to be able to facilitate interest (hence, motivation) in the students. Interest, understood etymologically, means that which is between or among. Applied to progressive education, Dewey (1966) suggests interest connects purpose to material otherwise distant. The teacher's task, then, is to reveal interest by exposing the multiple connections between science and society. Material which
might otherwise be alien, now assumes meaningfulness in students’ lives due to well planned intervention by the teacher.

In addition to Galbraith and Jones’ model of the teaching process involved when using moral dilemmas in the classroom, others have produced variations of that model (for a more thorough analysis of the application of moral dilemmatic strategies, refer to Scharf, 1978). A fruitful model of an alternative strategy which suits the needs of an interdisciplinary science curriculum has been developed by Stahl (1979). Stahl provides science educators with an excellent framework from which they may begin to organize scientifically related ethical investigations for their classroom, applicable to both secondary and college levels. He suggests that teachers follow three main guidelines. The first is to identify a central focus which may stress a specific area of science content or moral issue. Second, the content and context of the dilemma should be examined. Third, the moral setting that is most amenable to the central focus, content and context of the issue should be developed. Furthermore, Stahl identifies the most common classroom formats and techniques which will provide the opportunities necessary to practice and develop decision-making strategies. The teacher’s responsibility is, of course, to make the final decision as to which combinations (content, context, and setting) are most relevant to their classes’ needs in terms of curriculum design. This responsibility should not be considered lightly; for the content and context of moral dilemma have been found to significantly influence the propensity for students to use higher levels of moral reasoning (Zeidler & Schafer, 1983). Variations of these approaches have been used successfully in situations involving an entire school. The Just Community Approach in the Cluster School in Cambridge, Massachusetts, is a case in point (Reimer, 1981). Other approaches have focused on curricula for the individual science classroom such as the Generalized Approach described by Jacobson (1982).

Policymaking: The Foundation of Moral Education

It has been noted that policymaking plays a central role when discussing moral and ethical issues in science classrooms that are not detached from social concerns. Policymaking involves deliberation, negotiation, and collectively derived decisions. Indeed, the only way for conflicting parties in a contrived situation to determine policy is through joint participation. Benne and Birnbaum (1978) have realized that students will not ultimately arrive at the same positions, given the pluralistic nature of our society. It is in this regard that policymaking is a powerful tool in resolving controversy.

The goal of a policymaking activity is for students to arrive at decisions in which optimal competing claims and values are satisfied in a policy decision. Green (1975) expresses the concept of optimality as follows:

By optimality, I mean to refer to the best composition of conflicting goals so that optimization of the whole set may require something less than the maximization of each in order to get the greatest amount of them all in combination. The concept of ‘optimality’ understood in this way is an interesting notion. There is a kind of duality in its logic that may well mark it off as unique. On the one hand it has to do always with what can be chosen. Therefore, it is always related to the possible. ‘Optimal’ means ‘feasible’. But on the other hand, even etymologically, ‘optimality’ relates to what is best. There is always that normative aspect
to its logic. On the one hand, the concept of optimality deals always with what is possible, but on the other hand, it touches on what is ideal, which is best. (p. 76)

There are three important phases in policymaking (Raup et al., 1962) which students undergo in a social-science classroom. The first is the optative mood, in which students must be able to project into the future in order to invent, investigate, and foresee alternative ways of securing an optimal resolution to the problem at hand. The above authors reinforce the importance of optimal resolution by using the phrase “practical utopian thinking.” That notion would appear to have its roots in Aristotle’s Nichomachean Ethics (see Ostwald, 1975, book six, 1144b) and his philosophy on practical wisdom and moral virtue. The second phase is the indicative mood, during which point students are engaged in exploring actions that are practical (feasible) and are based on scientific knowledge (reason and fact) and technology (application). The third mood is the imperative mood, whereby students have not only chosen from an array of competing alternatives on how to act, but actively support their decisions. They should also realize that the policy should be flexible enough to allow future revisions in the light of new information and/or unforeseen factors. The outcome then, is for students to generate a workable and enforceable method of dealing with a science-social issue. The judgments made with regard to policy formation are pragmatic, are based on valid knowledge, and attempt to secure the best possible norms and means to resolve a problem.

Benne and Birnbaum (1978) warn of several pitfalls of policymaking that may divert its purpose. First, in a pluralistic society such as ours, different groups may hold certain convictions (e.g., religious, political). These convictions will publicly affect a group’s position on an issue. Hence, the process of policymaking should not be viewed as competing groups that must obtain a common system of moral ideologies. The probability of obtaining a rational policy outcome increases if the groups engaged in the process acknowledge differences among personal convictions and concentrate on optimal ways of resolving a conflict situation. Secondly, there may be a tendency for some of the class to polarize the issue into “good guys” (us) and “bad guys” (them). When this happens, groups tend to concentrate on promoting the power of their own group and consequently, the resolution of the original conflict becomes secondary. Lastly, if one or both of the above problems take root, a more serious problem may develop; the conflict is viewed as a fight to the finish. If this occurs, the policy conflict has become dehumanized and subsequently, the opposing parties engaged in the situation are viewed with lack of human dignity. Such pitfalls of policymaking are to be guarded against from the onset. The responsibility of making this clear to the students belongs, of course, to the science educator.

One classroom strategy teachers may use to alleviate polarization of an issue is to assign three listening groups in addition to the pro and con groups considering an issue. One of the listening groups judges the feasibility and persuasiveness of arguments of the pro side, and a second listening group does the same for arguments of the con side. The third listening group or “middle” group attempts to decide the best combination of both arguments and derive a position which reflects an optimal policy of all parties concerned. The third group may be likened to a utilitarian melting pot. This type of strategy involves the class as a whole, and provides realistic experience in policymaking.
Conclusion

If the goals of secondary and higher education could be condensed into a neat package which most educators would agree with, it might read something like this:

To develop the reasoning faculties of our youth, enlarge their minds, cultivate their morals, and instill into them the percepts of virtue and order; . . . And, generally to form them to habits of reflection and correct action, rendering them examples of virtue to others, and of happiness within themselves. (Honeywell, 1931, pp. 248–260)

The lucidity of this remark becomes more astonishing when one considers the foresight and wisdom that Thomas Jefferson possessed as he spoke those words in the early 1800s. It is not surprising that Jefferson's statement sounds similar to Dewey's ideas on progressive education, since Dewey was influenced by Jefferson, much as "modern" education continues to be influenced by Dewey. Dewey's (1978, 1977, 1966) contention was that education should be concerned with the intellectual and moral growth of the student, and he viewed the school as an "embryonic typical community" (1978). As such, students should be provided with experience that will have direct impact and relevance to their present and future social experiences.

Therein lies the task for science educators who understand the relevance of Dewey's ideas and wish to integrate them into their profession. And to that end, this article has argued that in order to achieve the long acknowledged goal of scientific literacy, it is necessary to include moral and ethical issues in an interdisciplinary science curriculum. The main argument is based on the premise that if individuals are expected to make rational, informed decisions about their society (one that is permeated by science and technology), then they should be provided with the necessary experiences in which to practice this kind of decision making. The suggestions in this article represent several important general guidelines to consider and are by no means exhaustive. Rather, they provide science educators with the means by which they can begin to fulfill the social responsibility they have to their students; providing students with the experience of making decisions that will be relevant to the worth of their lives now and in the future.

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