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The Aesthetic Dimension of Education in the Abstract Disciplines

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There are two senses in which education can be said to have an aesthetic dimension: the processes of teaching, learning, and knowing may have aesthetic aspects as may the subject matter itself. The present article seeks to show that all education has an aesthetic dimension in both senses and that, indeed, the aesthetic dimension is so essential that no education is possible without it.

It is fairly obvious that teaching and learning have aesthetic aspects, although the aesthetic aspect of knowing is quite interesting and highly controversial. These topics are discussed in section one. Section two explores the aesthetic aspect of subject matter — especially subject matter composed of abstract concepts. Section three discusses concomitant learnings as aesthetic by-products of content and method. Finally, section four relates these ideas to certain problems in curriculum development, teaching methods, school administration, and teacher education.

1. THE AESTHETICS OF TEACHING, LEARNING, AND KNOWING

Regardless of the subject matter involved, teaching is a performance. Teachers, of course, should not be judged according to the standards applied to actors, opera singers, ballet dancers, or artists; yet, it is clear that teachers do convey moods, use their voices, gesture and move about, and make drawings on the blackboard and, therefore, aesthetic criticisms are possible. There may well be disagreement concerning the

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importance of aesthetic criteria in evaluating teacher performance, and certainly, it is impossible to specify criteria as either necessary or sufficient for effective teaching. But there is general agreement that good teaching requires considerably more than knowledge of subject matter. Subject matter must be presented effectively, and this effectiveness is primarily determined according to aesthetic considerations.

An effective teacher may have a voice which soothes his students but on occasion may employ a harsh, rasping voice with equal effectiveness. But in either case, qualities of voice are significant. Sometimes teacher enthusiasm will stimulate the productivity of students, while at other times teacher apathy (perhaps deliberately portrayed) will disturb students and thereby encourage their productive thought or action. An effective teacher, like an effective actor, controls his performance, adjusting it to the requirements of changing circumstances in order to produce intended results. A teacher must appreciate the moods of his students, but he must also maintain an appropriate psychological distance in order to provide an intelligently manipulated organization of his conduct. For best results in handling "the discipline problem," a teacher must achieve an appropriate balance between empathy and distance.

While the learner's primary task may be to attend to the content of a lesson, it is also true that he undergoes an aesthetic experience as a spectator of the teacher's performance. Indeed, as we shall later see, some of the most important learnings occur as concomitant results of this aesthetic spectatorship. A behaviorist might well argue that teaching and learning are entirely analyzable as sequences of empirical stimuli and responses, but the behaviorist would also analyze art, poetry, music, and drama in the same way. In short, however one might analyze the fine arts, the same mode of analysis and criticism will yield significant observations about the processes of teaching and learning.

In examining teaching and learning as aesthetic processes, we tend to ignore that these processes serve the purpose of conveying subject matter and that the conveyance of subject matter may also be subordinated to the still larger purpose of putting the subject matter to use after the teaching-learning process has ended. But this argument does not destroy the validity of regarding teaching and learning as aesthetic performances: many works of art (including all that are "representational"), portray subject matter in the same sense and sometimes have the purpose of providing social or religious commentary. Whether there is recognizable subject matter and whether there are propositional lessons to be learned have nothing to do with the fact that criticism of a performance may be made on aesthetic grounds. Indeed, it has been asserted that a primary purpose of education is the sheer enjoyment of undergoing it.

Those who most strongly defend education for self-realization usually draw a distinction between learning and knowing. Learning enables one to cope with sensory phenomena, while knowing transcends the senses and has no purpose beyond itself. To use Plato's way of speaking: learning can provide right (or wrong) opinion about the world of appearances, while knowing provides certainty and wisdom pertaining to the world of Forms. Knowing is considered infinitely more valuable than learning; knowing is both a cause and a result of intense personal involvement and commitment; knowing is the highest kind of aesthetic experience.

The personal involvement and commitment to be found in the act of knowing have been explored at length by Michael Polanyi. He shows that knowing requires the creative integration of whatever evidence or propositions are available. Knowing always goes beyond the data. No proof ever *forces* the acceptance of its conclusion; rather, a successful proof expresses a truth in such a *convincing* way that whoever wrestles with the proof *comes to agree* with its conclusion. Knowing is a personal commitment to that which is known, as indicated by the tenacity and fervor with which knowledge is held and proclaimed.[1] The aesthetics of mystery are involved in a problematic situation; a drama unfolds as evidence is organized and partially understood; tension resolution, emotional release, and psychological closure occur as knowledge is finally discovered.

An excellent review of the history of the claim that knowing is an aesthetic activity is given by Frederic Will in his book *Intelligible Beauty in Aesthetic Thought.*[2] Will notes that Plotinus supplied a monistic, mystical completion to Plato's doctrine of ideas, and subsequent aestheticians have used this tradition as a basis for the notion of intelligible beauty. According to Will, the notion of intelligible beauty is "the belief that man's higher cognitive faculties are deeply and appropriately engaged in aesthetic experience."[3] Will shows how the notion of intelligible beauty functions in the philosophies of a number of thinkers. He

[1] Michael Polanyi, *Personal Knowledge* (London: Routledge and Kegan Paul, 1958).

[2] Frederic Will, *Intelligible Beauty in Aesthetic Thought* (Tubingen: Max Niemeyer Verlag, 1958).

'*Ibid.,* p. 16.

claims, "The most general agreement of Plotinus with Hegel, and with the post-Kantians in general, is on the tenet that reality is essentially thought, or intelligibility, and that the end toward which reality strives is total intelligibility."[4]

Plato's sun, cave, and divided line allegories in the *Republic* provide metaphysical explanations of what is being asserted in the claim that knowing is essentially an aesthetic activity. It will be recalled that as a potential philosopher-king acquires greater knowledge at higher levels of reality, he approaches knowledge of the supreme Form of the Good. When he finally does achieve this highest kind of knowledge, he undergoes a mystical conversion experience which alters his personality characteristics. There is thus profound personal involvement in the struggle for wisdom. Furthermore, Goodness, Truth, and Beauty are regarded as three aspects of the unified Form of the Good, so that knowing and aesthetic experience are identical at the highest level.

In speaking about the rise of the soul into the world of the Absolute, Plato says in the *Phaedrus,*

> It is there that Reality lives, without shape or color, intangible, visible only to reason, the soul's pilot; and all true knowledge is knowledge of her . . . when the soul has at long last beheld Reality, it rejoices, finding sustenance in its direct contemplation of the truth and in the immediate experience of it____[5]

In the *Symposium* Plato is even more explicit:

> This is the right way of approaching or being initiated into the mysteries of love, to begin with examples of beauty in this world, and using them as steps to ascend continually with that absolute beauty as one's aim, from one instance of physical beauty to two and from two to all, then from physical beauty to moral beauty, and from moral beauty to the beauty of knowledge, until from knowledge of various kinds one arrives at the supreme knowledge whose sole object is that absolute beauty, and knows at last what absolute beauty is."

The following points made by Plato deserve special emphasis here: particular phenomenal instances of beauty are inferior to and derive their beauty from more general, abstract kinds of beauty; both physical and moral beauty are particular embodiments of the beauty of knowledge; ultimate Reality (and hence ultimate beauty and ultimate knowledge) is "without shape or color, intangible, visible only to reason."

[4] *Ibid.,* p. 205.
[5] Plato, *Phaedrus,* trans. W. C. Helmbold and W. G. Rabinowitz (New York: The Liberal Arts Press, 1956), p. 30.
"Plato, *Symposium,* trans. W. Hamilton (Baltimore: Penguin Books, 1956), p. 94.

One of the most controversial points here is the claim that pure cognition, without any immediately antecedent sense perception, can be an aesthetic experience. It is customary to speak of aesthetic experience in connection with the perceptions of the five physical senses; yet, as Hospers points out,[7] aesthetic experience is actually concerned with meanings, associations, and emotions, whether these come to us through the senses or otherwise. This assertion is especially true of literature, where the actual sound (if any) is not important. Of course it may be claimed that reading produces mental images, so that some kind of sensory-like basis exists for the aesthetic experience in literature. But Hospers refutes this claim:

> . . . many readers can read appreciatively and intelligently without having any visual or other images evoked in their minds. . . . The inclusion of literature in the category of the perceptual by means of some image evocation theory constitutes a desperate attempt to make the facts fit a theory. However, the dismissal of literature as not being the object of aesthetic attention because of its nonperceptual character would seem to be a prime case of throwing the baby out with the bathwater.[8]

We shall see in the next section of this paper that abstract mathematics has important aesthetic aspects, although it is completely nonperceptual. As Hospers says,

> When we enjoy or appreciate the elegance of a mathematical proof, it would surely seem that our enjoyment is aesthetic, although the object of that enjoyment is not perceptual at all: it is the complex relation among abstract ideas or propositions, not the marks on paper or the blackboard, that we are apprehending aesthetically. It would seem that the appreciation of neatness, elegance, or economy of means is aesthetic whether it occurs in a perceptual object (such as a sonata) or in an abstract entity (such as a logical proof), and if this is so, the range of the aesthetic cannot be limited to the perceptual.'

Indeed, according to Plato the best aesthetic experiences are the most abstract and least perceptual.

Any attempt to provide a definitive characterization of what is meant by "aesthetic" or "aesthetic experience" is beyond the scope of this paper. Our purpose in die present section has been to indicate important similarities between activities generally acknowledged to be aesthetic and the activities of teaching, learning, and knowing. The significance for education of those similarities will be explored in section four. We

[7] John Hospers, "Problems of Aesthetics" in *The Encyclopedia of Philosophy*, ed. Paul Edwards (New York: Macmillan, 1967), Vol. I, pp. 38-39.

[8] *Ibid.,* p. 39.

[8] *Ibid.,* p. 38.

have emphasized the aesthetics of abstract knowing in preparation for the remainder of this paper. The author has elsewhere provided a more extensive analysis of what is meant by "aesthetic" and how the aesthetic aspects of teaching, learning, and knowing are interrelated.[10]

2. THE AESTHETICS OF ABSTRACT SUBJECT MATTER (ESPECIALLY MATHEMATICS)

Let us imagine that the subjects in a school curriculum have been arranged according to the relative "aestheticness" of their subject matter as normally conceived. Surely the arts would be close to one end of the continuum, while the abstract, logical disciplines such as mathematics and theoretical physics would be at the opposite end. Yet we shall see that the arts have a mathematics-like aspect, and that the subject matter of mathematics has an essential aesthetic aspect. The continuum suggested above is therefore really a continuum rather than a multichotomy. But what is most significant for our purposes here is that abstract subject matter has an aesthetic aspect and that, therefore, teaching mathematics and other abstract subjects for appreciation is as reasonable and, indeed, as necessary as teaching art for appreciation.

In claiming that mathematics possesses an essential aesthetic aspect, we must distinguish between mathematics as it is written and mathematics as it is held in the mind. Mathematicians may have poor handwriting, small in size and hard to read. Mathematical symbols might be considered ugly. Although it is true that configurations of symbols are manipulated by the mathematician in the process of proving theorems, and that seeing the configurations is usually helpful and sometime? apparently necessary in making discoveries. Manipulating symbols on paper strongly resembles moving furniture in a room or assembling a jigsaw puzzle: we often must try out a configuration before deciding whether it fits together and is pleasing. But the way die symbols appear on paper is obviously not crucial to the mathematician, who can adopt alternative systems of notation with no effect on his mathematical results. What really matters is the fittingness and pleasingness of the configurations of abstract concepts in the mind of the mathematician.

Mathematical discovery is a species of knowing, and as such has already been discussed in section one. Plato, for example, regarded mathematical objects as "shadows" of the Forms in his divided line allegory. He recommended a ten-year program of abstract mathematics in the curriculum of prospective philosopher-kings to accustom their

[10] Kenneth Robert Conklin, "The Aesthetics of Knowing and Teaching," *The* (Teachers College) *Record,* forthcoming.

minds to the abstract beauty of the Forms and to develop the power of intuitive, aesthetic appreciation of nonsensuous entities in order to prepare them for their "vision" of the Form of the Good.

The role of intuition in mathematics has been widely discussed. On the one hand, proofs must be based on strictly logical reasoning and must avoid overt dependence on intuitive or heuristic appeal. On the other hand, mathematical discovery seems to draw heavily upon intuition, and the most profound discoveries were often the products of the most profound intuitions. While it is true that intuition sometimes leads mathematicians to false conclusions, it is also true that mathematicians accept numerous theorems as intuitively obvious even though all efforts at proving them have failed.

Kurt Godel, who has been among the most successful mathematicians in using rigorous techniques of logic, is also one of the strongest defenders of the role of intuition. He argues that mathematical intuition is very much like sense perception, and that the question of the objective existence of the objects of mathematical intuition "is an exact replica of the question of the objective existence of the outer world."[11]

> I don't see any reason why we should have less confidence in this kind of perception, i.e., in mathematical intuition, than in sense perception, which induces us to build up physical theories and to expect that future sense perceptions will agree with them and, moreover, to believe that a question not decidable now has meaning and may be decided in the future. The set-theoretical paradoxes are hardly any more troublesome for mathematicians than deceptions of the senses are for physics."
>
> What, however, perhaps more than anything else, justifies the acceptance of this criterion of truth in set theory [clarity of intuition] is the fact that continued appeals to mathematical intuition are necessary not only for obtaining unambiguous answers to the questions of transfinite set theory, but also for the solution of the problems of finitary number theory (of the type of Goldbach's conjecture), where the meaningfulness and unambiguity of the concepts entering into them can hardly be doubted. This follows from the fact that for every axiomatic system there are infinitely many undecidable propositions of this type.[1]*

Intuition in cognitive discovery functions much like sensation in artistic appreciation. Perhaps Plato (doctrine of reminiscence) and Jung (racial memories) would argue that intuition in cognitive discovery is more like memory than sensation, but they would also say that

"Kurt Godel, "What Is Cantor's Continuum Problem?" in *Philosophy of Mathematics,* ed. Paul Benacerraf and Hilary Putnam (Englewood Cliffs, N.J.: Prentice-Hall, 1964), p. 272.

"*Ibid.,* p. 271.

[13] *Ibid.,* p. 272.

the "aestheticness" of sense experience comes from memory as well. In any case, the role of intuition in mathematical discovery is closely similar to the role of aesthetic sensitivity in artistic creation or appreciation. Henri Poincare uses vivid language to describe the drama, beauty, and joy of mathematical discovery in his own experience,[14] and Jacques Hadamard has made a major study of the psychology of mathematical discovery.[15] There can be no doubt that mathematical discovery is an aesthetic experience of the most profound kind.

We distinguished earlier between mathematics as it is written and mathematics as it is held in the mind, and we noted that only the latter kind of mathematics has a genuine aesthetic aspect. What should be compared with the arrangement of pigments on canvas is not the arrangement of symbols on paper but the arrangement of concepts in the mind as suggested by the written symbols, a kind of perception not far removed from the artistic appreciation of our perception of the colored shapes rather than an appreciation of the colored shapes themselves.

Thus far we have viewed the aesthetics of mathematics from the perspective of someone who discovers important mathematical truths, and the discussion to this point may seem relevant only to creative mathematicians engaged in original research. But this is not the case at all. The aesthetics of mathematical discovery is valid whether the discovery adds something new to the stock of mathematical knowledge or whether it is merely a rediscovery by a child of a truth commonly known to all who are not mathematically illiterate. Each discovery is original for the person who makes it.

But there is clearly a distinction between making a discovery independently and following a given argument, just as there is a distinction between creating a symphony and listening to one created by someone else. Yet, some of the aesthetic experience of discovery is surely present even for the person who only appreciates the work of another. Following a single proof or studying a whole branch of mathematics provides an aesthetic experience closely similar to that of reading a novel or seeing a play: there is a plot with sometimes unexpected twists and turns, there is a buildup of suspense, and in the end things either get resolved or stimulate us to look for a sequel. Even though a mathematician may have read a particular proof several times, if it is a significant or

[14] Henri Poincare, "Mathematical Creation" in *The World of Mathematics,* ed. James R. Newman (New York: Simon and Schuster, 1956), Vol. IV, pp. 2041-50.

[15] Jacques Hadamard, *The Psychology of Invention in the Mathematical Field* (New York: Dover Publications, 1954).

beautiful proof he enjoys reading it again. Mathematicians enjoy creating or reading many different proofs for the same theorem, just as music and drama lovers enjoy variations on a common theme. Just as there are standards of aesthetic judgment for works of art, music, and drama, so we should expect there to be standards of aesthetic judgment for mathematical products — and indeed there are such standards.

Poincare talks in general terms about the feeling of mathematical beauty, the harmony of numbers and forms, and elegance.

> Now, what are the mathematic entities to which we attribute the character of beauty and elegance, and which are capable of developing in us a sort of esthetic emotion? They are those whose elements are harmoniously disposed so that the mind without effort can embrace their totality while realizing the details. This harmony is at once a satisfaction of our esthetic needs and an aid to the mind, sustaining and guiding. At the same time, in putting under our eyes a well-ordered whole, it makes us foresee a mathematical law. . . . The useful combinations are precisely the most beautiful, I mean those best able to charm this special sensibility that all mathematicians know, but of which the profane are so ignorant as often to be tempted to smile at it."

G. H. Hardy, a professional mathematician, wrote a book celebrating the aesthetic aspect of mathematics as a justification for devoting his life to the subject. He provided a lengthy and precise description of standards for the aesthetic criticism of mathematics. Hardy notes that the mathematician is a maker of patterns with ideas. Creating or reading mathematics has aesthetic qualities like those found in playing or watching a chess game, except that mathematics is superior to chess in many ways.[17]

According to Hardy, the beauty of a mathematical theorem depends greatly on its seriousness, and the seriousness of a theorem is determined according to the theoretical significance of the mathematical ideas which the theorem connects.[18] Significant mathematical ideas are those having generality and depth.[19] A theorem is general if it summarizes a host of concrete facts or lower-level generalities,[20] and it is deep if it is somehow essential to a number of important truths.[21] In addition to seriousness, a beautiful theorem or proof also has unexpectedness (either in its

[16] Henri Poincare, *op. cit.*, pp. 2047-48.
" G. H. Hardy, *A Mathematician's Apology* (Cambridge: University Press, 1967), pp. 84-85.
[18] *Ibid.*, pp. 89-98. Hardy gives two examples of theorems with proofs which he considers beautiful.
"*Ibid., p.* 103.
[10] *Ibid.*, pp. 104-09.
[21] *Ibid.*, pp. 109-12.

conclusion or its development) combined with inevitability and economy.[22] Mathematics has a crude utility, but the "real" mathematics of the "real" mathematicians is almost completely abstract and "useless"[23] and "must be justified as art if it can be justified at all."[24]

Another author, John W. N. Sullivan, agrees that mathematics, like chess, is a beautiful art pursued for its own sake but claims that some of the beauty of mathematics comes from its applicability to the phenomenal world. Sullivan's main point, however, is that both abstract and applied mathematics make explicit the Kantian categories of knowing and perceiving and thus serve the same function as all the arts in telling us about ourselves![25] "Mathematics" he concludes, "is of profound significance in the universe, not because it exhibits principles that we obey, but because it exhibits principles that we impose."[26] Other authors have noted that mathematics, like art, is a cultural product and presumably gives us important insights into the culture that produced it.[27] The culture determines what kind of mathematics is studied and what counts as mathematics.[28]

Von Neumann agrees that mathematics is a cultural product and points out that changing cultural standards have changed the concept of mathematical rigor and the style in which proofs are written.[29]

> I think that it is correct to say that [the mathematician's] criteria of selection, and also those of success, are mainly aesthetical . . . one expects a mathematical theorem or a mathematical theory not only to describe and to classify in a simple and elegant way numerous and a priori disparate special cases. One also expects "elegance" in its "architectural," structural makeup. Ease in stating the problem, great difficulty in getting hold of it and in all attempts at approaching it, then again some very surprising twist by which the approach, or some part of the approach, becomes easy, etc. . . . These criteria are clearly those of any creative art.[30]

Von Neumann tells us that the criteria of excellence in these aesthetic factors change with changes in general cultural patterns, so that mathematics is subject to cultural influences just like any art.

"*Ibid.,* pp. 112-15.

"*Ibid.,* pp. 115-21 and pp. 131-43.

u *Ibid., p.* 139.

!3 John W. N. Sullivan, "Mathematics as an Art" in *The World of Mathematics, op. cit.,* Ill, 2015-21.

"*Ibid.,* p. 2021.

" See "Mathematics as a Culture Clue" in *The World of Mathematics, op. cit.,* IV, Part 25, pp. 2312-64.

28 Raymond L. Wilder, *The Foundations of Mathematics* (New York: John Wiley and Sons, 1965), pp. 281-99.

29 John Von Neumann, "The Mathematician" in *The World of Mathematics, op. cit.,* IV, pp. 2053-57.

K *Ibid.,* p. 2062.

Mathematicians, like artists, manifest their creativity at an early age. Hardy points out that most of the great discoveries in mathematics were made by men of age forty or less and that virtually nothing really new was done by people over fifty. Not only is mathematical discovery a "young man's game," it is also a field with many prodigies. Galois, the discoverer of vast and valuable territory in abstract algebra, died in a duel at age 21. Abel died at 27. Newton made his greatest discoveries in mathematical physics by age 24.[31]

Perhaps youthful prodigies are possible only in endeavors which, like mathematics and logic, meet the following two conditions: (1) the knowledge required is independent of the breadth of the knower's life experiences; (2) internal consistency is the primary standard for measuring the success of a product. The more nearly a field meets these conditions, the more frequently we would expect to find child prodigies making significant contributions to it. Thus, we would expect chess to have its prodigies — witness the case of Bobby Fischer who has dominated U.S. chess for a decade since first becoming U.S. champion at age fourteen — but not personnel management, medicine, or psychology. The two requisite conditions seem to describe areas which philosophers would call analytic and a priori.

Among the arts, music would seem to satisfy the criteria best, while art and sculpture satisfy them to a lesser extent, and epic-novel-writing or opera or playwriting satisfy them least. Common knowledge of these fields confirms the predicted relative frequencies of child prodigies in them. To the extent musical compositions include elements of common folk music or expressions of sentiments about life activities, as many classical pieces do, they depend upon broad cultural experience and prodigies would be unlikely. But the performance of music as a soloist requires no cultural experience, and it is here that we find many prodigies. We might recall that music in ancient times was studied as mathematical harmonics and was included in the quadrivium of mathematical subjects (with arithmetic, astronomy, and geometry) among the seven liberal arts. Many of the qualities which determine the aesthetic characteristics of music are essentially mathematical: internal consistency, temporal progression, "logical" inevitability or predictabilty, etc. Indeed, such mathematical qualities enable us to appreciate a finished product in any of the arts. Regardless of how much cultural experience may be necessary to create a work of art or to appreciate fully the associations it alludes to, any work of art can be appreciated to

[31] G. H. Hardy, *op. cit.,* pp. 70-73.

greater or lesser degree for its internal qualities of balance, form, rhythm, etc.

We have seen in detail how mathematics has an essential aesthetic aspect and how the arts have an important mathematics-like aspect. It should also be clear that any subject, when organized for formal study, has a mathematics-like aspect. Whenever general principles are used to explain particular phenomena, we have a species of mathematical, deductive logic. The beauty of a concept in an organized body of subject matter can be analyzed precisely as Hardy analyzed the beauty of a mathematical theorem: according to the significance of the ideas it connects, according to its generality and depth, and whether it possesses unexpectedness combined with inevitability and economy. Any subject can be made more inspiring and aesthetically enjoyable for students if teachers and curriculum planners organize the subject matter to maximize its logical beauty.

3. THE AESTHETICS OF CONCOMITANT LEARNINGS

Imagine that the professor of an education course of 500 students recommends in his lecture that large group instruction and the lecture format are not suitable pedagogical devices. We might well suspect his sincerity or integrity, but the humor and cognitive dissonance we experience occur because what is taught overtly in the lecture is the opposite of what is taught concomitantly by the example of the lecture.[32]

A method teaches itself concomitantly whenever it is used for the overt teaching of subject matter. Methods may be applied beyond the subject being taught, so that the concomitant lesson learned from a method may be more significant to the student in the long run than the subject matter that was overtly taught. Likewise, the teacher's attitudes toward the subject matter, toward teaching, and toward life in general are taught concomitantly. The teacher is a value exemplar with whom students identify, and thus the aesthetics of knowing, teaching, and learning has a more general, long-range impact upon the student than the aesthetics of subject matter.

Indeed, subjects also teach methods. A subject teaches concomitantly whatever disciplined methods of study and organization are found in its subject matter, and in this way the aesthetics of subject matter may have an influence beyond the field to which the subject matter belongs.

[32] Kilpatrick pioneered in the study of concomitant learnings. For a summary and interpretation of his work on this subject, see David W. Ecker, " 'Concomitant Learning' in Tomorrow's Schools," *Studies in Philosophy and Education*, Vol. 1 (November, 1961), 190-202.

A person who has studied and enjoyed mathematics at least moderately may well apply rigorous methods of proof to other subjects and will probably try to organize concepts in other fields into hierarchically constructed deductive systems.

Participation in, or concerned spectatorship with, a method and content alters our character toward closer conformity with that method and content. Plato recognized this fact and insisted that drama, art, and music be severely censored to ensure a morally sound upbringing for the young. Likewise, there are those who currently argue that people, especially the immature and impressionable, who are exposed to violence on television tend to become violent and to tolerate violence in real life. Similarly, role playing is effective in helping someone to understand an opponent's ideas and feelings precisely because of the tendency to identify with what is done or observed.

The appreciation of a work of art may be enhanced through empathy, both cognitive and emotional. The argument presented in this section may be regarded as an explanation of what is meant by saying that a learner empathizes with the learning situation to whatever extent he is successful in learning. Empathy automatically involves both cognitive and emotional aspects, and whichever aspect is attended to carries the other aspect with it concomitantly. Likewise, both method and subject matter are involved in a learning situation, so that the overt learning of one results in the concomitant learning of the other. The interactions between cognition and emotion and between content and method are obviously within the realm of general aesthetic analysis.

We may also note that actions and value commitments are concomitants of each other. When we assert a value commitment at a high level of generality, we are concomitantly asserting a host of lower level value commitments applicable to whatever situation is at hand. Conversely, when we take action in a particular situation, our action concomitantly teaches a commitment to the general values which justify the action. Some people might argue that "actions speak louder than words," but what is claimed here is simply that actions and words interact concomitantly. There is an aesthetic relation between actions and words, so that each signifies the other and a given combination of actions and words constitutes either a consonance or a dissonance.

4. SOME APPLICATIONS TO EDUCATION

We have seen that teaching, learning, and knowing, as well as subject matter have essential aesthetic aspects. We have also seen ttiat there are concomitant learnings accompanying all teaching-learning situations, and the concomitant learnings may be more profound and far-reaching than the overt ones. In the present section we shall explore some important applications of these observations to curriculum planning, educational methodology, school administration, and teacher education.

One obvious conclusion from all that has been discussed is that a much larger portion of the curriculum than simply the arts can be used to enhance a student's appreciative sensitivity. We have seen that the appreciation of mathematics is just as possible as art appreciation or music appreciation.[33] Indeed, the importance of mathematics and the other abstract symbolic disciplines in modern life suggests that learning the appreciation of them is indispensable in a well-rounded education. Traditionally, mathematics was taught for applicative use in adding up grocery bills or computing income taxes and grammar was taught as a way of getting students to improve their speaking and writing habits, and both subjects were taught as though students were to become professional mathematicians or grammarians. But within the last decade there has been an upsurge in "new" math, "new" grammar, and other "new" subjects which emphasize the study of subject matter for appreciation rather than merely for application in professional or ordinary life. The aesthetic dimension of general education has thereby been greatly expanded, and further expansion can be hoped for. Only a few years ago observers were amazed that grade school children could understand some of the most significant mathematical discoveries in set theory, abstract algebra, and topology. Yet, as was pointed out in the discussion of prodigies, a child is most capable of performing creatively in a subject which is independent of breadth of life experiences and in which internal consistency is the primary measure of successful products — and mathematics is clearly such a subject.

Curriculum planners must also pay more attention to concomitant learnings than they have in the past. Usually only the methodologists have studied concomitant learnings; yet, these learnings are as much a part of the content of a curriculum as what was overtly put there. While it is true that some concomitant learnings may be unforeseeable, it is also true that they can usually be forseen if we take the trouble to think more carefully about content and method. In some cases we have

[33] For a brief comparison of the appreciation of mathematics with music appreciation, see Hans Rademacher and Otto Toeplitz, *The Enjoyment of Mathematics*, trans. Herbert Zuckerman (Princeton, N.J.: Princeton University Press, 1957), pp. 5-7.

seen that what is learned concomitantly is far more important than what is learned overtly. Furthermore, important concomitant learnings may be unteachable as overt curriculum content because of their delicacy, profundity, or the psychological resistance students might have to them. For example, good study habits, respect for the authority of the teacher, and sportsmanship are probably best taught concomitantly rather than overtly. In general, values are best instilled concomitantly. Since concomitant learning, as was explained in section three, is analyzable as an aesthetic process, the aesthetician can be of great help in curriculum planning.

Teaching methods can obviously be improved by taking account of the aesthetics of teaching, learning, and knowing as discussed in section one. The aesthetician's analyses of methods can help improve teacher-effectiveness in transmitting curriculum content. Furthermore, the aesthetic dimension of education can be expanded at no cost, and often at considerable gain, to the brute content by organizing the subject matter so as to enhance its structural beauty. By understanding the aesthetics of teaching, learning, and knowing we can enhance the enjoyment of the educational process and help make the mastery of subject matter intrinsically rewarding. Discipline problems might be decreased, potential dropouts might be averted, and everyone might enjoy school more.

Both the internal disciplinary system and the external relations between school and community concomitantly teach values and modes of interpersonal conduct, which must be consonant with curriculum content if a credibility gap and cognitive dissonance are to be avoided. The effectiveness of a school administrator is, therefore, affected by his ability to foresee the aesthetic concomitants of his administrative decisions. As Dewey, Kilpatrick, and the progressivists point out, school is a place where life itself goes on. A student's character will be shaped more powerfully by what he lives through than by what he merely hears, reads, and writes.

Everything that has been said about curriculum, teaching methods, and school administration can be applied not only to elementary and secondary education but also to teacher education at the university level and in particular to the education courses they take. The teacher education curriculum could be improved by emphasizing the appreciation dimension of theory courses. Prospective teachers who learn to appreciate philosophical and psychological theory will be more likely to master and carry out the practical concomitants of that theory and to assume a more professional attitude toward their work. A professor should strive to make his class aesthetically enjoyable and pedagogically exemplary, since the methods he uses teach themselves as they convey the subject matter to the prospective teachers who are his students.