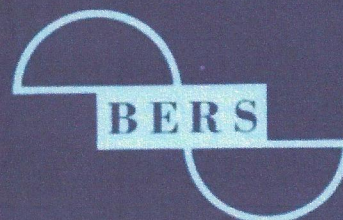


The Way of Educational Theorizing
Through Models

by
Elizabeth Steiner Maccia
and
George S. Maccia
Foundations Division
62-111

June 20, 1962

BUREAU OF EDUCATIONAL RESEARCH AND SERVICE / THE OHIO STATE UNIVERSITY



The Way of Educational Theorizing
Through Models

by
Elizabeth Steiner Maccia
and
George S. Maccia
Foundations Division
62-111

June 20, 1962

Single copies free. Additional copies 35¢ each. Please
order by title and number from the Bureau of Educational
Research and Service, 1945 N. High Street, 191 Arps Hall,
Columbus 10, Ohio.

Acknowledgment

This paper is the third in a series dealing with the methodology for constructing educational theory models and the rationale thereof, i.e. with the meta-theoretical dimension of Project 1632. This research is supported under the Cooperative Research Program of the Office of Education, U. S. Department of Health, Education, and Welfare.

"Would you tell me, please,
which way I ought to go from
here?"

"That depends a good deal on
where you want to get to," said
the Cat.

. . . the greatest and most difficult problem to which man can devote himself is the problem of education.¹

Since we have devoted ourselves to such a problem, where we want to get to is a solution--"a true conception of the method of education."^{2,3}

The way, therefore, must provide for arrival at conceptions. Unless conceptions are forthcoming, how can they be evaluated as to their truth? Already the main outlines of such a way have been drawn. Retroduction, a way of inquiring which devises conceptions and so is a help to the mind in producing science without defect, has been noted.⁴ Furthermore, retroduction has been given meaning in the context of models, points of view to be represented and so the source of conceptions.⁵ What remains, therefore, is the delimitation of the way in relation to our given problem.

Even though the problem has been stated as that of education, more needs to be said if the way is to be clear. What is wanted is an adequate educational theory or true conceptions or characterizations of the phenomena falling within the domain of the educative process.

¹Immanuel Kant, Education, trans. by Annette Churton, Michigan: The University Press, 1960, p. 11.

²Ibid., p. 12.

³Notice that 'method' is being used in a more comprehensive sense than is usual. The reference is to the entire educative process and not to a way of teaching.

⁴See "Ways of Inquiring," the first paper in this series, Publication 62-107, The Bureau of Educational Research and Service, The Ohio State University, 1962.

⁵See "Models and the Meaning of 'Retroduction'," the second paper in this series, Publication 62-110, The Bureau of Educational Research and Service, The Ohio State University, 1962.

What phenomena fall within this domain? Surely what is involved are persons doing something within a certain kind of setting. Students, faculty, and other staff such as administrators are counted among the persons. The doing ranges from teaching-learning activities to budgetary ones. The certain kind of setting is a school within a community; that is to say, an interrelation of persons with persons and with physical objects.

Granted that what is sought is a theory to cover the entire domain of the educative process, nevertheless such theory is hard to come by. Consider that most educational theorizing which has been attempted is not of the comprehensive type. Dewey's theory⁶ is almost singular in regard to scope. Rather educational theorizing falls within subcategories⁷ depending upon the portion of the domain characterized. Theory of guidance⁸ relates to persons; curriculum theory⁹, theory of teaching (methods)¹⁰ and learning theory¹¹ relates to the heart of the something done, the

⁶See Democracy and Education and other works.

⁷Footnotes 8 through 12 cite recent educational theorizing in each of the subcategories.

⁸R. H. Mathewson, "School Guidance: a Four-dimensional Model," in Personnel and Guidance Journal, Vol. 39, pp. 645-649, 1961.

⁹M. Millar, "Some Roles of Subject Matter in Curriculum Inquiry," in School Review, Vol. 68, pp. 329-345, 1960.

¹⁰H. Robert Anderson, Ellis A. Hagstrom, and Wade M. Robinson, "Team Teaching in the Elementary School," in School Review, Vol. 68, pp. 71-84, 1960.

¹¹W. Lawrence Downey, "Secondary Education: A Model for Improvement," in School Review, Vol. 68, pp. 251-265, 1960.

teaching-learning activities; and administrative theory¹² relates to the setting and some aspects of the something done.

It would appear at first sight that the educational scientist is simply a social scientist¹³ of a special kind. After all, his concern is with individual and group human behavior. What makes him a special kind of social scientist, of course, would be his interest in such behavior within a certain kind of setting, the school. But careful examination reveals something more. His endeavor usually involves commitment to a certain kind or kinds of behavior which are wanted. Rarely is it the case that the educational scientist is interested in simply characterizing the phenomena of the educative process. More often, he is interested in a characterization which includes an educational goal or goals. For example, when Guba turns to phenomena related to the curriculum, he becomes interested in a characterization which

is . . . capable of directing the child toward responsible

¹²Conrad Briner, "Unhinging the High School Principalship," in School Review, Vol. 68, pp. 318-328, 1960. The theorizing in this article is based upon the Getzels-Guba Administrative Theory.

¹³'Social scientist' is taken here in a very broad sense. The title refers to all scientists who seek for true characterizations of human behavior. We prefer to use the term, 'homological,' rather than 'social.' 'Social' has the difficulty of ruling out the psychological which emphasizes the individual. The terms, 'psychological' and 'behavioral,' also are deficient. 'Psychological' has the difficulty of ruling out the social, and the added difficulty of emphasizing mind as an entity over and above the body ('psychological' comes in part from the Greek, 'psychikos,' meaning soul or spiritual component). 'Behavioral' has the difficulty of bringing in concerns relating to animal behavior which properly belong in biology. 'Homological' formed in part from the Latin, 'homo,' indicates the true concern which is man.

behavior in the transactional sense here taken as appropriate in a democratic culture.¹⁴

An example from the popular genre would be the hue and cry directed at educationists to talk once more of the schools as places where "kids" are supposed to come to know. What it is to know is left vague and is argued about a great deal. Yet a characterization cannot be left vague, if it is to count as scientific. If goals are to be included in theory, then they must be given precision.

Now that where we want to get to has been clarified, the question of the way is before us. As already indicated, the essence of the answer resides in retrodution, or the utilization of a point of view as a model for devising educational theory. To say more about the way, a consideration of just such a devising undertaken for illustrative purposes should prove helpful.

Through a point of view from within the discipline of physiology, a theory of eye blinking, a conjecture or characterization of certain phenomena of the educative process, a theory of learning, was devised. Table I shows how the theory of eye blink is represented in the theory of learning, and thus is a devising model for it.

Although the illustrative theory was highly tentative in nature, a preliminary survey of the literature indicated a surprising degree of relevance and fruitfulness. By 'relevance' is meant connection of the theory

¹⁴Egon G. Guba, Role, Personality, and Social Behavior, The Bureau of Educational Research and Service, The Ohio State University, 1958, p. 68.

MODEL

EDUCATIONAL THEORY

- | | |
|---|---|
| 1. Either the eyes are or are not covered by lids. | 1. Either the student is distracted ("mind" is closed) or attentive ("mind" is opened). |
| 2. Blinking functions to protect the eye from contact and to rest the retina and the ocular muscles. | 2. Distraction functions to protect from mental stress and to rest from mental effort. |
| 3. Blinking may be either reflexive or non-reflexive. | 3. Distraction may be either non-voluntary or voluntary. |
| 4. Reflex blinking may be due either to corneal contact (touch competing with sight) or dazzle (sudden and intense light) or menace (movement of an object toward the eye). | 4. Non-voluntary distraction may be due either to competing or sudden or intense or threatening stimuli. |
| 5. Reflex blinking may be inhibited by a fixation-object or by drugs. | 5. Non-voluntary distraction may be inhibited by attention cues or by drugs. |
| 6. Non-reflexive blinking may occur if seeing is unwanted. | 6. Voluntary distraction may occur if learning is unwanted. |
| 7. There is a normal blinking rate statable in blinks per second. | 7. There is a normal distraction rate statable in distractions per unit time. |
| 8. There is a normal black-out index statable as 100 times the ratio of duration of blink to interblink. | 8. There is a normal non-receptive index statable as 100 times the ratio of duration of distraction to attention. |
| 9. A normal blinking rate or black-out index do not significantly affect vision. | 9. A normal distraction rate or non-receptive index do not significantly affect learning. |
| 10. Blinking rate increases with physiological excitation. | 10. Distraction rate increases with mental excitation. |
| 11. An excessive blinking rate can significantly impair vision. | 11. An excessive distraction rate can significantly impair learning. |
| 12. Malfunctioning in relation to blinking may occur due to inability to keep eyes open (blepharospasm) or due to fatigue of the eye (fibrillary twitchings). | 12. Malfunctioning in relation to distraction may occur due to inability to be attentive (certain neuroses and psychoses) or due to mental fatigue. |
| 13. Sleep is a sustained blink, and so inhibits most seeing. | 13. "Mental sleep" (may or may not be physiological sleep) is a sustained distraction, and so inhibits most learning. |
| 14. Normal sleep is recuperative for normal vision. | 14. Normal "mental sleep" (relaxation) is recuperative for normal learning. |
| 15. Normal sleep is preceded by a sleep ritual which usually includes voluntary closure of the eyelids. | 15. Normal "mental sleep" is preceded by a relaxation ritual. |

TABLE I

with other characterizations, and especially those which have checked out. By 'fruitfulness' is meant presentation, through the theory, of checkable characterizations beyond those we already have.

Turning first to relevance, Nichols¹⁵ reports concerning words which were found to distract listening audiences. He writes as if such stimuli induce non-voluntary distraction; however, his list of emotion-laden words suggests that threatening stimuli are learned, and so, at least initially, must involve voluntary distraction. Stopol¹⁶ employed failure stress as a distractor along with competing stimuli--bells, buzzers, and flashing lights; and his findings support the distinction between threatening and competing stimuli. Competing stimuli were employed or noted by the following investigators: McDowell¹⁷, Freeburne¹⁸, Kingsley and Garry¹⁹, and Broadbent.²⁰ Nichols²¹ and Broadbent²² report studies

¹⁵R. G. Nichols, "Ten Components of Effective Listening," in Education, Vol. 75, pp. 292-302, 1955.

¹⁶M. S. Stopol, "Consistency of Stress Tolerance," Journal of Personality, Vol. 23, pp. 13-29, 1954.

¹⁷A. A. McDowell, "Comparisons of Distractibility in Irradiated and Non-irradiated Monkeys," in Journal of Genetic Psychology, Vol. 93, pp. 63-72, 1958.

¹⁸C. M. Freeburne, "Effect of Music Distraction Upon Reading Rate and Comprehension," in Journal of Educational Psychology, Vol. 43, pp. 101-109, 1952.

¹⁹H. L. Kingsley and R. Garry, The Nature and Conditions of Learning, New York: Prentice-Hall, 1957.

²⁰D. E. Broadbent, Perception and Communication, New York: Pergamon Press, 1958.

²¹Op. cit.

²²Op. cit.

in which intense stimuli were employed. Stopol noted in his study that

It therefore seems reasonable to believe that in the present study the introduction of a second stress stimulus increased the intensity of the stimulating state of affairs to a point resulting in greater loss of efficiency.²³

Measures employing drugs and attention cues to inhibit distraction, as suggested by the theory, have been set forth by Daston²⁴ and Foulds²⁵. Although no verification is set forth in his paper, Holmes²⁶ also emphasizes the importance of attention cues in relation to inhibition of distraction. Kingsley and Garry²⁷ speak of a form of distraction, daydreaming, which might be considered voluntary. The attempts to measure attention span, which are apparent in the early studies on attention, fit in with the possibility of a normal distraction rate and non-receptive index which is set forth in the theory. The experiments of Mayer and Van Haller^{28,29} further suggest the feasibility of obtaining such a rate and index. Finally, the

²³Op. cit., p. 26.

²⁴P. G. Daston, "Effects of Two Phenothiazine Drugs on Concentrative Attention Span of Chronic Schizophrenics," in Journal of Clinical Psychology, Vol. 15, pp. 106-109, 1959.

²⁵G. A. Foulds, "Distraction and Affective Disturbance," in Journal of Clinical Psychology, Vol. 12, pp. 291-292, 1956.

²⁶C. E. Holmes, "One Thing at a Time," in Journal of Business Education, Vol. 30, p. 353, 1955.

²⁷Op. cit.

²⁸K. E. Mayer and B. Van Haller, "Attention Spans of Children for Experimentally Designed Toys," in Journal of Genetic Psychology, Vol. 87, pp. 187-201, 1955.

²⁹K. E. Mayer and B. Van Haller, "Concept of Attention Spans in Children," in Elementary School Journal, Vol. 54, pp. 464-466, 1954.

literature supports malfunctioning in relation to distraction arising from mental disturbance. The work of Daston³⁰ and of Foulds³¹ can be cited.

In regard to fruitfulness, the distinctions between competing, intense, sudden, and threatening stimuli suggested by the theory indicate an area of investigation into their effects and relative weight in developing distraction. In the research reviewed, the investigators assumed or ignored voluntary distraction. The theory hypothesizes that distraction may be induced voluntarily to shut out certain learnings. Attitudinal studies might shed some light on this aspect of distraction. Research on attention span appears to have overlooked the possibility of a normal rate of distraction and a normal non-receptive index which do not affect significantly an individual's learning. The measure of such a rate and index may have profound implications in regard to the teacher-student relationship and the media involved. The theory suggests that periods of relaxation are functionally related to learning, and this too has been suggested in the literature. Yet the theory opens up the possibility of a rigorous approach through rates and indices, rather than the usual rule-of-thumb approach. Undoubtedly more rigorous analysis would disclose many more possibilities; but the intent has been served, since fruitfulness has been shown.

What, then, does the illustrative devising tell us about the way? It is patent that at its very core the procedure is interdisciplinary. Within the discipline of education, what is wanted is adequate educational

³⁰Op. cit.

³¹Op. cit.

theory or true characterizations about the phenomena constituting the educative process. In a sense, what is sought is the making of education more of a discipline. The becoming of a discipline is becoming a body of knowledge, and a given body of knowledge is nothing other than adequate theory.³² In the retroduction the discipline of physiology was used. That it is a discipline would not be contested, since it contains adequate theories about the functioning of living organisms. One of these theories, that of the eye blink, was used as a model to devise part of the discipline of education, a theory of learning. Surely betweenness of disciplines was involved.

Two difficulties, common to all interdisciplinary work, immediately present themselves. Between what and what--what disciplines are to be interrelated--is the first. The second concerns who--in the light of contemporary specialization, the persons to carry out the work. In the context of the devising of educational theory through models, the first becomes what disciplines are to be marked off to explore for models, and the second becomes what qualifications are required of the theoreticians.

As a beginning point in the attempt to solve the first difficulty, a sorting out of the disciplines is necessary. Disciplines can be sorted into those forming part of the scientific endeavor and those which do not.

³²Let it be noted that (1) no discipline is ever completely made, since no theory is ever completely adequate; and (2) unification is only an ideal, for it is the case that no discipline has a comprehensive theory, but rather consists of theories covering different aspects of the phenomena within its domain. One has but to consider physics which numbers among the disciplines having the most right to the appellation, 'discipline.'

The former are of interest, for the concern is with such an endeavor in education. The aim is the development of scientific educational theory or adequate characterizations about the phenomena of the educative process. Disciplines forming part of the scientific endeavor are the empirical and the formal. The empirical disciplines, as their title indicates, are about experience or phenomena. Depending upon whether they are about non-human or human phenomena, they are either natural sciences or social sciences. Within the natural sciences, two subcategories are apparent in terms of the non-living and the living, the physical and biological. However, within the social sciences, the subcategories are not at all clear. This vagueness could be an indicator of the fact that the social sciences are in an earlier state of becoming disciplines than are the natural sciences. It is only after development of characterizations that the domain of phenomena, objects they refer to, can be subdivided. Nevertheless, psychology and sociology do belong within the social sciences, as does education.³³ The formal disciplines--logic and mathematics--are related to the scientific endeavor in so far as they provide ways of inter-relating or structuring or forming characterizations about phenomena. Indeed they are crucial, since the natural and social sciences only become so when, among other things, they are systematic, when their concepts are structured with precision.

This sorting about of the disciplines has marked off three areas to explore for devising models for educational theory: the natural sciences,

³³See page 3 of this paper.

the social sciences, and the formal disciplines. Can anything more be said that would indicate one area as worth exploring more than the others? The quest is for devising models, points of view from which scientific theory about education can arise. This means that an area containing more theory of a scientific nature has more to offer in regard to scientific form and substance. The scientific theory is the point of view, and through representation of it the sought-after new scientific theory arises. In the illustrative devising, not only did the scientific theory of eye blink furnish scientific form that could be represented, but it also furnished scientific substance. Not only did it suggest the relating of distraction to stimuli, but it suggested the kinds of stimuli: competing, sudden, intense, and threatening. Without a doubt, citation is unnecessary to substantiate the claim that the natural sciences have more to offer in this respect than do the social sciences. Who would contest the claim that the natural sciences contain more adequate theory than do the social sciences? The formal disciplines too suffer a limitation. They offer only form to be represented, when suggestions of a substantive kind also are required.

Although we are faced with the paradox that the sciences dealing with phenomena the most divergent from those of education appear to have the most possibility in the realm of devising models, yet the other two areas ought not to be ignored. Besides offering some possibility for devising models, the social sciences might give us representational models, i.e. ready-made theories which when explicated might characterize (represent) educational phenomena. This would not be surprising, since education

is a social science. Its phenomena are those of individual and human behavior. Besides offering some possibility for devising models, the formal disciplines might give us explicatory models, i.e. forms through which indefinite educational theory, which we have devised from another area or which we have taken over from another area, can be made definite.

Now that disciplines have been marked off for exploration, what of the second difficulty in regard to the nature of the explorers? It is patent that the key persons involved in developing educational theory should know education. Their field of specialization should be education.³⁴ They must know how far the discipline of education has come, so that it may be extended further. Yet it is this very extension and the way of doing it through other disciplines that requires more of them. Their competencies must extend into the disciplines being explored.³⁵ If the natural sciences are explored for devising models, then some competency is required therein. However, this is still not enough. Dorwin Cartwright, in introducing a work on a mathematical model for the social sciences, tells us why and what more is wanted:

. . . but an individual social scientist can hardly aspire to master large areas of mathematics with the sheer hope that

³⁴In this project, all of the principal investigators, E. S. Maccia, G. S. Maccia, and R. Jewett, and the research associate A. H. Jones, have at least one advanced degree in the discipline of education, and all are pursuing it as their specialty.

³⁵The competencies of the principal investigators and the research associate of this project extend beyond education into the formal disciplines and the natural and social sciences. Two of the principal investigators, E. S. Maccia and G. S. Maccia, have at least one degree in a discipline other than education.

he may discover something which will be appropriate to his substantive problems.

Cooperation between social scientists and mathematicians is required to solve this problem. Specialists in these fields must work together in a way that permits the social scientist to learn what ideas mathematics has to offer him, without the necessity of his becoming a mathematician. Once a promising lead has been discovered, the social scientist may need to acquire a working knowledge of the relevant branch of mathematics. But even then it will be profitable for the mathematician to continue working with the social scientist because new mathematical problems will usually be generated by the attempt to make new applications of mathematics.³⁶

Stated in the context of educational theory development, the competencies of the educational scientist do not extend far enough. Consequently, a counterpart, from whatever area the educational scientist is exploring for models, must be available to work with him.³⁷

The way of getting to adequate educational theory has been delimited in terms of its interdisciplinary qualities. Delimitation through educational disciplinary qualities still remains. This is required, for, even in the initial steps of the way of educational theorizing through models, the interdisciplinary phase in which the natural and social sciences and the formal disciplines are explored, an educational disciplinary phase must enter.

³⁶ Frank Harary and Robert Z. Norman, Graph Theory as a Mathematical Model in Social Science, Ann Arbor: University of Michigan, Institute for Social Research, 1953, p. iv.

³⁷ The following counterparts from The Ohio State University Faculty whose competencies are in the natural sciences, the social sciences, and the formal disciplines respectively will be working on this project with the principal investigators: Roland Fischer, Enrico L. Quarantelli, and Daniel J. Troy.

There is no completely³⁸ a priori way of knowing whether a given theory from another discipline can be used to solve our problem, adequate educational theorizing or characterization of the phenomena of the educative process. We cannot completely know beforehand whether a given theory from another discipline can be used to devise educational theory, to explicate educational theory, or used as educational theory. Stated differently, there is no completely a priori way of knowing whether a given theory from another discipline is a devising or explicatory model for educational theory, or even a representational model of educational phenomena. Only educational theorizing or cognizance of other educational theorizing or in some cases both will provide the way of knowing.

In the case of devising and explicatory models, they are found to be such through educational theorizing. Educational theorizing is nothing other than developing characterizations about educational phenomena through devising and explicating such characterizations. In the illustrative devising, a tentative theory of learning was set forth using the eye blink theory as a point of view. Through this setting forth it became known that the eye blink theory was a model for educational theory.

In regard to all the models, they are known in part to be such when the resulting theory is tentatively relevant³⁹ to education. Otherwise, the representational models would be models of something other than educational phenomena, and the devising and explicatory models would be models

³⁸The term, 'completely,' is used to indicate that there are some a priori grounds. See pages 11 and 12 of this paper.

³⁹See pages 4 and 6 of this paper.

for sheer speculation rather than for educational theory. We must go to the literature on education, as was done in the case of the tentative learning theory, and tentatively determine whether the educational theory is coherent with other educational theory, particularly that which has proven adequate. Coherence can be noted in the power to summarize other educational theory. Indeed this is the kind of coherence one strives for in producing all science. Knowledge is a matter of integrating or bringing together. Scientists, however, strive for something more. They are interested in extending knowledge. They will not settle for theory that is relevant only. It must be fruitful.⁴⁰

. . . it is now regarded by scientists as obvious that a good hypothesis⁴¹ may be expected to yield interesting new consequences.

What we want are models for such good theory. To complete our knowing whether theory from other disciplines are models, the resulting theory must be tentatively appraised for fruitfulness. We must see whether there are new characterizations about educational phenomena, as was done in relation to the illustrative theory.

A final important aspect of the way, which has not been pointed out, should be noted. We have been speaking as if models are always found ready-made and never constructed. Consider once again Cartwright's advice that, although the lead has been discovered, the mathematician

⁴⁰ See page 6 of this paper.

⁴¹ William Kneale, "Induction, Explanation, and Transcendent Hypotheses," in Readings in the Philosophy of Science, ed. by H. Feigl and M. Brodbeck, New York: Appleton-Century-Crofts, 1953, p. 361.

should stay on the job with the social scientist. He suggests that this advice be taken, because new mathematical problems may arise.⁴² What he is telling us is that the formal theory as is may not be utilizable as a model. We may have to change it, and so construct what will be a model. Usually such construction will be called for.

The way we go from here is clear in terms of where we want to get to. The methodology in terms of the problem is clear. The going remains. The first step in the task, the construction of educational theory models, now can be taken.

⁴²See page 13 of this paper.