Research, Development, and the Improvement of Education

An output-oriented model is contructed to aid in clarifying and illuminating important policy issues.

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For several months I have followed in *Science* the continuing discussions of research and science policy. I am generally concerned whether the policy questions which arise in educational research and development ought to be considered as a subset of those which arise for science as a whole. Thus I found the articles by Philip Handler (*1*), George Daniels (*2*), Harvey Brooks (*3*), Lee DuBridge (*4*), and Michael Reagan (*5*) of considerable interest. For the past 3 years I have been engaged in a general effort to improve the quality, effectiveness, and impact of the research effort in education. Much of that time has been spent grappling with many of the same issues which are discussed in the articles cited above. For some months I have been trying to develop a model which would express the different functions within the total research effort, the various sources of initiative for these different kinds of activity, and the relationships among both the functions and the sources of initiative. My thinking has been stimulated by recent debate about the ways in which schools, instruction, and education are likely to be improved most quickly and with the most lasting impact.

Reagan's analysis was particularly valuable as a summary of various viewpoints. The model presented in this article constitutes, I think, an instance of exactly what Reagan called for, namely, a discussion of research and development as seen from the point of view of a sponsor, planner, or user of research and development (*5*, p. 1386).

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One Current Model

Typically, discussions about research and development for education have centered on the description of the change process in education. Various models of change have been proposed. The one with the highest currency at the moment, the so-called Guba-Clark (*6*) model of change, places research and development in a linear arrangement. It begins on the left with research, carries through two stages of development (invention and design), two stages of diffusion (dissemination and demonstration), and three stages of adoption (trial, installation, and institutionalization). The objectives, appropriate criteria, and relationship to educational change of each stage are definable and distinct in relation to each of the other stages.

In proposing their model Egon Guba and David Clark warned that (i) the model was constructed on logical grounds and that it was largely unsupported by empirical research; (ii) it was not necessary for change to begin at the research or inquiry stage; and (iii) the model itself was a unidimensional analysis of change roles which are influenced by a multidimensional range of variables not entirely accommodated by the model's structure.

As a model of the change process, this particular schema has the virtues of being simple and logical. However, those of us who have worked intensely on problems of research policy in education see shortcomings. The Guba-Clark model does not emphasize sufficiently that initiative for different kinds of actions can take place at any point in their continuum and that those initiatives may come from locations other than where the action itself is to be performed. The model unwittingly implies that innovations begin with the findings generated by fundamental research.

Output Model

The purpose of developing an alternative model is to create a heuristic which illustrates the essential differences between research and development activities, and shows how the two are, or can be, related to one another and to the operating educational system. Such a model ought to illustrate the different sources of initiative and motivation for beginning various activities. It should be able to show or imply the interplay among all the functions in the effort to improve instruction and education.

The output model is based on the conviction that research, development, and school operations can be viewed as distinct kinds of activities with quite different objectives or outputs. It is constructed to indicate that initiatives for each kind of activity are the results of decisions based on different kinds of data and equally distinct kinds of internal and external needs. The model implies that while there may be a strong logical flow from the production of knowledge through the development of processes to their installation in operational settings, there may be just as strong a flow backwards as operational problems define development programs, which, in turn, reveal the need for certain basic information and theory.

Figure 1 depicts the model. Three planes are shown, each symbolizing the different orientation of activities conducted under research, development, and school operations. (The model is, as are all models, an abstraction from reality. In the real world these activities are not always neatly separated either in time or location. The point of conceptually, and therefore graphically, separating them here is to illustrate the essentially different orientations of the three types of activity and the consequences of those differences.) For each activity represented in Fig. 1, the model depicts an initiative (represented by circles) leading to outputs (represented by triangles) characteristic of that activity.

The lower plane symbolizes the knowledge orientation of research; the

object of research, of course, is to generate new knowledge. And, as is also well understood, one of the significant features of research is that when an activity is begun the specific outcome is not known. For research, *C* and *D* represent initiatives undertaken which culminate in a variety of research findings.

The middle plane symbolizes what I call the process orientation of development. The object of development is to produce materials, techniques, processes, hardware, and organizational formats for instruction which accomplish certain objectives, specified in advance, which are construed to be part of the broader goals of instruction or education. On this view one of the significant features of development distinguishing it from research is that when an activity is begun, the objective is known or established at the outset. The objectives for a development project, ideally, are cast in the form of performance specifications (*PS*), and all activities are geared to producing the necessary products and processes which will meet those specifications. In Fig. 1, *B* indicates an initiative undertaken for development culminating in the creation of a process which meets performance specifications PS_x.

The top plane symbolizes the activities characteristic of school operations. The operating educational system can be said to be production oriented. Thus, the object of school operations is to act upon human beings in order to train and develop in them various skills, attitudes, beliefs, and knowledge calculated to serve both society and themselves. Certainly one of the significant features of initiatives in school operations is the weight of the responsibility on the school administrator for choosing the right kinds of processes to achieve the outputs that society and individuals specify. In Fig. 1, *A* represents an initiative to install a process leading to the production of education output EO_x.

"Walk-Through" of the Model

To illustrate the relationships among the three types of activities, consider the following example. A responsible school official, faced with evidence that certain outputs desired by the society are not being achieved for a significant portion of the children in his charge, searches other school operations and ongoing or completed development projects for processes designed to meet his need. Should he find nothing to suit his particular problem (for example, the low reading achievement of culturally disadvantaged children), he may then exercise his prerogative to call for the initiation of a project to design and develop a process whose performance specifications are such that it will yield in his school the desired educational output (increased level of reading achievement in the target population).

Once the initiative for the development project has been undertaken and the performance specifications established, the development project then conducts a search for relevant research findings which may offer clues to guide the development project. (Whether or not this step is taken after the project is begun or immediately before is not really important. What is crucial is that at some point near the very beginning of the effort such a search is made.) Impressed with a particular finding [perhaps, for example, the great impact of parental attitude on student achievement as revealed by the survey conducted as part of the Plowden study (*7*)], the project might decide to develop a process which deliberately tries to engender a large measure of parental involvement in home instructional experiences which, in turn, are carefully geared to complementary experiences

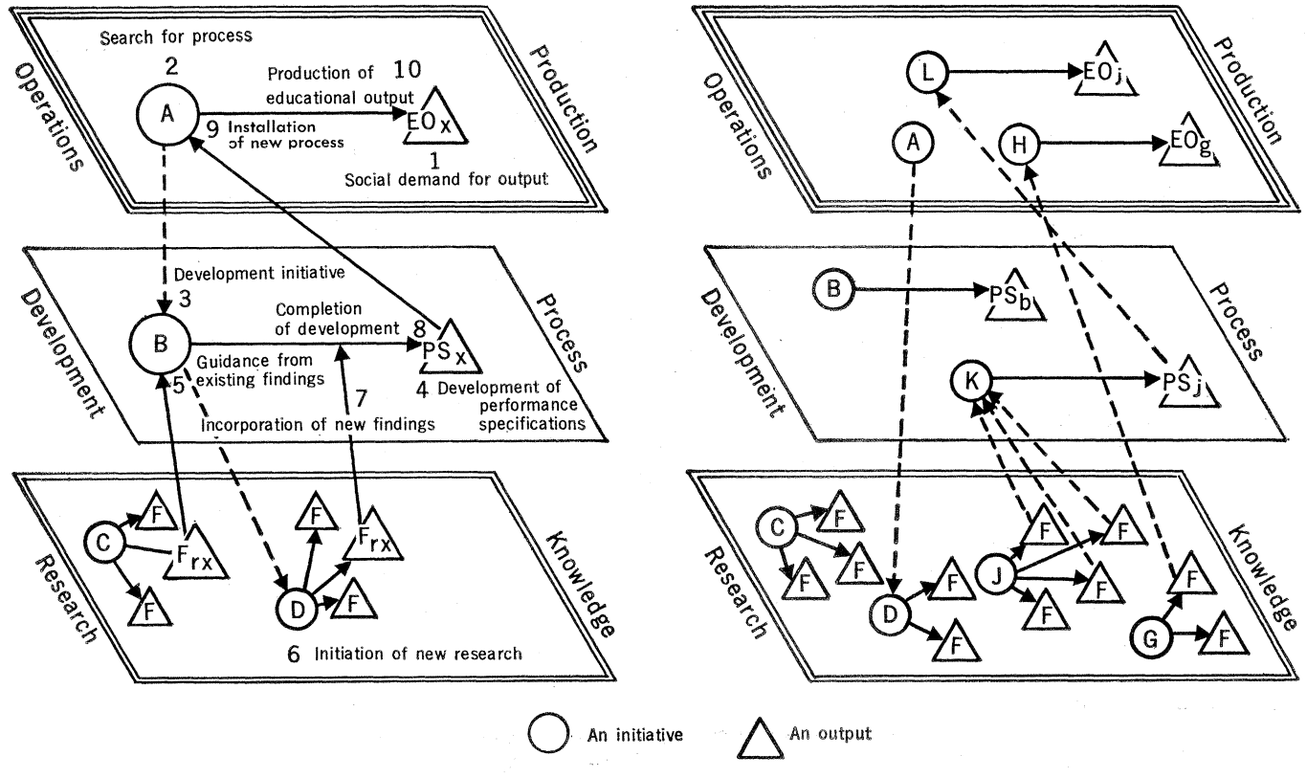

Fig. 1 (left). A "walk-through" of the output model of educational research and development. Fig. 2 (right). Sampling of other possible interactions in the output model.

in the school setting. Having made that decision the developers might then discover that they require further information about the specific nature of optimum parent-child interactions to stimulate maximum learner achievement. They might therefore call for a specific initiative of a research activity to generate further data to guide the development of materials. When useful findings are identified they can be incorporated in the development effort which then proceeds to a successful conclusion. When, using iterative techniques of design, development, trial, and redesign on the basis of feedback, materials encompassing both school experiences and parent-child interactions in the home are successfully developed and validated, they may then be transferred to the operating setting where the administrator may install them as part of his instructional program (*8*).

This example is illustrated in terms of the model through the interactions represented in Fig. 1; EO_x at *1* symbolizes the social demand for a certain kind of educational output (in the example just given, higher reading achievement for culturally disadvantaged children). This demand creates pressure on the school administrator to respond with some sort of initiative. That initiative is represented by *A* at *2*. It symbolizes his search for an effective process to install. Since he did not find it, his response was to call for a development initiative (*B* at *3*). The next step was to develop the performance specifications (PS_x at *4*) such that they correspond to the educational output desired by society. Once the specifications for the development project are established, the next step is to survey related research seeking guidance for the development effort. The search is conducted and the finding (F_{rx}) of relevance to the performance specifications and the desired educational output (the significance of parental attitude) is incorporated into the development project *5*. The call for additional research assistance is symbolized by *D* at *6*. The incorporation of relevant findings (again F_{rx}) from that initiative into the development effort is symbolized by the solid arrow to the development line at *7*. Number *8* represents the completion of the development project, *9* the incorporation of the process into school operations, and *10* the production of the desired output, higher levels of reading achievement, as a consequence.

Sampling of Other Possible Interactions

The depiction of a sampling of other possible interactions among research, development, and operations can be found in Fig. 2.

Example: A school official feels the need to assess the degree to which instructional programs are serving a particular target population. He calls therefore for an initiative in research. This is represented by the $A/D/F,F$ interaction.

Example: An organization engaged in development independently concludes that it would be useful to develop a certain process or product for instruction. This is represented by the B/PS_b interaction.

Example: Research is initiated for its own sake and pursued solely for the knowledge which it produces. No findings have yet been incorporated either in development or operations. This is symbolized by the $C/F,F,F$ relation in research.

Example: Research initiated for its own sake yields the findings that certain organizational structures for large city school systems are always problematical or that a certain vitamin supplement administered between the ages of 5 and 7 can prevent a form of mental retardation whose appearance cannot be detected until somewhat later. Neither one of these findings needs to pass through development. Each can be implemented directly in school operations (if so desired). This kind of relationship of research to practice is illustrated by the $G/F,F/H/EO_g$ interaction.

Example: Finally, consider an instance in the form of the linear flow or Guba-Clark model from research to development to implementation. Research on early childhood and cognitive growth, for example, uncovers a number of findings some of which may suggest the development of processes and environments which can actively enhance such growth. Development efforts are consequently supported and carried through to completion. The availability of the resulting products and processes is made known to educational administrators who are thereby persuaded to incorporate the newly developed early childhood instructional programs, at either private or public expense, into the nation's educational system. This kind of sequence is represented by the $J/F,F,F,F/K/PS_j/L/EO_j$ interaction (*9*).

Model as a Heuristic

All of these representations in Figs. 1 and 2 are fairly obvious and straightforward. The use of the model as a heuristic, however, profits from further explanation. One of these uses pertains directly to the problem of "change process" as applied to education. I have tried to structure the model (i) to illustrate that the incorporation of research findings into development is just as important as incorporating newly developed processes into operational settings and (ii) also to imply that it oftentimes may be just as difficult a proposition. The notion that there are obligations on both research *and* development to transfer their "products" to other activities means that each must pay careful attention to the way in which its outputs are presented and, perhaps, the very way in which the outputs are produced. In other words, the requirement that eventually there be transfer or incorporation into another type of activity places constraints upon the professional behavior in each activity which cannot be ignored without compromising later impact.

This requirement is particularly true for development projects, but I think it is as true for research activities. A few concrete examples illustrate the point. One is the researcher who publishes perfectly valid findings in a sloppy or difficult format and thereby hinders the likelihood of their being incorporated ultimately into practice. The researcher who inadvertently conceals or compromises his methodology or design encounters similar problems.

Similarly, the final requirement for a development project is that it be usable in operational settings. In order to incorporate the developed process in school operations, procedures must be provided (teachers' manuals, training procedures, and so forth) for carrying out the innovations. If transition requirements are not provided, the developer may well have rendered his product unusable. For example, the desire to involve teachers and other practitioners in the development process stems from the need to have their expertise and experience continually represented. They have already acquired a knowledge of many of the operational possibilities and constraints within which the finished process will operate. There are other good reasons for involving teachers, not the least being the respectability they lend to

the project. This is of no small importance in securing acceptance of the innovation in the entire profession. It is also essential that the involvement be meaningful and not merely window-dressing. Their presence lends respectability only if their contributions are fully utilized and their knowledge of what is or may be possible is thoroughly weighed in the development effort.

One final point should be made about the model's portrayal of the possibility for transfers back and forth among research, development, and operations. Emphasis needs to be given to the problem of information flow and techniques for applying better knowledge and better processes where they are intended. This is the direct responsibility of the researchers and the developers and those responsible for improving the entire R & D system.

A second feature of the model as a heuristic is the way it helps to clear up part of the problem of distinguishing between basic and applied research in education. The model clearly implies that basic research (studies generated independently in research for the sake of the findings alone) and applied research (research conducted to serve a particular need identified by people engaged in development or operations) differ from one another primarily in terms of the intent of the initiator (*10*). Thus the knowledge-orientation of the basic researcher is central to his activity. Applied research is also supported for the knowledge which results from it, but the initiator of the research knows to what instrumental use he is going to put the findings. By depicting both applied and basic research as similar kinds of activities, the model implies that *in and of themselves* they look very much alike. The procedures, the design, the sophistication must all be on par if either is to be valuable. What distinguishes the two from one another are the purposes for which they are initiated (*11*).

A third feature of the model as a heuristic is its suggestion that decisions to initiate activities of each of the three types are made according to quite different criteria and perhaps by quite different people. The fundamental scientific character of research suggests that independent initiatives exercised there depend heavily on advice from the science community. Development projects, however, can also be independently initiated, but decisions to begin these kinds of activities are subject to advice from both research and operations. With limited resources, deciding which needs to satisfy through development (for example, those independently generated by developers, compared to those stemming directly from school operations, compared to those growing out of research activities) becomes a particularly difficult problem. Finally, the kinds of lonely decisions required of school administrators at the operational level are made by people in the context of still different circumstances and institutions. By emphasizing the essentially different nature of the activities being undertaken, the model reminds the policy maker of the need to collect different kinds of data and statements of need when planning future activities.

Finally, the attempt to represent each of the activities in terms of particular kinds of outputs may well turn out to be the most significant aspect of the model. It forces the viewer to consider what the outputs of each activity are and to think about how they are of use to one another. The outputs of research, for example, are knowledge. Some of the knowledge produced through research will find its way into development and into school operation. Are there ways of improving the output of research, of making it more powerful, of increasing the likelihood of its being of use to instruction and education? What about the outputs of development? They constitute, on the one hand, the validation of research and, on the other, the means by which the educational system can improve the manner in which it carries out its functions. How can development be improved, how can research be organized to be of greater use to development, and how can the educational system direct itself toward utilizing more powerful, validated techniques?

Finally, what happens to educational operations when they begin to view their responsibilities in terms of output? The contrast can perhaps be most sharply drawn by considering the notion of grading schools on the basis of their outputs rather than students on the basis of their performance. The existing practice of grading students assumes at bottom that the student is responsible for his learning and that his failure or success is a tribute to or a consequence of factors intrinsic to him. The idea of grading a school on the basis of its outputs assumes that all students can learn and that the responsibility of the schools is to make that happen. (In medicine and law, for example, we judge success or failure of the system not so much by the patient's or client's end state as by the degree to which the doctors or lawyers skillfully utilized the most sophisticated practices in attempting to serve the client. We certainly do not "grade" the patient or client; quite to the contrary, it is the professional services themselves which are assessed. An output orientation for school operations would cause the same reorientation of the direction of assessment in education.) If the schools themselves are judged in terms of the degree to which they are accomplishing their "production goals," increasingly they may come to orient their activities to assessing their own effectiveness, identifying the techniques and processes which need improvement and, as a consequence, calling increasingly for the kind of development activity and research support which would provide the basis for continuing improvement.

Summary

I have presented an output-oriented model of educational research and development. I have tried to show that the outputs of research, development, and operating educational institutions are quite different, that performers of each of the three types of functions have important contributions to make in identifying proposed initiatives in their own sphere as well as all the others, and that these conditions create special demands upon the administrator of research. He must listen not only to science, but also to the behavioral technologist and the professionals administering educational programs of all kinds. The model suggests the importance of adequate dissemination and diffusion mechanisms among the different functions, the importance of the manner of performing the activities in each function in making transfer and feedback from one function to another possible, and the importance of collecting information from a broad range of input sources before making priority judgments. Finally, the discussion suggests that the notion of an output orientation in the educational system itself may well be the most significant procedural and managerial innovation we can think of because of the ways in which it may cause education pro-

fessionals to identify deficiencies in service and seek out research and development which will continually contribute to their efforts to serve society well.

References and Notes

1. P. Handler, *Science* **157**, 1140 (1967).
2. G. H. Daniels, *ibid.* **156**, 1699 (1967).
3. H. Brooks, *ibid.*, p. 1706.
4. L. A. DuBridge, *ibid.* **157**, 648 (1967).
5. M. D. Reagan, *ibid.* **155**, 1383 (1967).
6. E. G. Guba and D. L. Clark, *An Examination of Potential Change Roles in Education* (Airlie House, Va.), p. 8 (mimeographed).
7. *Children and Their Primary Schools: A Report of the Central Advisory Council for Education* (Her Majesty's Stationery Office, London, 1967), vol. 2, pp. 180 and 188.
8. Robert Glaser has suggested that I make explicit the assumption that in education a breed of developers and technicians exists, and that researchers, developers, and school administrators are presently skilled and courageous enough to identify and fulfill research and developments requirements (as Glaser put it to me, superhuman enough to know when and how to initiate development, how to set up performance specifications, and possessing both the courage and political climate which will permit iterative experimentation and not just a "safe improvement"). Those assumptions are present not because I think conditions in the field fully warrant them, but because assuming that such conditions should be present seems to me to be useful.
9. This example is, of course, clearly an idealized concept. It is instructive to keep the model in mind as one looks back over the past 4 years at the tremendous developing interest in the establishment of early childhood educational programs. While it is certainly difficult if not impossible to establish an individual cause for such a complex phenomenon, it is significant that Benjamin Bloom published his volume, *Stability and Change in Human Characteristics* (Wiley, New York, 1964), just at the time the Office of Economic Opportunity was beginning its planning toward the development of programs to fight the war against poverty. The significant thing about Bloom's book was that while his conclusions firmly underscored the importance of the early years in the development of cognitive skills, he also observed that there had been little actual experimentation designed to create environments to enhance such skill development. I think Bloom's argument can be interpreted as a call for rigorous efforts designed to produce environments and instructional programs which have the effect of enhancing human capabilities. The problem, however, is that which exists in all social domains. There are large numbers of children *now* whom we cannot afford to ignore, and the consequence has been the attempt to create operating early childhood programs based on those convincing research findings without first having gone through a developmental stage. The result has been a somewhat marginal impact on the target population despite the clear implications of the research summarized by Bloom.
10. The initiator and performer are, of course, not necessarily one and the same person or institution. The actual initiator of the research project might be a school man, a developer, a researcher, or a research administrator. The performer of that research effort may or may not have the same ultimate purpose as the initiator, in mind, as he undertakes the activity. Thus, for example, it would be perfectly possible for a research administrator to stimulate a series of research activities relating to reading, which he views as applied research necessary for a development effort to build improved reading curricula, while the performer of that research sees it as a basic research effort in perception or the psychomotor skills associated with reading.
11. This view fits fairly well with one part of Harvey Brooks's analysis of the distinctions between basic and applied research (*3*), when he noted that "as definite categories, [the terms] basic and applied tend to be meaningless, but as positions on a scale within a given environment they probably do have some significance." The principal shortcoming with Brooks' analysis in my view is that it proceeds almost entirely on the presumption that the distinction can be resolved by approaching it in some way from the researcher's point of view. My experience in the administration of research, as the model presented in this paper clearly indicates, leads me to believe that the researcher's view is only one of several which must be taken into account in attempting any analysis of the distinction between basic and applied research. The presence of rather different criteria and alternative vantage points convinces me that Reagan's argument for abandoning the distinction within research is much more persuasive as is the suggestion that the critical categorization is that between research and development.

12. I thank E. Svenson for his formative critique of the ideas found in this paper. Also, this paper was written in the author's private capacity with no official support or endorsement by the U.S. Office of Education.

NEWS AND COMMENT

Student Power: Demands for Change at Stony Brook's "Talk-In"

"The question is—is there a commitment to change here? If there isn't, we will have an explosion which will make Columbia look like a piker."—Student's statement during 3 days of public discussion at Stony Brook last week.

Stony Brook, N.Y. Angry rhetoric and, increasingly, angry actions are becoming the staples of university life. On 29 October, students at many universities observed a "time-out" called by the National Student Association to discuss the student movement and the "base and repressive" features of national politics and of the nation's universities. Last week the New York State University center at Stony Brook on Long Island held 3 days (22 to 24 October) of "intensive self-study" during which all classes were called off to enable students, faculty, and administration to discuss Stony Brook's future.

In part, the 3-day moratorium on classes at Stony Brook was a result of conditions peculiar to this university and of a continuing and perhaps worsening crisis of confidence on the part of many students concerning the university's administration. But, in a larger sense, the crisis at Stony Brook seems similar to that afflicting universities across the country.

In interviews with students, professors, and administrators, a major explanation given for student discontent is that those holding political and other forms of authority have been discredited. In the minds of students and their elders, the Vietnam war is a principal reason for this discrediting of figures of authority and for student unrest. Today's undergraduates are, politically, children of the Lyndon B. Johnson era. Most came to political consciousness during his administration and during the Vietnam war. For them, the previous President is a figure of the distant past. Many of today's undergraduates were in junior high school when John F. Kennedy was assassinated.

In the words of one senior here, "Vietnam hangs over me like the blade of the guillotine." For many men it poses the unattractive alternatives of exile, prison, or being sent to fight in a war which they regard as immoral. The edict earlier this year that graduate students would no longer be given draft deferment has increased the pressure and reduced the chance of escaping service in Vietnam. In recent weeks, draft notices have begun to descend on graduate students at Stony Brook. Prior generations of university students were able to cope with academic or personal pressures by leaving the university for a term or two; today's male students face Vietnam if they take a leave of absence. The Vietnam war has given an impetus to student criticism of universities accepting Defense Department research, criticism which would otherwise have been unlikely to have attained such momentum.