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Regional laboratories have been charged with serving as the link between so-called educational "research" and educational "practice," a link loosely known as "development." Research generates development and development generates research, with both leading to continued reduction of uncertainty, i.e., effort is allocated to different "uncertainty reducing possibilities" as development proceeds and knowledge accumulates. Activities in any product-oriented organization should be conducted according to certain basic assumptions: (1) The solution to a problem should be sought within the context of the problem. (2) The solutions to educational problems will be necessarily complex and many-faceted. (3) A successful solution requires the presence of certain essential conditions including people who accept the solution and are motivated by its evidence. (4) Precise assessment is fundamental to any R and D program. (5) A profession of educational engineers or developers must be trained. (6) The educational gatekeepers must not be subverted in the performance of their elected or assigned duties. An R and D staff, because it is a group of specialists working together within an independent institution, contributes to its own training and that of others through a climate which provides security, individual identity, and coordination of efforts. (JS)

Research and Development: The Reduction of Uncertainty

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RESEARCH AND DEVELOPMENT: THE REDUCTION OF UNCERTAINTY

> Knowledge is not practice and practice is not knowledge. The improvement of one does not lead automatically to an improvement of the other, and also, unfortunately, each can develop separately from the other and hence stuntedly in relation to the other.

All efforts to explain or legitimize the formation and continuation of development organizations are subsumed under the above statement by Fritz T. Roethlisberger (1962). Because there continues to be a tremendous gap between knowledge production and knowledge use - a gap that seemingly cannot be spanned by either the producer, the user, or the two working in concert - there is a continuous need for new mechanisms and agencies, using special techniques, to perform this linking function.

In the field of education, the regional laboratories were organized to help perform this function by pursuing objectives different than those of the university, the school district, the state department of education, or the research and development center, although all pursue the ultimate objective of continuing the advancement of educational practice. The educational laboratories have been charged with serving as the link between so-called educational "research" and educational "practice," a link loosely known as development. Each regional laboratory was directed by the Office of Education and Congress to choose one or two vital educational problems of national scope and/or regional relevance and to limit its work to a realistic area according to manpower and funding. This mandate again underscores the general belief that further work is needed before the ideas of the scientist can be applied to the

daily life of the practitioner. That further work shall be called research and development in this paper. The following reflect the organization of research and development activities at the Upper Midwest Laboratory as well as an attempt to identify the essential elements in a product-oriented organization.

REDUCING UNCERTAINTY

There is a growing body of experience and empirical data which portrays research and development as anything but an orderly process, especially when the steps of dissemination and adoption are a part of that process. Despite the usefulness of models generated by Hilgard (1964) and Guba and Clark (1965), they have led to the misconception that one can or should move in orderly fashion from R→D→D→A; that the activities of one are independent of the other; that the relationships are linear. Although not by intent, these models have implied that research (R) is complete once one moves into "development" and "dissemination;" that once we know the "what," all we must do is develop the "how;" that "what" will remain unchanged during the development of "how."

In reality, the valid development of an educational product, be it substantive or procedural in nature, is essentially a research operation in which the conduct of research is as vital as the consumption of research. Whether such research is to be called basic, applied, development-directed, development-based, functional, or what-have-you is a matter of polemics, irrelevant to the actual conduct of the organization's behavior. What is relevant is that research in a developmental

organization is conducted to fulfill specific developmental objectives and not to "just" produce knowledge. Such research contributes to the developmental goals of the organization, but also produces knowledge for consumption by others. In short, research must be conducted as well as consumed before the actual adoption of educational products can be said to rest on empirical and replicable grounds.

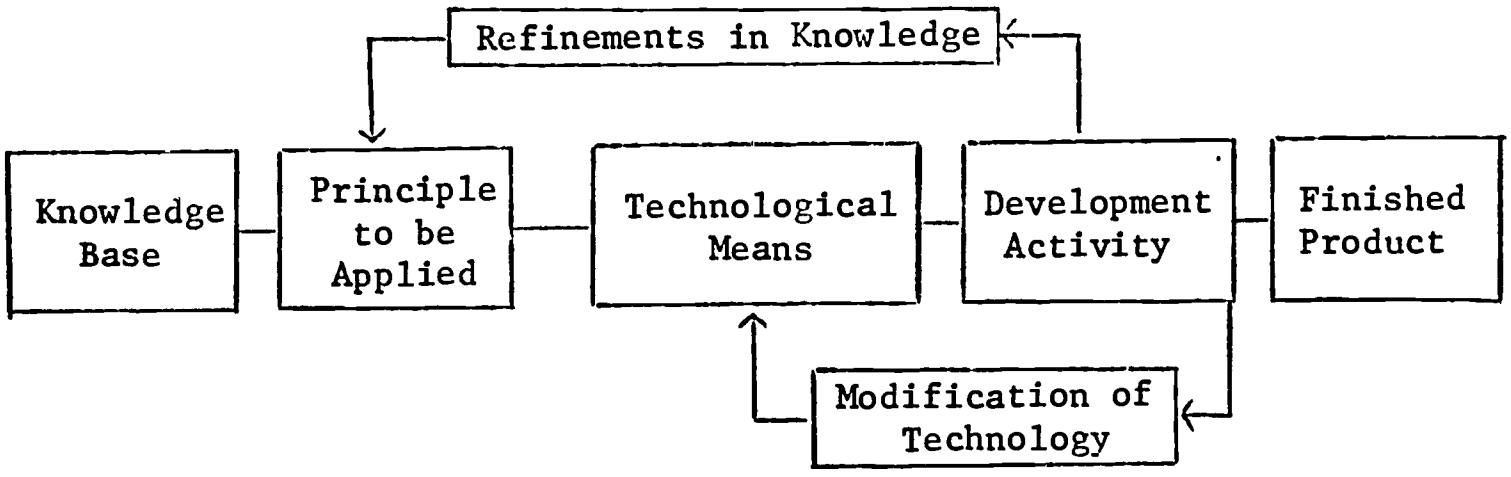
A description of development which is compatible with the above, and probably more eloquently stated, is that offered by Thomas Marshak (1967), in which he writes:

> By development, we understand the attaining of new knowledge, which, when combined with the existing body of knowledge, permits the creation of new and useful products. The relevant existing body of knowledge may be a set of physical laws learned through basic research or it may be a body of experience and practice. Whatever the source, there are uncertainties as to the nature of the new products that will be developed and the effort required to achieve them. We consider development to be a process of uncertainty reduction or learning. One learns by the application of some strategy for allocating and reallocating effort among different uncertainty reducing possibilities as development proceeds and knowledge accumulates.
>
> (Underlining added.)(p.1.)

Thus, research generates development and development generates research, with both leading to continued reduction of uncertainty. The sequence of activities results not only in the finished product itself, but also in the refinement of the basic idea upon which the product is based.

DIAGRAM I

The Research and Development Process



As Diagram I indicates, the most important distinguishing feature of research <u>for</u> development activities is found in the two feedback loops. By systematically attempting to apply an idea, the research and development staff learns about strengths and weaknesses in the technology used to put the idea into practice, and learns how the idea itself is modified by conditions prevailing in the particular environment where research and development are carried out. The learning referred to here is closely associated with learning as fostered by educational psychologists, i.e., the staff arranges (or measures) some aspects of an <u>environment</u>, observes the <u>behavior</u> or activity of machine and/or organisms, and notes the <u>consequences</u> of their actions. If the behavior of the machine or organism is not in the desired direction, the staff changes either environment or consequences to further approximate the desired end. Thus, learning is used <u>in</u> development activity while, at the same time, the developer learns <u>from</u> the results of his own behavior.

Such a strategy produces learning of greater magnitude and applicability than that associated with only the final outcome (product); it is a continual as well as an intimate and essential part of the developmental process. As technology, in its broadest sense, is used to convert an idea into practice, the research and development staff learns how each feature of a chosen technology contributes to the desired outcome and uses such information to design alternate technologies in its process of arriving at the finished product. To these ends, measurement operations associated with a research and development activity are refined and modified to better assess those variables of relevance to the staff. Also, the staff learns how empirical findings upon which the activity is based are altered by environmental conditions, resulting in a continuation of the empirical activity which undergirds the whole research and development effort.

In short, there are several relations among research, development, dissemination, and adoption, rather than a single linear R→D→D→A relation.

PROGRAM OBJECTIVES

Our research and development program is one of utilizing the principles of applied (development-directed) research to produce empirically derived systems of teacher training and subsequent institutional adoption of such systems.

Advances in the behavioral sciences have led to a significant increase in our knowledge of how organisms learn, yet these advances

are not manifested in the professional training of teachers. Aside from the teacher's critical need to "know" curriculum and "know" the characteristics of children, he must also possess a proceeds of skills which will enable him to manage the instructional environment of his students such that the achievement of each will be enhanced. In short, the teacher must behave much like the applied scientist. To prepare teachers for such a function, this laboratory is developing carefully researched training systems, whose effectiveness will be demonstrated in classrooms of varying populations and size and administered within different school organizational patterns. Within each of the laboratory's three major components, instructional management, curriculum programming, and systems organization, research and development activities are conducted according to the assumptions discussed below and the criteria outlined in Appendix I.

Basic Assumptions

(1) The solution to a problem should be sought within the context of the problem. As borne out by Project Hindsight (Sherwin, 1967) and the Mackie and Christensen study (1967), basic research and scientific theory remain fundamental ingredients in problem solving, but the knowledge produced by basic research, if and when available, tends to be too general to guide one in the solution of specific problems.

(2) Like social problems, the solutions to educational problems will be necessarily complex and many faceted. Simple solutions are

simply unlikely. As in the case of increases in agricultural yield, increases in educational yield are the result of many interacting variables (Sprague, 1967). For example, the development of a major new weapons system was shown to depend on the solution of a large number of relatively well defined, small, but critical problems (Carter, 1967).

(3) A successful solution requires the presence of certain essential conditions, including people who accept the solution and are motivated by its evidence, and a trained, motivated and experienced staff with long-term commitment to the problem (not the solution). Funding must be available not only for support of the staff but also to carry out the programs produced by that staff, which often times necessitates the training of large numbers of people to fulfill new practitioner roles.

(4) Precise assessment is fundamental to any research and development program, and should be continuous, objective, replicable, and include cost/effectiveness. The development of sound assessment procedures may be more costly than the product itself, and may often be the really important product.

(5) A profession of educational engineers or developers must be trained. As stated at the outset of this paper, the gap between the producer and the user is wide, and apparently cannot be reduced by either one alone or both working in concert. The education profession is seriously lacking people with the skills equivalent to those possessed by the architect, designer, or engineer which are necessary to bridge this

gap. Universities and governmental agencies must assume some responsibility for the training of such a corps of specialists.

(6) The educational gate-keepers must not be subverted in the performance of their elected or assigned duties, no matter how ill-defined or diffuse is their authority. School boards, legislatures, superintendents, city governments, etc. are in locations critical to the approval or disapproval of proposed solutions, no matter what the empirical evidence might be in support of the solutions. Educational development organizations must plan to alter the role of these gate-keepers, and educate them, if solutions are going to be adopted. As the organization proceeds with its development activities it must insure that the products developed are adaptable to the existing decision-making system, and efforts are put forth to simultaneously enable the system to make better decisions.

A statement eloquently summarizing the substance of these assumptions is made by Henry M. Brickell in these words:

> When research-based information does exist, it must take its place beside all the other information available. The research finding may coincide with and confirm the other information. In such case, the chances of its being used are good. Or it may be the only source of information on a specific topic, in which case its chances of use are possibly only fair because it is not substantiated by experience. Or it may conflict with other information, in which case the situation is one of competition.
>
> ....research findings do not compete well against such established, persuasive information sources as one's personal experience or knowledge of what other schools are doing....

> The prospective adopter (of a solution) is not likely to select the research-based solution solely because it stands on a base of scientific knowledge, especially if something else is less expensive, easier to install, preferred by the faculty, or otherwise attractive.
> (Underlining added.) (P. 235)

As stated earlier, we consider development to be a process of uncertainty reduction or learning, i.e., effort is allocated to different "uncertainty reducing possibilities" as development proceeds and knowledge accumulates. The behavior and reactions of both teachers and pupils are the basis for evaluating progress at each step, with pupil social and academic behavior as the final determinants of program success. As development proceeds from, and is accompanied by, empirical data, the objectives of development-directed research proceed in like fashion. Each objective, be it invention, design, demonstration, acceptance, or institutionalization, is assessed by an appropriate set of criteria, such as validity, reliability, appropriateness, viability, performance, generality, credibility, pervasiveness, adoptability, cost-effectiveness, continuance, growth, support, etc.

TRAINING EDUCATIONAL DEVELOPERS

As a research and development staff continues to reduce uncertainty (learns) it also contributes to the training of itself and others, which is another type of "product." A group of specialists working together within an independent institution, rather than as individual "attachments" to a university or school district, are able to pursue development goals

which further the cause of the organization and the growth of the individuals. This is made possible because such an organization can satisfy three hypothesized needs. These are:

(1) Security, which is a "home" and a degree of independence from both the world of practice and the world of theoretical dogma. The ambiguous, if not dubious, status of the developer in the university or the school district highlights the need for separate and autonomous development institutions;

(2) Identity, which is something each individual must achieve by himself through his own labors, but in daily interaction with others. Identity results from awareness by the individual and others that he is somebody, doing something valuable to somebody, which is distinguishable from what others are doing;

(3) Coordination, which serves a rational function is the organization by dividing the workload appropriately. Although such coordination works better on paper than in practice, and although there are constant battles between the causes of research and the causes of application, the outcome is worth the necessary effort.

As a development organization satisfies these hypothesized needs, it provides each individual with tremendous opportunities for personal growth and development, provides the profession with trained developers, and advances the program goals of the organization.

CONCLUSIONS

To the degree that this laboratory and its partners are able to operate as outlined in this paper, they will be successful. Since

models of organizational operation are only as good as the people who function in them, it behooves all those in educational research and development to avoid keeping their feet "firmly planted in mid-air." By whatever strategy or process they are able to "link" the knowledge producer with the knowledge user, it will no doubt be done by people, sophisticated and shrewd enough to assess all the known factors that can subvert success and be able to cope with them systematically.

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APPENDIX I

Procedures and Criteria for Assessing Program Activities*

A. Procedures. Program Coordinators at the activity level will collaborate with the Research Section and the Advanced Planning Unit in an objective and critical review of each developmental phase. Progress will be assessed regularly by methods meeting scholarly standards, and if suitable instruments do not exist, they will be devised. The efficiency of all training procedures developed will be measured in terms of time and resources expended for each teacher trained.

B. Criteria. Teacher reaction and pupil behavior will be the basis for deciding procedures to be used at the next step. Change in pupil social and academic behavior is the final determinant of program success. Specific criteria are as follows:

1. Objectives must be specific and measurable.
2. Strategies and procedures must be replicable by other researchers and developers.
3. There must be regular and systematic evaluation of progress towards achieving objectives.
4. The activity must be well-designed (research and development model) and feasible in terms of personnel and cost.
5. Criteria to measure success as related to the overall program must be indicated.
6. There must be included a development cycle, such as a PERT analysis, of activities involving a research development-assessment plan.

*Memo: November 1968

7. The activity must assure the development of replicable practices, consequences, processes, materials and/or knowledge.
8. There must be an indication that the activity will lead to an improvement in educational practices.
9. Staff resources should be used to the best advantage in contributing to the accomplishment of the overall program goals.
10. Effects must be measurable in terms of student behavior.
11. Activities and skills within the major program components must be interrelated with one another.