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ABSTRACT
        The theory of and research on the application of
operant procedures to the college classroom is reviewed. Practical
limitations of these procedures and shortcomings of this research are
discussed. Covered in this paper are: (1) theoretical foundations;
(2) operant foundations in education; (3) research on programed
instruction; (4) the effectiveness of operant applications; (5)
variables in applications; (6) research implications; (7)
applications in higher education; and (8) a conclusion and
implications for the future. (Author/KJ)

Toward a Conceptualization of Learning

Processes in the College Classroom I:

A Review of Operant Research

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With the increasing influence of operant theory in
psychology, there has been intimation of its use in the class-
room (cf., e.g., Skinner, 1965 and below). Recent research
which has focused on the college classroom has become frequent
enough to justify a review. This paper is intended to fill
the need for a review of the research on applications of operant
techniques in the college classroom. In addition, the theory,
both from the laboratory and from the educational setting, is
juxtaposed with this research review, so that educators and re-
searchers may be provided a conceptual base for their efforts.

A survey of the indexes for <u>Psychological Abstracts</u> through
1958 yields no references by title to applications of techniques
derived from the operant "camp" of behavioristic psychology to
the college classroom. This lack of research on teaching was
even more general, however; as Beck and Shaw (1960) have ob-
served:

The study of the psychology of teaching is apt to involve disappointment. The great number of studies in human learning generate the expectation of a speedy introduction to important principles of practical training. Nevertheless, it is apparent that, although a great deal is known about the many variables and conditions that affect learning, little is known about applying these to promote efficient training [p. 543].

Beck and Shaw's statement requires some modification because of the work in the decade since it was made. During this period, there has been much effort in attempting to extend the methodology and principles of operant conditioning from animal laboratories to "real, human" problems. This endeavor has been primarily within the "Skinnerian school" and is manifested in education by "programed instruction" and "teaching machines." The earliest effort in this area was made by Skinner and his colleagues (Skinner, 1958; Holland & Skinner, 1961), but was intimated by Skinner as early as 1948 (Walden Two).

In spite of the rapid growth in this area since Beck and Shaw's (1960) statement, there remains much reason for such "disappointment." As Lloyd and Knutzen (1969, p. 125) point out, the use of programed materials has been widespread, but has gone little beyond the use of programed textbooks (cf., Lumsdaine,

1964; Gagne, 1965). Several volumes have dealt with programed instruction (cf., e.g., Lumsdaine & Glaser, 1960; Glaser, 1965; Calvin, 1969), yet applications to the college classroom of operant techniques have been limited almost exclusively to programed textbooks. This suggests a need to specify the foundations and mechanisms in such an application of the operant technology.

In this section, the attempt is made to (1) specify and elaborate the "theoretical" foundations of operant techniques; (2) review research on the variables of programed instruction and its implications; (3) briefly review the limited literature on specific applications which have been attempted; and (4) suggest the direction in this area.

"Theoretical" Foundations

The general procedures employed in the conditioning of operant behavior (i.e., behavior by which the organism modifies or manipulates his environment) have been set forth by many authors, but most extensively by the major proponent of this approach, B. F. Skinner (cf., e.g., Skinner, 1953; Skinner, 1963). In this section, the general procedures applied in operant conditioning are presented, as drawn from the sources noted previously. In addition, procedures which are similar and aimed

specifically at education and programed instruction are discussed.

Generally, five "steps" are delineated in the process of conditioning an operant (behavior); (1) the final desired outcome is specified; (2) the pre-conditioning level of this operant is measured; (3) the appropriate reinforcers, discriminative stimuli, and contingencies of reinforcement are specified; (4) a suitable "learning space" is established; and (5) the desired behavior is "shaped up" and brought under the control of the previously specified discriminative stimuli and contingencies of reinforcement. The order of these "steps" is not necessarily fixed. For instance, step (2) above may be better placed after (3) and (4) in specific situations; steps (3) and (4) might also be reversed where appropriate. In addition, the final behavior is assessed to determine to what extent the " desired outcome" was accomplished.

In specifying the "final desired outcome," the experimenter must define what behavior (specifically, operant) is to be the end-product of this conditioning. In defining the operant, the measures by which the success of the conditioning is determined are also specified. As an example, in a typical condition'ng study, an experimenter may have decided to establish a color discrimination in a pigeon. In such a task, the pigeon is to exhibit an operant of pecking a key of only one color and not

another. In defining the final outcome, the experimenter also

specifies the criteria of learning. That is to say, the measures

whereby the operant is said to be conditioned or not are stipu-

lated. In the present example, the experimenter may be satisfied

that conditioning has taken place if the pigeon pecks the white

key only 90% as often as the red in a 60 minute session.

    In determining the "pre-conditioning level" of the operant,

the experimenter is interested in the probability (or, opera-

tionally, the frequency) of the response in the organism's

existing repertoire of behavior. In so doing, the "base rate"

for this particular operant in the specific organism is defined,

against which the final outcome of conditioning can be compared.

In the example of conditioning a pigeon to discriminate between

a red and a white key, this step is carried out by observing

the frequency of the pigeon's key-pecking behavior prior to any

experimental manipulations. In addition to determining the base

rate of the operant in question, in this step the experimenter

takes note of behaviors which could be components of a more com-

plex operant (i.e., a "chain" of responses) which the experi-

menter might wish to establish in the behavior repertoire of

the organism and for which the base rate is virtually zero. In

the example of the pigeon color-discriminating, if the desired

operant were a circle turned in the clockwise direction before
pecking the red key, the experimenter would note in the base
rate determination those behaviors which were emitted frequently
and could be components of the turning behavior, such as tilting
the head in the clockwise direction.

The third step noted above is most complex and deals with
"motivational" variables of learning, as well as, the physical
limits of the organism. In specifying the appropriate reinforcers,
the experimenter must be aware of or control the physiological
state of the organism. "Motivation" for learning (performance)
is typically operationalized by depriving the organism of some
necessity of life (e.g., food, water), but not to such an extent
as to impair the organism. Yet choosing, as a reinforcement
of the food-deprived pigeon in the previous example, a pellet
of dried meat would be inappropriate. In addition to reinforce-
ment defined appropriately by deprivation, other types of
reinforcers may be useful. Secondary reinforcers, when they
can be observed or established for the organism, may be more
appropriate in certain conditioning situations. (This is ap-
parent in considering the complex behavior of students control-
led by grades or "being right"; a point considered in greater
detail below.) In the example of the color-discriminating,

clockwise-turning pigeon, many circles may be turned just to be
able to peck the red key (the key becoming red only after n
circles are turned by the pigeon).

In specifying the discriminative stimuli, under the con-
trol of which the experimenter wishes to being the operant,
again the physiological limits of the organism must be recog-
nized. To require the pigeon in the, by now well-used, example
to discriminate between two shades of red, closely spaced on
the spectrum, would be an impossible task to learn. In addition,
the discriminative stimulus may vary in its appropriateness to
the task. (This point can be better exemplified in considering
educational uses of operant techniques discussed below.)

The specification of the contingencies of reinforcement
includes two primary considerations: (1) the interval between
operant termination and the presentation of reinforcement (termed
"delay of reinforcement") and (2) the number of operants required
prior to reinforcement ("schedules of reinforcement"). In this
regard, the physiological limits must be considered: a delay
of reinforcement of five minutes is likely to have little effect
on the color-discrimination operant of the pigeon, yet a grade
of 129/150 can have powerful effects for a student several weeks
after the behavior has been emitted. Likewise, expecting a

pigeon to emit ten circle-turnings for the first reinforcement
is unreasonable. Both the delay and schedules of reinforcement
have been extensively researched in the laboratory (cf., Ferster
& Skinner, 1957), and hence, the experimenter can readily find
guide lines for this step. (This procedure when applied in the
educational or thereapeutic setting has been termed "contingency
management," by some authors; see below).

In establishing a "suitable learning space," the experimenter
attempts to control as many as possible of the variables which
may impinge on the organism and interfere with conditioning. In
addition, the environment most conducive to learning is sought.
This includes making the methods of response and reinforcement
convenient to the organism. In the example of the discriminating
pigeon, this is generally accomplished by utilization of an operant
conditioning apparatus (so called, "Skinner Box").

Finally, the experimenter shapes up the specified operant
by reinforcing successive approximations of the behavior. In
addition, the behavior is brought under the specified discri-
minative (eliciting) stimulus and contingency of reinforcement.
The "key" to success in this step, is in the utilization of
small increments in moving from simple to complex behavior, in

bringing behavior under the control of specific (sets of) sti-
muli, and in establishing schedules of intermittent reinforcement.

Operant Foundations in Education

Several authors have delineated approaches to applying, to
the educational situation, operant techniques similar to that
discussed in the preceding section. Reviews by Gagné (1965)
and Barlow (1962) represent and summarize such work.

Barlow has maintained much of the language of "Skinner's
'operant' psychology," yet taken it from the laboratory setting
(as is exemplified in the preceding section) and placed the
emphasis on the classroom. Barlow states,

[T]he task of the teacher is to (1) determine the current
discrimin tive repertoire and effective reinforcers for the
potent al students; (2) carefully specify the desired terminal
behavior and conditions under which this behavior is appropriate;
(3) evoke and reinforce typical current behavior that is relevant
in order to "dipper" or "magazine" train the student; (4) care-
fully sequence SDs [discriminative stimuli] and reinforcement
in order to shape the behavior of the student until the desired
behavior is emitted in the presence of SDs typical of the natural
practical environment in which the behavior is appropriate; (5)

complete the sequence in such a manner that the new behavior will

be intrinsically reinforced and maintained after the sequence is

completed [p. 403].

It should be noted that, in addition to some differences

in the order of the steps outlined in the preceding section

and Barlow's, there are some differences in emphasis (if not

content). It should be helpful to indicate just how Barlow's

scheme relates to the more general one outlined previously.

Barlow's first point corresponds roughly to the third point in

the general scheme outlined above, that is specifying the appro-

priate reinforcers, SDs, and contingencies. In addition, this

step of Barlow's scheme implies the determination of base rates

which is the second point in the general operant procedure. In

addition to the third step of the general scheme, just noted,

Barlow's second step implies (1) of the general scheme, speci-

fication of the desired final outcome. The "conditions under

which this behavior is appropriate" can be taken as the relevant

discriminative stimuli and contingencies of reinforcement. Bar-

low's third and fourth points may be seen to correspond with

the fifth point of the general procedure, shaping and establishing

contingencies. The fifth point of Barlow's scheme is implied in

(5) of the outline of the general procedure: "intrinsically

reinforced and maintained" may be taken to correspond to

"brought under the control of the previously specified discri-

minative stimuli and contingencies of reinforcement." Barlow's

scheme apparently does not specifically consider step (4) of

the general procedure for operant conditioning, the establish-

ment of a suitable learning space. It is, however, implicit

in Barlow's whole description and most clearly implied in (3).

Gagné (1965) has emphasized the importance of specifying

the outcomes of conditioning and the conditions for the behavior

to be emitted (Barlow's second step). In addition, to the

necessity of this step apparent in the statement of the operant

approach in the laboratory (step (1) in the general scheme),

Gagné emphasizes some other and perhaps more practical considera-

tions. To Gagné the specification of terminal behavior desired

by the teacher is essential so that the "instructional designer"

may know the nature of what is to be learned. Gagné elaborates

on this point, stating that the "instructional designer" must

know the nature of the terminal behavior so that he can cor-

rectly design the terminal stages of his program. This depends

on the specification by the user of a program (teacher) of

"what the learner is expected to be able to do" having gone

through instruction. It is only with such a criterion that

the success of the program can be measured. Clearly, this ter-

minal behavior must be specified as an overt performance in order

to provide a suitable criterion. In addition to determining the

terminal sequence of the program, Gagné points out that the

specification of outcomes in overt behavior allows the programmer

to make inferences about behavior modifications to be made through

the program (pp. 23-24).

Gagné notes two more reasons for specifying the desired

outcomes of conditioning in terms of overt behavior. One such

specification allows the evaluation of the effectiveness of the

program in comparison to pre-conditioning behavior, as well as

comparisons of the effectiveness between programs. This is so

because the specification of overt terminal behaviors meets

the requirements of reliability and measurement. Finally, Gagné

suggests that the most important function of specifying outcomes

of conditioning is the provision of a basis for the shaping of

behavior (cf. steps (3) and (5) of the general scheme above).

Distinctions among the class of behavior to be established may

serve as a basis for modifying previous patterns of behavior.

Different classes of behavior require the application of dif-

ferent conditions for learning (p. 25). In Gagné's preceding

treatment "user" and "educational designer" are distinguished.

Often, however, it is the case that in the ad hoc use of

operant techniques in the classroom (the construction of a pro-
gram or writing of a programed text), these two "technicians"
are the same. Nevertheless, it should be emphasized that the
specification of clearly defined end-products for the condi-
tioning remain essential.

Gagné emphasizes one more role for the specification of
outcomes or "defining of objectives;" this has to do with the
role of reinforcement in applying operant techniques to human
behavior. The matching of behavior to specified outcomes
(i.e., "being correct") appears to be a powerful reinforcer of
human behavior (Gagné, 1965, p. 26). However, Gagné adds that
"reinforcement" has not been practically defined, beyond the
conceptual definition that a set of conditions coincident or
closely subsequent to a behavior which appears to increase the
probability of that behavior is termed reinforcement. Rein-
forcement is then taken to mean, in programed instruction, the
learner's matching of his own response production to a response
which is indicated as correct (p.27).

So far, the discussion has been limited to Barlow's second
point and to the additions suggested by Gagné. Skinner (1965)
has written an article which suggests some further clarifica-
tion of Barlow's outline and provides some additional translation

from the statement of operant procedure in the laboratory to the

application of these procedures in the classroom. Skinner offers

the following elaboration:

An important contribution of [operant research] has been

the so-called "programing" of knowledge and skills -- the con-

struction of carefully arranged sequences of contingencies leading

to the terminal performances which are the object of education.

The teacher begins with whatever behavior the student brings to

the instructional situation; by selective reinforcement he changes

that behavior so that a given terminal performance is more and

more closely approximated. Even with lower organisms quite com-

plex behaviors can be "shaped" in this way with surprising

speed; the human organism is presumably far more sensitive

[pp. 6-7].

The notion, contingency, implies both reinforcement schedules

and sequences of discriminative stimuli; behavior is brought under

the control of both. As Barlow suggests, "weaning" from the pro-

gram is essential also, so that the behavior is maintained by

the appropriate schedules and reinforcers and discriminative

stimuli in the "real world."

Reflecting the emphasis on specification of overt behaviors

as the terminal outcomes of conditioning made by both Barlow and

Gagné, Skinner (1965) also emphasizes the equally straightforward

(overt) function of the program (or teacher): "[T]he task of

the teacher is to bring about changes in the student's behavior.

His methods are equally conspicuous: he makes changes in the

environment. A teaching method is simply a way of arranging an

environment which expedites learning [p. 13]." This is the im-

plication of the third and fourth points in Barlow's scheme,

but it more clearly reflects the fifth point of the discussion

in the preceding section on operant techniques in the labora-

tory, that is the establishment of a suitable "learning space."

In addition to manipulation of contingencies of reinforcement

and discriminative stimuli, an environment "conducive to

learning" (i.e., a "learning space") is needed.

   Skinner also suggests a dichotomy of the role which operant

procedures play in the educational setting. As he views this role

of "programming," the arranging of contingencies of reinforce-

ment by the teacher to establish new forms of response, such as

handwriting and verbal and non-verbal behaviors as in sports,

arts, and crafts, are fairly straightforward. However, to ar-

range contingencies to bring existing behaviors under new stimu-

lus controls, such as with intellectual and ethical self-control

has not been so widely applied, but requires the application of

the same principles (1965, p. 13). This discussion corresponds

roughly to Barlow's fourth point, but also incorporates part

of Barlow's final point.

The second half of Skinner's dichotomy of the role of

operant procedures in education completes the fifth step of Bar-

low's scheme and reflects the "motivational" aspects in the pre-

ceding treatment of laboratory operant techniques. Skinner em-

phasizes the role of schedules of reinforcement in suggesting that

"a second kind of programing" results in the maintenance of the

strength (or probability) of a student's behavior. The form of

the response and stimulus control are not altered but the liklehood

of response is increased. The introduction of new reinforcers or

increasing the effectiveness of old ones can strengthen behavior,

as in Skinner's example of providing a student better reasons for

getting an education. He adds that another possibility is sug-

gested by the experimental analysis of behavior: available

reinforcers may be scheduled more effectively. Appropriate

terminal schedules will yield a "motivated" student; "interested,"

"perservering," "curious," and "industrious"; but less stringent

schedules are required first, in order to maintain the desired

behavior at every stage. Skinner stresses that, "The programing

of schedules of reinforcement is a promising alternative to the

aversive control which, in spite of repeated reforms, still prevails in educational practice" [1965, pp. 13-14].

At this point the "translation" of laboratory techniques of operant conditioning skills to be used in the classroom should be fairly complete. With the theoretical foundations of operant conditioning in education having been delineated, it is now possible to consider the relevant research on and programs of operant approaches in education.

Research on Programed Instruction

Conceptually, the operant conditioning approach to education can be considered under two major research questions. First, operant techniques (i.e., specific programs) can be compared with one another and with other educational approaches as to their effectiveness. Secondly, variables which may function within a program in relation to its effectiveness or some other measure may be of interest. Such variables might have to do with the program itself, such as size of increments of response required, number of items, nature of the reward; or variables which the learner brings into the learning situation, such as "intelligence," previous history of reinforcement, may be considered. Typically, these latter variables are indicated by correlational measures such as achievement scores and grade

point average (GPA). Before sampling the limited and generally

poorly executed research in this area, some of the possible

sources of the sparseness of this research are considered.

It appears very curious that an approach growing out of a

history of fervent research and an advanced methodology for

research (i.e., strict operationalism), an example of which is

programed instruction, evidences such a dearth of research.

Skinner (1965) suggests that this lack of research may be in

part a result of a "tradition" of research in education, which

is somewhat antithetical to that implied by the operant approach.

That is, the contribution of operant research to the technology

of education is in the analysis of reinforcement contingencies.

Under the influence of Thorndike's work in the measurement of

mental abilities, research in educational psychology has neglec-

ted causal relationships in the processes of instruction (pp.

16-19).

Skinner points out additional difficulties for research in

this area, but these can best be considered in the discussion of

the two research topics. However, before discussing specific

research questions, the orientation of research in this area

proposed by Skinner (1965) may be usefully presented:

[I]n education, no matter how important improvement in the

student's performance may be, it remains a by-product of

specific changes in behavior resulting from specific changes in

the environment wrought by the teacher. Educational research

patterned on an experimental analysis of behavior leads to a

much better understanding of these basic processes [p. 17].

The implication here, then, is that research employing tradi-

tional measures (e.g., GPA) is inappropriate; emphasis should

be placed on the "learning environment" (e.g., schedules of

reinforcement). In spite of this suggested emphasis, the

research tends to follow the traditional approaches, as is seen

in the following discussion. In the topics considered below no

effort is made to comprehensively summarize research designs and

"findings." The emphasis, rather, is to indicate the kinds of

variables which have been of research interest, along with

apparent limitations of such research.

The Effectiveness of Operant Applications

Although research in this area could conceptually center on

comparisons of various programs, the bulk of this limited re-

search deals with comparisons of operant approaches to traditional

approaches in education. Skinner (1965) at once has emphasized

the need for such research and pointed out its limitations. In addition to knowing the successfulness of a program in bringing about the desired behavior or the successfulness of one program compared to another, it may be useful to know what changes are brought about in the student, perhaps in addition to those specified. Traditional experimental procedures (reliability, correlation) and formulation of designs (insight of the teacher) are not sufficient for assessing the effectiveness of a program with individual students and rarely have directly resulted in improved practices (pp. 16-17).

A study by Rawls, Perry, and Timmons (1966) compared "conventional instruction and individual programed instruction in the college classroom." Programed instruction here consisted only of a commercially prepared programed text, while the "traditional" approach of lecture and assigned readings provided the second condition. The material to be learned was the physiological section of an introductory psychology course. Subjects, 21 pairs, matched on variables of sex, age, IQ, and formal training in biology, were tested immediately after the completion of the topic, and, six weeks later, were retested. The authors conclude that the programed instruction resulted in better long-term retention. This is exactly the kind of

research, traditional in education, which was criticized above.

The individual effects of the instruction are lost in group

means; whereas the operant approach emphasizes the unique learn-

ing of an individual student.

A study conducted by McGrew, Marcia, and Wright (1966)

evidences somewhat more research sophistication than that of

Rawls, et al (1966). In an effort to control for the differen-

tial practice possible in designs which compare traditional

with operant approaches, these authors employed a "branching

program" (i.e., when $\underline{S}$ gives a correct answer, he skips sub-

sequent repetitive frames). Using an analysis of covariance

of the test performance of 66 undergraduates, the authors con-

clude "that sheer repetition of material, regardless of the

medium employed, is a significant factor influencing the out-

come of comparative studies [p. 505]." These authors imply

that many of the studies comparing operant with traditional

approaches to education have failed to control for possible

differences in practice inherent in the techniques.

McMichael and Corey (1969) have also compared a traditional

with an operant approach to teaching introductory psychology.

Based on comparison of final examination scores, these authors

concluded that the operant approach was superior. However,

more interesting than this conclusion is the general use of
operant techniques beyond programed textbooks, known as "con-
tingency management," which is considered more completely below.

Variables in Application

As noted earlier such research could take two tactics
conceptually. The majority of the research deals with variables
students bring to the educational setting. The information on
the second research question, that of variables within the oper-
ant approach, has had an extensive history of laboratory research
(cf., e.g., Skinner, 1957). Hence, in the application of the
operant approach to education, much of this information is used
rather uncritically.

Coulson and Silberman (1960) report a study in which some
of these variables are discussed, yet the methodology Skinner
has criticized above is used. Three independent variables were
manipulated: response mode (multiple-choice vs. constructed
response), increment between steps, and linear vs. branching.
An analysis of covariance compared pre-test and criterion test
scores of two subject groups. Among other conclusions, these
authors report the superiority of small steps for learning and
no differences for the other two variables.

Representative of research on variables which the student brings to the operant situation are studies by Doty and Doty (1964) and Flynn (1966). The variables delineated in the first study were "GPA, creativity, achievement need, social need, and attitude toward programed instruction [Doty and Doty, 1964, p. 334]." They indicate that GPA and "social need" are important variables in the success of programed instruction. In the Flynn study the effect of programed and "regular classroom procedures" were compared for "achievers" and "underachievers Flynn, 1966, [p. 390] ." Flynn suggests that for "underachievers" the method has no effect on learning. For "achievers" operant techniques were superior.

Because of the nature of this research, only an indication of the sorts of questions which are of research interest has been presented in this section. In spite of the obvious need for such research in this area, there is apparently no compre- hensive research program or literature. The need for and dif- ficulty in such research has been succinctly summarized: Research in teaching, of course, must not lose sight of its main objective: to make education more effective. But improvement as such is a questionable dimension of the behavior of either teacher or student. Dimensions which are more intimately re- lated to the conditions the teacher arranges to expedite learning

must be studied, even though they do not contribute to improve-
ment or contribute to it in a way which is not immediately obvious
[Skinner, 1965, pp. 18-19]."

Research Implications

Although the literature discussed in the preceding sections
appears to leave many issues unexplored and suffers from poor
methodology, some implications can be drawn from it. With the
current demands of society on educational systems, the time-
effectiveness measures of teachers and programs have become
critical. Demands on and costs of education appear to have far
exceeded the "supply." If the application of operant techniques
to education can help to alleviate this situation, either by
increasing effectiveness of teachers and education or by reducing
educational costs (by whatever measures either is to be judged),
then there is a great need for research into and application of these
procedures (cf., Williams, 1967; Gilbert, 1969).

The need for operant techniques in college application
would appear to be even greater than for general education, if
judged by the standards suggested in the preceding paragraph.
One man's logic and preference for such an approach is evident
in the following:

In maximizing the student's success, programed instruction differs from so-called trial-and-error learning where the student is said to learn from his mistakes. At best he learns not to make mistakes again. A successful response may survive, but trial-and-error teaching makes little provision for actually strengthening it. The method seems inevitably committed to aversive control. For the same reason, programed instruction does not closely resemble teaching patterned on everyday communication. It is usually not enough simply to tell a student something or induce him to read a book; he must be told or must read and then be questioned. In this "tell-and-test" pattern, the test is not given to measure what he has learned, but to show him what he has not learned and thus induce him to listen and read more carefully in the future. A similar basically aversive pattern is widespread at the college level, where the instructor assigns material and then examines on it. The student may learn to read carefully, to make notes, to discover for himself how to study and so on, because in doing so he avoids aversive consequences, but he has not necessarily been taught. Assigning and testing is not teaching. The aversive by-products, familiar to everyone in the field of education, can be avoided through the use of programed positive reinforcement [Skinner, 1965, pp. 14-15].

With the apparent demand for the application of operant tech-
niques to higher education, it is disappointing to note what has
been accomplished.

Applications in Higher Education

The literature which reports application of operant prin-
ciples to the college classroom primarily are ad hoc attempts;
"ad hoc" in the sense that a specific program is written when
a specific need arises. In addition, these programs are
typically limited in the application of operant principles;
most of the literature sampled reports the use of programed
textbooks or of teaching machines, which are limited to a
specific course content. The principles derived from "operant
psychology" appear not to have been nearly as widely applied
to the college learning situation as is conceptually possible.
Very recently, however, some authors have reported what appears
to be movement in this direction. This general approach often
is termed "contingency management."

Programing for college education (primarily writing
textbooks) has covered a surprisingly wide range of topics
and been carried on by a surprisingly wide range of "programers."
Yet, the bulk of the work appears to be in introductory level
psychology (cf. e.g., Barlow, 1962; Lloyd and Knutzen, 1969;

McMichael and Cory, 1969). Williams (1967) reports on a pro-
gram in which operant techniques were applied to the under-
graduate electrical engineering curriculum at Carnegie Institute
of Technology. Williams concisely reviews the operant basis
for the effort at Carnegie and the reasons for the interest in
such an approach (see above). However, this program is limited
to teaching machines and particular content areas, and hence
does not offer anything of general interest in the application
of operant procedures to the college classroom.

Two extensive efforts to utilize operant procedures in
higher education are reported, which reflect wide interdiscipli-
nary interest. Gilbert (1969) comprehensively reports on the
role of programed learning in the "university instructional
services" at Northeastern University. In this program the
curriculum needs of undergraduates are referred by many depart-
ments to this service. Existing materials are appraised and
new programs of instruction written and evaluated, where re-
quired. Here again, however, the use of operant principles
is limited to the presentation of course content and so-called
"hardware" (i.e., teaching machines and textbooks). Gilbert
does not report the use of operant techniques to learning
situations, other than content. A more limited but similarly

interdisciplinary approach (both with regard to content and

designers) is reported by Jacobson (1962-1963) at Hamilton

College. Here programs were written by individual members of

departments of French, German, mathematics, psychology, and

philosophy, under the auspices of the Fund for the Advancement

of Education. Jacobson notes the same sort of reasons for the

interest in applying operant principles at Hamilton College as

those suggested by Gilbert and in the preceding section. The

Hamilton effort is subject to the same limits as were pointed

out for the Northeastern program.

Two efforts which go beyond the application of operant

principles to course content alone are of particular interest.

The course reported by Lloyd and Knutzen (1969) utilized oper-

ant principles in much more of the total educational situation

than just a programed text (Holland and Skinner, 1961). The

particular outline of the course is not important, but rather

the procedure for the utilization of operant principles is of

interest. Initially, the terminal behavior was specified for

the students and the existing contingencies (discriminative

stimuli and reinforcers) were evoked: students were told exactly

what activities were required at what deadlines for each grade.

Activities were "programed" in the sense that material completed

at one stage was prerequisite for the second. In addition,
behavior was "shaped" in students by requiring greater initia-
tive as the course progressed, and "weaning" was accomplished
by bringing the behavior under the control of discriminative
stimuli and contingencies of reinforcement outside the class-
room setting (e.g., library study). Lloyd and Knutzen describe
their aims as follows:

The purpose was to arrange an environment for the student
in which he would be performing many of the activities that
psychologists perform. What he must do was specified at the
beginning of the semester. Each activity was part of a sequence
of activities which added up to a terminal performance that was
equivalent to a given grade [p. 125].
In addition to applying operant principles to the classroom,
these authors also utilized an operant approach to the analysis
of the data: each student's cumulative record was plotted and
considered. In such an approach, it has been observed that,

The changes in behavior of the individual student brought
about by manipulating the environment are usually immediate
and specific; the results of statistical comparisons of group
performances usually are not. From this study of the behavior
of the individual student, the investigator gains a special

kind of confidence. He usually knows what he has done to get
one effect and what he must do to get another [Skinner, 1965,
p. 19].

The final example in this section is that of a second
rather extensive application of operant techniques. This is
an example of what has been termed "contingency management"
and follows a program first suggested by Keller (1966). The
innovative research question of McMichael and Corey's (1968)
study was "to test whether contingency management techniques
could be used to teach the subject matter of a standard text-
book [p. 79]." In this contingency management approach, rein-
forcements and their schedules, as well as appropriate discri-
minative stimuli were manipulated by requiring students to
complete one section to criterion before moving to the next.
These authors used a "traditional" statistical design to com-
pare terminal performances of control and experimental subjects,
the latter performing better.

It appears too early in the "data collection" to appraise
the application of operant principles to the college classroom.
However, the "pilots" of Keller (1966), McMichael and Corey
(1969), and Lloyd and Knutzen (1969) are encouraging. Some
speculations as to the future and some possibilities of why

the application of operant principles in higher education has
not progressed more rapidly are discussed in the conclusion.

Conclusion: Implications for the Future

Teaching is the expediting of learning. Students learn
without teaching, but the teacher arranges conditions under
which they learn more rapidly and effectively. In recent
years the experimental analysis of behavior has revealed
many new facts about relevant conditions. The growing effec-
tiveness of an experimental analysis is still not widely recog-
nized, even within the behavioral sciences themselves, but the
implications of some of its achievements can no longer be
ignored [Skinner, 1965, p. 6].
In spite of Skinner's conviction and in spite of the needs
noted previously, operant principles are not being widely ap-
plied to higher education. Some possible reasons have been
suggested and some other possibilities are apparent.

Williams (1967, pp. 378-379) has emphasized the large capi-
tal investment required for the "hardware." However, operant
principles can be applied without utilization of expensive
"hardware" (i.e., teaching machines). Investment of time and

effort on the part of "educational engineers" (teachers) are great, but only initially.

Two, more compelling, reasons for the failure to utilize operant procedures in higher education may be suggested. First, it does not appear that the literature on operant research in the laboratory has had wide circulation among educators. This lack of familiarity with operant principles may have resulted in few professors, in disciplines other than psychology, taking the interest or initiative to become familiar enough with this body of knowledge to be able to apply it. Wide dissemination of the basic operant principles and their channels of application may meet the problem. Secondly, there appears to be a "tradition" in education which opposes "manipulation" of individuals; part of the aim of American education is to produce "responsible, thinking" citizens. The operant approach has been attacked on such grounds, that it allows the subject no "freedom." This complex issue is more appropriately considered elsewhere (cf., e.g., Skinner, 1966).

The advantages of the application of operant techniques are both numerous and obvious to a thoughtful reader. A few summary observations however, should make firm this point. Gilbert (1969) has concluded:

As learning methodology, programed instruction promises
to relieve the teaching profession of some of the drudgery
that precludes a creative approach to teaching. Effective
programed instruction actually represents the preservation
of good teaching. The many real benefits from use of programed
instruction cannot help but accrue to all providers and all con-
sumers of education -- in fact, to all human beings concerned
with the needs of education, in our own country and throughout
the world [pp. 239-240].
A similar sentiment is reflected by Jacobson (1962-1963, pp.
51-52) and Skinner (1965) offers a somewhat novel addition to
this viewpoint.

Confidence in education is another possible result of
an effective technology of teaching. Competition between
the various cultures of the world, warlike or friendly, is
now an accepted fact, and the role played by education in
strengthening and perpetuating a given way of life is clear.
No field is in greater need of man's most powerful intellec-
tual resources. An effective educational technology based
upon an experimental analysis will bring it support commen-
surate with its importance in the world today [p. 19].

The conviction of those working with the application of
the principles of operant conditioning based on the experimental
analysis of behavior is perhaps typified by the following:

It is always tempting to argue that earlier ideas would
have been effective if people had only paid attention to them.
But a good idea must be more than right: it must command at-
tention; it must make its own way because of what it does.
Education does not need principles which will improve education
as soon as people observe them; it needs a technology so power-
ful it cannot be ignored. No matter how insightful the anti-
cipation of modern principles in earlier writers may seem to
have been, something was lacking -- or education would be much
further advanced. We are on the threshold of a technology which
will be not only right but effective [Skinner, 1965, p. 16] .

References

Barlow, J. A. Note: Operant techniques applied to the teaching of introductory psychology. *Psychological Record*, 1962, 12, 401-403.

Beck, J., & Shaw, W. A. Learning and teaching; An analysis and characterization. *Psychological reports*, 1960, 7, 543-553.

Calvin, A. D. (Ed.) *Programmed instruction: Bold new venture*. Bloomington: Indiana University Press, 1969.

Coulson, J. E., & Silberman, H. F. Effects of three variables in a teaching machine. *Journal of Educational Psychology*, 1960, 51, 135-143.

Doty, B. A., & Doty, L. A. Programmed instructional effectiveness in relation to certain student characteristics. *Journal of Educational Psychology*, 1964, 55, 334-338.

Ferster, C. B., & Skinner, B. F. *Schedules of reinforcement*. New York: Appleton-Century-Crofts, 1957.

Flynn, J. T. The influence of programmed instruction upon
learning in educational psychology. Journal of Educational
Research, 1966, 59, 387-391.

Gagne, R. M. The analysis of instructional objectives of
the design of instruction. In R. Glaser (Ed.), Teaching
Machines and Programed Learning: II Data and Directions.
Washington, D.C.: National Education Association, 1965.
Pp. 21-65.

Gilbert, J. E. Programmed learning and university instruc-
tional services. In A. D. Calvin (Ed.), Programmed
Instruction: Bold New Venture. Bloomington: Indiana
University Press, 1969.

Glaser, R. (Ed.) Teaching machines and programed learning:
II data and directions. Washington, D.C.: National
Education Association, 1965.

Keller, F. S. A personal course in psychology. In R. Ulrich,
T. Stachnik, & J. Mabry (Eds.), Control of Human Behavior.
Glenview, Ill.: Scott, Foresman, Inc., 1966. Pp. 91-93.

Lloyd, K. E., & Knutzen, N. J. A self-paced programmed
undergraduate course in the experimental analysis of
behavior. Journal of Applied Behavior Analysis, 1969,
2, 125-133.

Lumsdaine, A. A. Educational technology, programmed learning, and instructional science. In E. R. Hilgard (Ed.), <u>Sixty-third Yearbook</u>, <u>National Society for the Study of Education</u>. Chicago: University of Chicago Press, 1964. Pp. 371-401.

Lumsdaine, A. A. & Glaser, R. (Eds.) <u>Teaching machines and programmed learning: A source book</u>. Washington, D.C.: National Education Association, 1960.

McGrew, J. M., Marica, J. E., & Wright, C. K. Branching program, text, and lecture: A comparative investigation of instructional media. <u>Journal of Applied Psychology</u>, 1966, <u>50</u>, 505-508.

McMichael, J. S. & Corey, J. R. Contingency management in an introductory psychology course produces better learning. <u>Journal of Applied Behavior Analysis</u>, 1969, <u>2</u>, 79-83.

Meichenbaum, D. M., Bowers, K. S. & Ross, R. R. Modification of classroom behavior of institutionalized female adolescent offenders. <u>Behavior Research and Therapy</u>, 1968, <u>6</u>, 343-353.

Rawis, J. R., Perry, O., & Timmons, E. O. A comparative study of conventional instruction and individual programmed instruction in the college classroom. <u>Journal of Applied Psychology</u>, 1966, <u>50</u>, 388-391.

Jacobson, J. The Hamilton College Experiments: Programmed instruction in mathematics, modern languages, logic and psychology. Transactions of the New York Academy of Sciences, 1962-1963, 25, 45-52.

Skinner, B. F. Freedom and the control of men. In R. Ulrich, T. Stachnik, & J. Mabry (Eds.), Control of Human Behavior. Pp. 11-20.

Skinner, B. F. Reflections on a decade of teaching machines. In R. Glaser (Ed.), Teaching Machines and Programmed Learning: II Data and Directions. Washington, D.C.: National Education Association, 1965. Pp. 5-20.

Skinner, B. F. The experimental analysis of behavior. American Scientist, 1957, 45, 343-371.

Skinner, B. F. Science and human behavior. New York: Macmillan, 1953.

Skinner, B. F. Teaching machines. Science, 1958, 128, 969-977.

Skinner, B. F. Walden Two. New York: Macmillan, 1948.

Staats, A. W. & Staats, C. K. Complex human behavior: A

systematic extension of learning principles. New York:

Holt, Rinehart & Winston, 1963.

Williams, E. M. Innovation in undergraduate teaching.

Science, 1967, 155, 974-979.

Footnote

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