DOCUMENT RESUME

ED 221 522   SP 021 055

AUTHOR   Silverman, Stephen
TITLE   Aptitude-Treatment Interaction Research: Implications
                for Physical Education.
PUB DATE   Apr 82
NOTE   15p.; Paper presented at the Annual Conference of the
                American Alliance for Health, Physical Education,
                Recreation and Dance (Houston, TX, April 1982).

EDRS PRICE   MF01/PC01 Plus Postage.
DESCRIPTORS   *Aptitude Treatment Interaction; Educational
                Research; *Measurement Techniques; Physical
                Education; *Research Design; *Student
                Characteristics; *Teacher Effectiveness; Teaching
                Methods; Teaching Styles; *Test Validity

ABSTRACT
        The aptitude-treatment interaction (ATI) design
focuses on teacher effectiveness and on how the effectiveness of the
teacher interacts with the stable characteristics of the student. The
underlying assumptions of the ATI design are similar to and an
extension of other teacher effectiveness research designs, such as
the process-product design. The ATI research design can be used in
examining questions related to physical education. Steps an ATI
researcher would most likely pursue include: (1) Selecting treatments
that have a foundational base in the literature; (2) Identifying
aptitudes that have methods for reliable and valid measurement (The
number selected should be manageable within the framework of the
experimental design); (3) Identifying outcomes/skill measures (The
skill being tested should be that skill being taught by the teacher);
(4) Training teachers to execute the treatment as planned and teach
the material that is being pretested or posttested; (5) Discerning
and measuring aptitudes (Teachers or school records may be required
to obtain information on aptitudes, and all appropriate regulations
regarding privacy and student/subject rights must be respected); (6)
Randomly assigning subjects (Unless true randomization of subjects is
possible, a pretest is required); and (7) Measuring posttest skills
to obtain the necessary information on student learning for each of
the subjects and each treatment and aptitude level. (JD)

APTITUDE-TREATMENT INTERACTION RESEARCH:

IMPLICATIONS FOR PHYSICAL EDUCATION

Stephen Silverman
School of HPERD
Louisiana State University
Baton Rouge, LA   70803

What is Aptitude-Treatment Interaction Research?[1]

The aptitude-treatment interaction (ATI) design, in a general
sense, primarily is concerned with how student characteristics affect or
mediate what happens in the educational situation. The design focuses
on teacher effectiveness and how the effectiveness of the teacher
interacts with the stable characteristics of those students being
taught.

Since the mid 1950's Cronbach (1957) has urged researchers to
examine the role individual differences play in instructional methods
and educational outcomes. With his colleague, Richard Snow, Cronbach
coined the term Aptitude-Treatment Interaction. The term _aptitude_
refers to any relatively stable student characteristic that may be a
predictor of achievement. Gender, cognitive or psychomotor ability,
past experience with the subject matter, IQ, socio-economic status, age,
grade, and a number of other individual characteristics may be con-
sidered an aptitude.

A _treatment_ is any manipulable variable and is similar to the
process segment of the process-product model (Note 2). Treatment might
be the amount of time engaged in practice, teacher questioning style, or
method of instruction.

An _interaction_ occurs when treatments produce significantly differ-
ent effects in students with different levels of an aptitude. Inter-
actions may occur when treatments are manipulated experimentally or when
treatments are naturally occurring in the class. More precisely, in the
classical experimental model, "an ATI exists whenever the regression of
outcome from Treatment A, upon some kind of information about the

person's pretreatment characteristics, differs in slope from the re-
gression of outcome from Treatment B on the same information" (Cronbach
& Snow, 1977, pg. 5).

Essentially, this research method is an experimental design. In
the most simple sense, it can be thought of like the two-way ANOVA with
which we are familiar. The dependent variable is achievement in one of
the three domains (psychomotor, cognitive, affective). The independent
variable is the treatment and the blocked variable is the student
characteristic. Remember, this is the most simple case -- the ATI
design, in many instances, may be quite complex.

The underlying assumptions of the ATI design are, in many ways,
similar and an extention of other teacher effectiveness research designs
such as the process-product design. Process-product research tells us
which variables may relate to achievement and even whether or not this
relationship is mediated by certain student characteristics. When ATI
research follows-up on correlational research findings it is in an
attempt to "prove" causality. The assumptions of experimental or
quasi-experimental research designs are incorporated into the ATI
research design.

What are Typical Questions Asked
By an Aptitude-Treatment Interaction Research?

The prime question in ATI research concerns achievement in one of
the three domains and how levels of some treatment interact with the
levels of the characteristics of the students in the study. This really
asks two questions: 1) What are the overall effects of the treatment?;
and, 2) What interaction is there between the treatment and the student

characteristics (aptitudes)? As you may know, when interaction effects exist these take precedence over the main effects and require careful interpretation.

A great deal of ATI research in classrooms has focused on the aptitudes of cognitive ability, psychological processes, socio-economic status (SES), sex, age, and grade. Treatments have focused on teaching styles, time-on-task, questioning styles, and teacher-student inter-actions styles, to name a few. The questions that an ATI researcher asks are related to the three facets of the design -- student achieve-ment, treatment(s), and student characteristics(s).

Examples of questions one might ask if the ATI design is to be employed are:

1) What levels of student engagement produce the highest achievement and is this the same for high, medium, and low SES students?

or

2) In which of Mosston's styles do students achieve the most and is the same for males and females?

A more specific question related to physical education might be: At which level of teacher questioning do students best learn the forward pass and do internal and external locus of control students learn best under the same conditions? As can be seen by the above question, the answer to ATI questions may be involved and may require "finese" when presenting and interpreting results.

It should be pointed out that it is possible to ask inappropriate questions which focus on the ATI paradigm. Most of the inappropriate questions may involve too many simultaneous treatments in conjunction

5

with a wide variety of student characteristics. For instance, consider how difficult it would be to attempt to answer or interpret results stemming from this question: During which of Mosston's teaching styles, and various levels of questions do students learn the most and is this the same for students varying within the unique groupings of student psychomotor ability, SES, and sex?

The above question would have a number of different levels of interaction to interpret in addition to the main effects of teaching style, questioning levels, psychomotor ability, SES, and sex. The posing of ATI questions could, of course, be taken to the absurd. The important point is to carefully choose a small number of treatments and aptitudes which the research literature, or possibly common sense, may indicate as particularly potent for investigation.

At this time, one ATI study has been conducted with psychomotor skill improvement as the dependent measure. This was conducted by David Griffey (1981) now at the University of Texas at Austin. I have conducted a process-product study (Silverman, 1982) with special application of student characteristics as a prelude to future ATI research.

What Does an Aptitude-Treatment Interaction Researcher Actually Do?

This section will describe the steps an ATI researcher would most likely pursue in developing and implementing a teacher effectiveness study investigating aptitude-treatment interactions. Due to the complex nature and the number of steps, each step will be discussed in numerical order as listed. The reader is advised, however, that it could be possible to interchange the order of steps.

1. Identify treatments. The identification of treatments is more
than merely deciding which teacher behaviors or methods should be the
focus of the study. Treatments selected for an ATI investigation should
have a foundational base in the literature of correlation/regression
research. By this I mean, treatments should be selected when that
treatment occurring naturally has been shown to be a particularly potent
predictor of residualized outcome in earlier studies using the pro-
cess-product model for research on teaching. When the researcher has an
indication that a relationship exists between process and outcome, there
is support of selection as a treatment of various levels of the behavior
or among the teaching styles. When a treatment is selected without
knowledge of it's predictive ability on outcome, the researcher may
perform an involved experimental procedure with no foundation for the
selection of the variables being studied. This may cause those doing
the study to be frustrated by nonsignificant results. (N.B.: Results
also may be nonsignificant if there were process-product relationships,
but knowing that the relationship existed gives support for the se-
lection of the treatment.) It would be wise for the researcher inter-
ested in teacher effectiveness not to skip the correlational level in
pursuit of casuality.

2. Identify aptitudes. Aptitudes, like treatments, should be
selected with care. If previous research has shown certain student
characteristics have mediated process-product relationships, that would
be a basis for selection of the aptitudes. Common sense, intuition, and
characteristics which would have impact on pedagogical practice may make
other characteristics inviting to the researcher. It is important that
the aptitudes selected have methods for reliable and valid measurement

and that the number selected be manageable within the framework of experimental design.

3. Identify outcomes/skill measures. In any investigation focusing on student learning, the indentification and measurement of a pretest and posttest to obtain an outcome is very important. While the classroom researcher may have variety of reliable and valid tests for measuring student achievement, there are very few in physical education. Therefore, many teacher effectiveness studies in physical education have utilized previously designed instruments. Others, such as Bev Yerg, have designed elaborate systems to measure skill level. Whether a previously designed or new instrument is used, it is very important that the skill (or the cognitive concept or affective behavior) being tested is that skill being taught by the teacher. It is one thing to administer a pretest and posttest on serving a tennis ball when the serve is actually being taught and quite another when class time is spent practicing the volley or playing a game.

4. Train teachers. In an ATI study it is important that those teaching execute the treatment as planned and teach the material that is being pretested or posttested. A class where the treatment is not as designed or where the skills being taught are not the same as those being tested will obviously confound the analysis of the study. By planning ahead and working with those involved and by making certain each teacher is prepared to include the appropriate content and structure the class in ways consistent with the level of the treatment assigned, the investigator can help ensure the integrity of the study.

5. Measure aptitudes. Whatever aptitudes were selected for study

(Step 2) must now be measured. In some instances, students may have to be tested for psychomotor, cognitive, or affective attitudes. Teachers or school records may be required to obtain information on aptitudes. No matter which way aptitudes are discerned, the investigator should be certain to go through proper channels and to abide by all appropriate regulations regarding privacy and subject rights.

6. Random assignment. If the study is to utilize a true experimental design, random assignment of subjects would occur at this point. It should be noted that this is rarely possible and, therefore, the study would be a non-randomized experimental nature.

7. Pretest skill. Unless true randomization of subjects within treatments by aptitudes is possible a pretest is required. The pretest should be administered consistent with guidelines presented earlier and in non-randomized experiments serves a function similar to the covariant in analysis of convariance.

8. Implement treatments. Once aptitudes have been measured and a pretest has been administered, the experimental treatments are initiated as planned earlier. An ambious (and prudent) researcher might make certain that each treatment is being reliably implemented throughout the course of study.

9. Posttest skill. The final step prior to analysis is to posttest the skill. The posttest, after considering the pretest, will give the researcher necessary information on student learning for each of the subjects and for each treatment and aptitude level.

10. Analyze data. Analyzing the data from ATI studies may be intricate, since rarely can students and/or classes be truly randomized in accordance with the assumptions of the familiar randomized

experimental models. Therefore, methods for analyzing non-randomized

experiments should be employed. The reader might start by reading the

recent paper by Griffey (1982) and then consulting other references or

an experienced educational statistician prior to developing a strategy

for analyzing ATI data.

What are the Major Methodological/Instrumentation
Considerations in Aptitude-Treatment Interaction Research?

Many of the concerns related to methods and instrumentation have

een presented in other parts of this paper. As discussed earlier, the

researcher does need to be concerned with the reliability and validity

of the treatments and the measures for assessing skill level and. apti-

tudes. The concerns should be thought out and addressed prior to the

initial undertaking of the study.

An issue in measuring skill level or outcome is the test-retest

reliability of the performance. This may be particularly important when

a fluid skill is the focus of investigation. A system has to be devised

(or found) to have raters reliably rate the skill among each other.

There is another concern--is that performance of the skill that has just

been rated an accurate indication of the students' "real" skill level.

The researcher must be concerned with these two issues as well as

others. A well thought out and tested skill measurement and data

analytic system greatly will enhance any study, but the researcher

should be aware that no method is perfect and some will find fault no

matter how many precautions are taken.

The issue of generalizing an ATI study to other populations will

depend on many factors which are generally well known. If the study is

random the principles of general ability that apply to randomized experiments will hold true. If the study is non-randomized or quazi-experimental, only limited generalizations, if any, can be made to subjects other than those involved in the study. Of course, if we find many replications showing similar results in a variety of environments from variety of researchers, we may individually interpret the findings to provide a foundation for understanding what is happening with certain aptitudes and treatments in the gymnasium.

One final note concerning methods relates to the issue of the proper unit of analysis. Early in the planning stages the researcher will want to determine the most appropriate unit (student, class, school, etc.) for analyzing the data from the study. This is an important and controversial issue and should be confronted as _early_ as possible.

REFERENCE NOTES

1. The symposium was organized to address each of the questions which
   serve as headings for the sections of this paper.

2. Other paradigms selected for presentation at the symposium and the
   presentors are: Process-Product Research Models in Physical
   Education, Beverly Yerg and Bernard Oliver; Single-Subject Research
   Design, Patt Dodds and Thom McKenzie; Ethnographic/Ethnomethodo-
   logical Research, Tom Templin. The symposium was organized and
   moderated by Bernard Oliver.

REFERENCES CITED

Cronbach, L.J.   The two disciplines of scientific inquiry.   American
    Psychologist, 1957, 12, 671-684.

Cronbach, L.J. & Snow, R.E.   Aptitudes and instructional methods: A
    handbook for research on interactions.   New York: Irvington
    Publishers, 1977.

Griffey, D.C.   A study of aptitude by treatment interaction associated
    with student decision making in physical education classes
    (Doctoral dissertation, Stanford University, 1980).   Dissertation
    Abstracts International, 1981, 41, 347A.   (University Microfilms
    No. 81-03,514)

Griffey, D.C.   Alternative approaches to analysis of convariance:
    Non-simultaneous and simultaneous interference.   Research Quarterly
    for Exercise and Sport, 1982, 53 (1), 20-26.

Silverman, S.J.   The relationships among student achievement, student
    engagement, and selected characteristics in physical education.
    Unpublished dissertation, University of Massachusetts, 1982.

REFERENCES RELATED TO APTITUDE BY TREATMENT

INTERACTION (ATI) RESEARCH

Bennett, N. Teaching styles and pupil progress. Cambridge,
    MA: Harvard University Press, 1976.

Berliner, D.C. Impediments to the study of teacher effectiveness.
    Journal of Teacher Education, 1976, 27 (1), 5-13.

Clark, C.M. Five faces of research on teaching. Educational
    Leadership, 1979, 37, 29-32.

Cronbach, L.J. The two disciplines of scientific inquiry. American
    Psychologist, 1957, 12, 671-684.

Cronbach, L.J. & Snow, R. Aptitudes and instructional methods: A
    handbook for research on interactions. New York: Irvington
    Publishers, 1977.

Doyle, W. Paradigms for research on teacher effectiveness. In L.S.
    Shulman (Ed.), Review of research in education. Itasca, IL:
    Peacock, 1977.

Gage, N.L. Models for research on teaching (Occasion paper #9).
    Palo Alto, CA: School of Education, Stanford University, 1976.

Gage, N.L. THe scientific basis of the art of teaching. New York:
    Teachers College Press, 1978.

Griffey, D.C. A study of aptitude by treatment interaction associated
    with student decision making in physical education classes (Doctoral
    dissertation, Stanford University, 1980). Dissertation Abstracts
    International, 1981, 41, 347A. (University Microfilms No. 81-03,
    514).

Snow, R.E. Individual differences and instructional theory.
    Educational Researcher, 1977, 6 (10), 11-15.

Snow, R.E., Federico, P.A., & Montague, W.E. Aptitude learning and
    instruction. Hillsdale, N.J.: Lawrence Erlbaum Assoc., 1980.

Tom, A.R. THe reform of teacher education through research: A futile
    quest. Teacher College Record, 1980, 87, 15-29.

Whitely, S.E. & Davis, R.B. A model for psychometrically distinguishing
    aptitude from ability. Educational and Psychological Measurement,
    1975, 35, 51-66.

Winne, P.H. Aptitude-treatment interactions in an experiment on teacher
    effectiveness. American Educational Research Journal, 1977, 24,
    389-409.

Analysis/Measurement

Cronbach, L.J., Rogosa, D.R., Floden, R.E., & Price, G.G. Analysis of convariance in nonrandomized experiments: Parameters affecting bias (Occational paper). Palo Alto, CA: Evaluation Consortium, Stanford University, 1977.

Cronbach, L.J. & Furby, L. How should we measure "change" -- or should we? Psychological Bulletin, 1970, 74 (1), 68-80.

Furby, L. Interpreting regression toward the mean in developmental research. Developmental Psychology, 1973, 8 (2). 172-179.

Griffey, D.C. Alternative approaches to analysis of convariance: Non-simultaneous and simultaneous interference. Research Quarterly for Exercise and Sport, 1982, 53 (1), 20-26.

Harris, C.W. (Ed.) Problems in measuring change. Madison, WI: University of Wisconsin Press, 1963.

Hopkins, K.D. The unit of analysis: Group mean verus individual observation. American Educational Research Journal, 1981, 19 (1), 5-18.

Linn, R.LK. & Slinde, J.A. The determination of the significance of. change between pre- and post-testing periods. Review of Educational Research, 1977, 47 (1), 121-150.

Page, E.B. Statistically recapturing the richness within a classroom. Psychology in the Schools, 1975, 12, 339-344.

Potthoff, R.F. On the Johnson-Neyman technique and some extensions thereof. Psychometrika, 1964, 29, 241-256.

Rogosa, D. Comparing nonparallel lines. Psychological Bulletin, 1980, 88 (2), 307-321.