

● Research in Review

COLUMN EDITOR: JAMES RATHS

THE INDUCTIVE PROCESS: IMPLICATIONS FOR RESEARCH REPORTING

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EDUCATIONAL research shares with research in the other social and physical sciences a reliance on the inductive process. While this process is a powerful one, as demonstrated by the advances due to its use, there are also serious limitations associated with this method of inquiry that are not so widely known to the researchers in education. This paper will identify the strengths and weaknesses of the inductive method and cite implications these characteristics have for the authors of research reports.

Strengths

The strength of the inductive process is that it can be used to generalize beyond the findings of a particular study or research. As Skinner studies pigeons in a learning experiment, he generalizes to general laws of learning having to do with reinforcement. He distinguishes between the mean score of the pigeons on a particular task, on the one hand, and the conclusions he draws from these data on the other. As this differentiation is made, we can see that the real contribution of research to education can be in its confirming of general statements or laws dealing with teaching and learning. Many scholars

in education are dubious of any attempt to find generalizations dealing with human behavior. Homme (4) attacks such skepticism as follows:

In our culture, each of us has grown up repeatedly hearing that humans are very complicated and that every human is different from every other one. Generalizations about human behavior are, therefore, if not altogether bad, at the least, very risky. But one can make similar statements about a stone. No stone is like every other stone, and the micro-structure of stones is presumably quite complex. So we might conclude that stone generalizations are also very risky. However, the facts of the matter are that all stones, regardless of other individual complexities and peculiarities, obey certain laws—the law of gravity for example.

The point, then, is to identify the laws of human behavior and to test them. Studies that compare methods of teaching which do not at the same time test laws of human behavior do not make use of the potential power of the inductive process—namely the ability to generalize from specific data to a generalized statement or law. It would be as if Skinner generalized from his experiments with pigeons to another population of pigeons rather than to an

idea concerned with learning and reinforcement.

The most obvious limitation of the inductive process is that inductive procedures cannot be used to prove anything. Data may only support, fail to support, or in some cases, discredit a generalization. For example, suppose a researcher hypothesizes that Method A is more effective than Method B. This is a general statement that he wishes to test. He randomly assigns students to either of the two methods and finds that students in Method A did indeed do better than students assigned to Method B. Does this finding prove that Method A is better than Method B? To say that it does is to say that finding one triangle with 180 degrees as the sum of its interior angles proves that all triangles have 180 degrees as the sum of their interior angles. The researcher can only say that the credibility of the assertion that Method A is more effective than Method B is now strengthened as the result of his experiment.

A further limitation of the inductive approach in education is brought about by the use of the null hypothesis model of decision making. In the classic model of induction, while an affirming instance of the generalization only adds somewhat to the credibility of the generalization, a counter-example discredits the generalization. In this sense, finding a counter-example, say a triangle with only 150 degrees as the sum of its interior angles, is an important finding. It provides evidence that disproves the generalization.

When the null hypothesis method of testing statistical hypotheses is used, and when the results are not significant,

it is not appropriate to say that the null hypothesis is true, and thus the generalization tested is invalid. A null result only indicates that if a difference in methods exists, the researcher did not find it. Therefore, if the researcher mentioned above did not find significant differences in his groups, he cannot say that Method A is not more effective than Method B. He is restricted to saying that the hypothesis that Method A is more effective than Method B is not supported by the data of the experiment.

This limitation militates against the advice of Pratt (6) in his provocative piece in *Science* advocating the use of "strong inference." His argument is that researchers should eschew efforts to confirm hypotheses in favor of attempts to find instances that disconfirm hypotheses. As long as researchers use the null hypothesis model of decision making as their primary tool, they will be unable to find evidence that disconfirms hypotheses. Instead, they will only be able to collect evidence over a series of experiments that fail to support the hypothesis under test.

Two implications that may be drawn from this discussion for the writing of research reports are as follows:

1. To harness the power of the inductive process dealing with the extension of conclusions beyond the findings of a specific experiment, a research report should distinguish between what was found and what was concluded. The findings of most empirical studies deal with the means and standard deviations of data and the statistical decisions that result from the applying of statistical tests. The conclusion would answer the question: "What do

these findings mean concerning the hypothesis?" In almost all cases of educational research, the conclusion relevant to a given hypothesis will be simply either that the hypothesis is supported or that the hypothesis is not supported by the data.

A practice in research reporting that tends to confuse findings and conclusions is the stating of research hypotheses in the null form. Actually, this style is advocated by leading researchers in the field [See Guba (3)]. However, this approach can lead to a confusion between findings and conclusions—a confusion that frustrates the real power of the inductive process, generalizing to ideas.

2. To alert readers to the limitations of the research process, a research report should conclude that the hypotheses under study are either supported or not supported by the data. Any interesting relationships discovered during the course of the research (serendipital findings) and any implications of the findings for theory, for practice, or for further research should be clearly differentiated in the report from the conclusions of the study.

It may be held that these implications are so obvious that almost anyone dealing with research is aware of them. It is the point of this paper that this is not so. To give credence to this assertion, several researches appearing in the current literature are examined below. To be fair, it must be stressed that the authors of these reports may not agree at all with the assumptions of the research process that have been made here. To the extent that this is true, criteria are being applied to the work of persons

who do not accept them. As such may be the case, this analysis is not meant to reflect upon the quality of the research reported nor upon the competence of its authors.

Example 1: *A report of findings only.* Krumboltz and Yabroff (5) report in a study of the effects of inductive and deductive sequences that, "the two methods were about equally effective in producing accurate transfer of training." This is one of three statements that are advanced in the text of the article as conclusions. In view of the distinction advanced above, this statement summarizes a finding and not a conclusion. The purpose of the study, reported earlier in the article, was to "determine the teaching efficiency of inductive and deductive sequences of instruction with varying frequencies of alternation between problem solving and rule stating." As far as can be told, the authors never answer the implied question, "Which is more efficient?" The reader must supply that answer. To add to the confusion, the authors refer to the previously stated "conclusions" merely as "findings" in the summary. This analysis again is not to suggest that the research is of low quality. It is to suggest that a framework of reporting research that discriminates between findings and conclusions may clarify for potential users of the research the thought processes of the authors.

Example 2: *Conclusions beyond the data.* One common practice in reporting research, once significant confirming evidence has been compiled, is to merely restate the hypothesis in the form of a declarative sentence as a conclusion. Allen and McDonald

(1), for instance, cite that the purpose of their experiment was to test the hypothesis that "self organization of instructional materials by the learner will improve both his rate of learning and the amount he learns." Later in the report, the authors state, "the major conclusion is that performance is significantly lower when the student completely controls the organization of the instructional materials and the method used in learning than when these elements are completely or partially controlled by the instructor."

While the authors continued in their discussion to qualify the conclusion, it is the point of this analysis that the conclusion as stated goes beyond their data. Because of the limitations of the inductive process, a more valid conclusion would have been simply that the data of the research support the hypothesis of the study. While this point may seem only a quibble, actually it is relevant to the very heart of the research process. The most probable use that will be made of Allen's and McDonald's research is that the conclusion cited in the author's own words will be quoted again and again in the literature without the qualifying sentences that follow it in their narrative.

Example 3: *A qualified conclusion.* To end this discussion on a more positive note, there are researchers who do tend to make the distinctions advanced in this paper. Craig (2) in his study of discovery methods begins his discussion of the findings with the sentence: "The results of this experiment support the generalization that motivation for continued learning is fostered by procedures that combat the finality of a

learning task." This example is congruent with the point of view of this paper that data merely support hypotheses and do not prove them.

In summary, while there are many other ways in which research reports may be improved, this paper advocates that by distinguishing between findings and conclusions, and by properly qualifying conclusions, authors can take advantage of the strengths of the inductive process and take cognizance of its weaknesses.

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