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ABSTRACT

This paper suggests that considering fundamental issues in educational research may help researchers conceptualize more productive research methodologies for computer based instruction (CBI). Inconsistent findings and methodological shortcomings in media research, including CBI, raise the possibility that current research methodologies may be inadequate to significantly enhance our understanding of CBI. The purpose of this document is to highlight a set of conceptual and methodological considerations which may be relevant to a comparison of goodness of fit between research methodology and the types of questions for which researchers seek answers. An examination of these issues leads to specific recommendations for conceptualizing and conducting experiments involving the computer in instruction. Specific recommendations are discussed in the following categories: moving towards theory building, expanding research methodologies, and setting priorities for applied research. The need for inclusion of each category is explained and justified, and some common misconceptions about each are allayed. A list of references is included. (Author/JB)

ON CONCEPTUALIZING RESEARCH METHODOLOGIES FOR COMPUTER-BASED INSTRUCTION

Abstract

Current research methodologies may be inadequate to significantly enhance our understanding of computer-based instruction (CBI). Inconsistent findings and methodological shortcomings in media research, including CBI, raise this possibility. This paper suggests that considering fundamental issues in educational research may help researchers conceptualize more productive research methodologies for CBI. An examination of these issues should lead to specific recommendations for conceptualizing and conducting experiments involving the computer in instruction. Specific recommendations are discussed in the following categories: moving towards theory building, expanding research methodologies, and setting priorities for applied research.

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On Conceptualizing Research Methodologies for Computer-Based Instruction

The pitfalls of educational research are legion. The risks of succumbing to these pitfalls may be amplified when research involves innovative technologies like the computer. The exciting potential of the computer for enhancing instruction generates spontaneous enthusiasm and a concomitant need to justify this enthusiasm. Consequently, there may be a temptation to short-circuit the research process by asking superficial questions, by sacrificing sound methodology and by over-generalizing findings. The history of research investigating a variety of instructional media also suggests caution for those interested in researching topics in computer-based instruction (CBI). Several writers have chronicled the failure of researchers to create a useful research base for guiding the selection and use of instructional media (Clark and Bovy, 1983; DiVesta, 1975; Jamison, Suppes, and Wells, 1974; Leifer, 1976; Oettinger and Zapol, 1971; Saettler, 1968).

Existing CBI research appears to fare no better. Evidence that methodology, for example, is a serious concern can be found in Kulik's (1983) meta-analysis of CBI studies in which a majority of the available studies were eliminated due to methodological shortcomings. Before we accept the possibility that strong empirical evidence is not possible or alternatively continue to muddy the empirical waters, we should compare the

goodness of fit between research methodology and the types of questions for which we seek answers. The purpose of this paper is to highlight a set of conceptual and methodological considerations which may be relevant to such a comparison.

Fundamental Conceptual and Methodological Concerns

Research methodology is presumably a function of the types of questions the researcher chooses to address. A conceptualization of a research study begins, therefore, with a question in the mind of the researcher. The old saw about getting a good answer only if there is a good question is important at this stage but the process is more complex when put into the context of educational research. The researcher must also consider potential answers to the question, how those answers might be explained, and use these notions to formulate a methodology for research. The challenge of research is not simply generating good questions, but evolving strategies for generating a limited set of answers.

Put another way, the fundamental issue is whether or not research methodology will permit what Platt (1968) has termed strong inferences as opposed to weak generalizations. Strong inferences are, of course, preferred but are similarly more difficult to ferret out. They demand careful control of variables which sometimes means a movement towards "laboratory" as opposed to "real world" conditions. Achieving strong inferences is also facilitated by the presence of a guiding theory. A theory aids in the generation of testable hypotheses,

expedites methodological decisions, and also serves as a bench mark for interpreting the data gathered. A theory enables experimental results to be interpretted as "a case in point" as opposed to an isolated phenomenon with many alternative explanations. Without a theoretical perspective isolating a set of significant variables for study becomes difficult.

As an example consider the following question which is typical of those motivating existing CBI research: Can a computer help students learn concepts in biology? Without theoretical guidance or a concern for the level at which findings might be generalized a conceptually simple experiment may emerge from this question. A biological concept is selected and taught _via_ a computer to an appropriate population after which some achievement measure is employed to compare these subjects to others taught the same concept _via_ alternative media. The best a researcher can do using this methodology is to report results and speculate broadly as to what may have caused them. At worst, a misguided or over-enthusiastic researcher will on occasion use the resulting data to make general statements concerning the usefulness of computers to teach biological concepts.

Raw empiricism is the dominant characteristic of this type of study and many of the benefits of experimental research are lost or risk being perverted. Very little is contributed to an overall understanding of the computer in instruction or for that matter its utility in teaching biological concepts beyond the specific conditions of the experiment. Methodology in this case

has been conceived as only a logical extension of the question without considering the realm of possible answers. Current conceptualizations of CBI research methodology may suffer from this fundamental weakness.

Specific Conceptual and Methodological Recommendations

Even a casual review of CBI research indicates a tendency to duplicate the methodologies of other media research with little reason to believe that results will be any more enlightening. One way to address this concern is to re-examine the conceptual and methodological foundations of research involving instructional media. To be valuable, however, this exercise must result in specific recommendations which can guide the researcher. Below is an attempt to move in this direction. Recommendations have been grouped into three broad categories: moving towards theory building, expanding research methodologies, and setting priorities for applied research.

Moving Towards Theory Building

Lachenmeyer (1970) has argued that the predominant view of experimentation in the social sciences has been inefficient in that it does not facilitate the formulation of general theories. The typical research study in psychology and education investigates isolated hypotheses which are generated primarily from a review of previous research as opposed to observable phenomena. Presumably, the cumulative effect of many experiments will be the development of a general theory which consolidates findings into a unified whole. This has rarely, if

ever, occurred, however, in educational research.

Most successful theory building, on the other hand, occurs when general principles are inducted from directly observable, naturally occurring phenomena. The initial goal of the researcher is to develop adequate measurement instruments and methodologies for studying a readily observable phenomenon. Later, after fact finding pilot studies, a theoretical statement may emerge to explain facts related to the phenomena studied. At this point, the theoretical statement can be used deductively to generate hypotheses for experimental verification.

The need for developing a theoretical orientation to media research has been articulated by a number of writers. Salomon (1979) and Salomon and Clark (1977), for example, have attributed the lack of consistent findings in media research to the absence of a theoretical orientation. They feel that most of the existing research is a result, in their words, of investigations with media to determine instructional effectiveness. Instead, they propose that a theoretical oreintation leads to research on media to determine psychological effects. This puts the investigation of instructional media like the computer within the realm of psychological and educational theory instead of existing in a theoretical vacuum. Similarly, Clark and Bovy (1983) have cautioned against the confounding of technology and instructional method in formulating and conducting research involving instructional media. Ellis (1976) presaged these positions when he argued that understanding the use of computers

in education really begins with an understanding of education.

A move towards a theory building orientation in CBI research would have significant impact on research methodologies. More studies would be conceived, carried out, and interpretted as pilot or exploratory studies. The importance of studies which focus on sharpening measurement instruments and developing workable methodologies would be recognized. In addition, the likelihood that findings would be over-generalized would be reduced. In short, even the most applied research would be judged in terms of its contribution to a broader understanding of the computer's role as a medium of instruction.

At the same time focusing on theory building would provide a rationale for basic research in CBI. Basic research, for example, is possible when the computer is integrated into a more general theory of instructional media. Theoretical positions like those developed by Salomon (1979) and Olson (1976) could be used to guide the conceptualization of basic research hypotheses and the development of suitable metnodologies. By carrying out basic research founded on accepted theoretical positions researchers would be forced to confront and tease out the significant attributes of the computer as a medium of instruction. We would see fewer studies which make recommendations as to whether the computer is a viable medium for instruction and perhaps more that would give us insight into when, where, and with whom the computer might best be suited for particular categories of instructional content.

Expanding Research Methodologies

Building theory implies a search for those variables which may account for or predict the occurrence of a range of phenomena. When dealing with human behavior and learning, the researcher is assured that the number of variables and their interactions will be enormously complex. While a theory will reduce the number of variables to consider relevant for study, considerable complexity remains. When investigating instructional uses of the computer, identifying relevant variables becomes even more difficult. Computer technology makes the options for delivering instruction so open ended that even the set of possible variables may not be intuitively obvious (Reinking, 1984).

What does this imply specifically for research involving computers in instruction? In general this means expanding methodology to recognize a wider range of variables and to permit those which are significant to surface. Methodologies which recognize and pursue only technological differences may be too simplistic. Few useful inferences can be made about the computer's relationship to instruction when so many potentially significant variables are ignored.

A desire to contend with more variables may dictate the need for more complex methodologies in experimental research. A wider range of statistical techniques may be necessary; multivariate and regression analyses may need to supplement univariate ANOVAs. Even simple designs and straightforward statistical analyses, however, can be made more powerful by

including multiple dependent measures and attempting to replicate results. The latter option will, of course, require the cooperation of journal editors. The experimental bias of educational and psychologic.l research may also need to be tempered in order to encourage non-experimental methods employing correlational analyses or even case studies. Caution may also be necessary in foreclosing areas of inquiry on the basis of accepting a single null hypothesis.

Examples of how creative research methodologies could proceed from theoretical underpinnings and a concern for relevant variables can be found in Salomon and Clark's (1977) examination of research methodologies for media research. They have offered several viable research designs and statistical techniques which would be directly applicable to CBI research.

More productive methodologies may also be a result of collaborative research which brings together colleagues of varying expertise. The interacting variables which operate simultaneously when using the computer in instruction can rarely be seen clearly by one individual. Ideally expertise would be sought out to insure knowledge of media, the instructional content and its pedagogy, and cognitive psychology. Even these areas do not exhaust all of the sources of significant variation (eg. social and environmental factors).

Setting Priorities for Applied Research

A perhaps healthy tension has always existed between basic and applied research. Under ideal circumstances these research emphases complement each other so that both theory and practice

are mutually enriched. Under less than ideal circumstances the distinction between the two is unclear and research proceeds haphazardly with little clear direction. One of the theses of this paper is that the latter condition is more characteristic of media research in general and CBI research in particular.

A common misconception, however, is that basic research is uniformly more essential to the theory building process. Lachenmeyer (1970) has cited several examples from the history of science which suggests that the opposite is more likely the case. Theory building is at first more often a result of observing events in the real world which is the domain of the applied researcher. The applied researcher, however, must recognize the unique contribution applied research can make to theory building and conceptualize methodologies accordingly.

This means more than suggesting theoretical explanations for findings; it also means seeking out real instructional problems that may contribute to a broader theoretical understanding of CBI. Wilkinson (1984) has suggested priorities for selecting research topics to explore computer applications in the teaching of a content area. First, the computer should be used to manipulate content in a fashion which is not readily duplicated by other instructional media. Secondly, the use of the computer should be guided by accepted pedagogical principles for teaching the content selected. Finally, a high priority should be given to research which addresses areas of instruction which have proven to be problematic.

Researchers who subscribe to these priorities will increase

the likelihood that their research will be more relevant to the practitioner as well as contributing to the theory building process.

Conclusion

In summary, current research methodologies may be inadequate to significantly enhance our understanding of CBI. Inconsistent findings in media research, including CBI, raise this possibility. Considering fundamental issues in educational research suggests a broader range of research methodologies may be appropriate. The goal of CBI research should probably be identifying significant variables in an effort to build theoretical perspectives. Finally, the topics of applied research may need to be evaluated closely to insure their usefulness for both practice and theory development.

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