MACHINE AND LEARNER INTERACTION IN PROGRAMMED AND COMPUTER-ASSISTED INSTRUCTION[1]

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Until recently, most research reported in connection with Computer-Assisted Instruction (CAI) and its predecessor, Programmed Instruction (PI), has been focused upon (1) the relative effectiveness of programs utilizing various learning principles and modes of presentation and feedback, and (2) the comparison of the effectiveness of such instruction with other means of presentation of instructional materials. By and large, programs have been treated as though they provide learning situations that are inherently independent of the individual characteristics of the learner involved and the interpersonal conditions under which the instruction occurs. Much of the research conducted in this vein has been highly productive in improving program development and even in providing an empirical assessment of certain theoretical principles of learning. Nevertheless, a pressing need has developed for more research attention to the interaction between the conditions of instruction and the nature of the learner, an area which has been largely neglected. Although the total research rogram in PI and CAI at The University of Texas is much broader in scope, this paper is concerned only with research dealing with this interaction. It is that portion of the program to which my associates and I have devoted most of our efforts.

The aspect of the interaction that has received most attention from our group and among researchers in general is the relationship between the intellectual ability of the learner and achievement when exposed to a program of instruction. There are a number of reasons for preoccupation with this question. High on the list would be Skinner's theoretical, or, as some would insist, atheoretical, contention that intellectual ability would have no effect on achievement in PI provided the programming conforms to the Skinnerian principles of responding without error, immediate reinforcement, and proceeding at the learner's own rate of speed. Another incentive for investigating this problem is its obvious practical implication: will PI or CAI enable us to reach the slow learner where other instructional methodology has failed? Perhaps equally important in

incentive value is the researcher's intolerance of ambiguity and his desire to have things neat and clean. Intellectual ability, though far from ideal as a theoretical construct, elicits more compatible operational definitions from diverse researchers than any other personality variable, at least as long as one restricts himself to so-called convergent thinking and steers clear of such constructs as divergent thinking or creativity. Possibly this latter consideration also accounts for the fact that findings concerning intellectual ability and achievement do not present quite as wild a state of confusion as those having to do with the relationship between achievement and other personality variables. Nevertheless, confusion still exists, and efforts to resolve it continue.

Gonnella (1963) utilizing Evans, Glaser, and Homme's (1960) Skinnerian-type *Symbolic Logic* program, found that intellectual variables (University of Texas Verbal, Numerical and Total Aptitude Scores) provided highly reliable predictions of achievement regardless of whether criterion measures consisted of immediate or delayed true-false, completion, or problem-solving tests. Again, the greater the intellectual ability of the S, the greater his achievement as a result of programmed instruction.

Conoley (1966) demonstrated that high and low IQ junior high school students were no closer together on achievement criterion performance after being subjected to Skinner's short physics program so widely publicized in *Science* (1958) than similar groups who received the frames at random or for whom reinforcement was delayed until the end of the entire program. Indeed, regardless of the method of presentation, those subjects with higher IQ's as measured by the California Test of Mental Maturity (CTMM) revealed significantly greater achievement than their less talented counterparts.

One University of Texas Laboratory Study was recently completed in which Austin, Texas elementary school children were taught multiplication by CAI using IBM 1050 typewriter terminals. Correlation of intelligence as measured by the CTMM and achievement on the criterion tests exceed the .05 level of significance.

Sutter (1967), another University of Texas Laboratory researcher, employed a mathematical heuristic problem-solving program based on an approach developed by Polya (1957), and failed to find a significant relationship between SAT scores and CAI achievement. Gerry (1967) employed a verbal concept-learning and a quantitative problem-solving program and obtained similar results. The latter also investigated the so-called creative or divergent thinking aspects of intelligence, measured by Guilford's (1959) *Plot Titles Test* and by S's self evaluation of creativity, as related

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to CAI performance and failed to find a significant relationship. Both investigators used college students as S's, which procedure restricted the range of intellectual ability. The range of ability of Sutter's S's was even further restricted, because selection criteria included a quantitative performance score of 570 or above on the College Entrance Examination Board's Scholastic Achievement Test, since the task demanded a high degree of mathematical ability. In Gerry's case, the same tasks were taught by non-CAI methods, and intellectual ability, convergent or divergent, played no greater role in predicting achievement than when CAI was used.

In general, it may be said that our results parallel those of most other investigations. Neither PI nor CAI nor any particular method of programming *per se* can eliminate the effects of intellectual ability upon achievement, although CAI does offer some promise of minimizing these effects. Many other variables are of transcending import in the intelligence-achievement interaction. I would venture to hypothesize on the basis of findings to date that such variables include nature of the material to be learned, compatibility of material with the ability range of the subject population, degree of stress involved in a given situation for a given type of S, attitude of the individual subject toward the method of instruction, and many others yet to be identified.

Anxiety is a second personality construct that has been rather widely postulated to be differentially related in some way to achievement under PI and CAI methodology as opposed to that under other instructional methodologies. The anxiety construct is more nebulous than intellectual ability, and, for that very good reason, even fewer researchers have ventured to investigate its possible relationships to instructional mode. One thing contributing to the ambiguity is the theoretical problem as to whether anxiety is to be considered as a relatively stable personality characteristic, a sort of general motivating influence, or as an ephemeral emotional state identified with a particular situation. There is little agreement among equally competent psychologists as to an appropriate operational definition for the construct labeled "anxiety" (Sarbin, 1968).

Gonnella, trying both traditional approaches in 1964, was unable to find any correlation between either Taylor Manifest Anxiety Scale (TMAS) Scores or Mandler-Sarason Test Anxiety Scale (TAS) Scores and achievement on PI in symbolic logic. On the other hand, when the TMAS was supplemented by Eysenck's Neuroticism Scale (in a factor labeled "Neurotic Anxiety"), it did contribute significantly to the prediction of achievement.

Sutter (1967) found a particularly interesting relationship of TAS Scores to CAI performance when she had some S's working

alone at the terminal while others worked in pairs. High-anxious subjects achieved more when working alone, while the low-anxious achieved more when working with a partner. Low-anxious subjects showed more positive attitude changes toward CAI as a result of experience with the medium in both the alone and paired conditions.

Gerry (1967), in offering 110 S's unfamiliar with computers a choice of instruction by CAI or by a human tutor, found that only 28 chose the human tutor. These 28 scored significantly higher on Test Anxiety than those who chose CAI. However, the correlation between high anxiety and expressed preference for non-CAI diminished after experience with the computer. Males revealed more positive changes in this direction than females. In spite of these differences in preferences, high- and low-anxious S's achieved equally well whether the mode of instruction was by computer or by human tutor.

In general, with respect to anxiety, we have failed to find the marked relationships to PI or CAI performance that some have predicted. Instructional mode *per se* is apparently not as important as the social conditions under which it is administered.

Other personality constructs under investigation as to possible relationships to CAI achievement include autonomy vs. need for affiliation, dominance vs. submissiveness, scholastic motivation, and attitude toward mechanized instruction. Some of the results obtained thus far were reported earlier during this Southwestern Psychological Association convention, and it would be redundant to belabor all of them here. Suffice it to say that one particularly promising area for further investigation, based on preliminary findings, has to do with the dominant-submissive variable as measured by the California Psychological Inventory. Submissive individuals reveal a significant increase in positive attitude toward CAI when working at a terminal cooperatively with a dominant partner as opposed to working alone or when paired with a partner who is also submissive. There is some evidence, although as yet inconclusive, that the achievement of submissive individuals on CAI can be enhanced by pairing them with dominant partners.

In the past decade, the technological capabilities of auto-instructional devices have progressed dramatically. Paper-and-pencil programmed texts and simple turn-the-crank-and-see-the-next-frame teaching machines gave way to *Autotutors* capable of presenting visual materials in motion and responding appropriately to buttons pressed by the student. The latter were soon replaced by computers capable of presenting written stimulus materials and responding via typewriter to typewritten inquiries from students. Computers now operational not only send and receive typewritten messages but pre-

sent simultaneous aural and visual stimuli, the latter on TV-like screens. They also respond differentially to light pens directed toward various portions of the screen by the learner. Prototype devices capable of far more sophisticated computer-learner interaction are already in existence or on the drawing boards and are sure to become operational and widely available in the foreseeable future.

In contrast with these rapid technological advances in research apparatus, progress in attaining an understanding of human behavior in interacting with these machines has been painfully slow. However, more and more psychologists are being attracted to this type of research as the potential contribution to education becomes apparent to all. With better research tools available than ever before, progress is sure to accelerate rapidly, and important breakthrough are likely to occur in the very near future.

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ABSTRACT

One recent focus of attention of educational psychology researchers in PI and CAI at The University of Texas at Austin has been upon the area of interaction between the nature and conditions of instruction and the personality characteristics of the learner. Intellectual ability is revealed as one of the most important determinants of success regardless of the instructional medium employed, although there is some indication that the overriding influence of intelligence on learning can be minimized by CAI under certain optimal conditions. The influences of such personality constructs as "anxiety," "neuroticism," "dominance," "submissiveness," "attitude toward mechanized instruction," etc. on success in learning are also reviewed. One particularly significant finding concerns the fact that some Ss

perform better alone at a CAI terminal, while those with different personality characteristics do better if working in cooperation with a partner.

The spectacular development that has occurred in instructional technology is briefly outlined and contrasted with the paucity of experimentation that has been accomplished in an effort to comprehend the interaction between the nature of the learner and the conditions of the instructional situation. A pressing need for further investigation of this important interaction is deemed essential.

RESUMEN

Algunos investigadores en Psicología Educacional que trabajan en Instrucción Programada (PI) e Instrucción Asistida por Computadora (CAI) en la Universidad de Texas, han dirigido recientemente su atencón a las áreas de interación entre la naturaleza y las condiciones de instruccón y las características de la personalidad del estudiante. La habilidad intelectual se revela como uno de los factores más importantes rseponsables del éxito, independiente del método de instrucción usado; aunque existen indicaciones de que la fuerte influencia de la inteligencia en el aprendizaje puede ser disminuida a través del uso de CAI bajo ciertas condiciones especiales. La influencia de conceptos personalidad tales como "ansiedad," "actitud neurótica," "actitud submisiva," "actitud hacia la instrucción mecanizada," etc. en el éxito del aprendizaje son también revisadas. Un resultado de particular importancia se relaciona al hecho de que algunos sujetos se desempeñan mejor solos en el terminal CAI, mientras que otros, con diferentes caracterísicas de personalidad, se desempeñan mejor cuando trabajan en cooperación con algún compañero.

En un esfuerzo de comprender la interacción entre la naturaleza del estudiante y las condiciones de la situación de instrucción se ha señalado brevemente el fantástico desarrollo que ha ocurrido en la tecnología de instrucción y se ha comparado con la escasez de experimentación que se ha llevado a cabo. Se considera esencial urgentes investigaciones adicionales respecto a esta interacción.

RESUMO

Alguns pesquisadores em Psicologia Educacional que trabalham em Instrucão Programada (PI) e Instrucão Assistida por Computador (CAI) na Universidade de Texas, tem dirigido recentemente sua atencão às áreas de interacão entre a natureza e as condicões de intrucão e as caraterísticas da personalidade do estudante. A habilidade intelectual se revela como um dos fatôres mais importantes responsáveis pelo éxito, independente do método de instrucão usado; ainda que existam indicações de que a potente influência da inteli-

gência na aprendizagem possa ser diminuida através do uso de CAI baixo certas condições especiais. A influência de conceitos de personalidade tais como "ansiedade", "atitude neurótica", "atitude submissiva", "atitude para com a instrução mecanizada", etc. no éxito quanto a aprendizagem é também revisada. Um resultado de particular importância se relaciona ao fato de que alguns sujeitos mostram um desempenho melhor quando trabalhando a sós na terminal de CAI, enquanto outros, com características de personalidade diferentes, mostram um melhor desempenho quando trabalham em colaboração com algum colega.

Numa tentativa de compreender a interação entre as caraterísticas do estudante e as condições da situação de instrução, se assinala brevemente o fantástico desenvolvimento que se observa na tecnologia de instrução, mostrando-se, em comparação, a escassez de pesquisas neste campo. Se considera essencial que novas pesquisas visando o estudo desta interação sejam realizadas em futuro próximo.