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AUTHOR Higgins, Norman C.
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ABSTRACT

The Aircraft Instrument Comprehension (AIC) Program is a self-instructional program designed to teach undergraduate student pilots to read instruments that indicate the position of the aircraft in flight, based on sequential instructional stages of information, prompted practice, and unprompted practice. The program includes a 36-item multiple choice test designed to assess the students' ability to read a compass and an artificial horizon. Three developmental tryouts among Air Force Reserve Officer Training Corps students refined the test and the program. The first was conducted with three students who worked with the materials individually in a small observation room, and on the basis of this tryout revisions were made to control the amount of exposure to the task prior to instruction. The second tryout of the program was conducted with 25 students who worked through the materials in a large classroom; on the basis of this tryout the program was revised to include additional practice items, and a pretest was developed to assess student improvement as a result of instruction. The final tryout was conducted among 32 students working in a large classroom, and both the pretest and the AIC test were found to be acceptable. (JR)

DESIGN AND DEVELOPMENT OF THE AIRCRAFT INSTRUMENT COMPREHENSION PROGRAM

Norman C. Higgins

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Department of Educational Technology
Arizona State University
Tempe, Arizona

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Norman C. Higgins

Educational research frequently fails to answer applied questions related to the design of effective instructional programs. Apparently contradictory results obtained from different studies of a particular instructional variable can often be attributed to the instructional inadequacies of the materials and procedures used. The research literature on feedback, for example, is replete with studies in which the materials and procedures used contained such instructional inadequacies as insufficient instruction, insufficient or inappropriate practice, and lack of an incentive for improved student performance. Research findings that result from the use of ineffective instructional materials are of little value as the basis for the systematic design of instruction.

The research and development activities that will be described in this symposium were undertaken to determine the effects of four potentially powerful instructional variables on undergraduate student pilot performance in ground training systems. The Aircraft Instrument Comprehension Program (Higgins, 1973) was systematically designed to facilitate the study of instructional cues, practice, feedback, and incentives. The program was tried out and revised and its effectiveness was verified under classroom instructional conditions. The design and development of the program are described in this paper. The studies that were conducted to determine how selected variables contributed to the effectiveness of the program are described in two papers that follow.

The implications of this research and development activity for future research on instructional variables are described in the fourth and final paper of the symposium.

Design of the AIC Program and Performance Measures

The Aircraft Instrument Comprehension (AIC) Program is a self-instructional program designed to teach undergraduate student pilots to read instruments that indicate the position of an aircraft in flight. The content of the program was selected by training researchers in the Human Resources Laboratory, Williams AFB, Arizona, because it represents a multi-dimensional concept similar in complexity to other content taught in USAF ground training programs.

The AIC task requires a student to identify which one of four illustrations of an aircraft in flight is most nearly in the position indicated by a compass and an artificial horizon. There are three dimensions to the position of an aircraft in flight: its heading, its pitch, and its bank. A compass is used to determine the heading of an aircraft. There are eight headings used in the AIC materials: four primary points (N, E, S, W) and four secondary points (NE, NW, SE, SW). An artificial horizon is used to determine the pitch and the bank of an aircraft. There are three levels of pitch (30° pitch-up, 0° pitch, 30° pitch-down) and three levels of bank (30° bank-left, 0° bank, 30° bank-right) used in the materials. Figure 1 illustrates the aircraft instruments and four illustrations of aircraft in flight. The aircraft labeled D is most nearly in the position indicated on the compass and artificial horizon in this item.

The program is designed to successively approximate conditions under which the student is expected to identify an aircraft in any one of the 72 positions that can be derived from the dimensions taught. The program is divided into four instructional phases that systematically increase in their complexity. In the first instructional phase, the compass is presented alone and the student is taught to identify the heading of aircraft flying with 0° pitch and 0° bank. In the second phase, the artificial horizon is combined with the compass and the student is taught to identify the heading and the pitch of an aircraft flying with 0° bank. In the third phase, the student is taught to identify the heading and the bank of aircraft flying with 0° pitch. In the fourth and final phase of the program, the student practices identifying aircraft that vary on all three positional dimensions.

Instruction within each of the first three phases of the program consists of (1) providing the information needed to read an instrument and providing examples of aircraft in positions indicated by the instrument; (2) providing prompted practice in reading the instruments; and (3) providing unprompted practice in reading the instruments. Each of the three instructional components (information, prompted practice, and unprompted practice) is presented on a separate page in the program.

The program is bound into a loose-leaf binder to facilitate revision and experimental manipulation of each of the instructional components. Student responses to the program practice items are recorded on a separate response form. Confirmation of the accuracy of each response is provided by chemical-based feedback built into the response form.

The Aircraft Instrument Comprehension Test is a 36 item multiple choice test designed to assess the students' ability to read a compass and an artificial horizon. The 36 items are designed to be representative of the 72 possible aircraft positions defined in the content description (8 levels of heading x 3 levels of pitch x 3 levels of bank). Sample test items are included in Figures 1 and 2.

The instrument settings used in the item stems were systematically selected to insure that all possible combination of primary and secondary heading, pitch, and bank are represented. The alternative response choices were systematically selected to either minimize or maximize the differences between the alternatives. The items designed to minimize the differences between the alternatives have illustrations that vary on only one of the positional dimensions and are minimally different on that one dimension (see Figure 1). The items designed to maximize the differences between the alternatives have illustrations that vary on two of the positional dimensions and are maximally different on those two dimensions (see Figure 2).

The test includes directions for recording responses, a sample item, and the 36 test items bound into a loose-leaf booklet. Student responses are recorded on mark sense response sheets that are separate from the test booklets.

Developmental Testing

The AIC Test and the AIC Program materials were reviewed for content accuracy and clarity of presentation by USAF training personnel. The program was revised on the basis of their commentary prior to developmental testing. The initial developmental tryout was conducted

with a small number of students working under laboratory conditions. Subsequent tryouts were conducted with larger numbers of students working in a group situation that more nearly approximates classroom instructional conditions. All tryouts were conducted with undergraduate students enrolled in Air Force Reserve Officer Training Corps programs. A pretest-instruction-posttest design was used in each of the tryouts.

Developmental Tryout 1. The initial tryout of the program was conducted with three students who worked with the materials individually in a small observation room. The developers observed how the students worked with the materials and recorded the time required to complete the test and the instructional program. Student responses to the test items and the program practice items were recorded on mark sense response sheets.

The mean time required to complete the test prior to instruction was 15.9 minutes, the mean number of correct responses was 31.0 of a possible 36 responses (86% correct). The students worked straight through the program without making any errors on the program practice items. All three students required less time to complete the test after instruction and improved their performance scores. The mean number of correct responses was 34.3 of a possible 36 responses (94% correct) on the test after instruction.

On the basis of this tryout, the directions in the AIC test were revised to exclude instruction related to the sample item and the time spent on the test prior to instruction was limited to 3 minutes. These revisions were made to control the amount of exposure to the task prior to instruction and to discourage students from trying to "discover" the

relationship between the instruments and the illustrations. No revisions were made in the program or in the procedures for administering the test after instruction.

Developmental Tryout 2. The second tryout of the program was conducted with a group of 25 students who worked through the materials in a large classroom. The students were directed to complete as many of the AIC Test items as possible in 3 minutes prior to being instructed on the task. Students worked at their own pace through the AIC Program. After instruction the students completed the AIC Test at their own pace.

The mean number of items completed on the test prior to instruction was 8.8 items, the mean percentage of correct responses was 72%. Twelve of the twenty-five students scored 80% or higher on the test prior to instruction. The students worked straight through the program making very few errors. The mean number of correct responses on the program practice items was 13.1 of a possible 14 responses (94% correct). The mean number of correct responses on the test after instruction was 31.7 of a possible 36 responses (88% correct). Twenty of the twenty-five students scored 80% or higher on the test after instruction. An analysis of the most frequently missed items on the test administered after instruction indicated the characteristics of the difficult items. The difficult items were of the type designed to minimize the difference between response choices and involved aircraft positions with secondary compass headings combined with pitched and/or banked attitudes.

Based upon the results of this tryout, revisions were made in both the program and the test. The program was revised to include five

additional practice items in the fourth phase of the program. The additional items had the characteristics of difficult items described above. A separate nine-item test was constucted for use prior to instruction to identify those students who could demonstrate the greatest improvement in performance after instruction. The nine items were selected to represent the range of positions tested on the long 36 item test. The sequence of items on the longer version of the test was determined by random assignment; therefore, the first nine items were not representative of the possible positions. The procedures for administering the program and test materials were revised to include an incentive for correct responding on the test after instruction.

Developmental Tryout 3. The third and final tryout of the program was conducted with 32 students working in a large classroom. The students worked through the short, nine-item form of the test prior to instruction. Eleven of the thirty-two students scored 7 or higher on the test and were excused from further participation in the tryout. The 21 students who scored 6 or less on the test worked through the instructional program and the long form of the test at their own pace.

The mean number of correct responses for the 21 students selected to participate in the tryout was 4.8 of a possible 9 responses (53% correct) on the test given prior to instruction. The mean number of correct responses on the program practice items was 16.6 of a possible 19 responses (87% correct). The mean number of correct responses on the test given after instruction was 32.0 of a possible 36 responses (87% correct). Eighteen of the twenty-one students scored 80% or higher on the test after instruction.

No revisions were made in the program or test materials following the third tryout. The materials were considered effective enough to begin studies that would identify the contributions that each instructional component made to student performance on the aircraft instrument comprehension task. These studies and their implications for future research will be described in the papers that follow.

References

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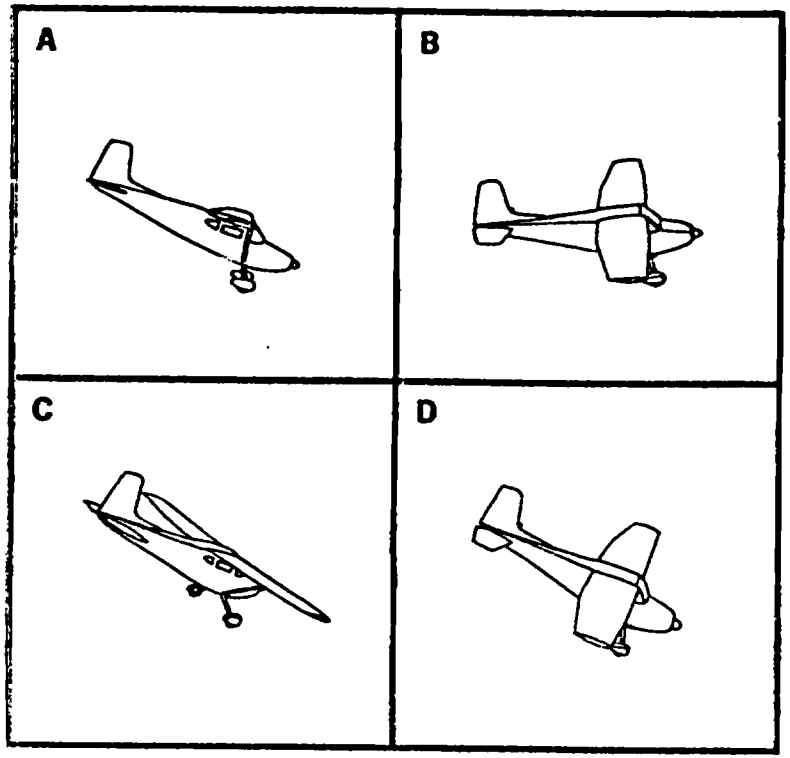
FIGURE 1

Test Item: Minimally Different Alternatives



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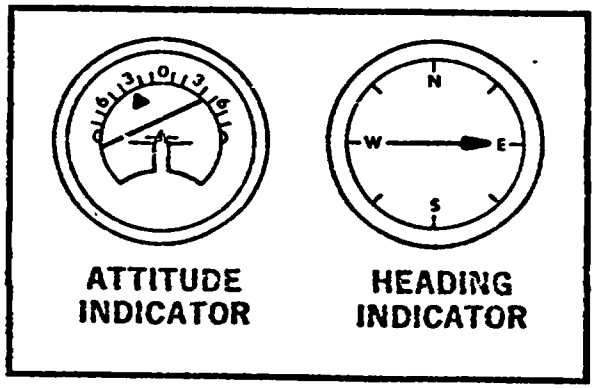
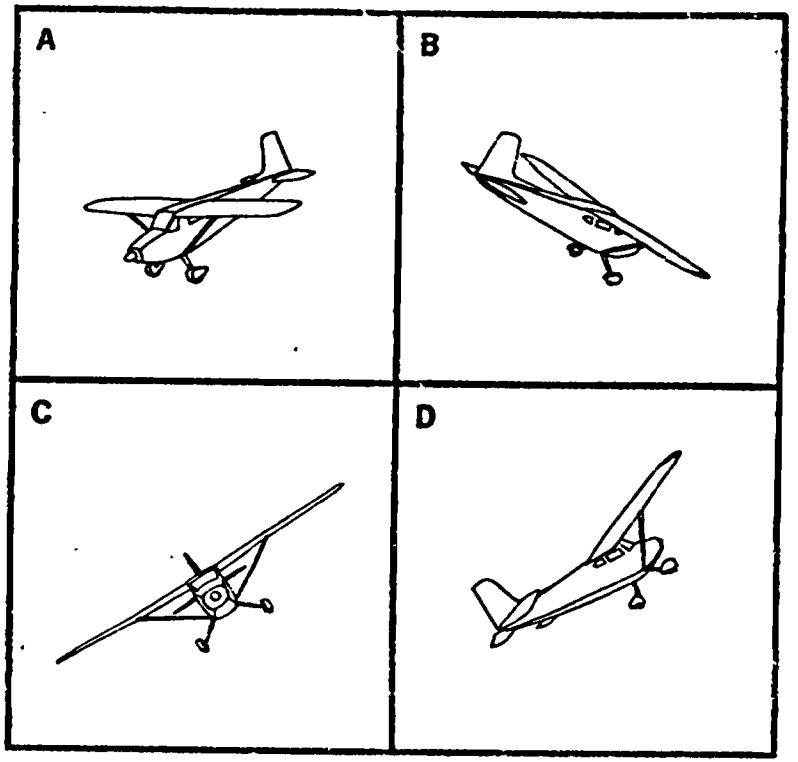


FIGURE 2

Test Item: Maximally Different Alternatives



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