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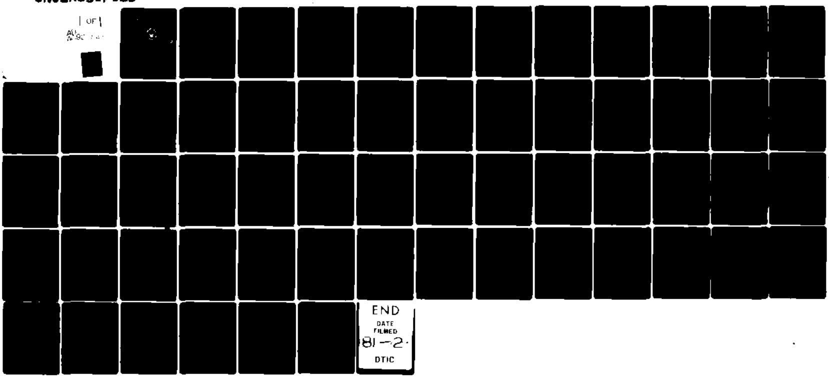

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THESIS

AN EVALUATION OF THE APPLICATION OF ISD
TO P-3 PILOT TRAINING

by

William Allen Snider

June 1980

Thesis Advisor: J. K. Arima

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To evaluate the Navy's training under instructional systems development (ISD) procedures the annual, force-level, NATOPS examination scores of pilots in operational squadrons who had been trained under the recently installed ISD program at VP-31 were compared with those who had not been trained under ISD. Scores from only the open- and closed-book written examinations, which pertain to normal and emergency procedures and aircraft systems knowledge, were used since their content reflected most closely

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the course objectives of the nontactical pilot training provided by VP-31. Pilot rank, designation, time-in-squadron, and squadron location were used as controls. The type of training made no difference in open-book scores. For closed-book scores, ISD training resulted in a marginal but consistently negative difference when interactive with squadron location. At one location ISD-trained pilots scored significantly lower while there was no difference among pilots at another location. The findings are discussed within the context of the study and with respect to training and ISD in general.

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AN EVALUATION OF THE APPLICATION OF INSTRUCTIONAL SYSTEMS DEVELOPMENT TO P-3 PILOT TRAINING

by

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Commander, United States Navy
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Submitted in partial fulfillment of the
requirements for the degree of

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from the

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ABSTRACT

To evaluate the Navy's training under instructional systems development (ISD) procedures the annual, force-level, NATOPS examination scores of pilots in operational squadrons who had been trained under the recently installed ISD program at VP-31 were compared with those who had not been trained under ISD. Scores from only the open- and closed-book written examinations, which pertain to normal and emergency procedures and aircraft systems knowledge, were used since their content reflected most closely the course objectives of the nontactical pilot training provided by VP-31. Pilot rank, designation, time-in-squadron, and squadron location were used as controls. The type of training made no difference in open-book scores. For closed-book scores, ISD training resulted in a marginal but consistently negative difference as a main effect and in a significant negative difference when interactive with squadron location. At one location ISD-trained pilots scored significantly lower while there was no difference among pilots at another location. The findings are discussed within the context of the study and with respect to training and ISD in general.

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I. INTRODUCTION

A. BACKGROUND

In support of its aviation mission, the U.S. Navy operates training facilities located throughout the country to prepare both officers and enlisted personnel for jobs within the aviation community. One such facility is Patrol Squadron Thirty One (VP-31), which is the Navy's west coast P-3 Orion Replacement Air Group (RAG). VP-31 is responsible for, inter alia, the training of maintenance and flight crew personnel destined for operational P-3 squadrons located in California and Hawaii.

Prior to the introduction of modern instructional systems design (ISD) methods, VP-31 conducted pilot training utilizing traditional methods and media consisting primarily of classroom lectures, examinations of comprehension, etc. Course objectives tended to be more content oriented --"familiarize the student with performance charts contained in chapters 11 and 12"-- rather than behaviorally oriented. Inherent in these traditional methods was the problem of measuring the effectiveness of training.

B. INSTRUCTIONAL SYSTEMS DEVELOPMENT (ISD)

Following World War II and the establishment of systems analysis as a scientific discipline, psychologists and educators recognized the possible benefits of applying systems technology to the field of instruction. These pioneers of modern instructional technology, who came not only from academia but also from quasi-governmental agencies such as RAND and HUMRRO, saw great potential in the use of techniques such as modelling to increase the precision, objectivity, and creativity of the judgment they exercised in solving the problems of course design [Montemerlo, 1979]. Perhaps the most significant contribution to the field of instruction by training technologists has been a demanding emphasis upon the precise definition of learning objectives and goal-oriented performance evaluation. Enabling objectives, final objectives, and course objectives form a hierarchy which serves to, among other things, provide a clear pathway for both students and instructors, and to answer the question--"precisely what will a student be able to do after successfully completing a course of instruction?" Goal-oriented performance evaluation provides a method to measure accurately the effectiveness of training programs that are oriented toward producing graduates capable of actually doing the job.

Instruction can be divided into five categories representing learned capabilities, i.e., verbal information, cognitive strategies, intellectual skills, motor skills, and attitudes [Gagne & Briggs, 1979]. Associated with each variety of learned capability are conditions for learning.

Traditional instructional methods have always emphasized external conditions for learning such as repetition and stimulous-response reinforcement. Modern theories of learning focus also upon the internal conditions for learning such as prior learning, recall, and various levels of memory [Gagne & Briggs, 1979].

Taxonomies such as the five types of learning described by Gagne serve to group similar objectives in a course design and provide for mutually applicable learning conditions. Additionally, grouping facilitates the employment of like methods of evaluation. Performance measures of a motor skill such as the manipulation of aircraft controls requires a student to perform bodily movements involving muscular activity. The performance measure appropriate to the learning of verbal information requires a student to state the relationship between two or more named objects or events either orally or in writing.

Attitudes are complex states of human beings relating to things, people, or events which can be described in terms of either their cognitive or affective aspects. Measurement of attitudes is most logically suited to the affective aspect and therefore centers upon observing a person's chosen alternative course of action from a selection of options.

Intellectual skills form a hierarchy which starts with simple discriminations and concrete concepts. Simple rules, which include defined concepts, follow discriminations and lead to problem solving through higher-order rules. Performance measures of intellectual skills range from the basic act of distinguishing objects to the formulation and employment of complex rules in order to achieve solutions to unique problems which are new to the student.

Cognitive strategies are special forms of intellectual skills. These special skills actually represent processes by which learners modify their ways of attending, learning, remembering, and thinking. The salient difference between intellectual skills in general and cognitive strategies is the object of the skill. Cognitive strategies focus upon the learner's own thought process whereas intellectual skills relate to objects and events [Gagne & Briggs, 1979]. The performance measure of a cognitive strategy requires the novel solution to a problem where familiar solutions are not suitable.

Goal-oriented performance objectives are requisite measures of learning success in ISD programs. However, the question of-- "performance quality" must be considered. Objective-referenced examinations employing a criterion-referenced interpretation provide the most acceptable procedure for a variety of reasons. The validity of an objective-referenced test is directly related to its congruence with the course objective. Reliability of such a test is derived from the degree of consistency of repeated examinations. In an objective-referenced test of intellectual skills, motor skills, or verbal information, mastery is a relevant concept and error-free performance can be achieved. However, cognitive strategies and attitudes are not suited to the mastery criterion because of their lack of an absolute measure [Gagne & Briggs, 1979].

Group instruction can be regarded in three separate categories which differ in the amount of precision afforded to the management of instructional events by the instructor. In a two-person tutorial situation, the instructor is provided with the most control over instructional events. A small group is defined as three to eight people and is dependent upon group interaction to provide instructional events such as feedback, recall, etc. [Gagne & Briggs, 1979]. Large groups of more than 15 people are characterized by weak control over instructional events by the instructor. Accordingly, in a large group, learning is highly dependent upon the learner's own strategies of self instruction. To counter the inherent weak control of learning in large groups, the mastery concept for enabling objectives serves to diagnose learning performance early on and facilitate attainment of the course objectives in ISD programs.

Individualized instruction is designed in the same fashion that individual lessons are designed for group instruction. Objective hierarchies, learning events, and conditions for learning all apply to the design of modules suited to individualized instruction. The distinction lies in the delivery system employed for individualized instruction. Modules are normally self-paced and the materials do most of the teaching. More frequent feedback and progress checks are found in programs of individualized instruction. Under an ISD system, students are typically provided a series of modules which each contain:

1. A performance objective
2. A set of materials and learning activities
3. A method of self-evaluation to determine mastery
4. A provision for verification of learning to the instructor [Gagne & Briggs, 1979]

As an organization responsible for a myriad of training programs ranging in subject matter from remedial reading to the conduct of war on a global basis, it was not at all surprising that the U.S. military establishment became interested and involved in the methods of ISD as it gained in credibility. With its basis in scientific methods and logical appeal, ISD became an attractive alternative to traditional training methods which offered the unique advantage of a capability to measure the effectiveness of a training program in terms of job-related performance.

Today, ISD is an integral part of the training conducted by all four services. ISD has been employed by the U.S. military to ensure that:

1. Courses are designed to teach only those tasks which, based upon objective field research and analysis of the tasks needed to be performed, the graduate will use and which can be taught in a formal training course.

2. Tests, the requisite for graduation, are accurate indicators of the ability to perform the required task [Department of Defense, 1980 p. XI-7].

The five phase ISD program, --i.e., analyze, design, develop, implement, and control-- and associated phase steps is presented in Figure 1.

The Navy is committed to the systematic design of its training courses [Chief of Naval Education and Training (CNET), 1975; Scanland, 1974]. The Interservice Procedures for Instructional Systems Development (Chief of Naval Education and Training) have been summarized by the Navy for its own use in a procedures manual entitled Procedures for Instructional Systems Development [CNET, 1978]. AF Pamphlet 50-58 [Department of the Air Force, July 1978] describes the Air Force ISD procedures and AF Manual 50-2 [Department of the Air Force, July 1975] promulgates the following policy regarding the utilization of ISD.

1. Apply ISD to all new instructional systems

2. Selectively apply ISD to existing instructional systems where economically feasible

The extensive use of ISD by the military has prompted periodic review of training programs [Brock, 1977; Logicon Incorporated, 1978] . These studies emphasize the importance of job-related learning objectives as a prerequisite to successful ISD programs. If lists of learning objectives are provided for students, it seems natural, however, that their efforts in learning will be generally limited to those items on the list. Consequently, ISD program designers must leave no stone unturned in an exhaustive search

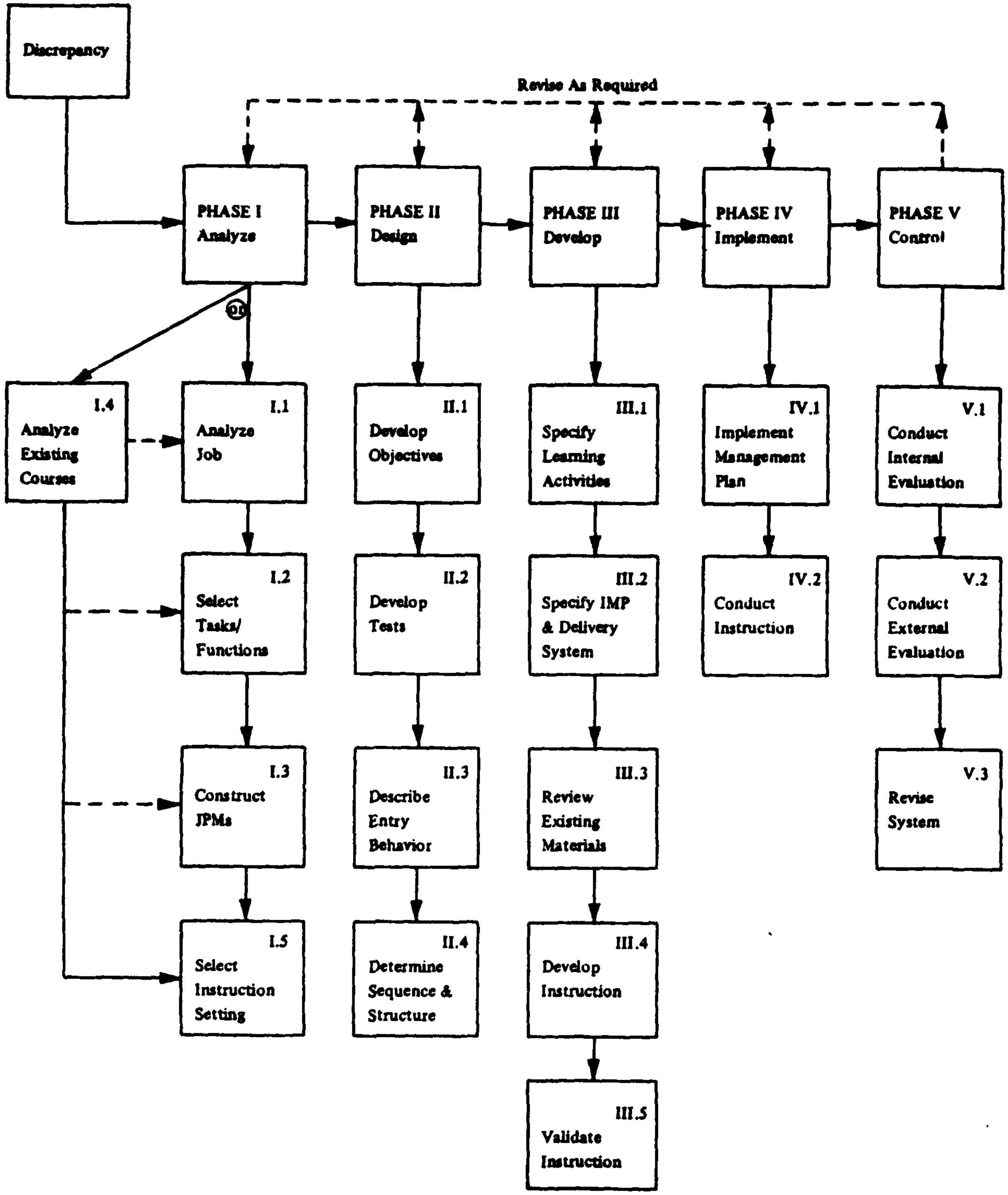

Figure 1. The Instructional Systems Development Process [CNAVEDTRA 110]

to identify all relevant items in a task analysis. Under ISD, it is naive to assume that the learning of important but easily overlooked items, such as a desired attitude or a knowledge of the relationship of components to a total system, will take place in the absence of specifically related learning objectives.

Montemerlo [1979] cautions designers of instructional systems against a potential problem associated with the atomization approach of ISD manuals. He alleges that students inundated with a torrent of modularized learning objectives may miss an overall goal. Atomistic descriptions tend to feed the learner a large number of new terms, definitions, and relationships faster than he can assimilate them [Montemerlo, 1979]. The spiral approach to learning, which is the basis for most apprenticeship programs, focuses upon progressively more complex hands-on practice interspersed with limited book-learning. It is because of channel capacity, which is the amount of information which a person can process before becoming confused, that Montemerlo [1979] asserts spiral learning works better than atomistic descriptions.

Training is an investment in human capital and represents an organizational asset. Associated with a training investment in human capital is an allocation of resources, such as time and money. The ISD method of instruction is extremely costly in terms of time required to develop and implement a program. Lexicon Incorporated, [1978] have tentatively suggested an excess of five years is required, under ideal conditions, for the conversion of typical flying programs. However, ISD programs, with self-instruction, offer the potential of reducing the manhours spent by instructors in teaching. In order to determine accurately the total cost of an ISD application, the extensive costs related to development of the program must not be overlooked as these front-end costs are significant.

The evaluation of a learning program is typically centered upon three questions:

1. To what extent have the stated objectives of instruction been met?

2. In what ways and to what degree is it better than the unit (of instruction) it will supplant?

3. What additional,possibly unanticipated, effects has it had and to what extent are these better or worse than the supplanted unit? [Gagne & Briggs, 1979]

Formative evaluation is normally conducted during the development of a new system and serves to enhance the final product through modification or revision. By formative evaluation, quality in the design of a program can be ensured. Summative evaluation, on the other hand, is performed upon an existing course of instruction and normally serves to compare a new system to an "old one." During a summative evaluation, variables such as student aptitude for learning, the process of instruction, and learning support items must be controlled if a truly meaningful and unbiased evaluation is to result.

The training of Naval Aviators for duty as pilots and copilots in P-3 aircraft involves primarily the learning taxonomies of motor skills,verbal information, and intellectual skills. However, positive attitudes towards things such as safety and furthering aviator skills should also be considered germane to a total training program. There is an emerging acceptance of ISD as a total systems approach rather than a series of steps to be accomplished on some segment or portion of flying training. This acceptance is primarily responsible for the fact that ISD teams are beginning to return to the task analysis in order to strengthen it by means of a systematic, rather than a cursory or short-cut approach [Lexicon Incorporated, 1978, p. 58].

The purpose of this study was to examine the effectiveness of the application of ISD to VP-31 pilot training as measured by scores achieved upon annually administered, force-level, NATOPS examinations. Another study currently underway [Fadness, 1980], has been designed to examine the application of ISD to the training of P-3 acoustic sensor operators at VP-31.

II. METHOD

A. APPROACH

In order to evaluate the effectiveness of pilot training at VP-31 under a new ISD program, a sample of both ISD and non-ISD trained graduates was required. Under ideal circumstances, an experimental group (ISD) and an identical control group (non-ISD) would be trained in parallel under conditions as identical as possible. Following graduation, the training received by both groups would be evaluated using identical, job-related performance measures. Further, retention of training could be measured at a later time.

Under the constraints that this study experienced, the experimental and control groups had to be reconstructed from individuals already in operational squadrons located at two west-coast P-3 bases who had received training under one condition or the other. Since the training received by these individuals had occurred over a considerable period of time, the individuals varied extensively in both pre- and post-training experiences. Accordingly, demographic data were collected to control for these differences statistically. Scores achieved upon annually administered force level standardization examinations were selected as the dependent variable because of the relatively constant examination content over the time period examined.

B. DESCRIPTION OF ANNUALLY ADMINISTERED STANDARDIZATION EXAMINATIONS

Standardization of normal and emergency operating procedures for crewmembers of Naval aircraft is provided by a program known as Naval Air Training and Operating Procedures Standardization (NATOPS). Included within the NATOPS program for P-3 Orion pilots is a squadron-level, initial certification to serve in the capacity of pilot-in-command and subsequent annual recertifications. Each certification process consists of two written examinations (one open book and one closed book) and an inflight check of piloting skills. Each phase of this examination process is designed to evaluate stated skill areas. Open-book examinations contain 24 multiple-choice questions relating primarily to performance charts located within the NATOPS manual. Pilots are required to compute various performance values from charts and select the correct answer to a written question from four choices. Closed-book examinations contain 40 multiple choice questions relating to normal and emergency procedures and aircraft systems. Pilots are required to respond to a written question by selecting one of four possible answers. Flight checks, which last approximately three hours, are designed to evaluate both knowledge of procedures and systems (verbal answers to verbal questions), and piloting skills. The content of written examinations must follow a distribution of subject matter --number of questions per subject-- specified by the force-level evaluation team. To assist in examination construction, the force-level NATOPS evaluation team maintains a sizeable bank of sample questions for each subject area. Objective performance criteria for flight checks is provided within the NATOPS program to aid in standardization.

In addition to squadron level NATOPS examinations, force level NATOPS examinations are administered to each operational squadron on an annual basis. Force-level examinations consist of two written examinations (one open book and one closed book) for all crewmembers and flight checks for only three selected personnel per crew position. Force-level evaluations are intended to be similar in content to squadron-level evaluations. Crewmembers certified by the NATOPS force-level evaluator are awarded squadron NATOPS instructor status and are authorized to conduct squadron-level NATOPS check flights for their crew position. The results of force-level NATOPS unit evaluations for west-coast (California and Hawaii) P-3 squadrons are maintained by the COMNAVAIRPAC P-3 NATOPS evaluation team. Force level NATOPS written examination scores achieved by P-3 pilots between 1978 and 1980 were made available for this study by the Commanding Officer, Patrol Squadron Thirty One, and the COMNAVAIRPAC NATOPS pilot evaluator. It was agreed that the names of individual pilots and their respective squadrons would remain anonymous throughout the analysis.

C. SAMPLE DESCRIPTION

Between January 1978 and May 1980, 31 west coast, operational P-3 squadrons received force level, NATOPS, unit evaluations. In the Spring of 1979, graduates of VP-31's new ISD training program began reporting to west-coast P-3 squadrons and participating in scheduled, force-level, NATOPS examinations. Three hundred eighty-two pilots from 10 squadrons located in California and Hawaii were selected as the initial sample. Composition of the initial sample was based upon two primary factors:

1. Obtaining a maximum number of ISD-trained pilots
2. The deployment status of squadrons which determined their ability to provide demographic data on sample pilots

Demographic data regarding the sample pilots were provided by squadrons through crew lists applicable to the date of the unit evaluation.

During initial analysis it was not surprising to discover that because of the January 1979 implementation date of ISD at VP-31, sample pilots trained under the ISD condition had generally been onboard their assigned operational squadrons only a few months. Accordingly, the sample was reduced to those pilots with 12 or fewer months experience onboard their assigned squadrons. This reduction provided for a total of 123 total pilots of which 61 were trained under the ISD program (Tables 1 and 2).

Table 1

Sample of Pilots Used in the Study by Rank, Months in the Squadron, Type of Training and Location*

RANK	MONTHS 1-4	MONTHS 5-8	MONTHS 9-12	TOTAL
		Location A		
0-5	2 (1)	0 (1)	1 (1)	3 (3)
0-4	2 (5)	4 (2)	2 (2)	8 (9)
0-3	1 (1)	2 (1)	2 (2)	5 (4)
0-2	6 (12)	8 (6)	14 (2)	28 (20)
0-1	1 (2)	2 (0)	0 (0)	3 (2)
Sub-total	12 (21)	16 (10)	19 (7)	47 (38)
		Location B		
0-5	0 (0)	1 (0)	0 (1)	1 (1)
0-4	0 (3)	1 (3)	0 (0)	1 (6)
0-3	0 (1)	1 (0)	1 (0)	2 (1)
0-2	1 (7)	5 (7)	5 (0)	11 (14)
0-1	0 (1)	0 (0)	0 (0)	0 (1)
Sub-total	1 (12)	8 (10)	6 (1)	15 (23)
Total	13 (33)	24 (20)	25 (8)	62 (61)

* Numbers in parenthesis represent those who were trained under the ISD condition

Table 2

Sample of Pilots Used in the Study by Rank, Designation, Type of Training, and Location*

RANK	DESIGNATION				TOTAL
	NOP	PP3P	PP2P	PPC	
			Location A		
0-5	1 (0)	0 (0)	0 (1)	2 (2)	3 (3)
0-4	3 (3)	0 (0)	1 (2)	4 (4)	8 (9)
0-3	3 (1)	2 (3)	0 (0)	0 (0)	5 (4)
0-2	8 (14)	18 (6)	2 (0)	0 (0)	28 (20)
0-1	2 (1)	1 (1)	0 (0)	0 (0)	3 (2)
Sub-total	17 (19)	21 (10)	3 (3)	6 (6)	47 (38)
			Location B		
0-5	0 (0)	0 (0)	0 (0)	1 (1)	1 (1)
0-4	1 (5)	0 (0)	0 (0)	0 (1)	1 (6)
0-3	0 (1)	2 (0)	0 (0)	0 (0)	2 (1)
0-2	5 (10)	6 (4)	0 (0)	0 (0)	11 (14)
0-1	0 (1)	0 (0)	0 (0)	0 (0)	0 (1)
Sub-total	6 (17)	8 (4)	0 (0)	1 (2)	15 (23)
Total	23 (36)	29 (14)	3 (3)	7 (8)	62 (61)

*Numbers in parenthesis represent those who were trained under the ISD Condition

D. DEPENDENT VARIABLES

Force-level NATOPS written examination scores achieved by the 123 pilots during unit evaluations were selected as the dependent variable on which to evaluate phase A and B pilot training conducted at VP-31. The suitability of force-level written examinations as a training effectiveness measure is established by the close agreement between the course objectives of phase A and B pilot training and the subject matter specified for testing in the P-3 NATOPS program. During phase A and B, pilot training subject matter consists of normal and emergency procedures and the operation of aircraft systems. It is during phase C and D, which have been purposely excluded from this study, that training in the various aspects of ASW and tactics is conducted.

E. INDEPENDENT VARIABLES

Various demographic variables in addition to the type of training received were considered, and the following five were ultimately selected (See Table 3).

1. Instructional Systems Development (ISD)

The Instructional Systems Development variable identifies the type of training that a pilot within the sample received while attending VP-31. Those pilots who were trained under the new system implemented in January of 1979 were coded 1, and those trained under the old system were coded 0.

Table 3

Definition of Variables

NAME	VALUE	LEGEND
Pilot Rank	1	Ensign
(RANK)	2	Lieutenant Junior grade
	3	Lieutenant
	4	Lieutenant Commander
	5	Commander
Designation	1	Patrol Place Commander (PPC)
(DESIG)	2	Patrol Plane Second Pilot (PP2P)
	3	Patrol Plane Third Pilot (PP3P)
	4	Non-Designated Pilot (NOP)
Months	1	1-4 Months Onboard Squadron at Time of Test
(DMONTHS)	2	5-8 Months Onboard Squadron at Time of Test
	3	9-12 Months Onboard Squadron at Time of Test
Training	0	Non-ISD-Trained Pilot
(ISD)	1	ISD-Trained Pilot
Squadron	1	All Squadrons Located at Location A
(DSQD)	2	All Squadrons Located at Location B

2. Pilot Rank

The rank of all sample pilots at the time they took the annual NATOPS examination was coded from 1 to 5 representing the prescribed military structure of 0-1 through 0-5.

3. Designation

Pilots in the P-3 community are grouped into four general categories which are determined by their qualification as pilots. Nonrated pilots (NOP) are those pilots who have not yet qualified. Patrol Plane Third Pilots (PP3P) have successfully completed the first stage of the P-3 pilot Personal Qualifications Standards (PQS) training but have not yet completed a NATOPS check. Patrol Plane Second Pilots (PP2P) have successfully completed the second stage of PQS training and a pilot NATOPS check. A PP2P is considered "safe for solo" and may serve as pilot-in-command during a nontactical mission. Patrol Plane Commanders (PPC) have successfully completed the required PQS and the training directed by the Commander, Patrol Wings Pacific (CPWP). Patrol Plane Commanders are authorized to serve as pilot-in-command of tactical missions.

4. Months

The months variable represents the number of months that a pilot in the sample was onboard his squadron at the time of the force-level NATOPS examination. Although this variable ranged from 1 to 36, the sample, as stated, was restricted to those pilots with from 1 to 12 months onboard a squadron when the examination was administered. This restriction reduced the sample size to 123 but provided for a more representative distribution of the ISD variable due to the newness of ISD at VP-31. To facilitate analysis, aggregation of the months variable resulted in three groups: 1-4 months, 5-8 months, and 9-12 months.

5. Squadron

The squadron variable served to distinguish the various squadrons to which west coast P-3 pilots are assigned subsequent to VP-31 training. Aggregation of the squadron variable resulted in two groups representing the two bases at which squadrons are located.

In the case of all variables, aggregation was identified by a preceding letter D.

F. ANALYSIS OF THE DATA

Analysis of the data was conducted at three levels to investigate all potential aspects of the problem. Initial analysis focused upon the distribution of open- and closed-book scores by demographic variables. Additionally, tests of independence between the distribution of the subjects on the ISD variable and each of the demographic variables were computed and examined using chi-square. Utilizing further aggregated variables (see Results section), a 2 x 2 x 2 x 3 factorial analysis of variance of open- and closed-book examination scores was conducted. This investigation utilized a Statistical Package for the Social Sciences [Nie, Hull, Jenkins, Stienbrenner & Bent, 1978] computer program and was designed to reveal the significance of four demographic variables (ISD, DSQD, DRANK, and DMONTHS) in accounting for the heterogeneity of open- and closed-book examination scores. Due to missing DDESIG data points in the sample (Table 2), the DDESIG variable was excluded from the factorial analysis of variance to permit the computation of two-way interactions. Further, in view of the high degree of dependence between the DDESIG and DRANK variables (Chi-square test of independence significant at <.001), exclusion of the DDESIG variable would not detract from the analysis. Three-way or higher interactions were pooled with the error sum of squares. Aggregated variables were again used for multivariate analysis of the variance among open- and closed-book examination scores considered simultaneously. This analysis was executed utilizing the Statistical Analysis System [SAS Institute, 1979] computer program and examined the effects of all five demographic variables in accounting for the variance of combined scores.

In addition to the statistical analyses described, operational factors associated with the conduct of training at VP-31 were examined. Fiscal year averages of salient measures were compared for FY77, FY78 and FY79. Factors such as staff size, instructor complement, student load, time spent in ground school during the familiarization phase, and total syllabus length were considered germane to the study.

III. RESULTS

A. SUMMARY RESULTS

Based upon the initially defined independent variables, means and standard deviations for open- and closed-book examinations were computed by category of training received at VP-31 (See Table 4).

B. AGGREGATED VARIABLES

Further analysis of the problem was enhanced by aggregation of the rank and designation variables to permit the use of multivariate procedures. The five-category rank variable was aggregated into two groups: 0-1 through 0-3 and 0-4 through 0-5. This distribution provided for not only a grouping of junior and senior officers, but additionally, it provided an identification of first- and second-tour pilots. The four level designation variable was combined to achieve two levels of designation: NOP and PP3P, and PP2P and PPC. This division provided a means to identify pilots who had completed a NATOPS certification check. The squadron variable and months variable were already aggregated (See Table 3). Means and standard deviations for the newly aggregated rank and designation variables are presented in Table 5.

Tables 6 and 7 present a contingency analysis of the training variable with each of the aggregated demographic variables to check for independence of the training variable

Table 4

Means and Standard Deviations of Annual
NATOPS Open and Closed Book Examinations
by Category of Training Received*

DEMOGRAPHIC	VALUE	TEST					
		OPEN			CLOSED		
		ISD	NON-ISD	ALL	ISD	NON-ISD	ALL
Pilot Rank	1	3.55	3.44	3.50	3.33	3.60	3.47
		.48	.34	.38	.59	.17	.41
(RANK)	2	3.69	3.73	3.71	3.42	3.62	3.53
		.31	.25	.28	.39	.27	.35
	3	3.60	3.51	3.55	3.32	3.54	3.45
		.32	.53	.44	.39	.30	.34
	4	3.85	3.89	3.87	3.74	3.77	3.75
		.18	.17	.17	.24	.30	.26
	5	4.00	3.79	3.90	3.68	3.78	3.73
		.00	.16	.15	.17	.26	.21
Designation	1	3.94	3.86	3.90	3.73	3.81	3.77
		.09	.15	.12	.21	.20	.21
(DESIG)	2	3.94	3.94	3.94	3.83	3.70	3.77
		.10	.10	.08	.15	.26	.21
	3	3.74	3.75	3.75	3.46	3.59	3.55
		.28	.27	.27	.33	.30	.31
	4	3.67	3.60	3.64	3.44	3.64	3.52
		.32	.34	.33	.42	.25	.37
Months	1	3.66	3.58	3.63	3.43	3.56	3.47
		.32	.39	.34	.44	.31	.41
(DMONTHS)	2	3.83	3.72	3.77	3.58	3.63	3.61
		.25	.28	.27	.28	.29	.30
	3	3.81	3.79	3.79	3.63	3.69	3.67
		.23	.24	.23	.29	.25	.26

Table 4 (continued)

Squadron	1	3.69	3.68	3.69	3.48	3.67	3.59
		.34	.31	.32	.43	.27	.36
(DSQD)	2	3.80	3.83	3.81	3.53	3.54	3.54
		.20	.22	.20	.30	.26	.29
TOTAL		3.73	3.72	3.73	3.50	3.64	3.57
		.30	.30	.30	.38	.28	.34

*Means above and standard deviations below in each set of data

Table 5

Aggregation of the Rank and Designation Variables with Means and Standard Deviations of Annual NATOPS Open and Closed Book Examinations by Category of Training Received*

Demographic Variable and Values	Aggregated Variables and Values	TEST					
		OPEN			CLOSED		
		ISD	NON-ISD	ALL	ISD	NON-ISD	ALL
RANK	DRANK						
(1-3)	1	3.67 .32	3.68 .32	3.67 .32	3.40 .40	3.61 .27	3.51 .35
(4-5)	2	3.88 .17	3.86 .16	3.87 .16	3.73 .23	3.77 .28	3.74 .25
DESIG	DDESIG						
(1-2)	1	3.94 .09	3.88 .14	3.91 .11	3.75 .20	3.78 .22	3.77 .20
(3-4	2	3.69 .31	3.69 .31	3.69 .31	3.45 .39	3.61 .28	3.53 .35

*Means above and standard deviation below in each set of data

Table 6

Contingency Analysis of the Distribution
of ISD and Non-ISD Trained Pilots
by Demographic Variables

DEMOGRAPHIC VARIABLES	VALUES	ISD	NON-ISD	CHI SQUARE	SIGNIFIANCE OF CHI SQUARE
DRANK	1	42	49	1.17	.30
	2	19	13		
DSQD	1	38	47	2.03	.15
	2	23	15		
DDESIG	1	11	10	.00	.97
	2	50	52		
DMONTHS	1	33	13	17.81	.00
	2	20	24		
	3	8	25		

Table 7

Contingency Analysis of the Distribution of ISD and Non-ISD Trained Pilots by Aggregated Months and Location

LOCATION	DMONTHS	ISD	NON-ISD	CHI SQUARE	SIGNIFICANCE OF CHI SQUARE
A	1	21	12	8.52	.01
	2	10	16		
	3	7	19		
B	1	12	1	11.95	.00
	2	10	8		
	3	1	6		

distribution. There was a significant degree of dependence in the distribution of the ISD variable by DMONTHS at both squadron locations examined. This result was not surprising since pilots trained under the new ISD system were more likely to have fewer months onboard their squadron than non-ISD trained pilots at the time of the unit NATOPS evaluations. The adjusted chi-square computed for the DMONTHS-ISD matrix was 17.8 and significant at the .0001 level.

C. FACTORIAL ANALYSIS OF VARIANCE OF OPEN BOOK SCORES (TABLE 8)

The DRANK, DSQD, and DMONTHS variables were found to be significant as main effects in accounting for the observed heterogeneity among sample open-book NATOPS examination scores. Additionally, the interaction between DSQD and DRANK variables was determined to be significant. Mean open-book examination scores for both values of the DRANK variable were demonstrated to be nearly identical at location B and quite different at location A. Accordingly, although the DRANK and DSQD variables were significant when considered separately, the predictive power of the DRANK variable was enhanced by knowing the location variable (See Table 9 and Figure 2). It is interesting to note that in spite of the significant degree of dependence in the distribution of ISD by DMONTHS, the two-way interaction between these variables in the factorial analysis was not significant. Further, ISD, per se, was not identified as a significant effect in this analysis.

Table 8

Factorial Analysis of Variance of Open-Book
NATOPS Scores by Demographic Variables

DEMOGRAPHIC VARIABLE		D/F*	F VALUE	SIGNIFICANCE OF F
ISD		1	.577	.45
DMONTHS		2	5.075	.01
DRANK		1	14.151	.00
DSQD		1	6.002	.02
Two Way Interactions				
ISD	DMONTHS	2	.072	.93
ISD	DSQD	1	.514	.48
ISD	DRANK	1	.041	.84
DMONTHS	DSQD	2	.992	.37
DMONTHS	DRANK	2	.279	.76
DSQD	DRANK	1	6.233	.01

*Total D/F = 122

Table 9

Mean Open-Book NATOPS Scores for Location (DSQD) by Rank (DRANK)

Value of DRANK	Location	
	A	B
1	3.61	3.82
2	3.9	3.81

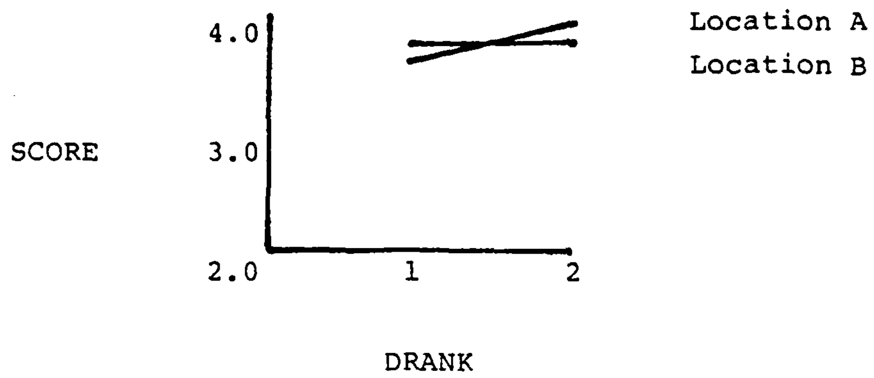

Figure 2. Interactive Effects of Rank and Location on Open-Book NATOPS Examination Scores

D. FACTORIAL ANALYSIS OF THE VARIANCE OF CLOSED-BOOK SCORES (TABLE 10)

The factorial analysis of variance of closed-book scores identified the DMONTHS and DRANK variables as significant main effects. Although not significant at the .05 level, the ISD variable was significant at the .08 level. Further, the two-way interactions of ISD with DSQD and DSQD with DRANK were significant in accounting for score variance. Details of these interactions are shown in Table 11 and Figure 3. Pilots stationed at location B were observed to achieve nearly idential mean scores on the NATOPS closed-book examinations regardless of the type of training received while at VP-31 or their current rank. However, the mean scores achieved by pilots stationed at location A varied considerably by the type of training received while at VP-31; the non-ISD-trained group had a higher mean score than the ISD-trained group. The difference in these two means, as measured with a t test, was significant at the .01 level. Additionally, although the DRANK variable made no difference in the mean closed-book score at location B, it did account for a meaningful difference in mean scores at location A in that the pilots with higher rank, and presumably more experience, made better scores.

E. MULTIVARIATE ANALYSIS OF VARIANCE OF OPEN- AND CLOSED-BOOK NATOPS SCORES (TABLE 12)

A multivariate analysis of open- and closed-book NATOPS

Table 10

Factorial Analysis of Variance of Closed-Book NATOPS Scores by Demographic Variables

DEMOGRAPHIC VARIABLE		D/F*	F VALUE	SIGNIFICANCE OF F
ISD		1	3.051	.08
DMONTHS		2	3.032	.05
DSQD		1	.177	.67
DRANK		1	16.271	.00
Two Way Interactions				
ISD	DMONTHS	2	.051	.95
ISD	DSQD	1	4.618	.03
ISD	DRANK	1	1.806	.18
DMONTHS	DSQD	2	.391	.68
DMONTHS	DRANK	2	.598	.55
DSQD	DRANK	1	7.842	.01

*Total D/F = 122

Table 11

Mean Closed-Book NATOPS Scores for Location (DSQD) by Training (ISD) and Rank (DRANK)

VARIABLE	VALUE	LOCATION	
		A	B
ISD	0	3.67	3.54
	1	3.48	3.53
DRANK	1	3.50	3.54
	2	3.83	3.52

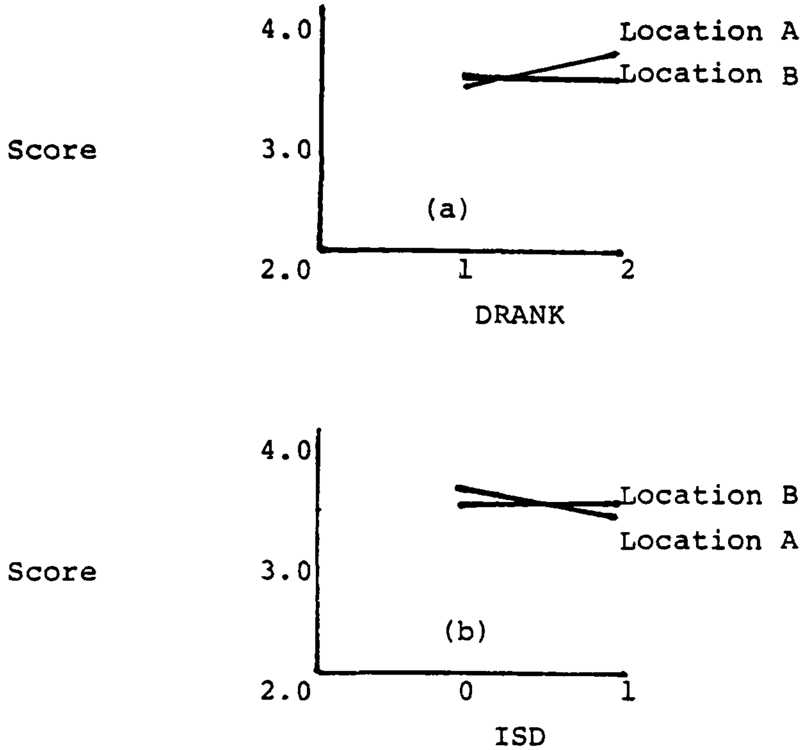

Figure 3. Interactive Effects of Location (DSQD) with (a) DRANK and (b) ISD on Closed-Book NATOPS Examination Scores

Table 12

Multivariate Analysis of Variance of Annual NATOPS Open- and Closed-Book Examination Scores

HYPOTHESIS OF NO OVERALL EFFECT BY:	F*	SIGNIFICANCE OF F
ISD	2.05	.13
DRANK	4.67	.01
DMONTHS	2.53	..04
DDESIGN	0.63	.54
DSQD	3.90	.02

*F Determined by Wilk's criterion where:

$$F = \frac{1-\sqrt{L}}{\sqrt{L}} \times \frac{(NE+Q-P-1)}{P} \text{ with } 2P \text{ and } 2\,(NE+Q-P-1)\ d/f$$

$$L = \frac{DET(E)}{DET\ (H+E)}$$

H = sum of squares and cross product matrix for the null hypothesis

E = error sum of squares and cross product matrix

P = number of dependent variables

Q = degree of freedom of null hypothesis

NE = D/F of error

examination scores, considered simultaneously, identified the DRANK, DMONTHS, and DSQD variables as significant in accounting for score heterogeneity. Because of the previously discussed sensitivity of open- and closed-book NATOPS scores to the experience variables (DRANK and DMONTHS) and the squadron location variable (DSQD), the multivariate analysis was performed to test the power of these effects on the combined scores. Although the correlation between open- and closed-book scores was computed to be only .33, the effects of squadron location and both experience variables were again statistically significant in the multivariate analysis. All interactive effects were excluded from this test because of a singular matrix caused by missing data points for the DDESIG variable which prohibited the computation of two-way and higher interactions. As in the factorial analyses, the ISD variable was not statistically significant.

F. OPERATING DATA COMPARISON (TABLE 13)

The most noticeable changes in operational factors over the time frame examined (FY77 through FY79) have occurred in the following four areas:

1. Student/instructor ratio
2. Second tour pilot load
3. Ground school time
4. Enlisted staff size

Table 13

A Comparison of Operating Data for VP-31 Training

FACTOR	TYPE OF FACTOR	FY77	FY78	FY79
Student Instructor Ratio		1.18	1.16	1.55
Aircraft Flights per Student	First Tour	8		5
	Second Tour	6		5
Simulator Periods per Student	First Tour	0		7
	Second Tour	0		6
Allotted Ground School Time (Hrs)	First Tour	196		232
	Second Tour	162		207
Syllabus Length	First Tour	9 wks 3 days		10 wks
	Second Tour	8 wks 2 days		6 wks 6 days

As illustrated in Table 13, the student/instructor ratio was increased between the pre-ISD period of FY77 and FY78 and the ISD period of FY79 by approximately .39. This increase occurred concurrently with an expansion of the second-tour pilot load and would indicate that the efficiency of self-instruction associated with ISD was being realized. Ground school time specified for the familiarization phase was increased between FY77 and FY79 due to the introduction of the flight simulator and the inclusion of simulator time in ground school totals. In aggregate, operational data seem to have remained essentially constant over the time frame examined, except for a modest, but steady, increase in the enlisted staff size.

IV. DISCUSSION

The preceding analysis suggests that VP-31 pilot training under the new ISD condition serves to account only for lower scores on force-level, closed-book, NATOPS examinations by pilots assigned to one, of two, west-coast P-3 bases. Further, this study identified rank, squadron experience, and squadron location as statistically significant effects in accounting for the variance of examination scores. These results raise three salient questions regarding P-3 pilot training and subsequent NATOPS evaluation.

1. Is the pilot training provided by VP-31 in conformance with the best and proper application of ISD?

2. Is the force-level NATOPS testing program an appropriate measure of the effectiveness of VP-31 pilot training?

3. Is ISD a more effective system for teaching pilots to learn, retain, and apply a knowledge of P-3 operating procedures and systems than the previous traditional system?

To determine the degree of conformance between current training at VP-31 and the best and proper application of ISD would require a formative evaluation, the magnitude of which is beyond the scope of this study. On the surface however, it appears that with but a few exceptions, such as the lack of entry level testing and a true self-paced learning program which would allow students to complete training at a self determined schedule, the basic principles of ISD are being followed. Courseware Incorporated, a private-sector ISD consultant, has been largely responsible for the design of VP-31's new training program.

The appropriateness of the force-level NATOPS testing program as a measure of VP-31 pilot training effectiveness was established by the close agreement between course objectives and the areas specified for evaluation in the NATOPS program. (See Appendix A for a detailed listing.) Although a certain degree of latitude is permitted in the construction of individual examination questions, the specific subject matter is clearly defined for both open- and closed-book examinations. The open-book examination is a particularly appropriate measure of training effectiveness because in general it requires pilots to compute values associated with aircraft performance which are identical to those required on the job. Analysis of the variance of open-book examination scores suggests that among the variables considered, the effects of experience (rank and months) and squadron location are statistically significant. Further, the effect of the training variable (ISD or non-ISD) was not significant.

Closed-book examinations measure primarily verbal information and intellectual skills associated with operating procedures and aircraft systems. Since the examination requires pilots to first read and interpret a question before selecting a written answer, the relationship to on-the-job requirements is not as close as in the open-book examination. Analysis of the closed-book examination scores revealed, as with open-book scores, a sensitivity to the rank and months variables. The type of training received was significant at the .08 level as a main effect and at the .03 level when interacted with the squadron location variable (ISD trained pilots scored lower than traditionally trained pilots at location A). The direction and consistency of the main effect is very obvious in Table 4. Of the 14 contrasts, in all but one the ISD-trained pilots have lower closed-book examination scores.

The preceding discussion suggests that organizational climate, as well as experience, is strongly related to pilot performance on NATOPS examinations. Formal syllabus training received at VP-31, either ISD or traditional, serves to provide pilots with a basic knowledge of P-3 systems and procedures. Retention of these skills and further learning takes place in the field at the squadron level where previously learned skills have the opportunity to grow or deteriorate. Under a positive climate, learning is reinforced and performance is rewarded. Measurement of the learning climate associated with an organization should be based upon the attitudes of individuals which result from choices, such as whether or not to maintain previous learning and further develop aviator skills.

The ISD method focuses sharply upon the development of a precise list of learning objectives based upon task analyses. Although the logic of the atomized approach toward learning specified in design manuals is sound, course designers must exercise particular attention to detail when assembling task inventories and subsequent learning objectives. If graduates are deficient in an area not listed among the objectives, the problem is with the list and not with the program. The learning of attitudes, which is not emphasized within the Navy's ISD design manual, should be considered by course designers as a desired outcome of pilot training.

This study seems to indicate that perhaps a truly positive attitude toward the further development of knowledge in the squadron environment is not being learned as well under the ISD system as it was under the traditional methods. Something may have been overlooked in the time-consuming atomization process of ISD when learning became limited to those items on the list. Additionally, emphasis on the individualization of instruction and self-instruction may have served to eliminate the positive effects of peer and instructor interactions in the learning of favorable attitudes.

V. CONCLUSION

This study suggests that by utilizing force-level NATOPS examination scores as criteria for the effectiveness of pilot training conducted at VP-31, enhancement by the application of ISD has not yet been achieved. The following findings are germane:

1. A reduction in closed-book NATOPS examination scores associated with ISD trained pilots, particularly at one of two west-coast P-3 bases, was identified. Although these ISD trained pilots did score lower on average than their traditionally trained counterparts, it is somewhat presumptuous to attribute the difference to the process of ISD until a formative evaluation is conducted at VP-31 to establish the degree to which the pilot-training program conforms to the best and proper utilization of ISD.

2. Upon completion of a formative evaluation, further summative evaluation, under the controlled conditions of parallel training previously discussed, is required to determine the effectiveness of a program verified to be a proper application of ISD. An evaluation of this type is necessary to justify the extensive cost in terms of manpower and money allocated to the development of ISD at VP-31.

3. Pilot training provided by VP-31 during the time frame examined (either ISD or non-ISD) seems to have a limited effect upon force-level NATOPS examination scores.

However, the effects of squadron location and experience (rank and months) are statistically significant in accounting for the variance of NATOPS scores.

APPENDIX A

A COMPARISON OF TRAINING OBJECTIVES AND THE SUBJECT MATTER OF NATOPS EXAMINATIONS

Examination Subject	Training Objective	Unit	Lesson #
	Open Book Examination		
Ordnance/Zero Fuel Weight Computation	Define and Compute Zero Fuel Weight	1	8
Fuel Density/Minimum Fuel for Flight	Utilize Minimum Fuel Flight Chart	1	8
Center of Gravity Limits	Define and Compute Center of Gravity, State Limits	1	8
Minimum Control Speed	Compute VMC	3	1
Runway Wind Components	Compute Runway Wind Component	3	1
Refusal Speed	Compute Refusal Speed	3	1
VR, RCR	Compute Correction to Refusal Speed for RCR	3	1
Vro, Vlof, V50 (3)	Compute Take Off Speeds Vro, Vlof, V50 (3&4 Eng)	3	1
Distance to Liftoff	Compute distance to Liftoff	3	1
Stall Speed/Stall Buffet	Compute Stall Speed	3	1
Climb Performance	Compute 3/4 Eng Climb-out Flight Path	3	2
Altitude Selection	Compute Max Range Altitude	3	4
Max Range Airspeed	Compute Max Range Air-speed	3	6
Max Range SHP	Compute Max Range SHP	3	6

Examination Subject	Training Objective	Unit	Lesson #
Max Range Fuel Planning	Utilize Max Range Charts	3	4
Loiter Time Prediction	Compute Loiter Time Available	3	5
Angle of Attack	Define AOA	1	25
Composite Cruise Flight Performance Chart	Utilize Composite Cruise Performance Chart	3	7
Ditch Speed	Compute Ditch Speed	4	12
Available Range Remaining	Compute Available Range Remaining	3	8
Landing Ground Roll Distance	Compute Landing Ground Roll	3	3
NATOPS Manual/ Evaluations	NATOPS Program Review	1	2
Emergencies	Emergencies covered in	4	all

Closed Book Examination

Aircraft General	General Aircraft	1	
Power Plants	Describe the Operation and Limits of the Engines	1	9
Propeller	Describe the Operation and Limits of the Propeller	1	15,16, 17
Electrical System	Describe the Operation and Limits of the Electrical System	1	3, 4, 5
Hydraulic System	Describe the Operation and Limits of the Hydraulic System	1	6
Auxiliary Power Unit	Describe the Operation and Limits of the APU	1	13

Examination Subject	Training Objective	Unit	Lesson #
Flight Controls	Describe the Operation of the Flight Controls	1	6
Automatic Flight Control System	Describe the Operation and Limits of the Automatic Flight Control System	1	26,27
Air Conditioning and Pressurization	Describe the Operation and Limits of the Air Conditioning and Pressurization System	1	18,19
Fuel System	Describe the Operation and Limits of the Fuel System	1	11,14
Radio and Nav Aids	Describe the Operation of the Radios and Nav Aids	1	21,22, 23,24, 25
All Weather Systems	Describe the Operation and Limits of the Foul Weather Systems	1	20
Armament	Covered in Tactics Section		
Instruments	Describe the function and limits of cockpit instruments	1	25
Weight and Balance	Define and Compute Weight and Balance Data	1	8
Aircraft Performance and Cruise Control	Compute Max Range Cruise	3	6
Ditching and Bailout	Describe Procedures for Ditch and Bailout	4	12
Normal and Emergency Operating Procedures	Normal and Emergency Operating Procedures	2&4	all
Limitations	Normal and Emergency Operating Procedures	2&4	all

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