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ABSTRACT

Lecturing is a poor method of giving instruction for Army tasks, since it is suitable for only a small segment of learners and a small number of tasks. The APSTRAT (derived from "aptitude" and "strategies") model is designed to train men at many levels of aptitude and with wide differences in educational backgrounds for a variety of tasks. The model, which is now undergoing tests, simulates on-the-job training. The central feature of the model is its use of peer instruction, which has been found to be both practical and efficient. For each task, the trainee passes through this cycle: observation of the task being performed, learning the task, job-performance (in which the trainee is observed by a new trainee), and teaching (in which the trainee instructs another). The trainee passes through this cycle until he has learned each task thoroughly, as judged by observation and testing administered by the instructor. A prototype of this model has proved successful in preliminary tests, but it is not yet established whether it is generally suitable for the wide variety of application for which it is intended. (JK)

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The APSTRAT Instructional Model

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16. Abstract

This paper describes a low-cost instructional model suitable for multi-aptitude training populations, stressing individualized, self-paced learning in an operational functional context and utilization of peer instruction. The model, developed in pilot studies involving the Army's Field Wireman Course (MOS 36K), is designed as a generalizable instructional system.

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Prefatory Note

This paper represents the core conceptions of the instructional model developed by Work Unit APSTRAT. The Work Unit deals with the development and testing of training strategies appropriate for men of various levels of aptitude in the operational, field-training context for a variety of military occupational specialty courses.

The substance of this document has been presented in briefings by the Work Unit staff on several occasions to representatives of the Department of Defense and the Department of the Army.

This research is being conducted by members of the Human Resources Research Organization, Division No. 3, Presidio of Monterey, California.

THE APSTRAT INSTRUCTIONAL MODEL

Kenneth Weingarten, Jacklyn Hungerland,
Mark Brennan, and Brent Allred

INTRODUCTION

Current input of Army personnel under Selective Service poses a challenge for educational technology. Every week, Army training personnel are confronted with incoming classes that must be taught a considerable amount in a short and relatively fixed period of time. The men who arrive for training are likely to be an extremely heterogeneous group in educational background and learning aptitude. Thus, a typical class will have men ranging all the way from functional illiterates to college graduates, and from those scoring at the lower limit of the Armed Forces Qualification Test to those scoring at the upper limit.

The conventional lecture-centered instructional method characteristic of much Army training is effective, at best, for a relatively narrow band within the larger educational and aptitudinal spectrum. This band for which training is oriented can be shifted to some degree by allocating more or less time or by proceeding in smaller or larger teaching steps. However, it cannot really be broadened unless the training population is subdivided into several homogeneous classes and lectures prepared for each class.

This multiple tracking "solution" is really no solution at all. It would require many more instructors, a larger physical plant, more elaborate administrative arrangements, and, in addition, would risk a decline in morale relating to trainee placement.

The lecture, which is a compromise technique based on unfavorable teacher-student ratios, is not an optimal training method for any educational or aptitudinal subgroup. Even with the use of training aids, the lecture method is inclined to abstraction. There is, with this method, an undesirable temporal separation of information and practice and an insensitivity to the individual differences found even in the most homogeneous groups. These limitations render the lecture method merely less than optimal for the better educated and brighter segment of the training population; for those at the opposite end of the continuum, they constitute an increasingly effective barrier to learning. Thus, to provide adequate training for all segments of the training population, new methods of instruction are needed.

This paper presents a brief description of a training model that has grown out of Work Unit APSTRAT. "APSTRAT," which is derived from the terms "aptitude" and "strategies," represents the central goal of the project: to devise effective instructional strategies for training hetero-aptitudinal populations as described above. The project plan is two-fold: combining these strategies in a complete training model, and testing this model in a pilot study in a typical Army training course.

The course selected for the pilot study would meet two criteria: first, its student population must be heterogeneous in educational background and measured aptitude; second, the training objectives must include the widest range of skills. The Field Wireman Course (MOS 36K) was chosen on the basis of these criteria. Preliminary studies have already been completed, and a full test of the model will be conducted in the Wireman course. A report of the results will be prepared in Fiscal Year 1971.

DESIGN OF THE MODEL

The structure of the training model was governed by the attempt to develop more effective strategies for instructing hetero-aptitudinal training populations within a set of practical constraints that limit options. The model that evolved emphasizes peer instruction in an on-the-job functional context.

Strategies

HumRRO and other research agencies have been studying the nature of human learning for some time with the object of improving the technology of instruction. Recently, HumRRO has turned its attention to the question of instructional strategies appropriate for trainees at the lower end of the educational and aptitude spectrum, particularly recruits entering the Army under Project 100,000. Many of these strategies are suitable for all segments of the training population without respect to education or aptitude. But while brighter and better educated students can learn fairly well even with non-optimal training strategies, the less bright and less educated, under similar circumstances, can learn very little. For the upper end of the continuum, then, the development of training methods that incorporate the most powerful instructional strategies would be desirable; for the lower end of the continuum, their development is urgent.

These strategies may be briefly stated as follows:

1. Performance orientation. Significant improvement in training requires a clear specification of what the trainee is expected to learn if he is to perform his job adequately. The training process must focus on these job-performance objectives. Quality control, correspondingly, must consist of tests of the trainee's ability to *perform the various tasks that make up the job* rather than of his ability to answer questions *about* these tasks.

2. Self-pacing. For various reasons, including differential aptitude, some people are capable of learning faster than others. Instructional methods, such as the lecture, that fix the pace at which learning must take place, leave some students behind and bore others. While the need for self-pacing is somewhat less urgent for "homogeneous" groups (especially those composed of trainees rated high on the educational and aptitudinal scales), no group of men is ever perfectly homogeneous. Consequently, self-pacing is desirable in any training effort.

3. Insistence on mastery. The weaknesses of fixed-pace training methods are clearly demonstrated by the frequency with which large numbers of students fail to master the skills they are being taught. Differential achievement in training is the inevitable result of attempts to force people to learn at a rate faster than their capabilities. But fixed-pace instruction is so common in our culture that many individuals have come to the erroneous conclusion that differential achievement is an inevitable consequence of all training. It is typical to conclude from fixed-pace instructional methods that some students are *better* learners than others. However, experience with self-pacing methods suggests it would be more accurate to say that some students are *faster* learners than others. Experience has demonstrated that, when students can proceed at rates appropriate to their various capabilities, a great majority can attain high levels of achievement. And, it should be noted, the time needed for mastery by the slowest learners is often less than the time needed for teaching the same material by conventional fixed-pace methods.

4. Rapid and detailed feedback to trainees as to the adequacy of their learning. Training methods that permit only delayed feedback to trainees in the form, for example, of end-of-cycle exams, compound mislearning and often produce negative effects on motivation. It is always preferable for trainees to experience a sense of security in what

they have already learned before they proceed to learn something else. This implies that accurate feedback should be presented to trainees at the earliest possible moment at each critical step of the learning process. Feedback, therefore, should be both rapid *and* detailed.

5. Rapid and detailed feedback to the trainer as to the adequacy of instruction. The more information a trainer receives about the degree to which trainees are learning what they are supposed to learn, the better he can modify his own procedures for greater effectiveness and efficiency. The faster he receives this information, the sooner he can make these modifications.

6. Functional context. In learning skills for particular circumstances, trainees will, in general, learn better and faster if those circumstances are present in the learning situation. On-the-job training is an example of a method which focuses on learning in a functional context. Learning to operate a switchboard can be accomplished best if information about switchboard operation is presented while the trainee is actually operating a switchboard. This approach avoids any temporal separation of the presentation of information and practice, which is generally unavoidable in lecture-centered training methods.

These six instructional principles comprise the APSTRAT instructional "policy." The question now is—how is it to be realized—given expression in a concrete training model?

Constraints on the System

The APSTRAT model was shaped largely by consideration of the following practical constraints facing a pilot study embodying the six principles.

1. The training course versus on-the-job training. On-the-job training incorporates many of the strategies described above. However, there are compelling reasons for rejecting this alternative. First, the placement of untrained men in field units would impair unit readiness since these units would be required to devote time to individual training that is needed for unit training. Second, the operational requirements in field locations would be restricted severely by the trial and error inherent in the learning process. Even when no direct physical danger would be involved, unit performance would almost certainly experience some degree of degradation with a constant influx of significant numbers of untrained men. Third, the sequence of events experienced by the trainee in the field cannot be arranged for optimal instructional value.

The decision to focus on training prior to field assignment was thus a forced choice. An attractive option, however, was to redesign training courses to simulate on-the-job training, retaining most of the advantages of this form of training and avoiding its hazards.

2. Costs. The operational cost of a training model is of critical concern, especially when there is interest in wide application. Even moderate increases in cost in a single course cumulate to a substantial sum when many classes in the course are involved. Decisions concerning personnel, time, operational equipment, and instructional hardware and software are, therefore, crucial and are constraints in the development of the training model.

a. Personnel. Many training courses are undermanned, with the effect that undue burdens are often placed on the existing staff. If the APSTRAT model were to require a significant increase in cadre, its general utility would be considerably reduced. A constraint on the APSTRAT model was that it should not require a substantial increase in cadre. Instead, it should make more effective use of the skills and knowledge possessed by the regular cadre, and, if possible, upgrade its instructional and supervisory functions.

b. Time. In general, the proficiency gained as a result of training could be somewhat improved merely by lengthening the training period. However, the normal length of this period in ongoing courses is fixed by regulation, thereby establishing a maximum for each course.

A minimum training time for trainees is fixed by public law.[1] Any acceleration of a faster learner through the training system creates utilization problems during the time between completion of training and eligibility for field assignment. The APSTRAT model must take into consideration the desirability of acceleration for the faster learner by devising ways of utilizing the time of the early graduate in useful, productive roles.

c. Operational equipment. Many training courses are concerned with the development of skills for the operation of various types of equipment. These courses are issued such equipment in limited quantities. To be capable of wide application, a training model must be able to function within such limits.

d. Instructional hardware. Many instructional innovations require the use of very costly hardware, computer-assisted instruction being a prime case. Of lesser magnitude but still substantial are the costs of television and other audio-visual recording and display equipment. The proper use of such equipment can enhance learning. However, the APSTRAT model was planned under the assumption that large amounts of this expensive equipment would not be generally available and, therefore, should not be required.

e. Instructional software. The production of educational software is extremely time-consuming and costly. High quality, programmed instructional manuals, for instance, can cost more than $3,000 per average hour of learning time. Alterations in training objectives, as a result, for example, of changes in equipment, require modifications of instructional materials that are also time-consuming and costly. A model relying heavily on instructional software (even if elaborate hardware were not required for its presentation) would have less general utility than an alternate model that could avoid this expense of time and money. Thus, the use of elaborate software was rejected in the development of the APSTRAT model.

f. Trainee output. Training courses are required to produce in a stipulated time period certain numbers of men qualified in an MOS. A model would not be feasible if it reduced this output, either permanently or initially, below required levels.

Rejection of high-cost options in the development of the APSTRAT model does not imply that models using more personnel, time, equipment, and sophisticated instructional hardware and software, or reducing trainee flow, would not produce dramatic improvements in training effectiveness. Nor do we wish to imply that the initial high costs of such an alternative could not be partially or fully offset by future net savings. While this is a very real possibility, the practical difficulties of carrying out such a program are considerable. A training model that attempts a more effective arrangement of the elements in ongoing training courses, without substantial increase in cost, would appear to be an alternative well worth exploring.

3. Problems of implementation. The constraints described so far are unavoidable and place strict limits on the nature of the training model. Additional constraints concerned with facilitating implementation were considered desirable and therefore, were imposed.

a. Training and orientation of course personnel. Effective operation of the model should not require retraining or extensive orientation of present course personnel.

[1] Public Law 51 precludes the assignment of men to overseas field assignments until they have had 16 weeks of service.

b. Amenability of the model to improvement. When a new training model is put into operation for the first time, it will almost always need some modifications to improve effectiveness and efficiency. A model that would tend to "lock in" its initial procedures, making improvements difficult to accomplish without overhauling the entire system, may lead to the rejection of a promising method of training. It was seen as desirable, therefore, to build into the APSTRAT model an ability to incorporate improvements without discontinuing operations.

c. Gradual changeover. Revision of an entire training course presents many difficulties but they can be considerably reduced if changeover can be accomplished gradually and concurrently with the ongoing system. In this way, refinements can be made in a developmental module (or segment) of the curriculum while output is maintained. The corresponding segment in the standard course should be phased out only when the new module is functioning reliably and satisfactorily. If possible, the standard training method should be continued during the period of changeover.

Gradual changeover of a model has many advantages: it is easier to troubleshoot a limited portion of a course than the entire course; experience in setting up one module will almost always provide more realistic guidelines for setting up additional modules; the tendency toward skepticism about the feasibility of innovation in training can be modified gradually by showing that the new model works—in one area of the course, then two, three, and so forth; for reasons that will be clear when the model is described, gradual changeover allows for a more effective utilization of the limited number of cadre. Therefore, the model to be selected was to possess this property.

d. Accommodation of extra-instructional duties. Many house-keeping tasks in training centers are performed by trainees. These assignments, during the 16-week training period, are, at present, not well coordinated with training goals, and both the effectiveness and the efficiency of the training system suffer as a result. The APSTRAT model, therefore, was to be designed to accommodate these additional duties without interfering with training.

THE MODEL

There would be considerable leeway in designing a training model with the desired instructional strategies were it not for the severe restrictions of cost constraints. With these constraints, however, the model would have to be structured principally from resources already present in the training courses: cadre, trainees, and operational equipment.

Peer Instruction

While some self-instructional materials may be included in the model, they could not constitute more than an ancillary function because of the expense and time for preparation. Under these circumstances, the only available medium of instruction is the "live" instructor, and there are too few cadre to fill this role except as lecturers to large classes—exactly the method we are attempting to replace because it violates so many of the principles we are trying to put into practice. It would seem that the only feasible alternative consistent with these principles is the use of trainees as instructors. Thus, the central feature of the APSTRAT model is the instruction of trainees by other trainees, or peer instruction—a method shown by laboratory and field test, so far, to be both practicable and effective.

With peer instruction, a one-to-one student-teacher ratio can be established, which provides both trainer and trainee the flexibility for self-pacing and rapid feedback for the trainee's learning. With two additional factors—job-performance orientation in curriculum presented in a situation that simulates on-the-job training, and a quality control system that demands mastery—the model does possess the desired attributes and satisfies the various practical constraints.

The peer instruction method offers certain advantages especially appropriate for trainees low on the educational and aptitudinal spectrum. These men often approach a formal training situation with forebodings of failure based on their previous experiences, and often these forebodings turn into self-fulfilling prophesies, lack of confidence breeding lack of accomplishment. On the other hand, trainees who receive instruction from other trainees who have mastered new skills well enough to teach them, are more likely to believe that they, too, are capable of similar accomplishment. In addition, differences in rank between trainee and instructor tend to inhibit communication to the detriment of the learning process. But a man instructed by a peer will feel more free to display ignorance or uncertainty and will ask the questions necessary for him to learn effectively.

The peer-instructional method is also valuable to the peer instructor, because in his role of instructor a trainee must review newly acquired knowledge and practice newly acquired skills.

A further advantage of peer instruction, emphasized by experimental subjects themselves, is the eagerness to learn when they know they are going to have to teach others what they learn. This increased sense of responsibility is personally motivating and can lead to greater group cohesion than is ordinarily found in training situations.

Operation of the Model

The main elements of the model are probably best presented in terms of the model being in full operation.

The course is organized around a series of job-performance stations that represent the various duties that must be performed by a person competent in the Field Wireman Course (MOS). (The number of such stations, of course, will vary from one MOS to another.) Trainees do not enter the system on a weekly schedule, as is currently the case, but on a daily schedule, in classes equal in size to 20% of the average weekly trainee input. At each station, an advanced trainee performs all job duties under the supervision of cadre, while a newly-arrived trainee observes the job-performer at his job. In this way, the newcomer gains familiarity with the duties he himself will be performing. The period of time devoted to job-performance and observation at a station depends on the number of duties and the time required to perform them. An average estimate is one day.

After a "day" of familiarization with the job duties at the station, the trainee will spend one day or more in learning the skills necessary to perform the job.[2] His instructor during this period is the trainee whose job-performance he observed on his observation day. The period of time allocated to the learning phase is determined by the amount of time required by slower learners to reach mastery.

The peer instructor is given a simple, printed checklist of procedural steps as a memory aid, to assure that the instructor will not inadvertently omit any critical step in instructing his trainee. When both trainee and peer instructor are convinced that the trainee has mastered the skills necessary to perform a given task, they report to a

[2] It should be noted that, although not essential, it is convenient in administration of the system for the various phases in the instructional process to be arranged in units of whole days. Reference would then be in terms of one or more job-performance days, one or more learning days, and so forth.

cadreman for the trainee's proficiency test. The cadreman scores the trainee on his ability to perform the task on a pass-or-fail criterion.

If the trainee passes, he proceeds to the next task in the sequence, repeating the procedure of learning and testing. If he fails any test, he must review and practice until he can pass. When the trainee has passed all proficiency checks for a given station, he and his instructor may be given a period of open time, the limits of which are prescribed by the noncommissioned officer-in-charge, in accordance with announced policy. (At present, the model calls for self-paced learning, but within a fixed overall time frame. In the future, an alternative procedure will be tested that will allow for accelerating the rapid learner.) The trainee, having demonstrated his proficiency in the required number of tasks, can now be scheduled for his job-performance day. An incoming trainee observes his performance, and the training cycle is repeated with the former trainee assuming the role of peer instructor.

The cycle—observation, learning, job-performance, and instruction—is repeated until the trainee completes the requirements of each station in the curriculum. One or more "administrative" buffer days may be added at the end of the cycle at each station to provide available substitutes for job-performers and peer instructors who are absent, or to accommodate garrison duties such as guard duty and kitchen police. A trainee does not have a peer instructor assigned on an administrative day.

Based on the "day" system, the cycle a trainee will follow is expressed as follows:

1. O Observation Day
2. L Learning Day
3. JP Job-Performance Day
4. T Teaching Day
5. A Administrative Day

With a daily input of trainees, and with one day assumed to be adequate for each step in the cycle, the training schedule would appear as in Table 1.

Table 1

Training Schedule for "One-Day" Sequence

Training Day	Class 1	Class 2	Class 3	Class 4	Class 5
I	O				
II	L	O			
III	JP	L	O		
IV	T	JP	L	O	
V	A	T	JP	L	O
VI		A	T	JP	[illegible]
VII			A	T	JP
VIII				A	T
IX					A

The number of O, L, JP, T, and A days will fluctuate according to the needs of any particular module. Table 2 illustrates a module in which there are two L days (and the corresponding two T days) and two A days.

Table 2

Training Schedule with Fluctuating Time Sequence

Training Day	Class 1	Class 2	Class 3	Class 4	Class 5
I	O				
II	L1	O			
III	L2	L1	O		
IV	JP	L2	L1	O	
V	T1	JP	L2	L1	O
VI	T2	T1	JP	L2	L1
VII	A1	T2	T1	JP	L2
VIII	A2	A1	T2	T1	JP
IX		A2	A1	T2	T1
X			A2	A1	T2
XI				A2	A1
XII					A2

It should be noted that the model's operational feasibility requires that the number of days allocated to a station be sufficient for even slow learners to attain mastery. However, the number of days in *all* stations must not exceed the available time fixed by regulation. The procedure adopted is initially to assign to each station the amount of time allocated to that portion of the course in the present system. Subsequently, the *time maximum* for any station can be reduced, or increased, provided there is a compensating decrease elsewhere in the system.

Role of the Cadre

In the operation of this kind of model, the role of the cadre shifts from that of instructor to that of supervisor and administrator of an instructional system. The system relies on the expert knowledge of the cadre to maintain rigorous quality control, through spot-checks of instruction and tests of proficiency. Cadre are also responsible for traffic management and maintenance of discipline, and serve important functions in planning and priming the system.

In the planning stage, the cadre, as subject matter experts, have the major responsibility for redefining course objectives in terms of performance and designing task-modules to incorporate these performance requirements. They must also develop proficiency tests and mastery standards for the defined requirements and make estimates of the time required for slow learners to master the skills in each task-module. (It should be noted that these time estimates do not have to be precise, since the system allows for adjustment during the priming phase. However, the initial estimates should be generous.)

In the priming stage, the cadre are responsible for the initial job-performance and instruction until replaced by the trainees advancing through the system. (The start-up phase is gradual, one station being fully primed before the next station is started, and the old system is phased out in a correspondingly gradual manner. When all cadre have been replaced in these roles in a given station, and all necessary modifications have been made to obtain the stipulated levels of mastery, the next station can be started. Until then, graduates of a station return to the regular course for the rest of their training.)

The model's teacher-student ratio of one-to-one may be temporarily suspended during the priming stage if the number of cadre cannot support this ratio. A ratio of four- or five-to one is probably sufficient in most cases.

Based on a minimum-day module, the priming of a station and the phasing out of cadre can be represented as in Table 3.

Table 3

Priming of Station and Phasing Out of Cadre

Training Day	Class 1	Class 2	Class 3	Class 4
I	C- O			
II	C- L	C- O		
III	JP -3	C- L	C- O	
IV	T -3	JP -4	C- L	C- O
V	(A1)	T -4	JP -5	C- L
VI	(A2)	(A1)	T -5	JP -6
VII		(A2)	(A1)	T -6
VIII			(A2)	(A1)
IX				(A2)

The symbols aligned vertically with each class number (O, L, JP, T, A) are identical with Table 1. The left-hand symbols denote the peer instructors whom trainees observe and learn from ("C"-cadre). The right-hand symbols denote the class receiving instruction. For example, on day III, Class 3 has just entered the station and is observing Class 1 performing the job (JP). (This information is contained in the columns for both Classes 1 and 3). On day III, Class 2 is on its learning day under the instruction of cadre.

CONCLUSION

This paper has described the objectives and constraints that led to the development of a peer-instructional model of training. A prototype of this model has proved successful in preliminary tests, but it remains to be seen whether the model is generally suitable for the wide variety of application for which it is intended.

A full-scale test of the model is planned for early FY 71. Current plans call for the test to be conducted in an ongoing CST course with course personnel responsible for planning, priming and operation. The role of the Work Unit staff will focus on consultation and data collection.

When the system is in operation, we will begin examination of the effects of incentive systems on trainee proficiency. In addition, we will initiate a study of ways to accelerate and utilize rapid learners in the system.

The training model involves changes in the nature of the roles of cadre and trainees, calling for a higher degree of responsibility from trainees of all aptitude levels. Since attitude changes have been evident in the preliminary research phases, we will further examine the areas of role and attitude change for possible implications, especially with regard to training systems appropriate for an Army composed of volunteers.