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AD-A160 678

PRELIMINARY ASSESSMENT OF SOLDIER PERFORMANCE
ON LAND NAVIGATION AND MAP READING TASKS (1982)

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for

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER RESEARCH NOTE 85-91	2. GOVT ACCESSION NO. AD-A160678	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Preliminary Assessment of Soldier Performance on Land Navigation and Map Reading Tasks (1982)	5. TYPE OF REPORT & PERIOD COVERED Feb. 1983 - May 1983	
	6. PERFORMING ORG. REPORT NUMBER --	
7. AUTHOR(s) Robert J. Pleban and M. Janell Grainer	8. CONTRACT OR GRANT NUMBER(s) --	
9. PERFORMING ORGANIZATION NAME AND ADDRESS ARI Field Unit at Fort Benning, Georgia P.O. Box 2086 Fort Benning, GA 31905-0686	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 2Q162717A790	
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Institute for the Behavioral and Social Sciences, 5001 Eisenhower Avenue, Alexandria, VA 22333-5600	12. REPORT DATE September 1985	
	13. NUMBER OF PAGES 25	
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) --	15. SECURITY CLASS. (of this report) Unclassified	
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE	
16. DISTRIBUTION STATEMENT (of this Report) -- Approved for public release; distribution unlimited.		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report) --		
18. SUPPLEMENTARY NOTES --		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Map Reading Land Navigation		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The present study summarizes soldier performance on end-of-course tests in land navigation and map reading at Ft. Benning for the year 1982. Summary data are reported for the following courses: One Station Unit Training (OSUT) Advanced Non-Commissioned Officer Test (ANCO), Infantry Officer Basic Course (IOBC), Infantry Officer Advanced Course (IOAC), and Officer Candidate/Branch Inmaterial Candidate Course (OCS/BIOCC). First administration failure rates (No Gos) for the above-mentioned courses range from 15-22%. The significance of these failure rates are discussed, as are suggestions for future research.		

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Proficiency in both land navigation and map reading is critical in placing every unit and every weapon system, no matter what size, into effective action on today's battlefield. Observations at the National Training Center (NTC) indicate, however, that land navigation and map reading are performed poorly. A recent report by the Government Accounting Office noted that units training at NTC are plagued by "systemic deficiencies" in four areas - one of which is land navigation. Of the ten brigades which had trained at the NTC as of 18 November 1982, all ten brigades had weaknesses in navigation.

Based in part by these findings, the Army Research Institute (ARI) has been tasked to conduct research to improve Army wide instruction in map reading and land navigation. In response, ARI Ft. Benning Field Unit has initiated research to critically assess Army wide training and review factors that may have an adverse impact on map reading and land navigation performance.

One of the first steps in this assessment process entailed summarizing the available data on soldier proficiency in both land navigation and map reading in the Army. The present study summarizes end of course test results for land navigation and map reading for 1982 at Ft. Benning.

Method

Test results were obtained from the following courses: OSUT, ANCOC, IOBC, IOAC, and OCS/BIOCC¹. The major findings for each course are described in the sections which follow.

¹Test results for ANCOC, IOBC, IOAC, and OCS are maintained only for the most recent twelve month period. Therefore, when yearly performance data was requested in March 1983 for the year 1982, the obtained test results covered (approximately) March 1982 - February 1983.

Performance data for PNCOC (Primary Non-Commissioned Officers Course) and BNCOC (Basic Non-Commissioned Officers Course) for 1982 were not obtainable since test results are destroyed following the completion of each course.

Results

OSUT (One Station Unit Training)

As a graduation requirement, soldiers are tested on a minimum of 40 POIQT (Performance Oriented Infantry Qualification Test) tasks following the completion of their training². Seventy percent of the tasks must be passed in order to graduate. Under the current standards an enlistee may fail all tasks in a particular area such as land navigation and map reading and still graduate as long as the total score does not drop below 70%.

Three of the 40 POIQT tasks deal specifically with land navigation and map reading. These tasks are:

Task 7: Determine a magnetic azimuth using a compass.

Task 8: Identify terrain features (natural and manmade) on the map.

Task 9: Determine the grid coordinates of a point on a map using the military grid reference system.

To receive a passing score (i.e., Go) the enlistee must meet all criteria established for the specified task. The criteria associated with each task are listed below.

Task 7

- 1) Remove helmet and weapon and place them aside.
- 2) Determine azimuth to within 3 degrees (50 mils).
- 3) Determine azimuth within 1 minute.

² Currently, for an enlistee to graduate from OSUT he must pass 70% of the POIQT tasks. Theoretically, he can be tested on as many as 40 tasks. Formal testing for graduation takes place upon completion of the 12-week OSUT course. If an enlistee fails more than 30% of the tasks, he is retested immediately on the failed tasks. If the necessary number of tasks aren't passed, he is retested again on all tasks. If a satisfactory score is not obtained, the enlistee may be retested a third time or the commander may recommend that he be discharged under the Trainee Discharge Program (TDP).

Beginning summer 1983, the soldier must pass 90% of the POIQT tasks. Formal testing for graduation will occur during the middle of the training cycle and at the end of the cycle.

The mid-cycle test will consist of 15 basic training tasks and 5 infantry common tasks. The end of cycle test will consist of 15 basic training tasks, 5 infantry common tasks, and 5 NOS specific tasks.

Task 8

- 1) Identify terrain features.
 - a) Hilltop
 - b) Valley
 - c) Ridge
 - d) Saddle
 - e) Depression
- 2) Complete performance measure 1a-e within 3 minutes.

Task 9

- 1) Correctly use 100,000-meter grid square identifier.
- 2) Determine the 6-digit grid coordinates to within 100 meters for the point designated.
- 3) Complete performance measures 1-2 within two minutes.

The performance data for 1982 showed that 16% of the soldiers failed task 7, 16% failed task 8 and 22% failed task 9 (See Table 1). If 20% or more of the unit fail a particular task the unit cadre list, on a separate comment sheet, the specific performance measure (criterion) that was failed. Additional comments are sometimes included (See Appendix A). Tables 2, 3, and 4 show the frequency with which a given performance measure was failed. For task 7, the majority of errors centered around the second performance measure. Enlistees failed to determine the azimuth to within 3 degrees (50 mils).

Error breakdown for task 8 indicates that most errors occurred because enlistees could not differentiate between a valley and a ridge. Error breakdown for task 9 indicated that the majority of enlistees failed to determine six-digit grid coordinates to within 100 meters for a designated point.

Task difficulty. To obtain some idea of the difficulty of the three land navigation/map reading tasks in relation to the other POIQT tasks, a random sample of 23 units was selected (covering the entire twelve month period for 1982). Task difficulty was defined by the number of enlistees who failed (i.e., received a No Go) a given task. The tasks were then rank ordered from most to least difficult for each of the units that were sampled. Once this was accomplished, the mean rank order for each task was determined. (See Table 5).

Table 1

End of Course Test Results for POIQT Land Navigation Tasks
(January 1982 - December 1982)

<u>TASK</u>	<u>Total N</u>	<u># Gos</u>	<u>% Gos</u>	<u># No Gos</u>	<u>% No Gos</u>
Determine a magnetic azimuth using a compass	25,247	21,204	84	4,043	16
Identify terrain features (natural and manmade) on the map	25,247	21,304	84	3,943	16
Determine the grid coordinates of a point on a military map using the military grid reference system	25,247	19,592	78	5,655	22

Table 2

Error Breakdown for POIQT Task Number 7:
Determine a Magnetic Azimuth Using a Compass

<u>Performance Measures</u> ^a	<u>Frequency of Occurrence</u>
1. (Did not) remove helmet and weapon and place them aside.	0 ^b
2. (Did not) determine azimuth to within 3 degrees (50 mils).	36
3. (Did not) determine azimuth within 1 minute.	2

^aThese performance measures serve as the actual criteria that are used by graders to assess soldier proficiency on this specific POIQT end of course task. If 20% or more of the company failed to meet any one of the criteria, that specific measure was listed along with any related comments in the summary report for the commander.

^bThis figure represents the number of companies who reported failure rates of 20% or greater for the specific performance measure in question.

Table 3

Error Breakdown for POIQT Task Number 8:
 Identify Terrain Features (Natural and Manmade) on the Map

<u>Performance Measures^a</u>	<u>Frequency of Occurrence</u>
1. (Did not) identify terrain features.	
a. Hilltop	1 ^b
b. Valley	38
c. Ridge	40
d. Saddle	7
e. Depression	2
2. (Did not) complete performance measure 1a-e within 3 minutes.	0

^aSee footnote in Table 2

^bSee footnote in Table 2

Table 4

Error Breakdown for POIQT Task Number 9:
 Determine the Grid Coordinates of a Point on a Military Map
 Using the Military Grid Reference System

<u>Performance Measures</u> ^a	<u>Frequency of Occurrence</u>
1. (Did not) correctly use 100,000-meter grid square identifier.	4 ^b
2. (Did not) determine six-digit grid coordinates to within 100 meters for designated point.	49
3. (Did not) complete performance measures 1-2 within 2 minutes.	3

^a See footnote in Table 2

^b See footnote in Table 2

Table 5

Mean Rank Order Difficulty for End of Course POIQT Tasks
for OSUT (January 1982 - December 1982)^a

<u>Task Description</u>	<u>Task #</u>	<u>Mean, Rank^b</u>	<u>S.D.</u>
Perform operator Maintenance on an M16A1 Rifle, magazine, and ammunition	31	3.5	3
Install and fire an M18A1 claymore mine	26	4.5	2.6
Determine grid coordinates of a point using the military grid reference system	9	7.4	4.6
Put on and wear M17-Series protective mask	15	7.9	6.0
Load, reduce a stoppage, and clear an M16A1 rifle	30	7.9	5.2
Collect/report information--salute	25	8.1	4.4
Perform mouth-to-mouth resuscitation	5	8.2	6.4
Decontaminate your skin	19	8.7	4.6
Apply immediate action to correct a malfunction on an M72A2 LAW	34	8.9	5.5
Determine a magnetic azimuth using a compass	7	10.1	5
Identify terrain features (natural and manmade) on a map	8	11.3	4.3
Install the M16A1 bounding antipersonnel mine (without tripwires)	29	11.9	7.3
Use challenge and password	23	14	6.7
Identify friendly and threat (OPFOR) armored vehicles	24	15.1	7.3
Prepare an M72A2 LAW for firing	33	15.6	6.1
Locate mines by probing	27	16.2	6
Load, unload, and clear M203 grenade launcher	35	17.3	5.8

<u>Task Description</u>	<u>Task #</u>	<u>Mean Rank^b</u>	<u>S.D.</u>
Install radio set AN/PRC-77 for operation	1	18.3	4.7
Put on a field or pressure dressing	3	18.4	5.9
Move under direct fire	12	18.8	6.7
Prevent shock	4	19	8.2
Install M21 metallic antitank (AT) mine	28	19.3	5.9
Splint a suspected broken arm or leg	6	20.9	5.4
Recognize and give first aid to a nerve-agent casualty	17	20.9	5
Use limited visibility firing techniques with the M16A1 rifle	32	22.6	5.1
Give the alarm for a chemical or biological (CB) hazard	16	22.8	5.8
React to a nuclear hazard	22	27.2	3.5
Use visual signals to control movement (dismounted)	13	27.5	2.8
Install telephone set (TA-1/PT)	2	28.4	2.0
Recognize and react to chemical or biological (CB) hazards	21	28.5	2.9
Select temporary fighting positions	11	29.3	1.8
React to indirect fire	10	29.5	1.4

^aThe information reported is based on a random sample of 23 units drawn from the complete data base of 143 companies for the period January 1982 to December 1982.

^bTasks are rank ordered from most to least difficult.

Table 5 indicates that task 9 was the third hardest task of the 32 tasks that were ranked. Moreover, all three land navigation/map-reading tasks were located in the top third of the difficulty range.³

Clearly, these three tasks were among the more difficult of the POIQT tasks that were tested. In terms of percentage of No Gos, however, it is difficult to make an unequivocal judgment as to whether the present 16-20% No Go rate represents a serious problem. Personal communication with an officer who was responsible for the development of the OSUT Program of Instruction indicated that the current rate is too high and should be cut to approximately 10% (CPT Bennett, DTD, 3/25/83).

Performance over time. A breakdown of the OSUT performance data by month yielded an interesting pattern. Fewer No Gos were reported in the last four months of 1982 for tasks 7, 8, and 9. The percentage of No Gos is consistently in the lower teens or lower for the last four months of the year as compared to a No Go rate in the high teens to low thirties for the first eight months. All three tasks seemed to show the same basic trend (See Appendices B, C, and D).

Because this trend seemed so pronounced (and unexpected) it was felt that additional performance data from 1981 should be collected so that a comparison of the No Go rates between the two years could be made. This task proved to be impossible for the first six months of 1981 since the specific information that was required could not be extracted from the records. The remainder of the year did not include test results for task 9 since this task was not introduced into the POIQT until January 1982. Performance data for tasks 7 and 8 was available for the last half of 1981. For whatever reason, though, units were not tested consistently on task 8 during this time period.

A comparison between the two years showed that the trend observed in 1982 was not present in the 1981 data. This suggests that the increased percentage of Gos for the land navigation/map-reading tasks for the last four months of 1982 may have been an aberration instead of a portion of a cyclical yearly trend. To be certain, however, further research would be needed using longer time intervals. (See Appendices E and F)

ANGOC (Advanced Non-Commissioned Officer Course)

Proficiency in the land navigation/map-reading phase of the Advanced Non-Commissioned Officer Course is assessed using a nine-item test totalling 100 points. (See Appendix G for an example of the type of test used.) To receive a passing grade, students must obtain a score of 70 or greater. The test is conducted in daylight and must be completed within three and one-half hours. For every minute over the time limit that it takes to complete the test, two points are deducted from the students' total score. Points are also deducted for certain items based on degree of accuracy. For items 1, 3, and 5 students are required to give an eight-digit grid coordinate which must be within 50 meters of the actual location on the stake. For every 10 meters that the

³Tasks 14, 18, 20, 36, 37, 38, 39, and 40 were eliminated from consideration since they were not included in the end-of-course test for the majority of companies. (Performance on tasks 36-40 was assessed only once.)

student is off points are systematically deducted as shown below:

<u>Meters Off</u>	<u>Points Deducted</u>
0-50	0
60	3
70	5
80	7
90	9
100(+)	11

Item 9 also requires the student to give an eight-digit grid coordinate, but the point deduction pattern is different. This is shown below:

<u>Meters Off</u>	<u>Points Deducted</u>
0-50	0
60	2
70	4
80	6
90	8
100(+)	11

In addition, one point is deducted if the grid square identifier does not precede the eight-digit grid coordinate.

For item 7 the student is required to give the number of a stake at a particular location on the ground. He must come within one stake (on either side) of the correct stake.

For every stake (over + 1 stake) that the student is off, points are deducted as shown below:

<u>Stakes Off</u>	<u>Points Deducted</u>
1	0
2	3
3	5
4	7
5(+)	10

For questions 2, 4, 6, and 8 no deviation is allowed.

Analysis of the various items indicate that questions 1, 3, and 5 deal primarily with map/terrain association while questions 2, 4, and 6 entail both land navigation and map/terrain association. Question 7 is primarily a land navigation problem. Question 8 is a map-reading problem which requires that the

student be familiar with grid-magnetic conversions. Question 9 requires the student to locate an unknown point on the map (ground) using resection.⁴

End of course test results for ANCOC (March 1982 - March 1983) revealed that 82% of the students passed the test on the first administration. If the test was failed, the individual was allowed one retest. A different version of the same exam was used for the retest. Of those failing on the first administration, 76% passed when retested (See Table 6).

IOBC (Infantry Officer Basic Course)

For the IOBC, students receive the same general type of test as that given in ANCOC. However, in addition to the nine items in Appendix G, there is also a night land navigation phase consisting of two items. The eleven items are worth a total of 100 points. As in ANCOC, to pass the land navigation/map reading phase of instruction, students must obtain a score of 70 or higher on the test.

If the test is failed, students are allowed one retest. A second retest is allowed if approved by the Brigade Commander. Different versions of the same exam are used for retests.

End of course test results for March 1982 - March 1983 indicated that 82% passed the test conducted during daylight hours, and 87% passed the night test on first administration (See Table 6). Of those who failed the first administration, 73% passed the daylight retest and 79% passed the night retest. Of those who failed the first retest, 58% passed the second retest for the daylight part and, 81% passed the night part. Results are reported for a third retest (N=3). This administration may be a direct result of some students missing the first administration. Therefore, the third retest would be equivalent to the second retest for these students.

IOAC (Infantry Officer Advanced Course)

The test format and criteria are identical to ANCOC. If a student fails the first test, he is allowed one retest. A second retest is possible but is administered only in special cases. End of course test results showed that 85% of the students passed the test on the first administration (See Table 6). Of those students who failed the first administration, 67% passed the first retest. Of those who failed the first retest, 81% who took the second retest earned a passing score.

OCS/BIOCC: (Officer Candidate School/Branch Immaterial Officer Candidate Course)

The test format and criteria are identical to ANCOC. Like IOAC, if a student fails the first test, he is allowed one retest. A second retest is possible, but is administered only in special cases. OCS test results indicated that 82% of the students passed the test upon first administration. Of those who failed the first administration, 79% passed the first retest. Of those

⁴ Apparently, the structure of the exam never changes. That is, questions 1, 3, and 5 for example, will always deal with map/terrain association, no matter what version of the exam is used.

Table 6

End of Course Test Results Presented by Course for
Land Navigation/Map Reading (March 1982 - March 1983)

<u>ANCOC</u>			
<u>Test</u>	<u>Total N</u>	<u># Gos</u>	<u>% Pass</u>
First Administration	686	560	82
Retest	110	83	76

<u>IOBC</u>				
<u>Test</u>	<u>Total N</u>	<u># Gos</u>	<u>% Pass</u>	
First Administration	Day	1330	1096	82
	Night	1320	1152	87
First Retest	Day	204	148	73
	Night	141	112	79
Second Retest	Day	45	26	58
	Night	21	17	81
Third Retest	Day	3	1	33

Table 6 - Continued

<u>Test</u>	<u>IOAC</u>		
	<u>Total N</u>	<u># Gos</u>	<u>% Pass</u>
First Administration	1177	1004	85
First Retest	149	100	67
Second Retest	16	13	81

<u>Test</u>	<u>OCS</u>		
	<u>Total N</u>	<u># Gos</u>	<u>% Pass</u>
First Administration	1134	934	82
First Retest	197	156	79
Second Retest	13	11	85

students who failed the first retest, 85% passed the second retest (See Table 6).

Discussion

As was the case with OSUT, the question of whether or not the present No Go rate in ANCOC, IOBC, IOAC, and OCS represents a significant problem is difficult to answer. Percentage-wise the No Go rates for these courses were as follows (these figures are based on the first administration): ANCOC, No Gos = 18%; IOBC, No Gos = 18%; IOAC, No Gos = 15%; OCS, No Gos = 18%. In terms of actual numbers, the failure rate for the first administration for ANCOC, IOBC, IOAC, and OCS was: 126, 236, 173, and 200 respectively.

In one respect it might be argued that the current No Go rate in ANCOC, IOBC, IOAC, and OCS is too high since the individuals attending these courses are either officers or high ranking NCOs who occupy (or will occupy) critical leadership positions in their unit, and thus, should be competent in all combat survival tasks, which include land navigation and map reading. When mistakes are made at this level, the consequences are magnified because of the number of individuals who will be affected by the error.

Discussions with an officer from the land navigation committee (CPT Black, Personal Communication 3-28-83) provided some support for this conclusion. However, this officer noted that the relatively high percentage of No Gos may be a result of a number of factors. For example, a number of students failed the land navigation and map reading test, not because they could not read maps, but because they made careless math or clerical errors. Also, the land navigation tasks are more performance oriented in nature and these tasks generally result in greater failure rates than tasks in which the individual must simply memorize a number of facts or procedures and recall the information at a later date.

While the land navigation tasks are more performance oriented, and generally more difficult, this should not be allowed to serve as an excuse for the high No Go rate which presently exists in the advanced courses. In conclusion, to the extent that the current No Go rate for land navigation and map reading in ANCOC, IOBC, IOAC, and OCS can be regarded as serious, then it would seem that the next step should be to try and identify those conditions which may contribute to the soldiers' difficulty in mastering the skills necessary to become proficient in these critical combat tasks.

Appendix A

Related Comments for Performance Measure 2, Task 7

	<u>Frequency of Occurrence</u>
o Azimuth reported in meters or feet.	1 ^a
o Failure to hold compass level while sighting.	1
o Four reports of failure to state whether azimuth was in degrees or mils.	1
o Incorrect reading of the azimuth.	1

Related Comments for Performance Measure 1, Task 8

	<u>Frequency of Occurrence</u>
o Could not differentiate between a valley and a ridge.	4 ^a
o Most failed to understand any terrain features.	3

^aThis figure represents the number of companies who reported failure rates of 20% or greater for the specific performance measure in question.

Related Comments for Performance Measure 1, Task 9

	<u>Frequency of Occurrence</u>
o Soldiers used the incorrect grid square identifier.	2 ^a
o Difficulty with grid square identifier.	2
o Used grid square identifier from reinforcement training maps.	3
o Reversal of grid square identifier.	1
o Did not understand how to find grid square identifier.	1

Related Comments for Performance Measure 2, Task 9

	<u>Frequency of Occurrence</u>
o Reversed first 3-digits with last 3-digits	1 ^a
o Soldiers used wrong scale on the protractor	1
o Protractor used incorrectly	10

^aThis figure represents the number of companies who reported failure rates of 20% or greater for the specific performance measure in question.

Appendix B

End of Course Test Results Presented by Month for POIQT
 Task Number 7: Determine a Magnetic Azimuth
 Using a Compass^a

<u>Month</u>	<u>Total N</u>	<u># Gos</u>	<u>% Gos</u>	<u># No Gos</u>	<u>% No Gos</u>
Jan	1629	1263	78	366	22
Feb	1841	1526	83	315	17
Mar	1555	1359	87	196	13
Apr	2686	2182	81	504	19
May	2476	1880	76	596	24
Jun	2155	1755	81	400	19
Jul	2812	2272	81	540	19
Aug	2108	1685	80	423	20
Sep	2389	2114	88	275	12
Oct	2206	2016	91	190	9
Nov	1859	1707	92	152	8
Dec	1531	1445	94	86	6

^aResults are based on the period of January 1982 - December 1982

Appendix C

End of Course Test Results Presented by Month for POIQT
 Task Number 8: Identify Terrain Features (Natural and Manmade)
 on the Map^a

<u>Month</u>	<u>Total N</u>	<u># Gos</u>	<u>% Gos</u>	<u># No Gos</u>	<u>% No Gos</u>
Jan	1629	1345	83	284	17
Feb	1841	1518	82	323	18
Mar	1555	1311	84	244	16
Apr	2686	2154	80	532	20
May	2476	1953	79	523	21
Jun	2155	1759	82	396	18
Jul	2812	2205	78	607	22
Aug	2108	1672	79	436	21
Sep	2389	2138	92	201	8
Oct	2206	2005	91	201	9
Nov	1859	1713	92	146	8
Dec	1531	1481	97	50	3

^aResults are based on the period of January 1982 - December 1982

Appendix D

End of Course Test Results Presented by Month for POIQT
 Task Number 9: Determine the Grid Coordinates of a Point on a
 Military Map Using the Military Grid Reference System^a

<u>Month</u>	<u>Total N</u>	<u># Gos</u>	<u>% Gos</u>	<u># No Gos</u>	<u>% No Gos</u>
Jan	1629	1262	77	367	23
Feb	1841	1411	77	430	23
Mar	1555	1211	78	344	22
Apr	2686	1985	74	701	26
May	2476	1774	72	702	28
Jun	2155	1545	72	610	28
Jul	2812	1894	67	918	33
Aug	2108	1468	70	640	30
Sep	2389	2040	85	349	15
Oct	2206	1940	88	266	12
Nov	1859	1634	88	225	12
Dec	1531	1428	93	103	7

^aResults are based on the period of January 1982 - December 1982.

Appendix E

End of Course Test Results Presented by Month for
 POIQT Task Number 7: Determine a Magnetic
 Azimuth Using a Compass^a

<u>MONTH</u>	<u>TOTAL N</u>	<u>#Gos</u>	<u>%Gos</u>	<u>#No Gos</u>	<u>%No Gos</u>
Jul	273	224	82	49	18
Aug	1804	1500	83	304	17
Sep	1684	1389	82	295	18
Oct	2713	2218	82	495	18
Nov	1914	1558	81	356	19
Dec	866	746	86	120	14

^a Results are based on the period of July 1981 - December 1981.

Appendix F

End of Course Test Results Presented by Month for
POIQT Task Number 8: Identify Terrain Features
(Natural and Manmade)

<u>MONTH</u>	<u>TOTAL N</u>	<u>#Gos</u>	<u>%Gos</u>	<u>#No Gos</u>	<u>%No Gos</u>
Aug	713	592	83	121	17
Sep	1544	1305	85	239	15
Oct	1363	1011	74	352	26
Nov	1454	1180	81	274	19
Dec	866	755	87	111	13

^aResults are based on the period of August 1981 - December 1981.

Appendix G

Land Navigation Field Experimentation

1. Proceed from your present location to a stake on Yankee Road numbered _____. What is the coordinate location of this stake to the nearest ten meters? (12 points)
2. From this position proceed by any route to coordinate _____. What Position Stake is located at this coordinate? (11 points)
3. Proceed from this position on a magnetic azimuth of _____ to Control Stake located on Control Road. What is the coordinate location of this stake to the nearest ten meters? (12 points)
4. From this position proceed by any route to coordinate _____. What Position Stake is located at this coordinate? (11 points)
5. Return to the Control Road and proceed along this road until you arrive at Control Stake _____. What is the coordinate location of this stake to the nearest ten meters? (12 points)
6. From this position proceed by any route to coordinate _____. What Position Stake is located at this coordinate? (11 points)
7. Return to the Control Road and proceed along this road until you arrive at Control Stake _____. From this Control Stake, what numbered stake is located along Yankee Road on a magnetic azimuth of _____ and a distance in meters of _____. (10 points)
8. On a map sheet having a current G-M angle of _____, determine the magnetic azimuth between two points if the grid azimuth between the same two points is _____. (10 points)
9. An observer is located somewhere on your map sheet. From his location the road junction at GL _____ is on a magnetic azimuth of _____ degrees and the hill top at GL _____ is on a magnetic azimuth of _____ degrees. What is the coordinate of the observer's location to the nearest 10 meters? (11 points)