

Chapter Three

Results, Discussion, Implications, and Recommendations

Problems Encountered

Course record data for the cohort was collected in a timely manner from CTC and MRC and then merged by social security number with demographic data from the Navy Enlisted Master File to produce a total of 11,005 individual data record sets. Examination of these for completeness and accuracy found the following missing or incomplete data fields:

one record was missing age, years of service, and paygrade data

48 records were missing educational level data

57 records were missing end of course grade data

2775 records had missing or incomplete ASVAB data

In an effort to obtain the missing or incomplete data, it was learned that the 57 records containing missing grade data were records which had been classified by MRC as “non-student”. In each of these cases the Sailor had been dropped from the course or term without penalty prior to starting any classes. Accordingly, these 57 records were eliminated from the cohort as not applicable to the study. The 48 records with missing data fields were also dropped from the study because the data were missing and unrecoverable from the EMF, and there was no reason to believe that these records were other than randomly generated due to errors in record keeping. Efforts to collect these missing data from the individuals themselves were considered but abandoned due to inevitable delays in locating each and obtaining permission to use their personal information in the study.

The unanticipated missing or incomplete ASVAB data presented a significant data collection problem due to the importance of ASVAB to the study and the large number of records affected. Like the other 48 records with missing data, the source of the missing ASVAB

data was the EMF and there was no practical way to recover the data. As stated earlier, ASVAB as measured in this study is the composite of Paragraph Comprehension (PC) and Arithmetic Reasoning (AR) test scores. The missing or incomplete data fields consisted of one of three conditions: no data, PC data only, or AR data only.

For the remaining 8230 complete ASVAB records, PC and AR raw scores were converted to an ASVAB composite (AR & PC) using the most current formula established by the Department of Defense for this purpose. This renorming procedure was used to eliminate the possibility of confounded data due to multiple composite norming procedures used over the past 20 - 25 years. However, renorming could not be accomplished for 2775 missing or incomplete ASVAB records due to the aforementioned missing or incomplete raw data. In an effort to retain these 2775 data record sets in the study, it was decided to test for differences in the distribution of grades between records having complete ASVAB data and those with missing or incomplete data. A determination of no significant difference would have permitted this researcher to substitute the mean raw scores in PC and AR from the complete data in place of the missing or incomplete data. Using Levene's test for equality of variances and a two tailed independent samples t test¹, differences in grade were found to be statistically significant ($t(11,003) = 3.28, p < .05$) (see Appendix A). Since there was no reason to believe that the incomplete or missing ASVAB data were other than randomly generated due to errors in record keeping, and considering the large size of the data base overall, it was decided to eliminate the 2775 incomplete records from the study. When combined with the records previously eliminated this resulted in a final data set of 8,124 complete records. These included records of individual courses taken as well as records of multiple courses by Sailors during the 1995-1996 cohort period. Included in this number were 88 records for Sailors who had attempted the same course a second time. The range of data for each variable in the final data set was then examined to

¹ Complete documentation of all statistical tests is contained in the Appendix.

determine the presence of any obvious outliers. All data were found to be well within the range of normal limits and were retained for analysis.

Prior to conducting descriptive analyses on the data, the distribution of end of course grades was measured in order to determine whether the data were suitable for inferential statistical procedures to include hypothesis testing for significant differences among variables. The resulting distribution is shown in Figure 1.

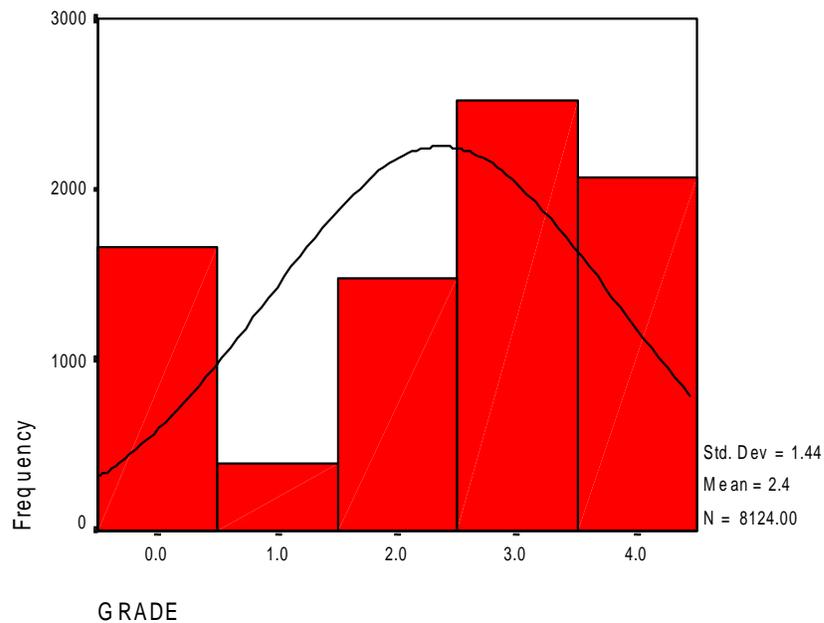


Figure 1. Distribution of Grades. 0.0=F/W; 1.0=D; 2.0=C;3.0=B; 4.0=A

As can be seen, the grade data appear bimodal and do not represent a normal distribution. This abnormal distribution presented the most significant problem with the data because assumptions of normality must be met in order to perform inferential testing. This precluded conducting significance testing of differences observed for the descriptive types of research questions. Nevertheless, answers to the descriptive research questions were derived, analyzed, and reported through purely non-inferential means. The absence of a normal distribution for grade data is not surprising in view of the extensive variation that often occurs in behavioral research of this type. As described earlier, the PACE program is particularly complex in this

regard as there is wide variation in many key factors which were difficult to measure such as motivation, teaching methods, grading criteria, environmental conditions, and command support. The inability to properly control for these variables is one likely reason why much of the experimental media comparison literature reviewed earlier has produced findings of no significant difference.

A minor complication easily resolved was the wide range of data for the following continuous variables:

<u>Variable</u>	<u>Range</u>
Semester hours of recent college courses passed (RECENTCO):	0 - 320
ASVAB (PC +AR) Composite:	56 - 130
Age in years:	18 - 53
Years of Service (YOS):	0 - 21

In order to simplify the analysis and to standardize the reporting process, each of these variables was grouped into five sub categories as shown below:

<u>RECENTCO (Semester Hours)</u>	<u>ASVAB (PC + AR Score)</u>
0	Less than 90
1 - 6	90 - 100
7 - 18	101 - 110
19 - 48	111 - 120
over 48	over 120
<u>AGE</u>	<u>YOS (Years of Service)</u>
20 and below	4 and under
21 - 25	5 - 8
26 - 30	9 - 12
31 - 35	13 - 16
over 35	over 16

Finally, in preparing the data for LOGIT regression analysis (research question 9), some minor complications surfaced while converting multiple course records into a single data record

for Sailors who had taken more than one course. After the data were categorized into 6 course groups as specified in Chapter Two, they were then categorized by social security number to identify records of multiple courses taken by the same Sailor in each course group. Detailed analysis of each set of multiple course records for all course groups revealed that three Sailors had taken multiple courses using more than one delivery mode. Since MODE is a key variable of interest in the planned regression, and in order to abide by the principle of random assignment for regression purposes, it was necessary to select data for only one mode to be used in the single record data set for each Sailor. Accordingly, a coin flip procedure was used to select the records, by delivery mode in each of these three cases. A second issue not previously anticipated in converting multiple record data sets into a single record was the likelihood that any one Sailor would have taken multiple courses in more than one type of ship. There were two instances where Sailors took courses in different ships. However, in each case, the type of ship was the same, requiring no adjustment to the data since ship TYPE, and not SHIP, was the previously specified variable of interest for the regression analysis. No further problems were encountered with the data.

Descriptive Analyses

Research questions 1-7 are reiterated here to facilitate their recall:

1. What is the average end of course grade for Sailors enrolled in PACE by gender, age, marital status, race/ethnicity, ASVAB, educational level, semester hours of recent college courses passed, years of active service, paygrade, rating, ship, type of ship, home port, coast, number of attempts, and delivery mode?
2. Is there a difference in course grade by gender, marital status, race/ethnicity, educational level, paygrade, type of ship, number of attempts, and delivery mode? For those in which there is a difference, which have a mean difference of at least one whole letter grade?
3. Is there a correlation between course grade and ASVAB, semester hours of college courses passed, years of service, and age?
4. Is there a difference in satisfactory course completion rates (A-D Versus W/F) between gender, age, marital status, race/ethnicity, ASVAB, educational level, years of active service, paygrade, type of ship, coast, and delivery mode? For those in which

there is a difference, for which types of ship, delivery modes, ASVAB, etc. do Sailors achieve the highest satisfactory course completion rates?

5. What is the completion rate by ship for Sailors enrolled in PACE who satisfactorily completed college courses during the cohort period of this study?
6. For each delivery mode, what are the percentages of Sailors enrolled in PACE by type of ship, Navy occupational rating, years of service, and paygrade?
7. What are the average ASVAB scores for Sailors enrolled in PACE by educational level, years of service, paygrade, ship type and delivery mode?

Answers to these questions were obtained by calculating frequency distributions, means, standard deviations, correlations, and contingency tables for each variable of interest using SPSS v. 7.51 statistical software. The software was particularly robust yet simple to use in both analyzing the data and in producing clear and concise summary tables and graphs. A series of bar charts has been included with the discussion of each descriptive research question for ease in displaying and interpreting the results. In order to provide continuity and to simplify the reporting of results and implications for each finding, the discussion will focus on one variable at a time until each of the research questions has been answered. It must be reemphasized that these results and implications are based on descriptive statistical procedures only and no prediction or inference is implied from this portion of the study.

Gender: This variable was included in the study to determine whether there were any differences in grade or in satisfactory course completion rates by gender. As can be seen in Figure 2, 7695 males achieved only a slightly higher mean grade than the 429 females in the cohort (2.36 vs. 2.22). Also, successful course completion rates in Figure 3 were only slightly higher for males than females (79.7% vs. 76.5%). These differences appear to be consistent with the research reported earlier by Stone (1988) that differences in failure rates between men and women graduate engineering students were not statistically significant. This finding is not surprising due to the same minimum ASVAB (PC & AR = 100) score requirement for both men and women to take PACE courses. Implications for the college level PACE program from this

analysis are that men and women are likely to perform at nearly the same levels and should require no differential testing or additional screening prior to enrollment in classes.

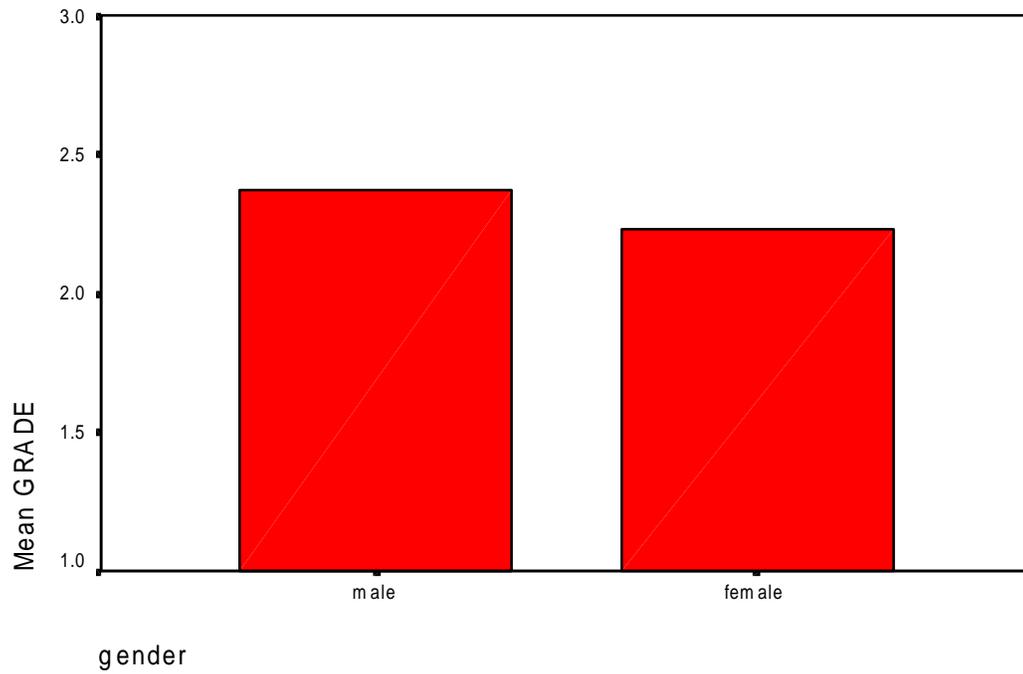


Figure 2. Grade by Gender, N=8124

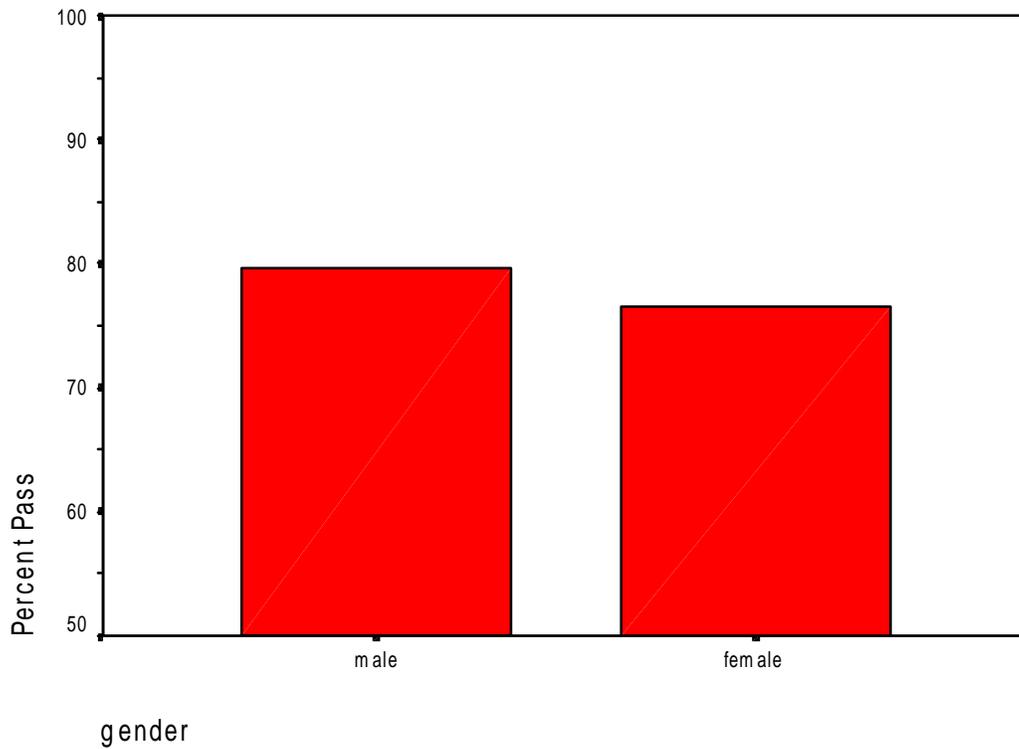


Figure 3. Completion Rate by Gender, N=8124

Age: Like gender, this variable was included because of contradictory findings in the literature as to its possible impact on end of course outcomes. A positive effect of age on grade and satisfactory course completion rates was found as shown in Figures 4 and 5. A Pearson's correlation test was performed on age versus grade resulting in a finding of significant positive correlation ($r = .110, p < .01$) (see Appendix B).

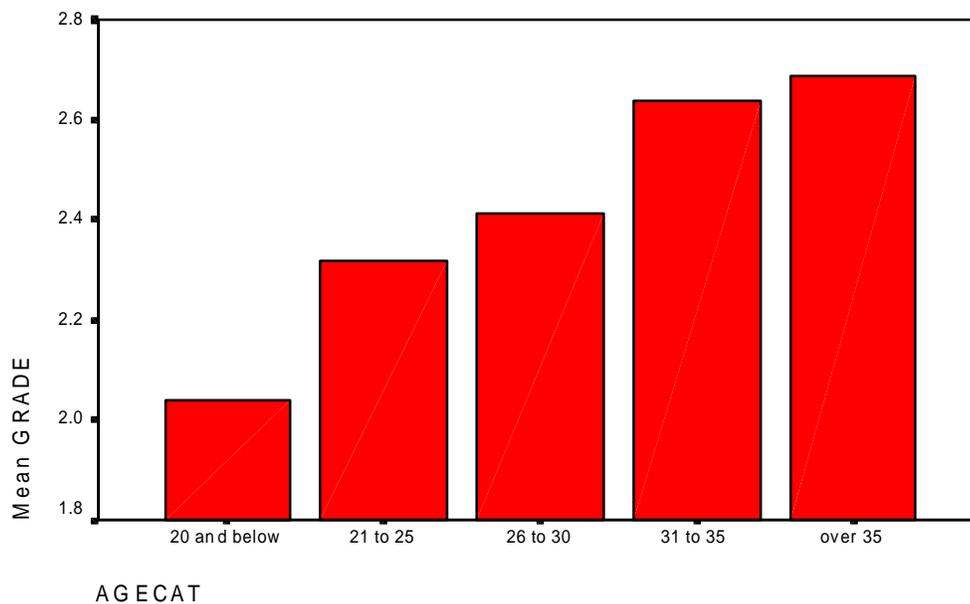


Figure 4. Grade by Age Category, N=8124

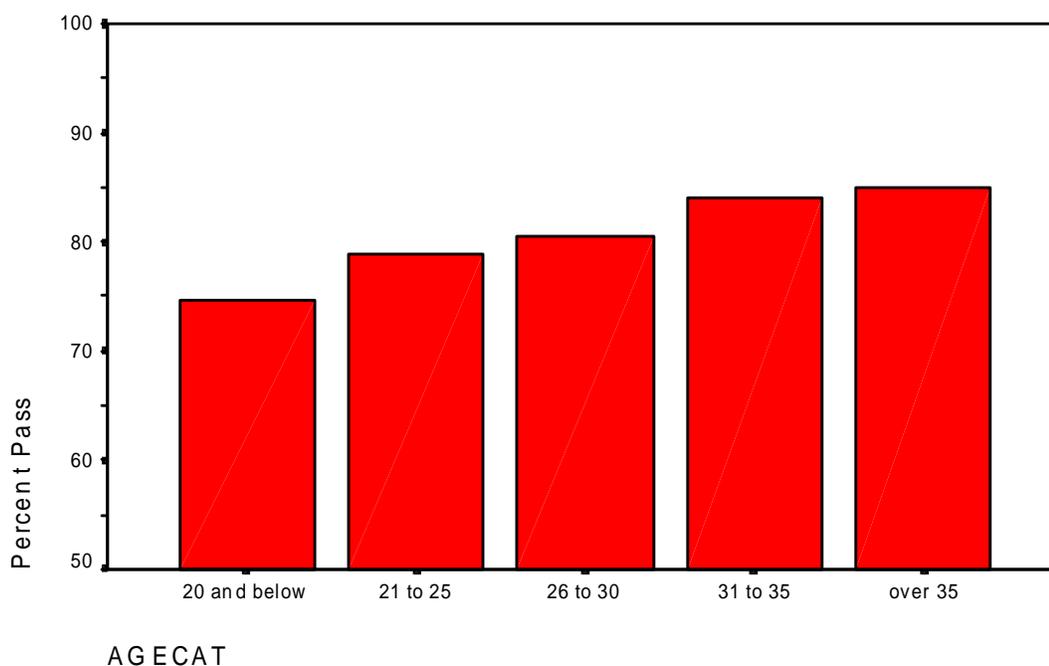


Figure 5. Completion Rate by Age, N=8124

These results are attributed to the rigid performance screening which all Sailors undergo prior to reenlisting every four years. Improvement in PACE performance over time is also not surprising in view of the fact that Sailors not meeting these performance criteria are not permitted to reenlist and are therefore no longer able to take PACE courses beyond a certain point in time. This screening and selection process most likely accounts for improvement in academic performance to a greater extent than age itself. These findings have potentially important implications for reducing costly failure rates and improving end of course outcomes for Sailors taking PACE college courses. For example, for Sailors under age 25, more intense screening combined with additional placement testing might be considered to better assess their aptitude for college courses prior to enrollment.

Marital Status: As shown in Figures 6 and 7, the results obtained for mean grade versus marital status revealed that 3835 married Sailors outperformed 4289 single Sailors (2.48 vs. 2.25), and that overall satisfactory course completion rates were higher for married Sailors as well.

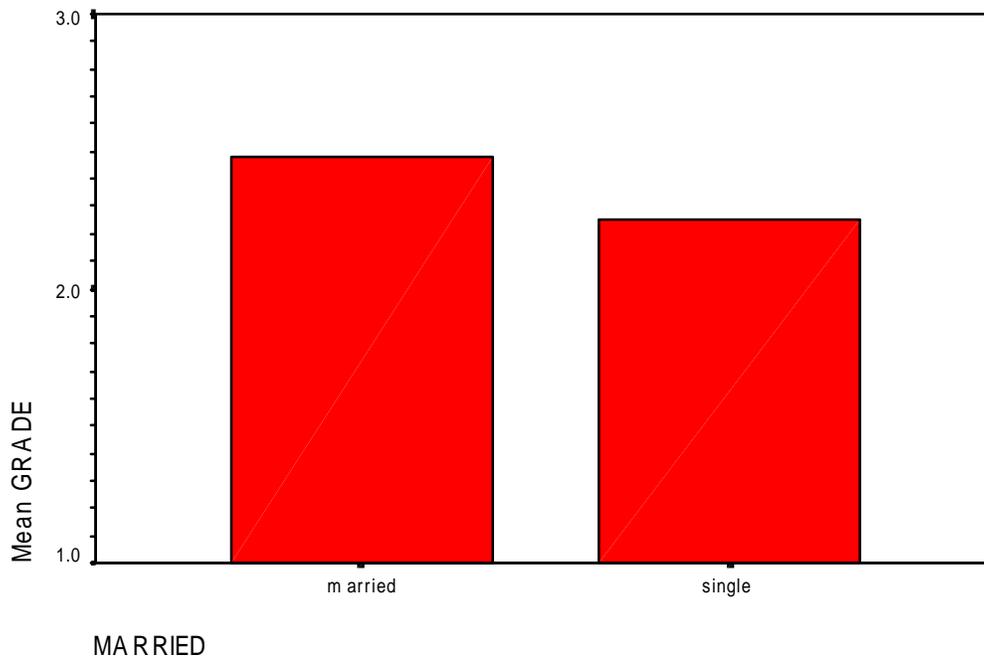


Figure 6. Grade by Marital Status, N=8124

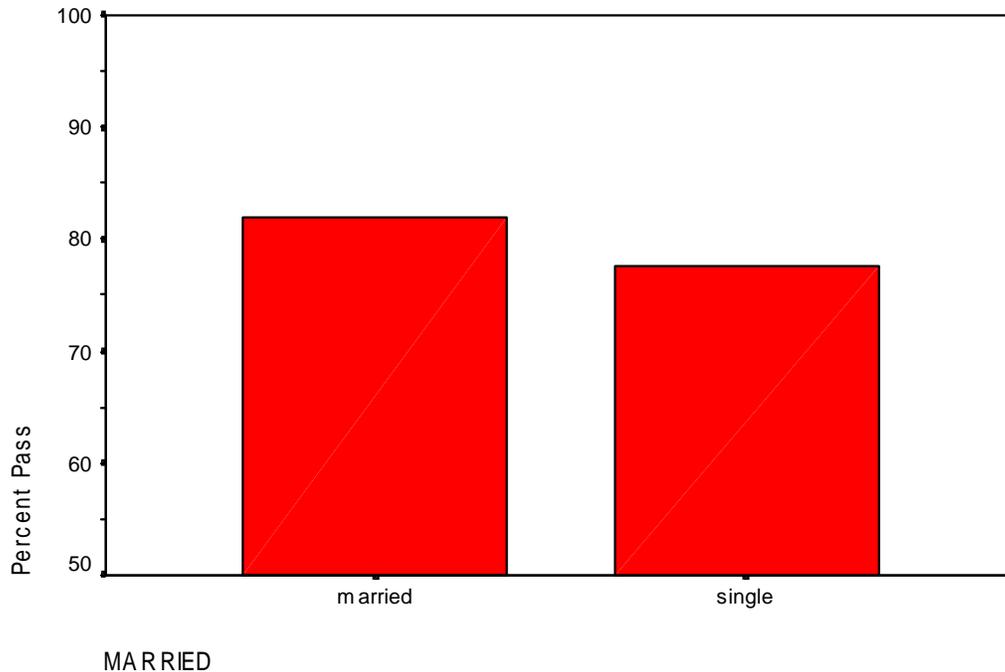


Figure 7. Completion Rate by Marital Status, N=8124

These results were as expected in that married Sailors are generally perceived to be more focused, if not more mature, than their single counterparts. Despite the differences noted, the magnitude of difference in grade was only .23 on a 4.0 scale and for completion rate 4.3% on a scale of 1-100%. These findings indicate that while married Sailors generally do better than single Sailors, differences between them are likely to be relatively minor and probably do not warrant any major procedural changes to the PACE course screening process due to marital status.

Race/Ethnicity: Results of testing mean grade and satisfactory course completion rates by race/ethnicity are shown in Figures 8 and 9.

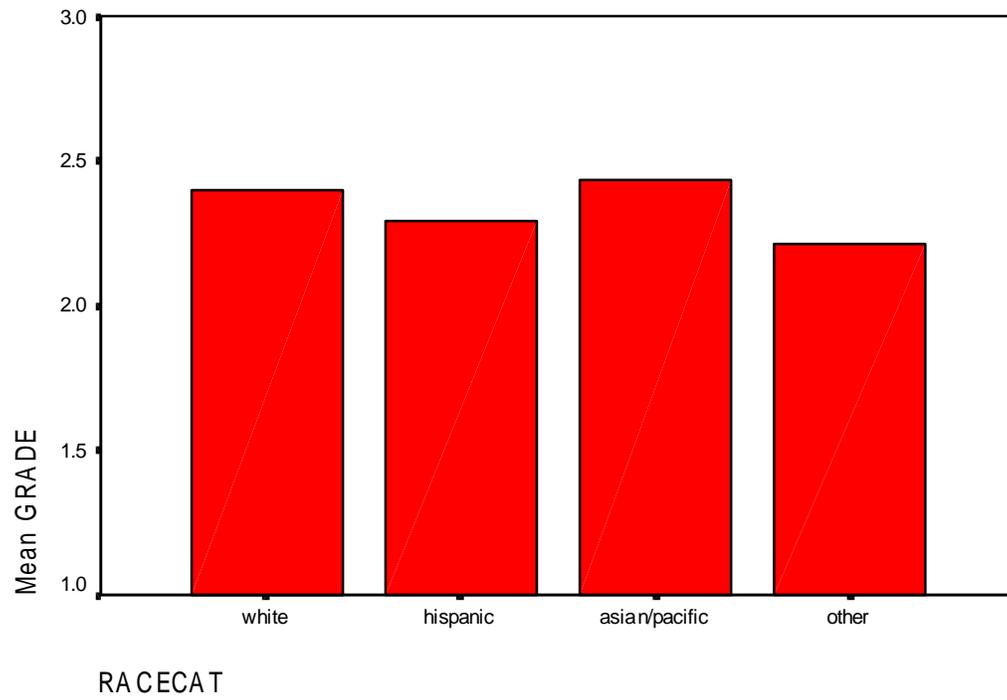


Figure 8. Grade by Race/Ethnicity, N=8124

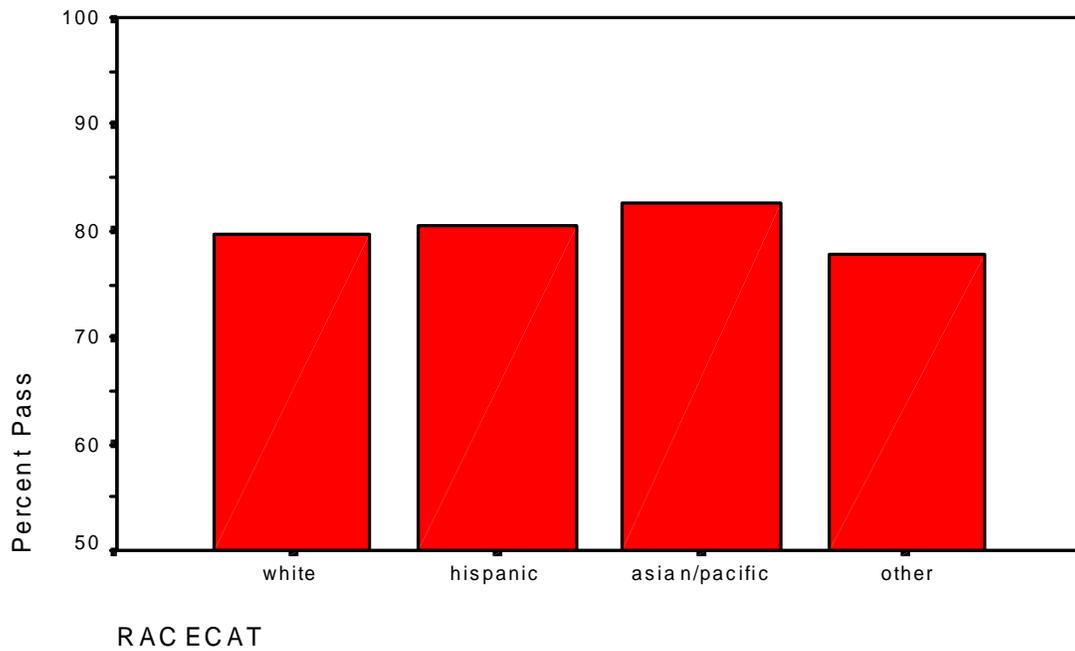


Figure 9. Completion Rate by Race/Ethnicity, N=8124

As expected, there was little difference found among any of the four categories examined in the cohort. “Asian-Pacific Islanders” achieved both the highest mean grade (2.43) and completion rate (82.7%), while results for the category “Other” were slightly below all other groups. Asian-Pacific Islanders comprise less than 4% of the entire cohort, so differences between groups are likely less significant than they appear. These findings are consistent with those of Smittle (1995) cited earlier and may be attributed in part to the minimum ASVAB (PC & AR = 100) required of all PACE participants. Accordingly, no changes to PACE screening on the basis of race or ethnicity appear to be warranted.

ASVAB: A positive correlation was expected to be found between ASVAB Composite (PC + AR) and course grade. As shown in Figure 10, the data generally support this hypothesis with the exception of the higher mean grade for Sailors with an ASVAB of less than 90 and those between 90 and 100.

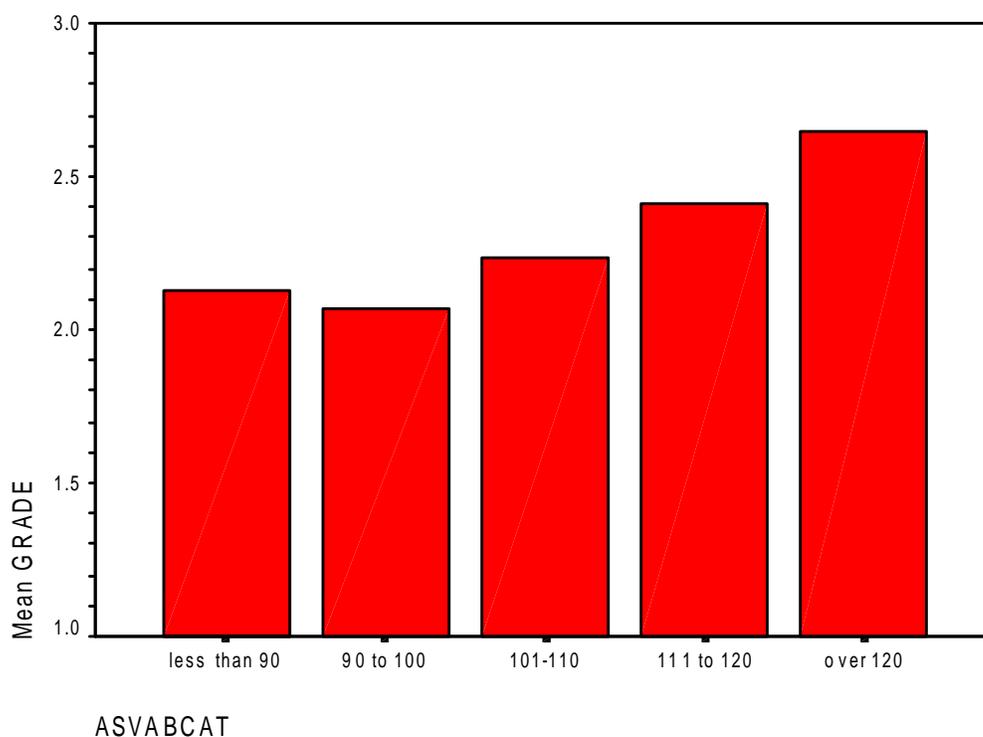


Figure 10. Grade by ASVAB Category, N=8124

This irregularity in the data may be due to Sailors who have not re-taken their ASVAB test but have successfully completed one or more college courses enabling them to pass an asset (placement test) in lieu of meeting the minimum ASVAB score (100) for admission into PACE. These would likely be more senior Sailors who have performed well in the Navy despite their low initial ASVAB score. Re-testing Sailors with an ASVAB below 90 and who have achieved B averages or better in college courses would be one means of validating this explanation. Significant improvement in ASVAB scores for these individuals would enable them to compete more equitably for career programs requiring higher ASVAB scores.

Of particular interest in Figure 10 is the magnitude of the difference in mean grade that occurred between Sailors with an ASVAB of 90-100 and those above 100. The noticeable increase in mean grade that occurred for Sailors above a 100 ASVAB tends to confirm a similar finding by Dunlap et. al (1989) reported earlier in this study. The present results serve to reinforce the wisdom of the Navy's current policy which requires Sailors to achieve a minimum ASVAB Composite (PC + AR) of 100 in order to take PACE courses, unless a passing score is obtained in a related college level asset test.

Satisfactory course completion rates by ASVAB are depicted in Figure 11 below.

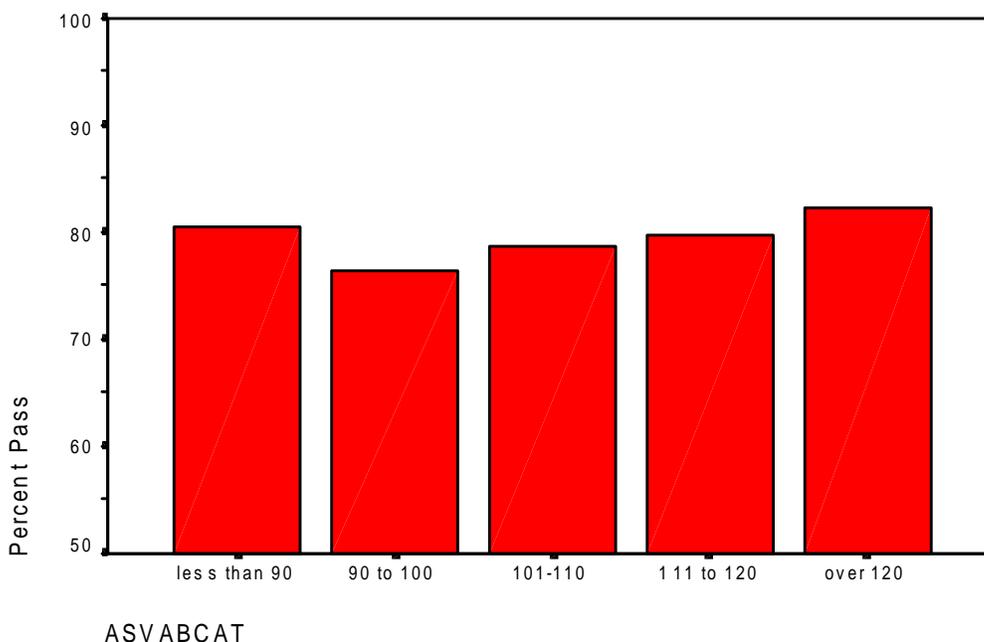


Figure 11. Completion Rate by ASVAB, N=8124

A trend similar to grade was found between ASVAB and course completion rates as well, with rates rising from a low of 76.3% for those with scores of 90-100 to over 82% for scores above 120. Next a Pearson's correlation test determined that there was a significant positive correlation between ASVAB score and grade ($r = .127, p < .01$) (see Appendix C). These findings are consistent with the literature cited earlier that found college student ability levels were correlated with GPA (Lavin, 1965). The data in the present study seem to suggest once again that mental ability as measured by ASVAB Composite (PC + AR) is a critical indicator of how well a Sailor is likely to perform in PACE courses.

Finally for ASVAB, Figures 12-16 provide descriptive summaries of average ASVAB scores for Sailors enrolled in PACE by educational level, years of service, paygrade, ship type, and delivery mode. A brief analysis of each of these findings and potential implications for the PACE program follow each figure.

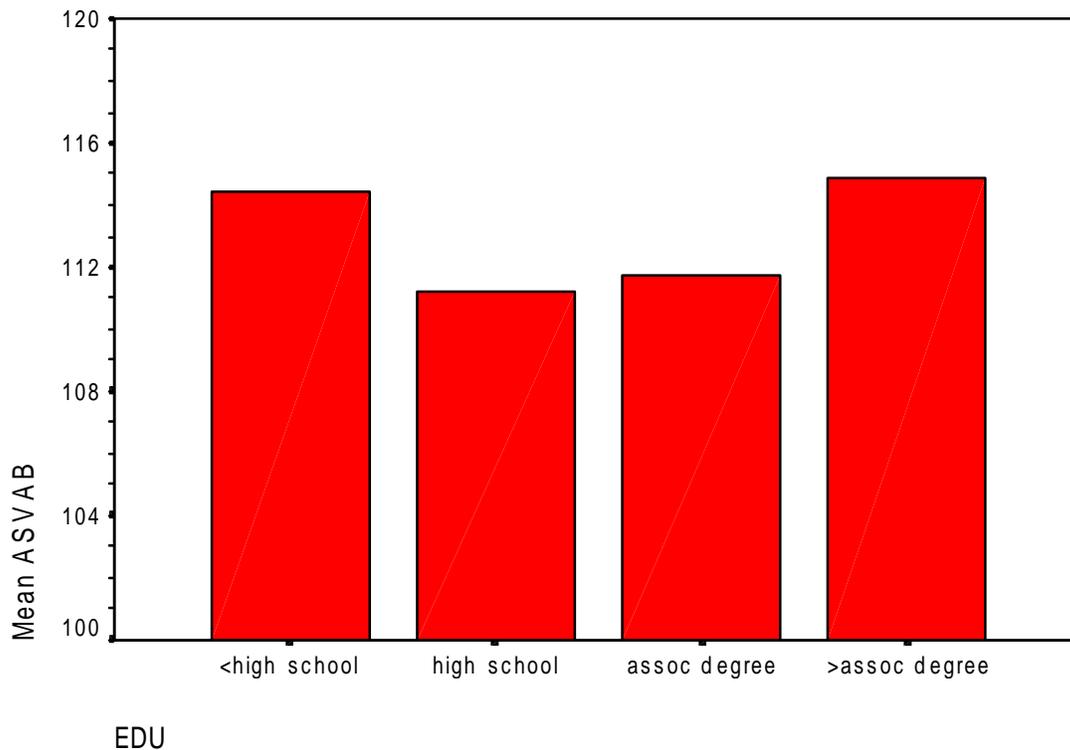


Figure 12. ASVAB Score by Educational Level, N=8124

Sailors with less than a high school education have a higher average ASVAB than do high school graduates and Sailors with an associate's degree. Although this finding is contrary to expectations stated earlier in this study, a possible explanation for this finding may be that many Sailors who failed to complete high school have retaken their ASVAB and were successful in raising their original score. Slight differences in ASVAB between Sailors with a high school diploma and those who have earned an associate's degree are not surprising in view of the comparable effort required for success in each level. On the other hand, those going beyond an associate's degree are likely motivated toward obtaining a bachelor's degree and as expected, have the highest mean ASVAB score. It would appear from these findings that ASVAB score may be a more meaningful measure of ability than education level, particularly at the lower end, for determining a Sailor's potential to succeed in higher education.

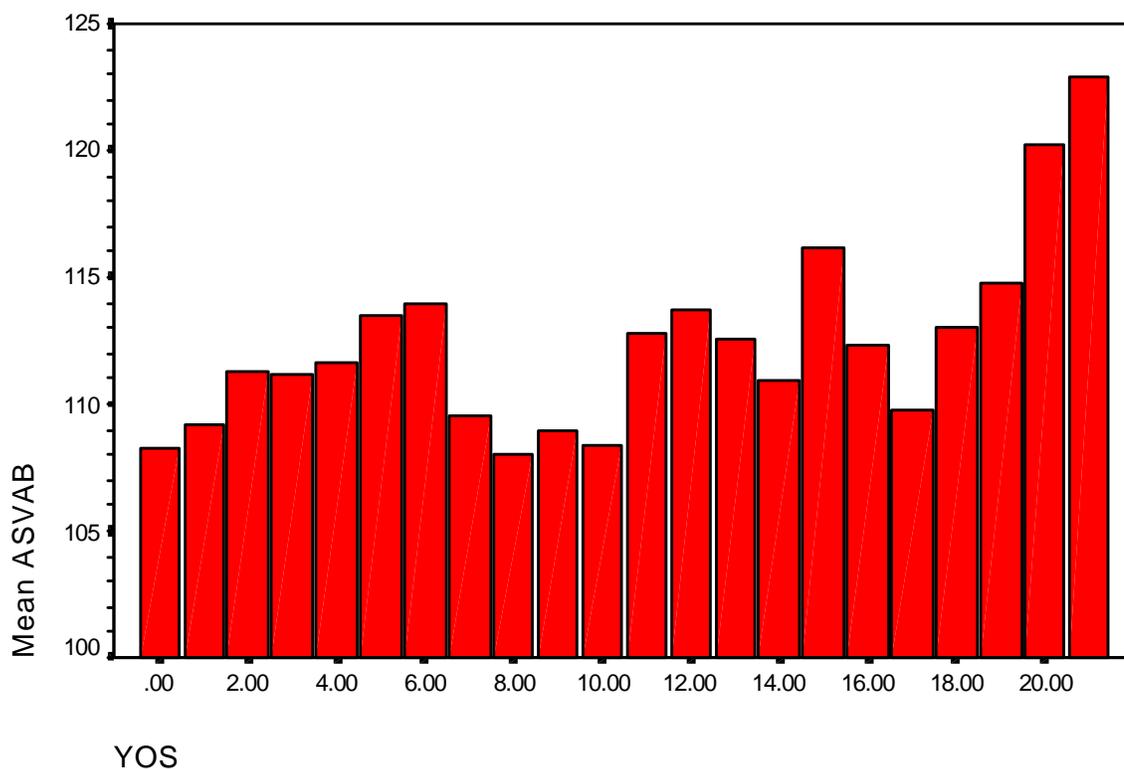


Figure 13. ASVAB Score by Years of Service, N=8124

There is no clear overall trend in the data when examining ASVAB by years of service. This is likely due to the fact that most Sailors take the ASVAB just once upon accession into the Navy and their score remains unchanged regardless of the number of years served. On the other hand, a possible explanation for the relatively strong rise in ASVAB scores between 18 and 21 years of service may be that some career Sailors have retaken the test in order to qualify for career enhancing opportunities requiring a higher ASVAB. In either event, there does not appear to be a relationship between ASVAB and YOS.

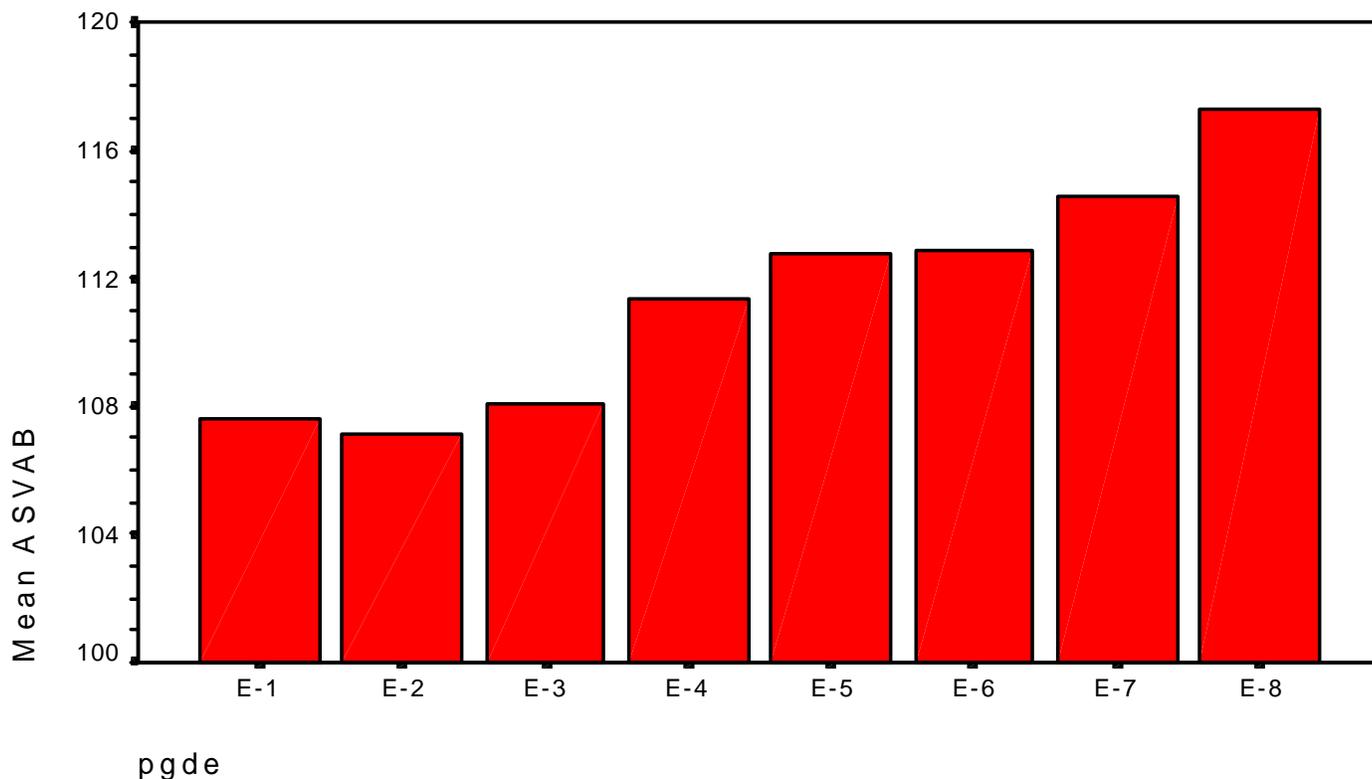


Figure 14. ASVAB Score by Paygrade

Interestingly, a clear, positive relationship was found to exist between ASVAB and paygrade. Unlike years of service, incremental changes in paygrade occur in multiple year intervals and are the result of a thorough screening and selection process. Progression from one

paygrade to the next is a function of a Sailor's performance over a significant period of time. The promotion system attempts to select those best fit for advancement. Sailors with higher ASVAB scores qualify for career enhancing opportunities which make them even more competitive for promotion. Implications from these data are that Sailors in higher paygrades may be more likely to have higher ASVAB scores and in turn produce better grades in PACE courses.

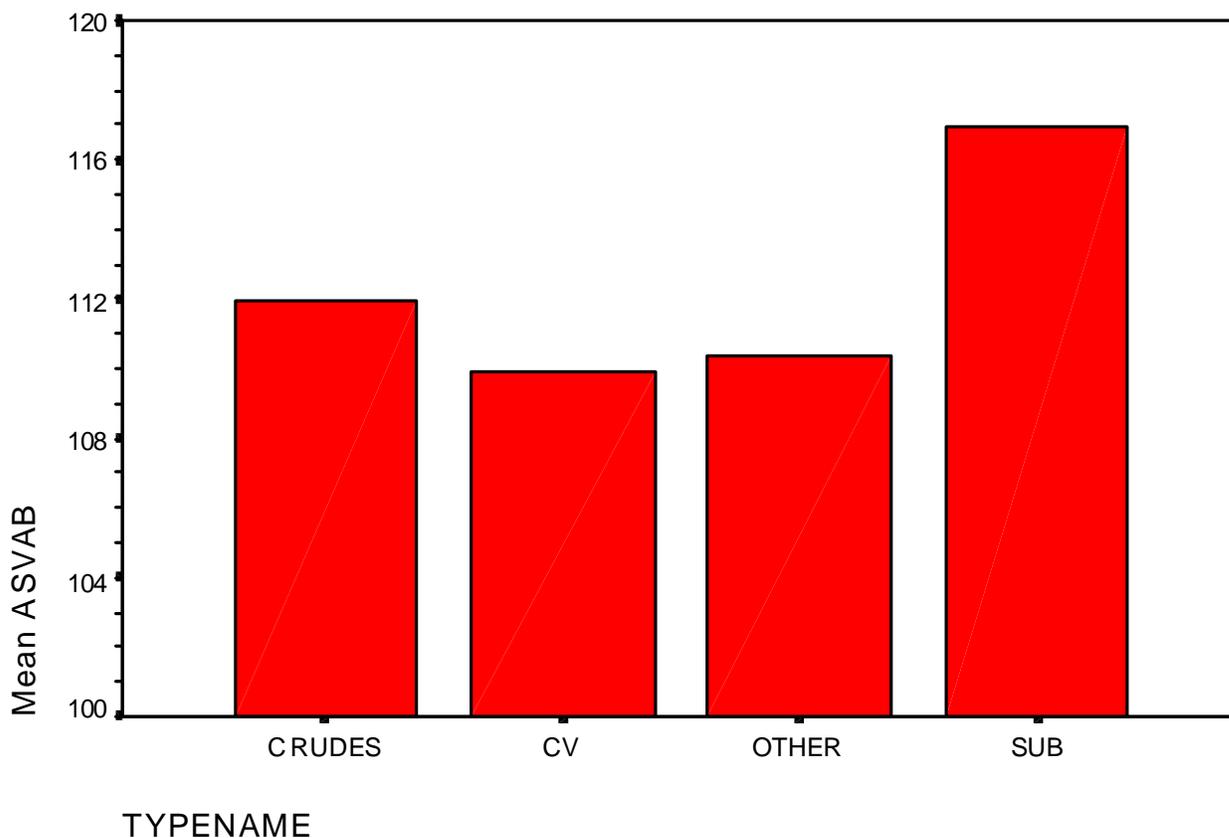


Figure 15 ASVAB by Ship Type, N=8124

As expected, the data in Figure 15 confirm that Sailors assigned to submarines have a much higher mean ASVAB score than their counterparts in other ship types. This difference is attributed to much more thorough screening and selection processes for submarine crews due to the highly technical nature of their duties and the extreme living and working conditions they are required to endure for months at a time. Differences in ASVAB among the three remaining type

categories were negligible. These data imply that Sailors in submarines may be more likely to do

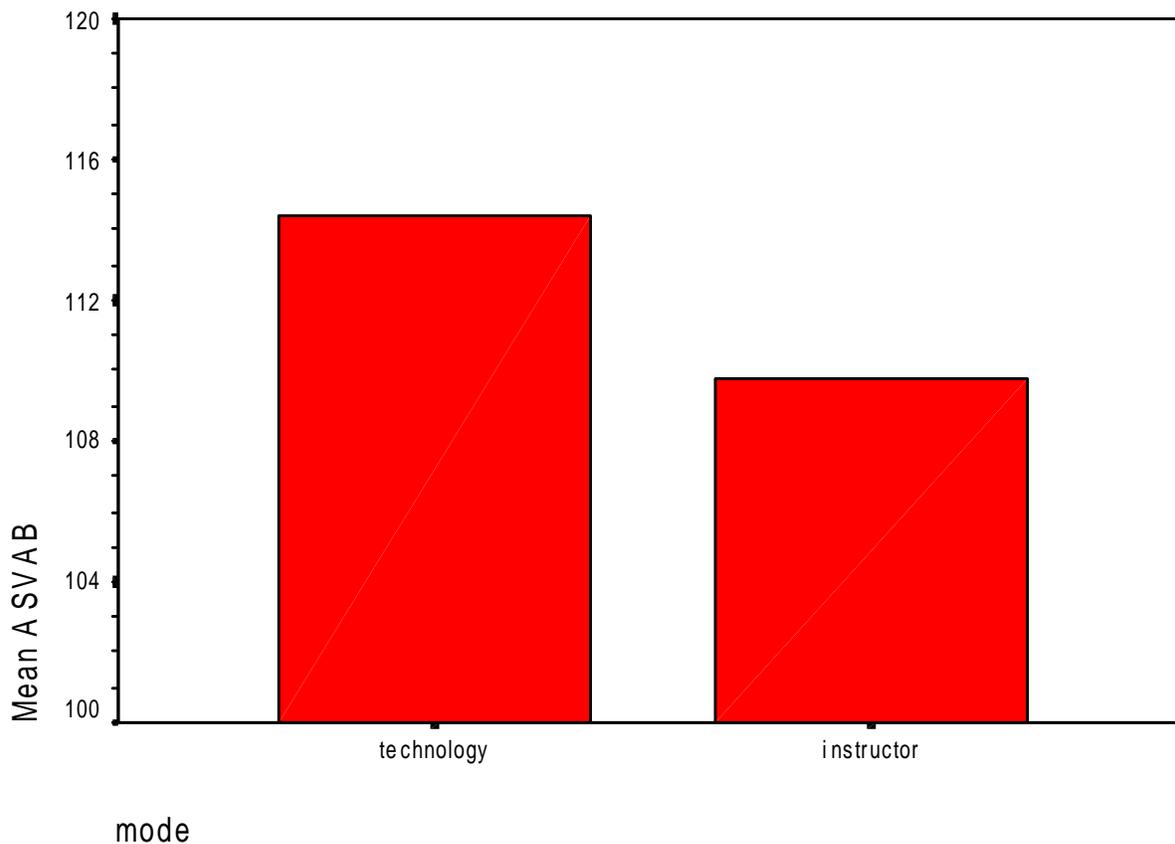


Figure 16. ASVAB Score by Delivery Mode, N=8124

The most striking difference for ASVAB among all the variables examined was between Sailors taking technology delivered versus traditional instructor delivered PACE courses. This finding is not surprising in view of the fact that Sailors with the highest ASVAB scores are assigned to submarines where technology delivery mode is the only PACE course option. Another likely factor for this difference is the screening process performed by the contractors during registration. As stated earlier, Sailors with higher ASVAB scores and/or a record of satisfactory college course completion are more likely to be selected for technology delivered courses. Implications for the PACE program from this data are that Sailors taking technology delivered courses are more likely to be brighter or more mentally astute than their counterparts in instructor delivered courses.

Educational Level: Turning next to educational level and its association with mean grade and course completion rates, Figures 17 and 18 indicate that Sailors who had earned an associate's degree prior to entering the Navy performed better than those at any other level in the cohort. Also, there was very little difference between those with less than high school and those who completed high school prior to enlisting.

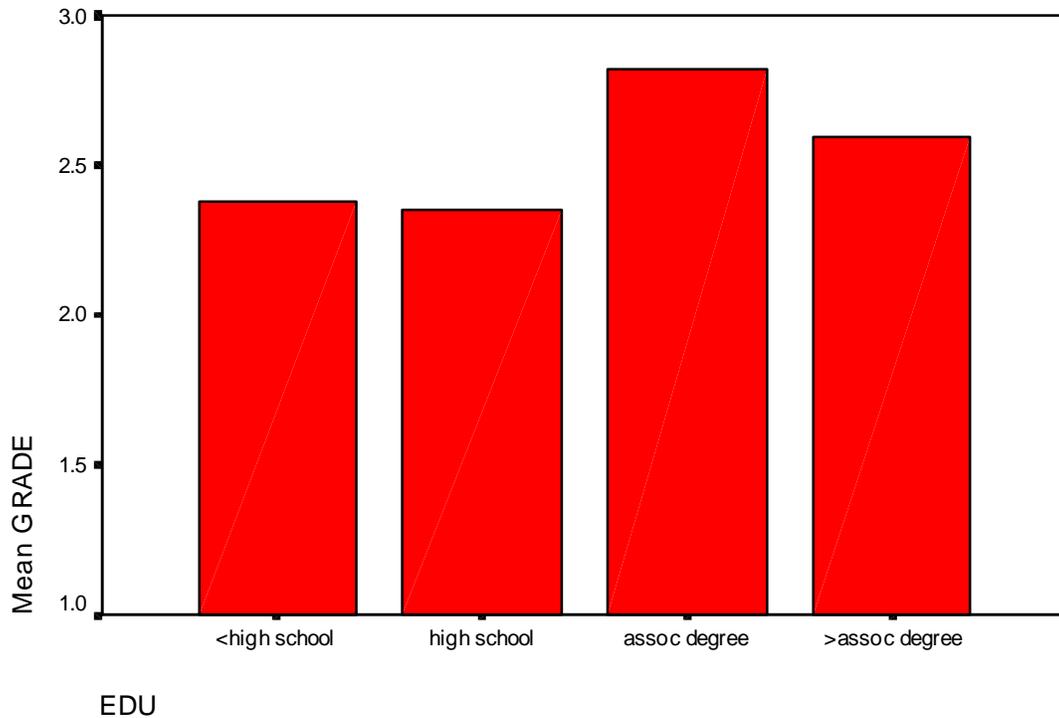


Figure 17. Grade by Educational level, N=8124

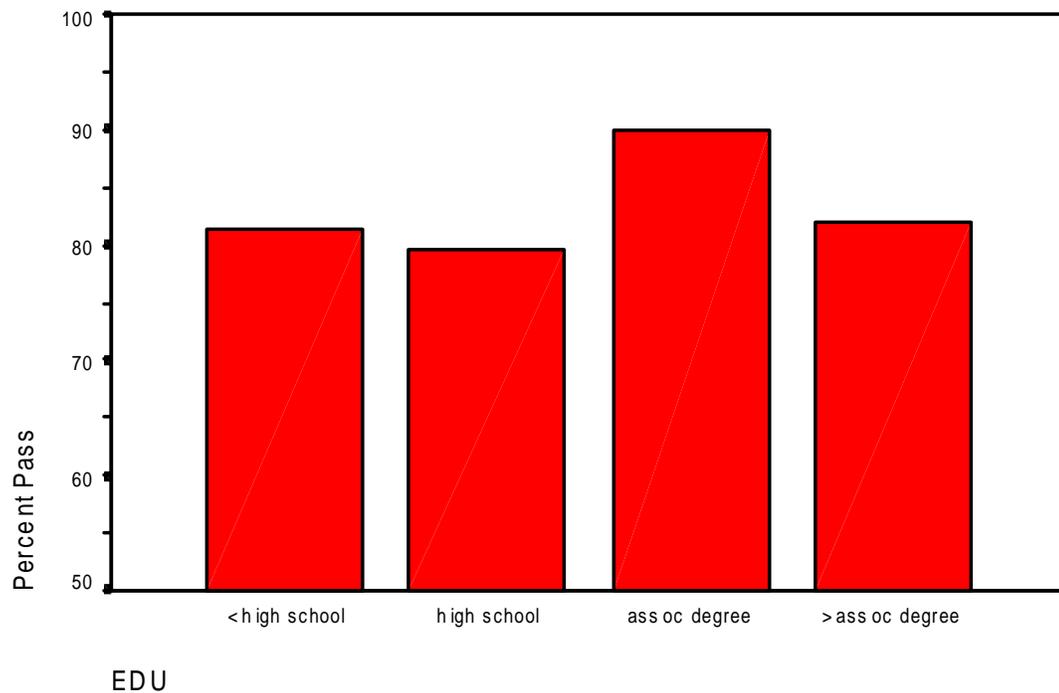


Figure 18. Completion Rate by Educational Level, N=8124

A possible explanation for the differences in grade and completion rates for Sailors with an associate's degree is that they have already made a substantial investment in time and expense toward a baccalaureate degree and are therefore more motivated to perform well in PACE college courses. Conversely, Sailors who already earned a baccalaureate degree may not have the same motivation to excel because they have already achieved a significant educational milestone. Implications for the PACE program are that Sailors who have earned significant credit hours towards a baccalaureate degree may be more likely to excel in PACE college courses than others.

Recent College: Semester hours of recent college courses passed had a positive relationship with end of course grade as shown in Figure 19.

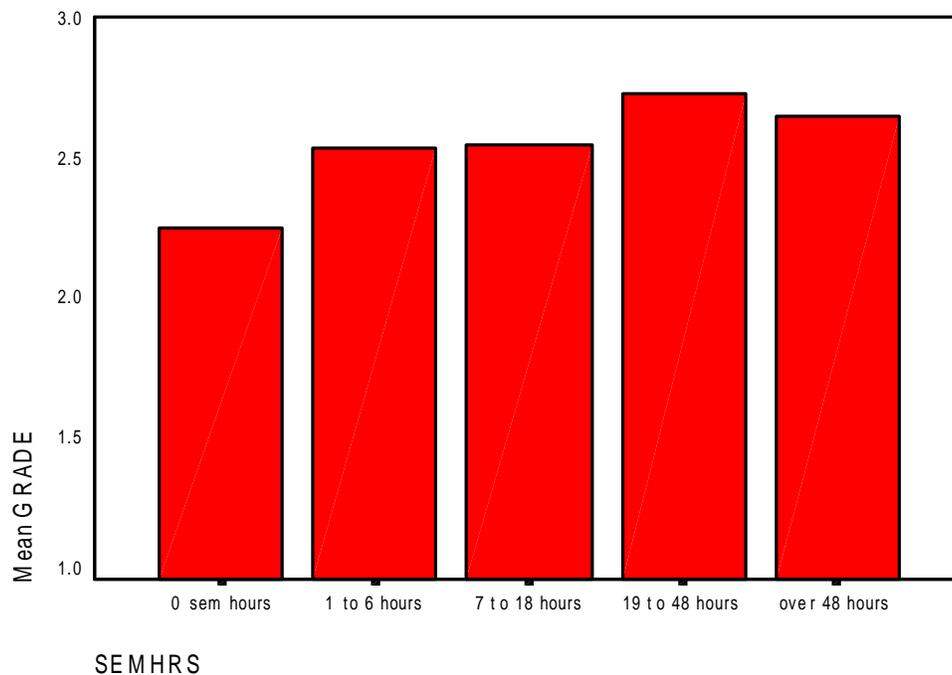


Figure 19. Grade by Recent College Semester Hours Passed, N=8124

Mean grade varied from a low of 2.24 for 5254 Sailors comprising 64% of the cohort with no prior college, to a high of 2.64 for 226 Sailors representing 2.7% who had taken more than 48 hours of college courses. A Pearson's correlation test resulted in a finding of slight but significant positive correlation ($r = .070$, $p < .01$) between recent college semester hours passed and grade outcome (see Appendix D). As hypothesized, this finding was expected and is consistent with the literature cited earlier (Fredrick and Wolberg, 1980) that knowledge levels increase with the level of schooling. It would appear from these data that Sailors who have successfully completed college courses may be more likely to excel in PACE than those without previous college experience. Accordingly, it is appropriate that verifiable prior college history be considered in screening Sailors for enrollment in PACE.

Years of Service: As expected, there was a substantial positive association in the data between years of service, grade, and course completion rates as shown in Figures 20 and 21. A Pearson's correlation test resulted in a finding of significant positive correlation ($r = .132$, $p < .01$) between years of service and grade (see Appendix E).

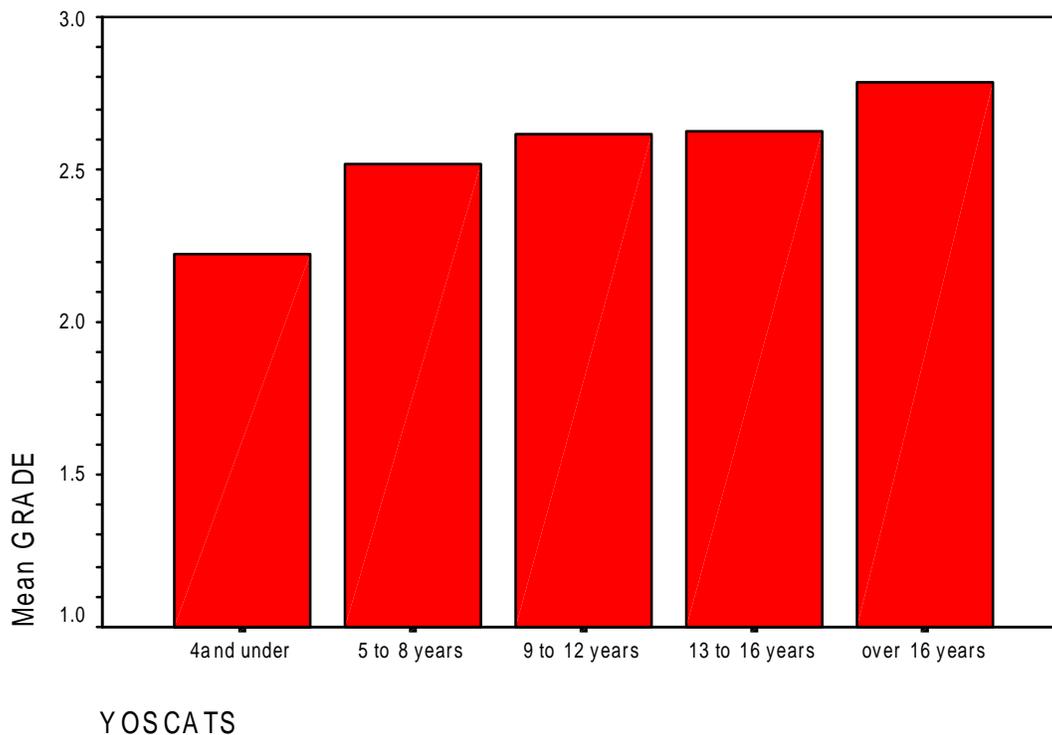


Figure 20. Grade by Years of Service, N=8124



YOSCATS

Figure 21. Completion Rate by Years of Service, N=8124

These results are attributed to retention and reenlistment of Sailors who have the best performance records and who are assessed as having the greatest potential to succeed in more challenging assignments. Beyond the second four-year enlistment, Sailors remaining in the Navy are generally motivated toward fulfilling a twenty year career. For these reasons, those who take college PACE courses from 9 to 20 years of service could likely be expected to outperform their more junior counterparts.

Paygrade: Analysis of paygrade on course grade and completion rates resulted in the strongest positive association for any of the variables examined in this study. As shown in

figures 22 and 23, the data reflect a nearly continuous increase in grade performance and completion rate with each incremental step in paygrade.

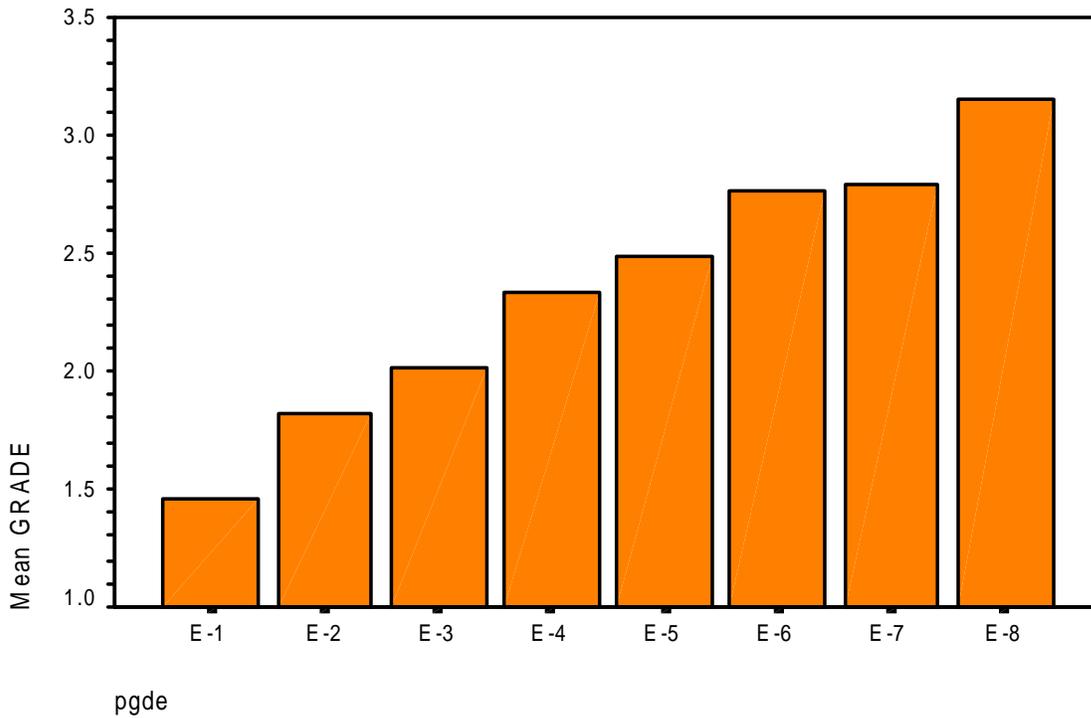


Figure 22. Grade by Paygrade, N=8124

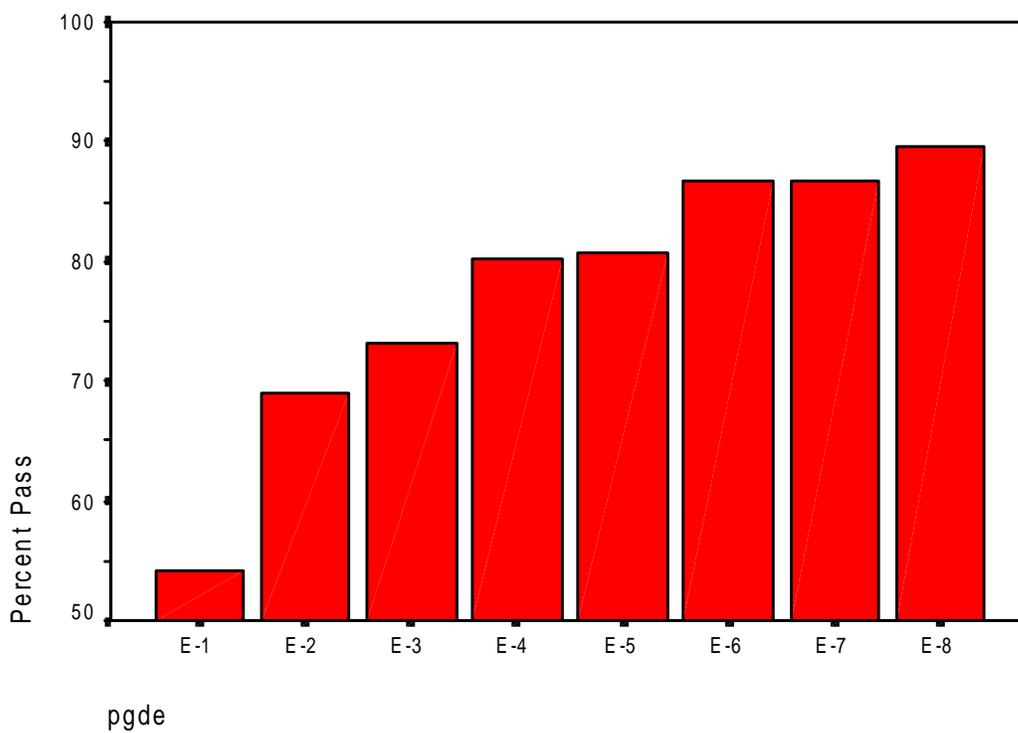


Figure 23. Completion Rate by Paygrade, N=8124

This correlation was expected based on performance and motivational factors cited

Figure 23: Completion Rate by Paygrade, N=8124

This correlation was expected based on performance and motivational factors cited previously which tend to increase with promotions, higher compensation, and the additional challenges that come with increased responsibility and accountability. Of significance, it should be noted that the magnitude of differences in mean grade between E1 and E5, E2 and E8, and E3 and E8 exceeded one whole letter grade. These data indicate that Sailors in middle and senior paygrades may be more likely to excel in PACE courses than those below the grade of E5.

Ship Type: As expected, Sailors in submarines achieved the highest grades and completion rates of any other ship type as shown in Figures 24 and 25.

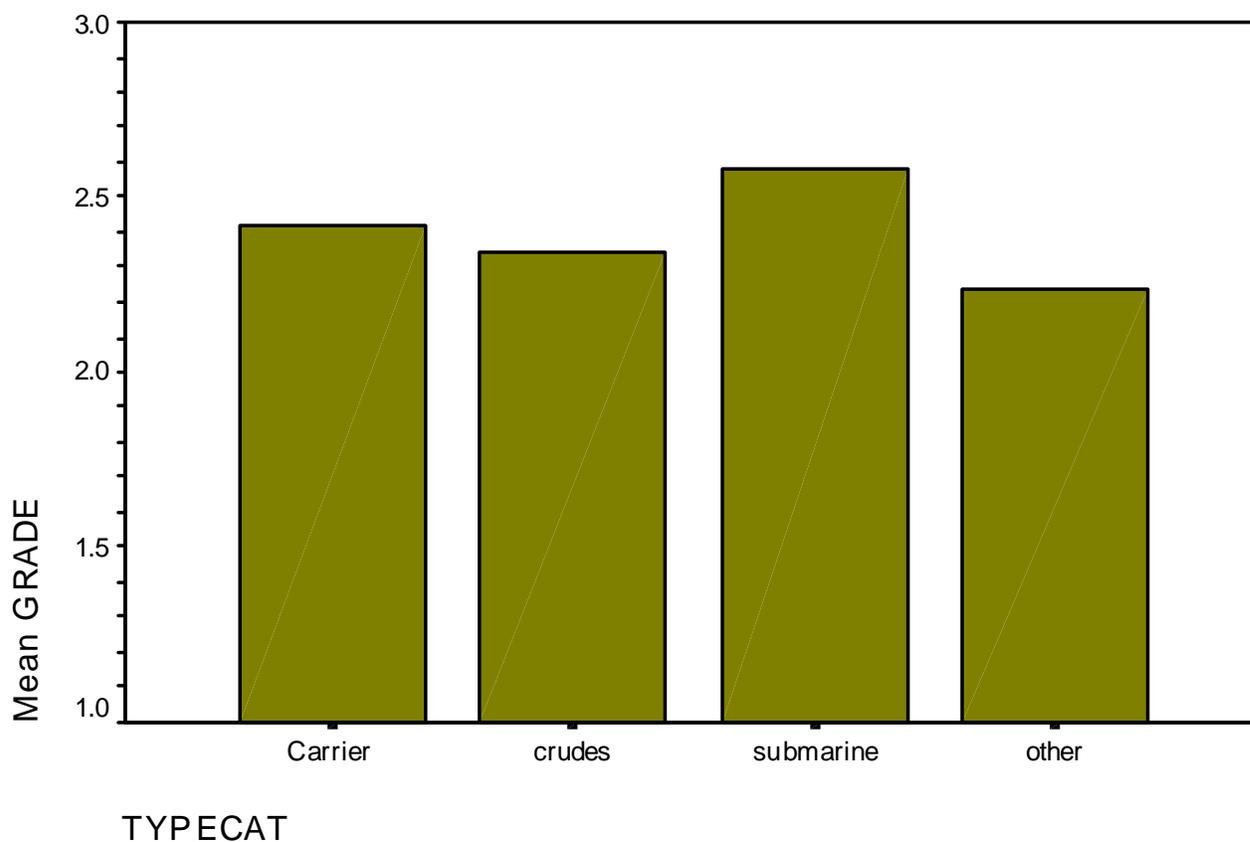
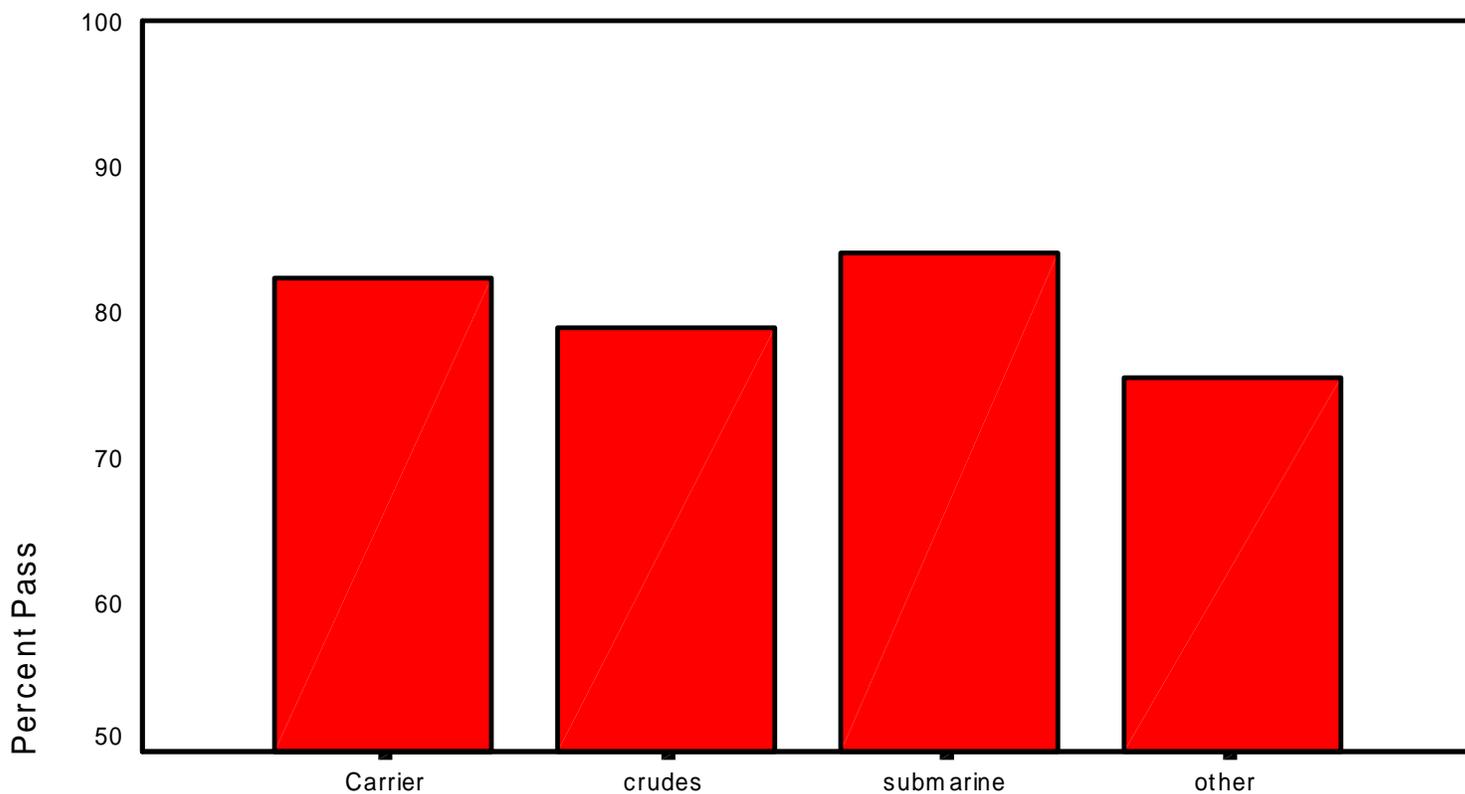


Figure 24. Grade by Ship Type, N=8124



TYPECAT

Figure 25. Completion Rate by Ship Type, N=8124

Again, this finding is most likely the result of more rigid screening and selection processes for Sailors assigned to submarines. Carrier and Cruiser-Destroyer Sailors performed roughly the same, but Sailors in the “other” ship type category performed markedly lower. Ships in this category include amphibious, auxiliary, mine countermeasures, and combat logistics force units among others. As reported earlier, ASVAB scores for Sailors in the “other” ship type

category were equivalent to those of Sailors in Carriers and Cruiser-Destroyer. Given this finding, there must be some other unexplained reason for their lower mean grade and course completion rate. This may appropriately be the subject of further research since approximately one third of all Sailors in the PACE program within the cohort were assigned to these types of ship.

COAST: With regard to possible differences in grade and completion rate by coast, Figures 26 and 27 show that there were almost no differences, with west coast Sailors achieving just slightly higher grades and completion rates.

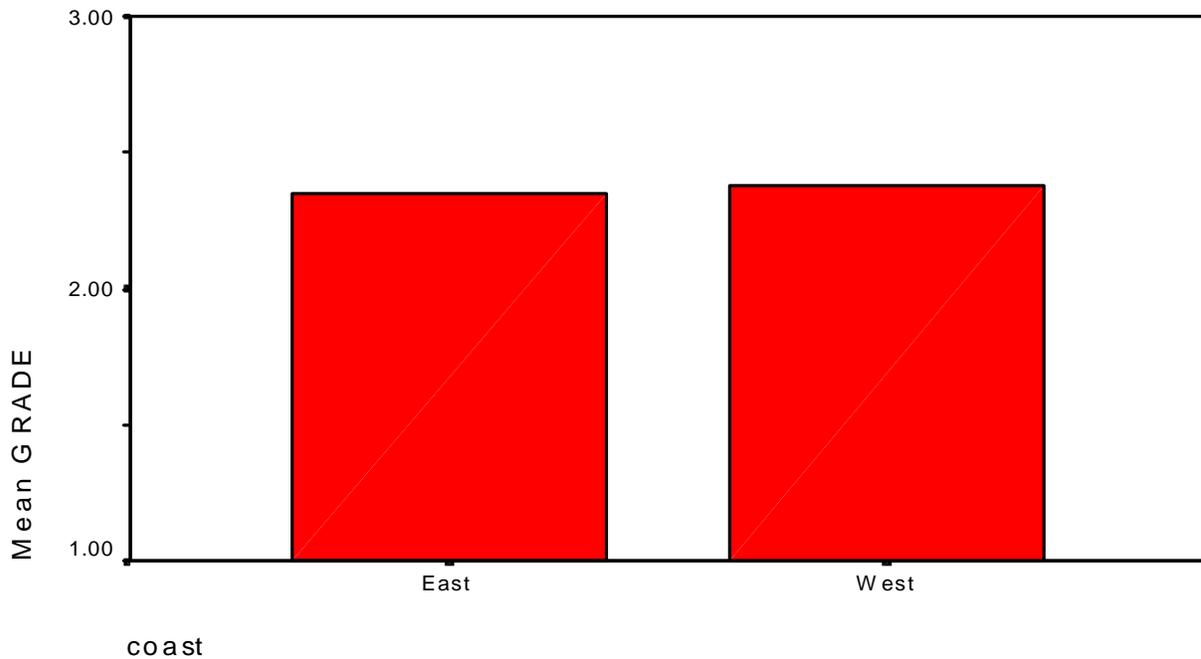


Figure 26. Grade by Coast, N=8124

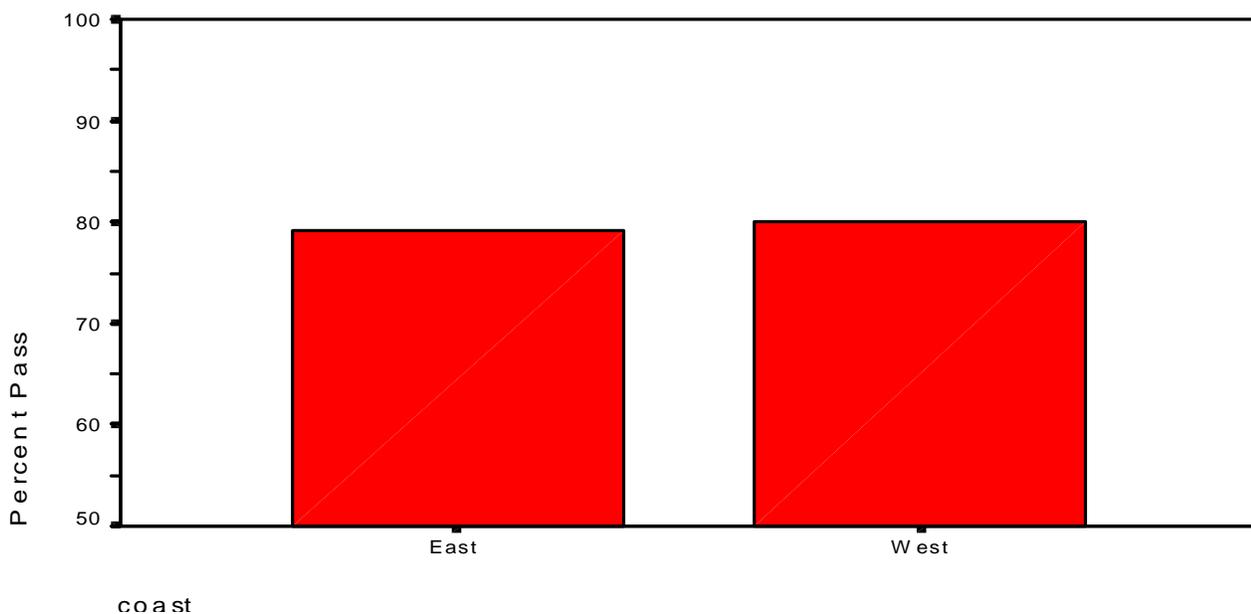


Figure 27. Completion Rate by Coast, N=8124

This finding was surprising in that it was expected that Sailors in the Atlantic would do better than their Pacific counterparts due to the additional two weeks time on task in the Atlantic for instructor delivered courses (8 weeks versus 6 weeks). An additional cross-tabulation test was performed on this data to determine any grade differences between coasts for instructor taught courses only. Mean grade for the shorter West Coast instructor taught courses was 2.59 whereas the mean grade for East Coast courses was 2.43. These findings suggest that Sailors taking six week uninterrupted courses in the Pacific do better than those with an eight week course interrupted by port visits in the Atlantic. A possible explanation for this difference is that Sailors in the Atlantic may become distracted and lose their focus on academics due to the break in course continuity.

Number of attempts: Sailors who took a course the first time performed much better than those who were taking a course for the second time as shown in Figure 28.

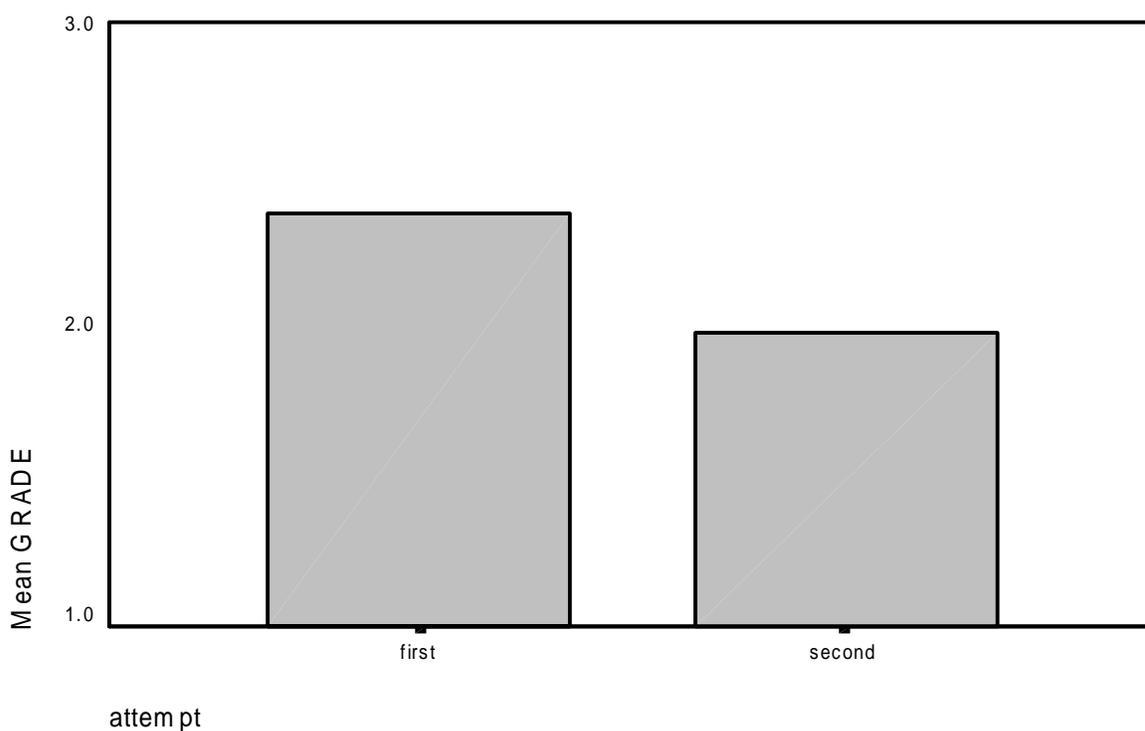


Figure 28. Grade by Attempt, N=8124

Course records from the entire population of (1992-1996) were reviewed to identify Sailors in the 1995-1996 cohort who were taking a course for the second time. Accordingly, the data for first and second attempt represent independent samples from within the cohort period based on whether the course taken was a first or second attempt. Sailors most likely achieved a much lower grade on the second attempt due to lack of confidence or difficulty with the material since they had presumably failed or done poorly in the course on the first attempt. Accordingly, the data suggest that Sailors taking a course the second time may be less likely to achieve as high a grade as those taking courses for the first time.

MODE: Both grade and completion rate by course delivery mode produced large differences in favor of instructor delivery as shown in Figures 29 and 30.

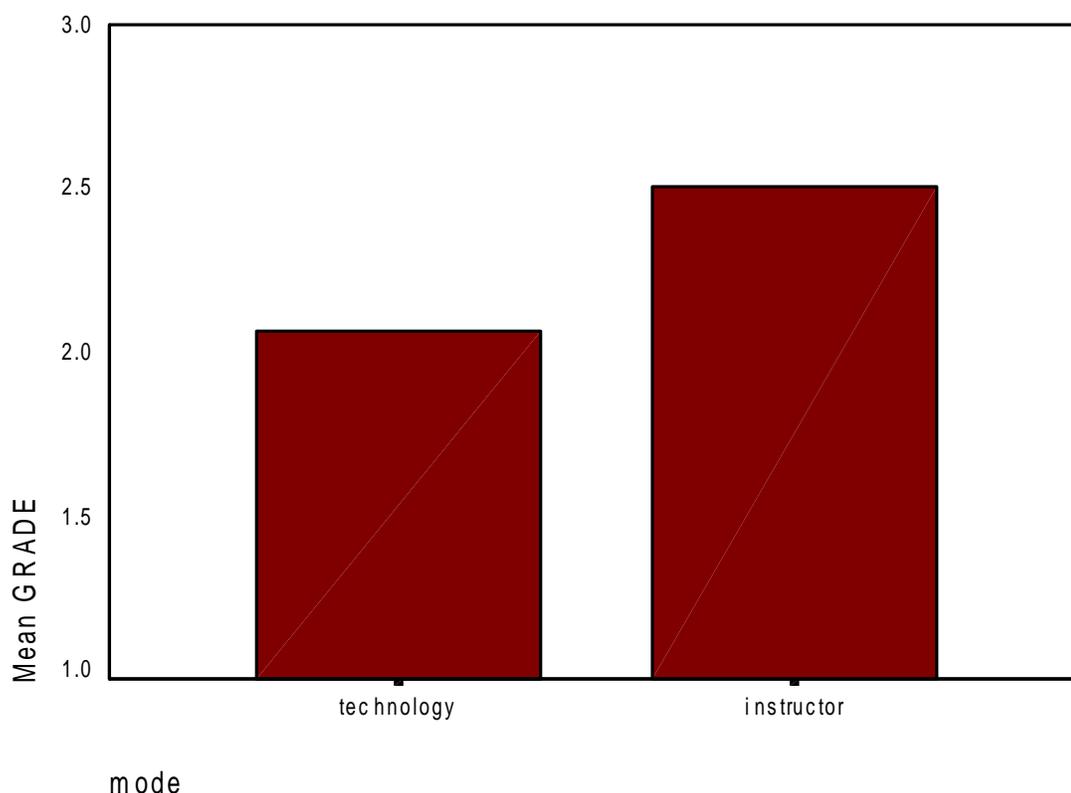


Figure 29. Grade by Mode of Delivery, N=8124

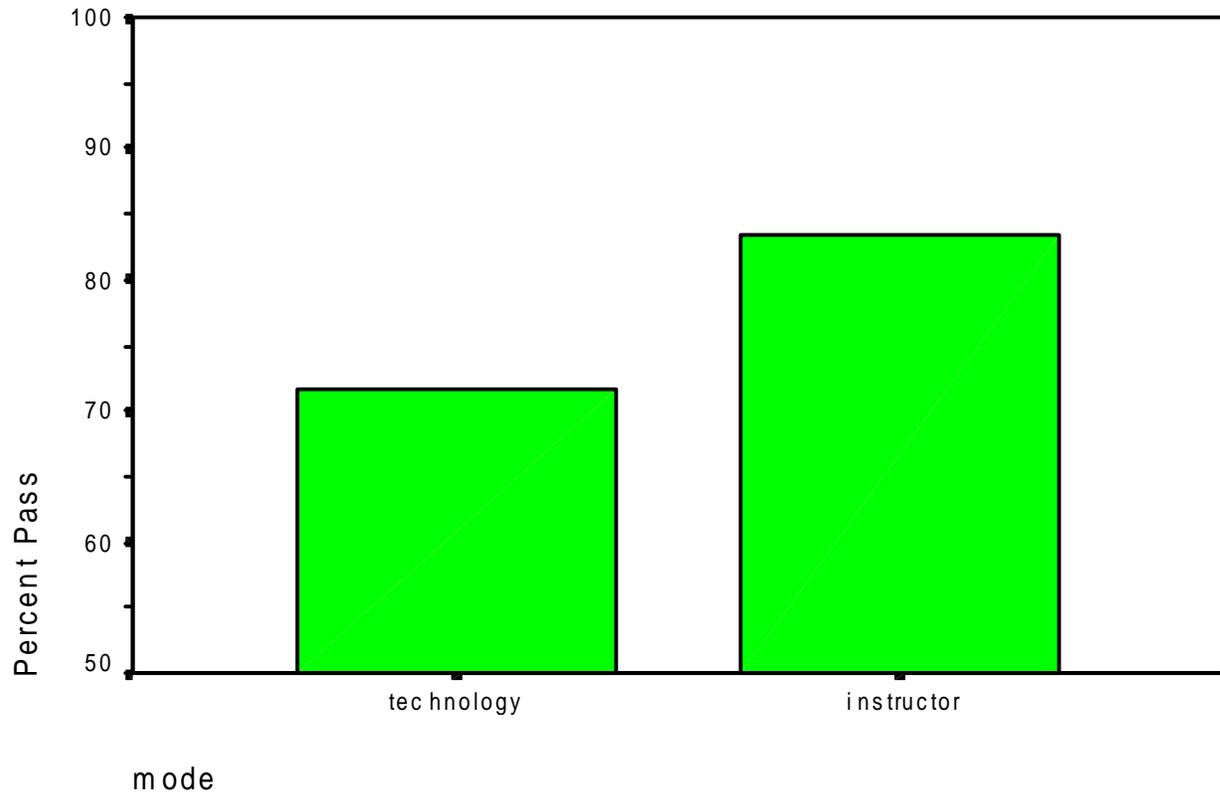


Figure 30. Completion Rate by Delivery Mode, N=8124

Failure rates (including withdrawals) were 28.4% for technology delivered courses versus 16.7% for instructor delivery. While these rates represent an improvement from those reported by Dunlap et. al (1989) in Table 4 to this study, there is a consistent pattern in that technology delivered courses still experience much higher failure rates. Recall that this variable represents far more than merely the choice of instructional media. It combines all the nuances of difference between them such as methods of instruction, teacher effects, learner style and motivation, ability to learn better independently or in a more structured classroom setting, etc. Taking all these into account, the data show that Sailors in the cohort performed better, by nearly half a letter grade on average in instructor delivered courses. Add to this finding the previously

reported results that showed Sailors in technology delivered courses have much higher ASVAB scores, and these results become all the more interesting. Moreover, the expectation presented earlier that there would not be a difference in grade outcome, based on numerous findings of no significant difference in the experimental literature, was incorrect.

A possible explanation for these results may be that despite all the complexities of the variable, Sailors may be more comfortable learning in a structured environment where they can receive individual attention from a teacher when needed. Another factor may be the influence of group paced learning versus individualized learning. Teachers often determine the ability level of their class, particularly in smaller classes such as PACE, and adjust their rate of instruction and the amount of material presented to the needs of the majority of learners. This tendency might make it easier for a more capable student to achieve a higher grade, while tending to raise grades for others in the same class who may be under achievers. Technology delivered courses may offer less flexibility in this regard, often holding each student equally accountable for completing all the material in the specified sequence and time frame.

Implications of these findings for the PACE program may be significant in a number of ways. First, there appears to be a need for both instructor and technology delivered PACE courses since a clear majority of Sailors in each mode within the cohort achieved a satisfactory completion rate. Second, improved screening for indicators of a Sailor's motivation and ability to work independently might help narrow the difference in grade and completion rate outcomes, and possibly reduce the number of withdrawals or failures in technology delivered courses. Third, instructor taught courses appear to add value to the PACE program and probably should continue to be provided in all ships that can accommodate an instructor.

Additional descriptive data were calculated in response to question 6 which asked for the percentages of Sailors enrolled in PACE by delivery mode for ship type, rating, years of service and paygrade. Summary tables of these findings are provided for general information and

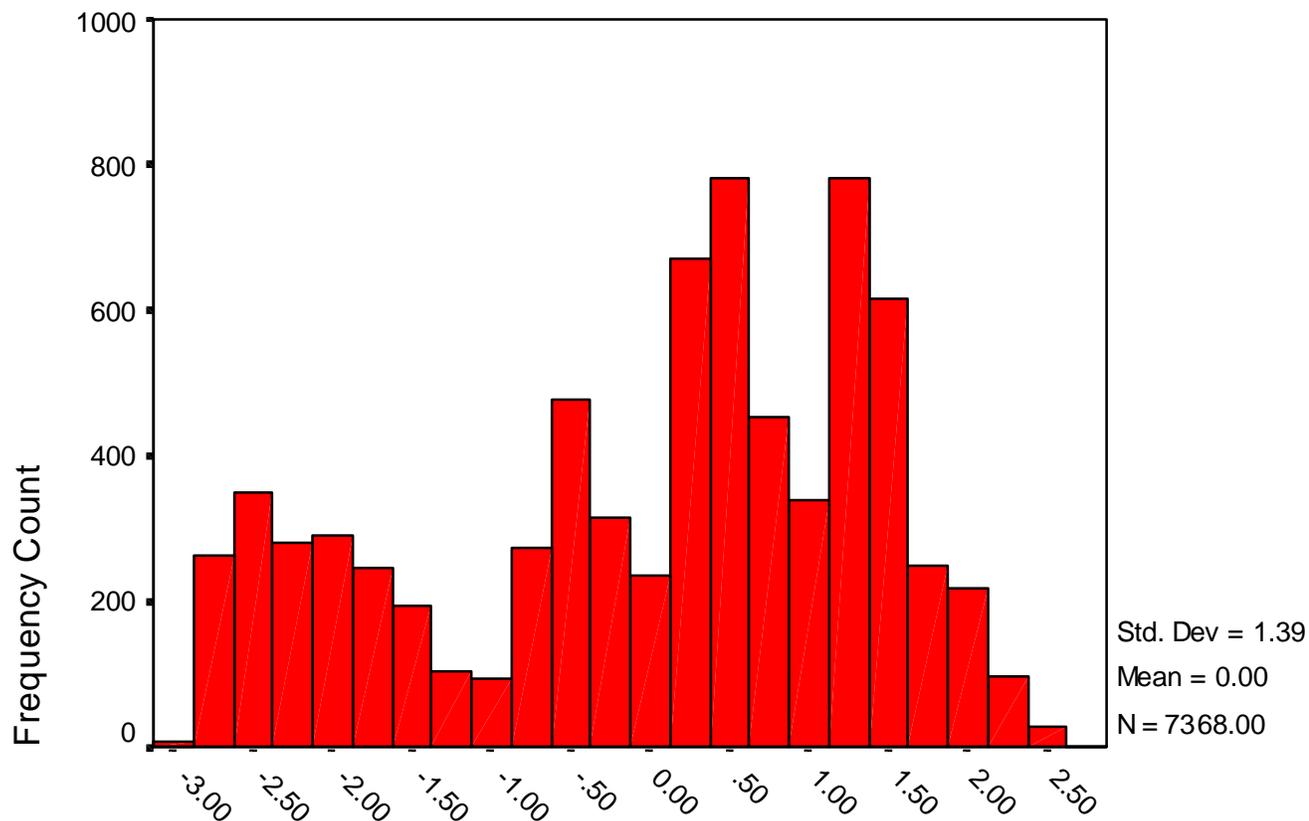
reference purposes only (see Appendices F-I). The most common finding among these data was that a clear majority of Sailors for each of the variables examined was taught by instructors.

Finally, general information tables were prepared of additional descriptive summaries to include listings of mean grade for each individual ship, rating, and homeport contained in the cohort (see Appendices J-L). Also, a table was prepared listing the satisfactory completion rate, by ship, for Sailors enrolled in PACE within the cohort (see Appendix M). Data compiled in these tables provide an opportunity for further study to determine the most likely reasons why particular ships, homeports, or ratings achieved the highest grade outcome between 1995 and 1996.

Inferential Analyses

Turning next to the inferential portion of the study, recall that research question 8 asked: “Taking ASVAB scores into account, to what extent do end of course grades differ for each delivery mode by ship type?” This question was designed to investigate the extent to which main and/or interaction effects might be present in the data. Submarine data were to be omitted from the analysis since only technology delivered courses are offered in submarines. Results of this inquiry, if successful, would lead to a more accurate and meaningful assessment of the relationships of the key variables in the study.

The model selected for analysis was based on the 3 X 2 design factorial ANCOVA depicted in Table 10 and included MODE, TYPE, MODE x TYPE interaction, with ASVAB as the covariate. Like the descriptive analyses, the dependent variable in the ANCOVA was end of course grade. Preliminary residual error testing of 7368 records for Sailors in all ship types except submarines confirmed once again that grade data were not normally distributed as shown in Figure 31.



Residual for GRADE

Figure 31. Unstandardized Residual Error Distribution For Grade (Less Submarines)

Attempts were then made to transform the residuals using the most common methodologies to include LOG, ARC TAN, ARC SIN, SQR ROOT, SQUARE, and EXPONENT. All failed to produce a normal residual error distribution. This result precluded analysis of covariance testing of the present model due to its failure to meet the necessary assumptions. Upon further analysis it was determined that the most likely explanation for this distribution problem was that original continuous grade data had become categorical as a result of converting each Sailor's numerical end of course grade to a letter grade. Once converted to letter grades, the number of possible grade outcomes was limited to just a few categories making

the data appear as a mixture of normal distributions within a single histogram as shown in Figure 31. This effect became even more pronounced when MRC grades with plus and minus suffixes were converted to a whole letter grade scale for consistency in handling the data since grade suffixes were not available from CTC. As a result, the converted grade data did not meet the assumptions necessary to perform analysis of covariance.

Based on this analysis, an alternative ANCOVA design as shown in Table 11 was developed to determine main and interaction effects between delivery mode and ship type. A mean grade for each PACE college course offered to Sailors for every ship in the cohort was used in place of individual end of course grades as the dependent variable. Mean course grades by ship consisted of numerical, continuous data which, if normally distributed, would meet each of the assumptions for analysis of covariance. A drawback to this modified design, however, was that the covariate necessarily became the mean ASVAB score for all Sailors enrolled in the same course. This limited the effectiveness of the covariate in controlling for individual Sailors' differences in ASVAB. As a means of offsetting this reduction in covariate effectiveness, a third factor, course group (CSEGRP), was added to the interaction model because it was found that Sailors achieved better grades in some types of courses than in others as shown in Figure 32. Accordingly, course group was expected to improve the model's ability to explain variance in the data.

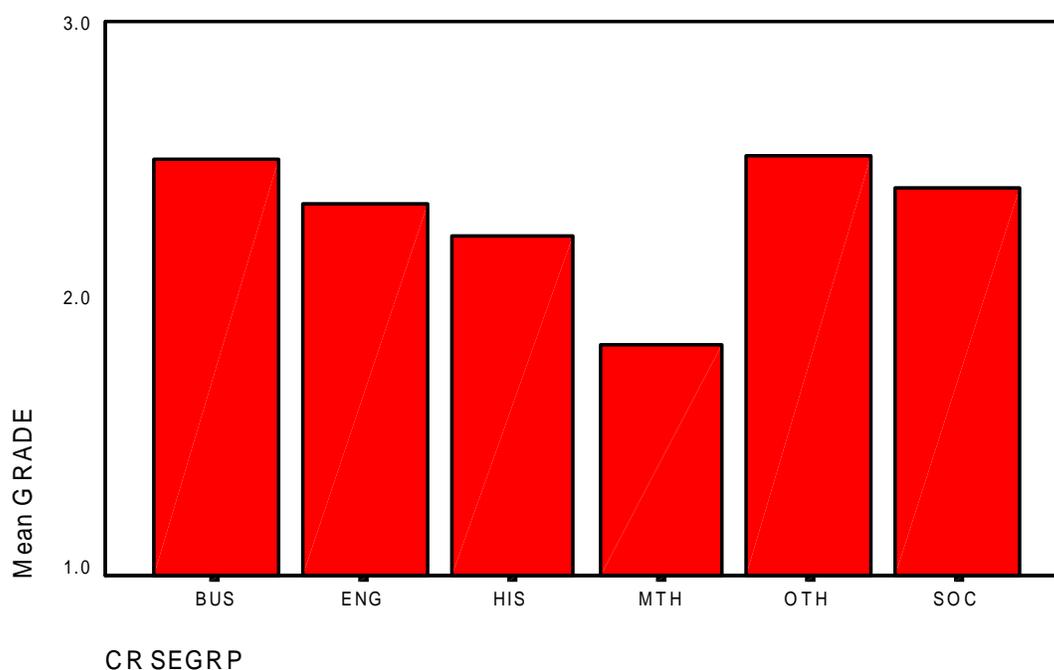


Figure 32. Grade by Course Group

It was decided to proceed with the revised ANCOVA model in view of the additional factor and the large sample size comprising 1276 college courses. The new model included MODE, TYPE, CSEGRP, CSEGRP x TYPE, CSEGRP x MODE, TYPE x MODE, and CSEGRP x TYPE x MODE with mean ASVAB as the covariate. Results of residual error testing were markedly improved over those obtained in the previous ANCOVA model. As shown in Figure 33, a normal bell-shaped curve was produced indicating that the data were suitable for main and interaction effects testing.

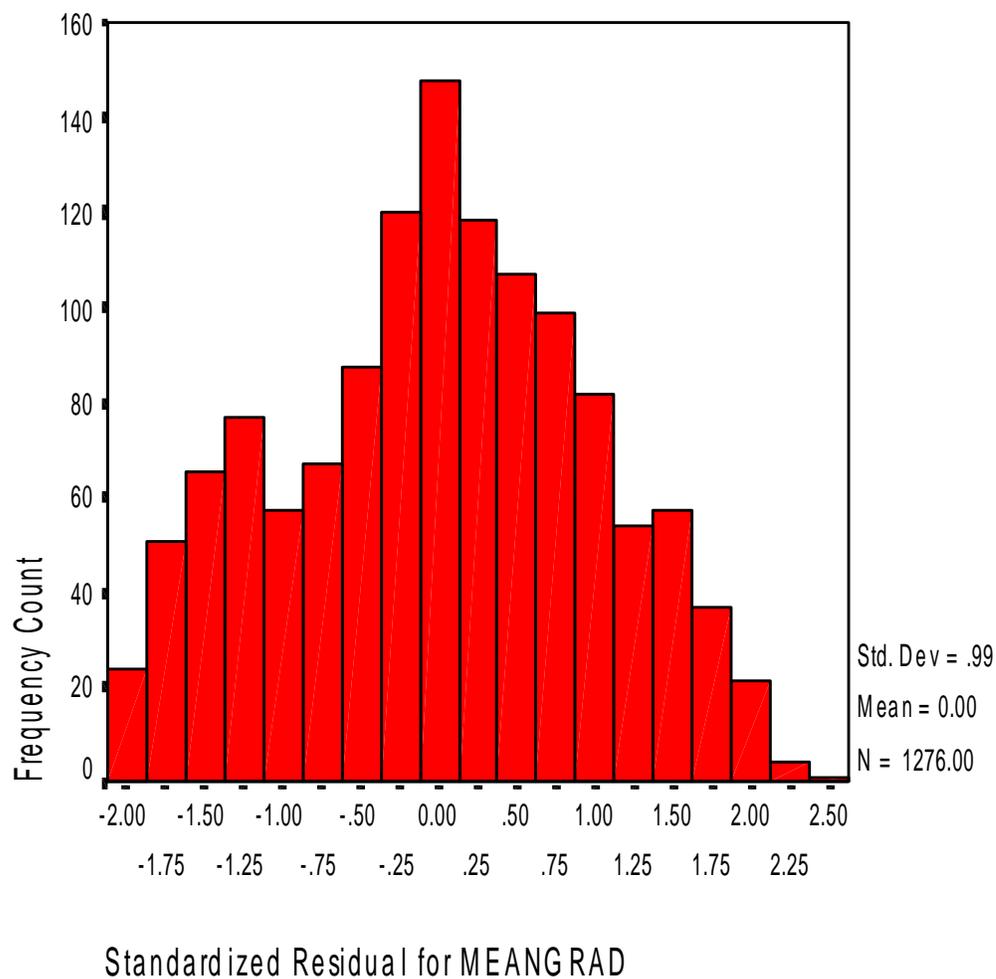


Figure 33. Standardized Residual Error For Mean Course Grade, N=1276

The revised ANCOVA was performed with no further problems encountered (detailed results of between subjects tests and simple effects obtained are provided in Appendices N and O). Of significance, the R^2 for this model was .124, more than twice the R^2 (.065) obtained previously for the unsuccessful ANCOVA model. This improvement is attributed to having an additional factor, CSEGRP, in the model for greater explanation of variance due to differences in grade by course group. Significant main effects ($p < .001$) were observed for each factor in the model. For delivery mode, Sailors did significantly better in instructor taught courses than those taking technology delivered courses. For course group, a post-hoc analysis of the main effect using a Dunnett's multiple comparisons test showed that Sailors in the "Other" course group achieved significantly higher grades than those in Math and History (see Appendix P). Also, with the exception of History, grades for Math courses were significantly lower than all other course groups. Finally, for ship type, a similar post-hoc analysis showed that mean grades of Sailors in Aircraft Carriers and Cruiser-Destroyers were significantly higher than for those of Sailors in the "Other" category (see Appendix Q).

The most remarkable finding from the ANCOVA, however, was that there were no significant interaction effects among any of the three factors as shown in Figures 34, 35, and 36.

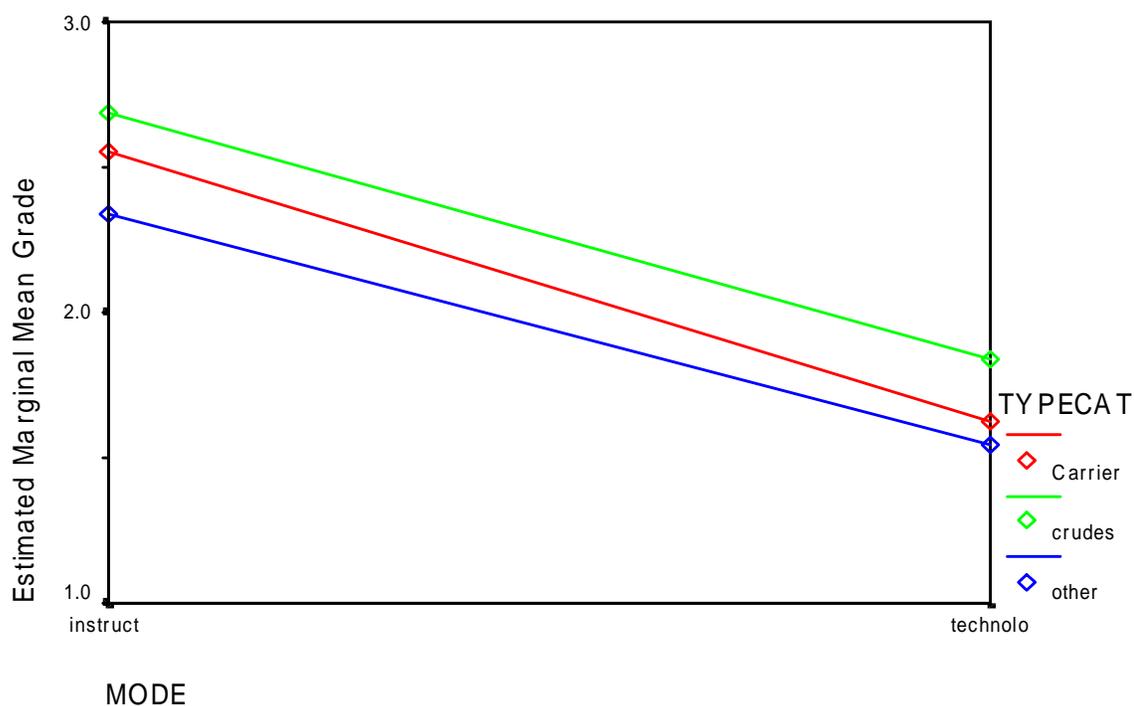


Figure 34. Interaction Effects For Ship Type by Delivery Mode, N=1276, (p=.862)

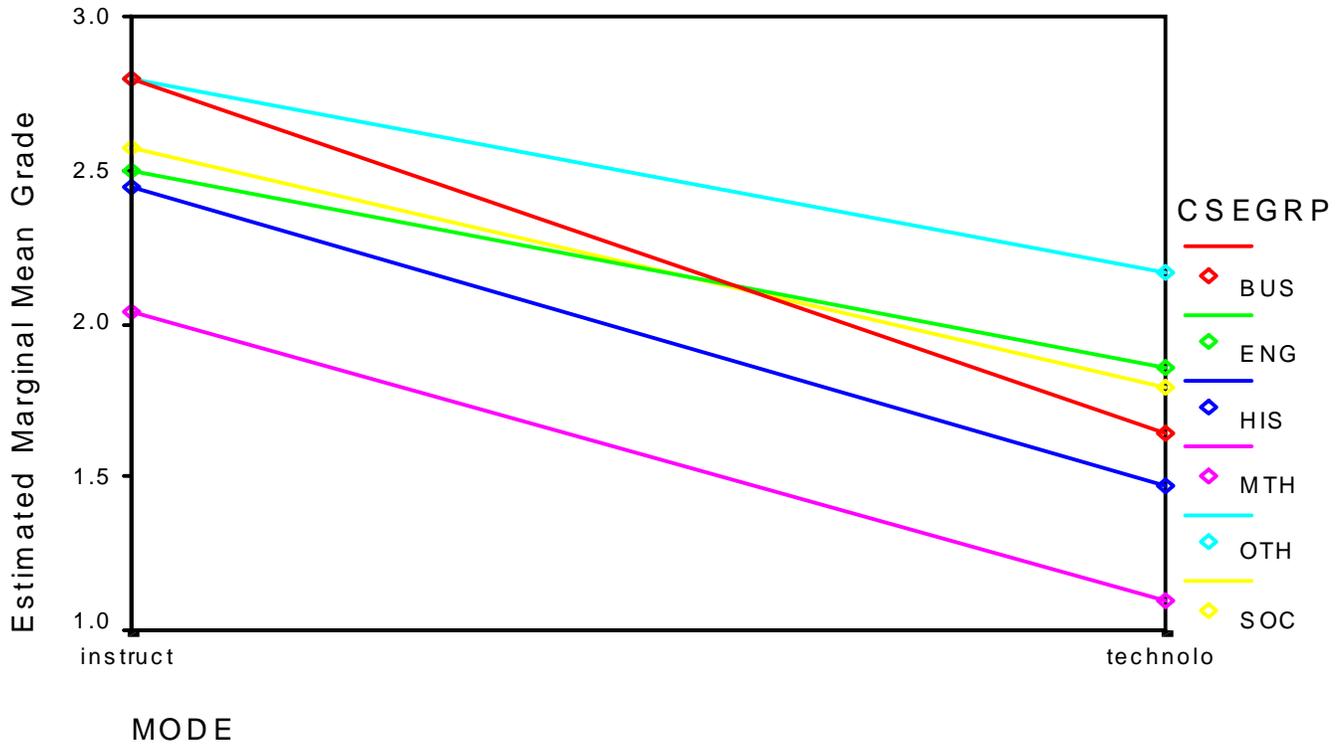


Figure 35. Interaction Effects For Course Group by Delivery Mode, N=1276, (p=.519)

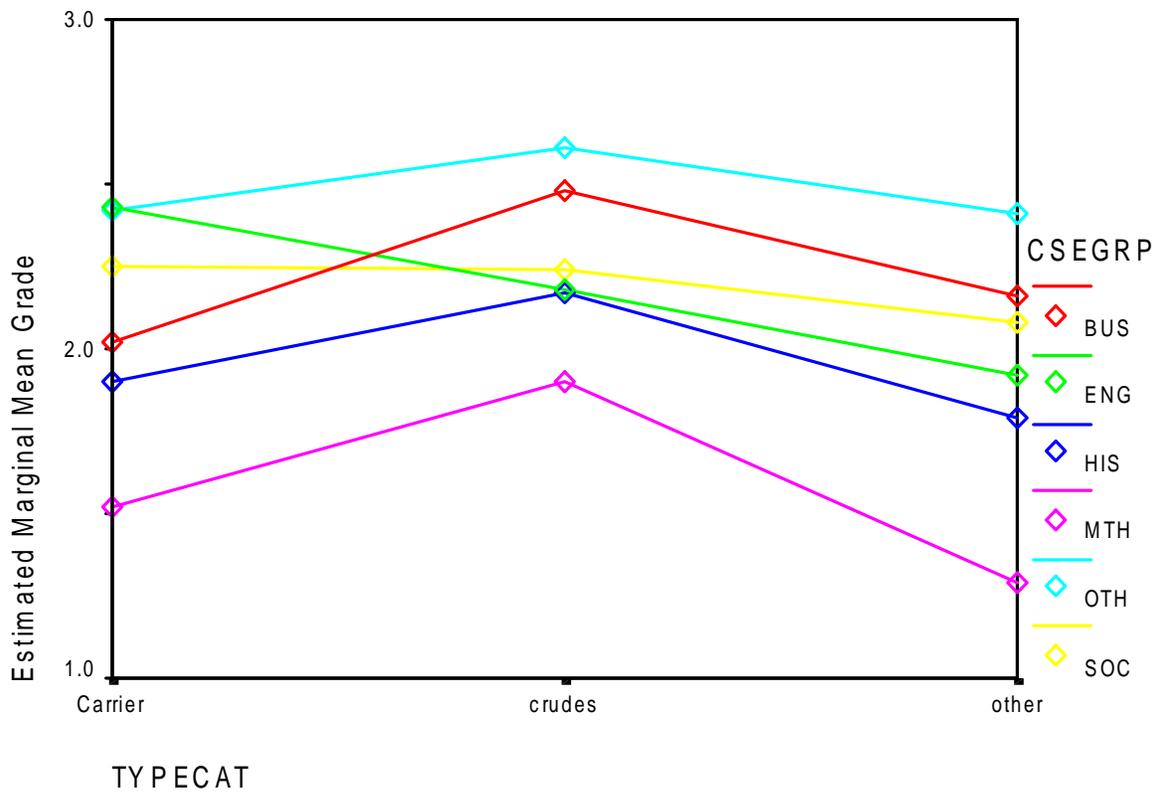


Figure 36. Interaction Effects by Type Ship and Course Group, N=1276 (p=.929)

This analysis provides the most compelling inferential finding in the entire study: Sailors perform much better in instructor delivered PACE courses regardless of type of ship or course group. It is reiterated that all findings in this study are based on descriptive analyses and cannot be used to prove cause and effect. Also, recall that this variable includes far more differences than merely the instructional medium itself. Nevertheless, the ANCOVA clearly shows that there is a statistically significant difference in level of achievement between the two delivery modes. Although Figure 35 indicates some interaction between course group and mode for business, English, and social studies groups, these were not statistically significant and therefore could be attributed to chance. Likewise, minor interaction indicated in Figure 36 between these same three course groups and ship type could be due to chance as well.

Likely explanations for these impressive results for instructor delivered courses are similar to those previously offered for grade differences observed between delivery modes. Additional arguments might include the possible benefits on learning of human interaction in a classroom setting, to include the ability to obtain clarification or extra help from the teacher or classmates on specific questions and issues of concern to Sailors. For others the formal structure of a classroom environment (in some ships during normal working hours) where attendance is mandatory, homework assignments are collected and evaluated, and instructor feedback is provided at each class meeting, may be helpful. Sailors working alone in technology delivered courses likely face a more difficult challenge finding and allocating time for PACE because they must choose a time and place to study from among many other demands on their personal time.

Differences found in grade outcome by delivery mode have potentially significant implications for improving instructional effectiveness in the PACE program. There is a clear and significant benefit to having instructors continue to teach PACE college courses. Any

restructuring of PACE should include instructor taught courses in order to meet the learning needs of a majority of Sailors in the fleet. Also, Sailors who are capable of performing college level work but who may be lacking self-motivation or self-direction will likely perform better if placed in instructor delivered courses.

The final inferential question asked: “To what extent do differences in age, gender, race/ethnicity, ASVAB, marital status, years of service, paygrade, educational level, semester hours of recent college courses passed, coast, satisfactory ship completion rate, ship type, and delivery mode explain variation in end of course pass/fail outcomes?” As specified in Chapter Two, a logistic (LOGIT) regression model was developed for each of six course groups as follows: Business (BUS), History (HIS), Math (MTH), English (ENG), Social Science (SOC), and Other (OTH). The other category included miscellaneous courses such as astrology, geography, personal computing, foreign languages, etc. Each course group comprised a separate data set for regression with PASS/FAIL as the dichotomous dependent variable for each. Because some Sailors had taken multiple courses within each course group, a mean grade was calculated to determine a single PASS/FAIL outcome for each.

Multicollinearity diagnostics were performed on all the regression variables listed in the question for each data set, resulting in a finding of linear dependency in all course groups between age and years of service. These factors were combined into a single predictor variable in order to reduce multicollinearity in the data. Multicollinearity testing was again performed on each data set, this time using the new variable AGE/YOS. This resulted in the elimination of the following variables from all six data sets in order to produce the best prediction models: educational level (EDU), completion rate (COMPRATE), and AGE/YOS. For the English course group, an additional variable, ship type (TYPE) was eliminated. Finally, for the Business data set, gender (SEX) and COAST fell out of the model in addition to EDU, COMPRATE, and AGE/YOS. In all six models, elimination of these variables significantly reduced

multicollinearity by greater than fifty percent. Variables remaining in each of the six models for LOGIT regression analysis were as shown in Appendix R.

Next, stepwise LOGIT regressions were run for each course group (see Appendices S-X for complete results of each regression). Using a cut value of .5, each prediction model was tested to determine its ability to correctly predict at least fifty percent of all observed PASS/FAIL outcomes. The models did an excellent job predicting PASS outcomes, correctly predicting better than 90 percent of all observed PASS responses in the original course group data sets. However, the same models did not achieve success in correctly predicting FAIL outcomes. Percent of correctly predicted FAIL responses ranged from a low of 2.54% for English courses to a high of 30.3 % for Math courses. Based on these mixed results it was concluded that the regression models would not be useful for predicting the probability of PASS/FAIL outcomes for PACE college courses. The most likely explanation for the poor prediction results for FAIL outcomes is that the predictor variables available for use in the model are not adequate to reliably explain or predict failure as a grade outcome. Had additional variables such as a Sailor's motivation and anxiety level associated with taking PACE courses, and a measurement of command support for PACE been available for analysis, these might have resulted in a more balanced prediction capability. A more useful result of such a capability would be to correctly predict FAIL outcomes in order to identify Sailors who are at risk of failing. These Sailors could then have been offered appropriate remediation to help prepare them for college. Regrettably, the available data did not support development of reliable prediction models for this purpose.

As a means of remedying this dilemma, it is recommended that Sailors be required to complete a short questionnaire at time of enrollment and upon completion of their course in order to collect information which could be used to enhance prediction capabilities in future research efforts. Factors such as degree of motivation and anxiety level associated with the course for which they are registering, and their post course assessment of the level of command support

provided, could serve as valuable discriminative data for predicting pass/fail. These responses should be archived by social security number and correlated with actual end of course outcomes for future research. In this way it might still be possible to develop a reliable predictive equation for use in screening Sailors more effectively into appropriate PACE courses.

Summary of Findings And Recommendations.

This post-hoc descriptive study was designed to determine those elements or factors which contribute most to successful outcomes for Sailors enrolled in college level PACE courses. A combination of descriptive and inferential statistical analyses were performed on a representative sample of the PACE student population consisting of 8,124 Sailors enrolled worldwide between July 1, 1995 and May 31, 1996. Dependent variables were end of course grade and PASS/FAIL outcomes. Factors analyzed for each participant included up to 18 variables consisting of a broad array of demographic, career, environmental, academic, and mental ability data.

Differences in end of course grade were found to occur between subjects for many of the variables, while others produced no apparent significant differences. These results provide evidence of correlation between certain factors and end of course grade. This knowledge could be used effectively to improve screening and placement of Sailors into PACE courses in order to enhance program effectiveness and reduce costly failure rates.

Factors which were found to have a positive correlation with grade and satisfactory completion rate were age, mental ability as measured by ASVAB (Composite PC+AR), paygrade, years of service, and semester hours of college level courses passed in the previous four years. Formal education at the level of an associate's degree or higher was also positively associated with grade and completion rate. Married Sailors performed better than single, and Sailors who were taking a course for the first time scored higher than those who attempted a course the second time. There were differences by course grouping as well. Those who took

business, social science, and “other” types courses achieved the greatest success while those in history and math earned the lowest grades. The greatest difference observed for any variable was delivery mode, a complex dichotomous variable consisting of technology or instructor delivery. On average, Sailors in instructor delivered courses exceeded those in technology delivered courses by one half a grade point regardless of type of ship in which the course was taught or course group such as business, math etc. This difference was remarkable because Sailors assigned to technology delivered PACE courses had significantly higher ASVAB scores than those who took instructor taught courses.

It is emphasized that this finding does not imply that one delivery medium per se is better than another. Rather, the differences observed take into account all the variability that occurs in PACE settings aboard ships such as differences in instructional strategies, teacher effects, learner styles, learner motivation and self-direction capability, command support for PACE, etc. As concluded earlier from the review of literature, an attempt to conduct a media comparison study within the context of the PACE program by empirical means would have been neither practical nor effective in establishing a clear advantage simply for one medium over another.

Based on these results, several recommendations are offered for improving PACE instructional effectiveness. First, a more comprehensive screening and assignment process is recommended prior to enrollment. This process should include at a minimum a review of each of the following factors or academic risk assessment indicators: ASVAB, age, paygrade, years of service, semester hours of recent college courses passed, educational level, course group, and marital status. In addition, it would be helpful to determine whether the course is a second or first attempt. A thorough assessment of each of these risk factors should help education counselors make a more informed judgment when deciding to assign Sailors to college or pre-college level PACE courses and to an appropriate delivery mode. Second, supervisors in the Sailor’s chain of command should be more directly involved in providing a recommendation to

PACE enrollment authorities regarding the Sailor's potential to perform effectively in one delivery mode versus another. As noted earlier chain of command participation in the PACE screening process is encouraged but not required. As a result course assignments may be made in some cases by counselors who lack sufficient knowledge of the Sailor's true potential.

Third, in order to facilitate further research towards developing a reliable pass/fail predictive equation for use in screening Sailors for college level PACE courses, it is recommended that all Sailors be required to complete a short questionnaire at time of enrollment and upon completion of each college course. In the first case, individual motivational and anxiety levels associated with the course for which they are registering could provide valuable discriminative data for predicting pass/fail. Likewise, a Sailor's immediate post-hoc assessment of the level of command support provided for the PACE course(s) just completed should be taken into account as well. These responses ought to be archived by social security number to permit comparison with actual end of course outcomes for each Sailor in future research efforts. In this way it might still be possible to develop a reliable predictive equation for use in screening Sailors more effectively into appropriate PACE courses.

Fourth, in the event that restructuring of the PACE program is required, it is recommended that both technology and instructor delivered courses be retained because each provides a useful and practical means of instruction under a challenging if not arduous learning environment. The data clearly show that while some Sailors perform better in one delivery mode than another, both modes of delivery are achieving remarkable results under difficult conditions. Based on these findings, an appropriate challenge to the director of the Navy's VOLED programs in an era of declining resources would be to determine the most affordable and effective mix of instructors and technology for optimizing program efficiency. This should be a topic for further research prior to formulating major policy changes to the PACE program.

Fifth, with regard to the current policy of requiring Sailors to have achieved a minimum ASVAB (PC+AR) of 100 in order to take PACE college courses, the sharp increase in grade performance beyond a 100 ASVAB score seems to support continuation of this policy. It should be noted though that many Sailors with less than 100 were admitted based on successfully completing an asset test in the appropriate subject area. Grade results in the data for Sailors below a 100 ASVAB seem to support continuation of the asset test waiver policy as well.

Sixth, differences in course length for instructor taught courses for Sailors in the Atlantic and Pacific do not appear to make a difference in end of course grade. Accordingly, it is recommended that course lengths be standardized in both the Atlantic and Pacific except in those cases where a ship's operating schedule includes a port visit or other activity which would interrupt a continuous six week course sequence.

Seventh, the summaries of grade and course completion rates by individual ship provided in Appendices J and M provide an excellent resource for further inquiry into learning what additional factors at the unit command level contribute to PACE program success in the fleet. Although the data from the cohort are nearly two years old, there should be sufficient information remaining in many ships such as command policies and practices that were in effect at that time which might shed new light on ways to improve PACE effectiveness throughout the Navy. It is strongly recommended that a survey of successful ships be conducted in the near future to capture the lessons learned from their success for future program improvement. It would be particularly interesting to conduct this survey in successful ships within the "Other" category. Sailors in these ships scored about the same on their ASVAB as their Carrier and Cruiser-Destroyer counterparts, yet they generally achieved the lowest mean grade and completion rates among the four ship types. A survey of command policies and practices related to PACE support in the most successful of these ships might produce some interesting lessons learned for improving academic performance in less successful ships of the same type.

Finally, it is recommended that collection and archival of PACE course data be standardized by the agencies and contractors involved to improve access to data in future studies of this type. Two specific recommendations in this regard are offered. First, the number of Sailors in each section of instructor taught classes should be recorded in the archived data base in order to permit class size to be used as an additional predictor variable. Second, a common grading scale is recommended for all PACE college courses regardless of the source college or university. These procedures would enable future researchers to better assess the extent to which class size may effect grade outcomes, and would provide a standard dependent variable measurement for comparing grade outcomes across all types of delivery systems.