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ABSTRACT

This document consists of volumes 1-9 of the Mathematics Association of America's (MAA) Placement Test Program Newsletter. The MAA is the professional association primarily concerned with undergraduate education in mathematics. It has responded to the increasingly difficult problem of placing freshmen students in mathematics courses by developing a battery of tests which are available through its placement testing program. These newsletters were designed to serve as a forum for the higher education institutions which are subcribers to the placement testing program. (PK)

PTP NEWSLETTER

news about placement testing from the
MAA PLACEMENT TEST PROGRAM

Volume 1, Number 1 February 1978

GOOD START FOR PLACEMENT PROGRAM

The Mathematical Association of America is the professional association primarily concerned with undergraduate education in mathematics. It has responded to the increasingly difficult problem of placing freshmen students in mathematics courses by developing the battery of tests which are currently available to colleges and universities through its Placement Test Program (PTP).

The Committee on Placement Examinations was appointed to administer PTP, a subscription program which was introduced on a national scale in the Fall of 1977. The initial response has been gratifying with some two hundred thirty - five subscribers. The composition of schools represented is given below according to the highest degree offered.

Associate	24%
Bachelors	39%
Masters	22%
Doctorate	15%

The PTP is indeed in its infancy. Its growth and direction will be influenced greatly by the experiences of its subscribers. The battery of tests available through PTP will be expanded and revised to reflect the needs of subscribers and changes in curriculum. Validation of new tests and normative data for each test will be possible as users share their data with the MAA.

The Committee believes that subscribers can maximize their benefits from PTP by combining their experiences in placement with those of other users across the country. The PTP Newsletter, which will be published periodically, will serve as a forum for sharing such information.

Betty Hinman, Chairman
Committee on Placement Examinations

POLICY ON TIMING OF TEST DEVELOPMENT

The Committee on Placement Testing has established the following policy concerning the development of new tests:

A new test will be developed in each area covered by the program every three years. The development of each new test will be accompanied by study of curriculum change. In each of the two years intervening between the development of new tests, a parallel form of the most recently developed test will be issued. The items on a parallel form will be nearly identical to the corresponding items on the test which is being paralleled.

PTP QUESTIONNIARE RESULTS

About 40% of the PTP program subscribers responded to the questionnaire which was mailed in October. Of these, over 60% used one or more test forms. Several others indicated intent to make use of PTP tests within the year. Some of the information about reported test usage is indi-

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(Questionniare, from page 1)
cated below:

	SCHOOLS USING THIS TEST	NO. OF STUDENTS TESTED	TIME ALLOWED (MIN.)
BA/1	33	9363	30
AA/1	11	1405	30
A/3	16	4240	45-50
T/2	15	1401	45

In most cases the tests are being administered by math department instructors during the first week of classes. Furthermore, there are only three responding institutions at which placement on the basis of test scores is compulsory. Several institutions indicate that placement may be made compulsory as soon as they have more experience with the tests, establish norms and carry out follow-up studies on sample populations.

Very few respondents urged that changes be made in the current tests. There is some interest in seeing items on lines, slopes and intercepts in the more basic tests. However the current tests seem to meet the needs of most responding institutions in the areas covered by the tests. Many institutions indicate a need for tests in other areas. First, a test must be developed in arithmetic and basic skills. Second, there should be a test for courses in Mathematics for Elementary School Teachers. Finally, some interest was shown for the development of one or two different types of calculus tests.

There is divided opinion on the regularity with which new forms of existing tests should be written. A plurality of respondents indicate a preference for new forms every two years. But an equal number split evenly between réquesting a new form each year and a new form every four-or-more years. A smaller group requests a new form every three years. The committee policy on this issue appears on the front page of this Newsletter.

PLACEMENT EXAM COMMITTEE MEMBERS

The names and addresses of members of the Committee on Placement Examinations are listed below. You are encouraged to contact any or all members with questions or concerns about the program.

Betty J. Hinman (Chairman)
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NOTES

The next issue of the PTP Newsletter, to be published in early April, will contain data on norms and articles on follow-up studies.

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Members of the Committee on Placement Examinations will be available to attend a limited number of section meetings of the Association in the Spring of 1978. Committee members can report on the progress of the program, participate on panels or otherwise take part in your section's program. If the program for your section meet-

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ing is not complete and you wish to make use of the services of the Committee, make your request to Alfred B. Willcox, Executive Director, The Mathematical Association of America, 1225 Connecticut Avenue, N.W., Washtionton, D.C. 20036

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The Committee believes that there are several opportunities for good research in the area of mathematics placement testing. Directors of the research of doctoral students in Mathematics Education may contact the chairman of the Committee for research topics and discussion of where testing data may be available.

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Time schedule for PTP:

April----
Newsletter containing norming data and follow-up articles.

All Spring----
Committee members participate in section meetings.

Early Summer----
PTP subscribers renew their subscriptions to the program.

Late Summer----
Parallel forms of BA/1, AA/1, A/3 and T/2 to be issued to subscribers.

Late Summer----
First form of test on arithmetic and basic skills to be issued to subscribers.

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If sufficient interest is shown, a QUESTIONS section of the Newsletter will be established. PTP subscribers should submit questions on any aspect of placement testing directly to the editor of the Newsletter (address above). Replies will be sent to the questioner. In some instances, answers may appear as articles in subsequent issues of the Newsletter.

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Articles and/or information which may be of interest to the placement testing community may be sent directly to the editor of the Newsletter for possible inclusion in an issue of the paper.

NEWSLETTER

news about placement testing from the
MAA PLACEMENT TEST PROGRAM

Volume 1, Number 2 May 1978

MATHEMATICS PLACEMENT TESTING: A THREE COURSE STUDY

The Mathematics Placement testing program began at Southwest Texas State University in the Fall semester of 1975. Although initially thought of as a supplement to standard methods of counseling freshmen students with regard to the most appropriate "first" mathematics course, the program has been expanded to encompass several other areas of interest to the department. These include insuring, as best we can, that students placed in a particular course will have sufficient mathematical background to perform satisfactorily there and that those with "stronger" background be placed in the course most likely to challenge their ability. It is useful to note that the average ACT score for freshmen at Southwest Texas is within a point of the national average.

<u>Course Descriptions</u>

Mathematics 1311, Basic Mathematics (intermediate algebra), includes the following topics: basic structure and properties of the real number system, integer exponents, polynomial arithmetic, linear equations and inequalities, rational function arithmetic, solutions of quadratic equations and applications. Math 1311 generally satisfies the mathematics requirements for majors in the non-science related areas.

Mathematics 1315, College Algebra, includes theory of functions, equations, inequalities, logarithms, matrix arithmetic, complex number arithmetic, and induction.

Mathematics 1319 is the first of two courses required by majors in the

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AN ATTEMPT AT PRODUCING NORMS

The development of meaningful norms for the four existing MAA placement tests has been a difficult task. The MAA exercises no control over who takes the tests (freshmen, sophomores, etc.) and so, while our sample populations are composed mostly of freshmen, they do contain all classifications of students. The MAA exercises no control over the administration of tests (30 min., 45 min., etc.; orientation period, first week of classes,

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PLANS FOR THE FUTURE

During the 1978-79 academic year the Committee on Placement Testing plans:

a) to write parallel forms for tests BA/1 (Basic Algebra), AA/1 (Advanced Algebra), and SK/1 (Arithmetic and Basic Skills),

b) to develop a new version of the Trigonometry test,

c) to develop a Calculus Readiness test,

c) to research further the placement testing needs of two-year colleges and to identify types of tests which can be developed to help meet those needs.

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PLANS, con't. from page 1

The plan to revise the Trigonometry test is made in response to comments and requests of people who have used the existing one. The new form will probe students' understanding of elementary concepts and definitions more broadly than is done by the existing form. It will require less memorization of specific formulas than is required by the current test.

Several subscribers have requested a Calculus Readiness test. The Committee members understand that there is a wide variety of courses, which are used to prepare students for calculus. The Readiness test cannot be geared to the content of any one such course. Instead, the test should probe conceptual understanding. A high score on the test should indicate a level of mathematical maturity appropriate for beginning calculus students. Of course, certain algebraic skills, and the understanding of geometric ideas and function notation will be tested. Items which test trigonometry will appear at the end of the Calculus Readiness test. Users can easily include these or exclude them depending on the requirements of their own calculus courses.

The Committee would appreciate comments and suggestions which will help optimize the usefulness and effectiveness of the Readiness test. *The Committee would also appreciate receiving recommendations for people to serve on the panels which will develop the Trigonometry and Calculus Readiness tests.* Several members of the panel which developed the Basic Skills test were recommended for the task by subscribers. The Committee will be equally responsive to recommendations for personnel for panels which will work during the next academic session. Send comments, suggestions, and recommendations for panel personnel to A. B. Willcox, Executive Director, the Mathematical Association of America, 1225 Connecticut Avenue, N.W., Washington, D.C., 20036.

The Committee is not certain that

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THE BASIC SKILLS TEST

The Basic Skills Test, SK/1, is in the final stages of development and will be distributed later this summer to PTP subscribers. The test consists of twenty-five items and is designed to be given in thirty minutes. A complete list of topics covered follows:

- Arithmetic of whole numbers
- Arithmetic of fractions
- Arithmetic of decimal fractions
- Arithmetic of integers
- Percentages
- Positive integral exponents
- Square roots
- Ratio and proportion
- Averages
- Order relation on number line
- Area, perimeter and volume
- Elementary linear equations
- Formula evaluation
- Graph and table interpretation
- Word problems

The first eleven items on the test do not involve negative numbers.

Pretesting of items proposed for SK/1 has been carried out at an urban two-year college, a suburban two-year college, a large state university, and a regional state university. The pretest population, several hundred students, consisted of three categories of students. Some were enrolled in arithmetic courses, some in beginning (basic) algebra courses, and some in intermediate algebra courses. Mean raw scores on the 25 items selected for SK/1 for the three categories of students were approximately 8, 12, and 16 respectively. The items which appear on the test were selected from those on the pretest following a study of an item analysis.

The panel which was responsible for developing SK/1 was chaired by B. L. Madison, Louisiana State University. The representative of the Committee on Placement Testing was R. A. Northcutt, Southwest Texas State University. Panel members were: T. A. Carnevale, Essex County College; G. F. Lowerre, Northern Virginia Community College; B. E. Rhoades, Indiana University; and M. P. Sward, Trinity College, Washington, D.C.

UNIVERSITY OF KANSAS AND BA/1

The following was received from P. R. Montgomery, Pre-calculus Coordinate at the University of Kansas:

"The MAA Placement Test BA/1 was given to approximately 500 students in Intermediate Mathematics at the end of the Fall 1977 semester. The text for the course was Keedy and Bittenger's *Intermediate Algebra, A Modern Approach.* The class format was lecture twice a week and recitation twice a week. Each of the problems was worth two points. The scattergram below shows the distribution of scores versus final grades for the course. The average score for the exam was 29.1 with a standard deviation of 7.53. The correlation between the two measurements (A=4, B=3, C=2, D=1, F=0) was 0.652."

Grades vs. MAA-BA/1 Test Scores

	A	B	C	D	F	Totals
50						
48	1					1
46	1					1
44	7					7
42	13	2				15
40	19	0	4			23
38	13	9	2			24
36	8	8	4			20
34	16	19	4	1		40
32	14	13	6	4	2	39
30	11	14	8	8	1	42
28	5	12	8	9	3	37
26	7	7	10	6	1	31
24	2	10	12	4	3	29
22	2	8	9	7	2	28
20	2	1	10	10	12	35
18		1	2	5	6	14
16			3	4	6	13
14			1	3	3	7
12			1	0	1	2
	121	104	84	61	40	410

PLACEMENT TESTING, con't from page 1

School of Business and deals with theory of equations, systems of equations and inequalities, finance, matrix arithmetic as applied to optimization problems, linear programming and basic probability. The second course of this sequence involves calculus and its application to business related problems.

Testing Procedures

During the first class meeting of the Fall semester, 1977, the BA/1 placement test was given to a total of 1738 students in each of the three courses 1311, 1315, and 1319 (638, 767, and 333 students respectively, which represents roughly half of the total enrollment of these courses for that semester). During the second class meeting, students were told their scores and given information appropriate for the interpretation of that score. This information varied among the courses and consisted of recommendations based on grades received by students with that course-score combination from past semesters.

Those desiring to change course based upon the information provided were permitted to do so during the "drop-add" period (fourth and fifth class days). For example, those taking the test in 1315 with 0 to 8 correct (of 25 questions) were encouraged to drop 1315 and add 1311, those with 9 to 18 correct were advised to remain in 1315, and those with 19 to 25 correct were counseled individually to consider exchanging 1315 for the "next" course required by their major area. This last recommendation was influenced by a variety of factors, including requirements of the major area, matters of satisfying prerequisites, and student input.

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PLACEMENT TESTING, con't from page 3

At the end of the Fall semester, these scores were compared with the grade received in the course attempted and the results analyzed with the aid of the University of Pittsburgh SPSS-10 computer program: *Statistical Package for the Social Sciences*. A summary of this analysis follows:

Students Receiving Grades in 1311

Among the students taking the test, 701 received a grade in 1311, and their performance is summarized below:

Percent correct of 25 questions

	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-100
% of total with score	1.3	7.6	27.7	24.1	22.8	8.0	6.7	1.6	0.3	------
% this score making A,B,C	22.0	24.5	51.5	59.8	69.8	82.1	87.2	100.0	100.0	------

Of those taking the test in 1315 with score range 0 to 8, 72 followed our advice to attempt 1311 instead. It is interesting to note that 56% of these made A, B, or C in 1311 as compared to only 20% for those with this score range who stayed in 1315.

Students Receiving Grades in 1315

The following table describes the performance of the 720 students who received a grade in 1315:

Percent correct of 25 questions

	0-9	10-19	20-29	30-30	40-49	50-59	60-69	70-79	80-89	90-100
% of total with score	.14	.56	6.7	10.4	27.0	17.0	18.6	9.6	8.3	1.8
% this score making A,B,C	---	-----	18.7	30.7	46.7	51.3	70.4	85.5	91.7	100.0

To summarize (and correlate with score ranges used for "recommendations" at the beginning of the semester) we have:

# Correct (of 25)	of 720 % ABC	Row total: #	%
0-8	20.4	83	11.5
9-18	55.2	536	74.5
19-25	91.0	101	14.0

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PLACEMENT TESTING, con't from page 4

Students Receiving Grades in 1319

Finally, of the 317 students receiving a grade in 1319:

	Percent correct of 25 questions									
	0-9	10-19	20-29	30-39	40-49	50-59	60-69	70-79	80-89	90-100
% of total with score	0.0	0.3	4.4	7.6	20.2	12.9	26.5	12.3	12.0	3.8
% this score making A,B,C	---	---	21.4	33.3	42.2	56.1	71.4	82.1	89.5	91.7

Further Comments

The discriminant analysis portion of SPSS-10 identified 11 of the original 25 questions as being sufficient (when properly weighted) to provide predictive capability for 1315. Using this approach, we find that 71.8% of the students attempting 1315 could be correctly classified (predicted grade vs. actual) based on test score, broken down as follows:

		Actual grade in 1315	
		A,B,C	D,F,W
Predicted	A,B,C	76.2%	23.8%
	D,F,W	34.0%	66.0%

The inability to further refine the predictive performance is not surprising, considering the complexity of factors which might cause a student to do poorly on a test, and yet perform satisfactorily as the course progresses.

In a similar manner, a subset of 14 questions appears to suffice for predictions in 1311 (70.1% can be correctly classified) and only 9 questions for 1319 (for 73.2%).

Although data has not been processed for the Spring semester of this year, we do anticipate additional studies.

James D. Smith, Wilbon P. Davis

NORMS, con't from page 1
etc.) and so our sample populations took the exams under varying circumstances. Populations which contribute to the figures below were not chosen by scientifically endorsed procedures. They were selected as follows. The questionnaires, returned by PTP subscribers to the MAA last fall, were scanned to identify institutions testing reasonably large numbers of students. The institutions identified in this way were asked to send students' answer sheets to the MAA for use in the norming process. Almost all of the answer sheets from institutions which responded to the request were used. Readers should interpret the figures and distributions presented below in the light of the facts presented here. It may be that as more institutions use more tests, more meaningful norms can be developed.

See charts on page 7.

The more score sheets we see from various institutions, the more we realize that statistics of the type which we are trying to compile are sensitive to variations in admissions policies. There was a ten point difference on the 32 questions test, A/3, between average grades calculated for freshmen at two institutions.

Furthermore, these statistics vary considerably between different populations within a single institution. One institution which identified the courses in which the students who took the test A/3 were enrolled, displayed the following variations:

Students in a basic algebra (remedial) course
average grade 3.8*

Students in a finite math course
average grade 11.6*

Students in service calculus courses
average grade 12.9*

Students in a calculus course for prospective math concentrators
average grade 18.8*

It seems clear that national norms, developed with scientifically endorsed procedures or otherwise, are of limited value in helping institutions use placement tests for placement purposes. *For best results, institutions must experiment with tests in their own setting, observe the performance of students with different ranges of scores in different courses, and set cutoffs for placement advising in accordance with observations.* A second line of action, one for people at institutions where analysis of data is difficult or inadvisable, involves reading of follow-up studies prepared by subscribers at institutions similar to their own. Our first follow-up study appears in this issue of the NEWSLETTER.

We are grateful to the following individuals and their institutions for materials used in the preparation of this article:

G. W. Hinkle and M. Z. Williams, Westminister College;

F. Holley, Metropolitan State University;

B. Kastner and J. Kneen, Montgomery College;

L. C. Larson, St. Olaf College;

H. E. Reynolds, Golden West College;

R. Svoboda, Indiana University-Purdue University at Fort Wayne.

*Throughout the article, "grade" refers to the number of correct responses. No correction is made for guessing.

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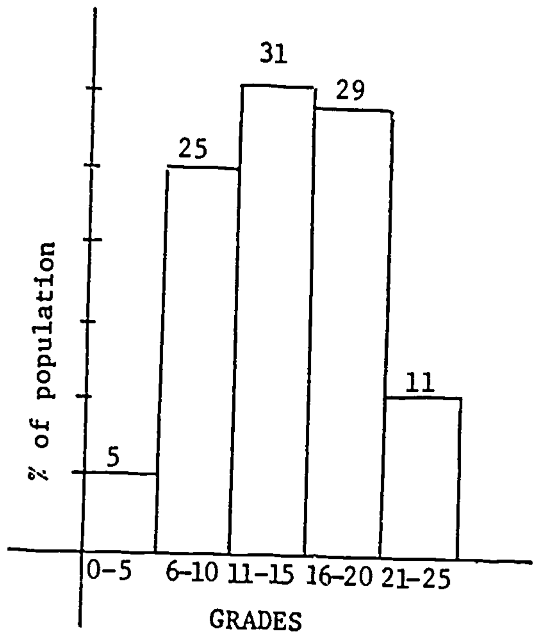
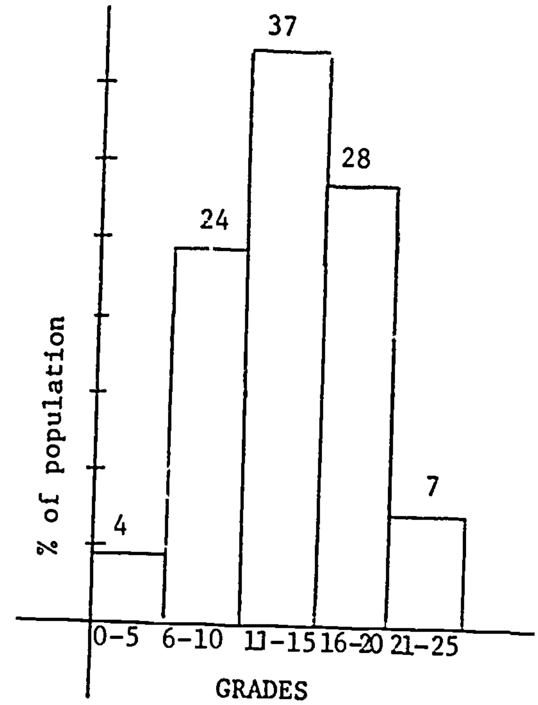
the Basic Skills test and the existing Algebra tests are all that is needed by our subscribers from two-year colleges. Several attempts at determining the testing needs of this group of subscribers are being made. Any one with information on this subject should send that information to A. B. Willcox (address in previous paragraph).

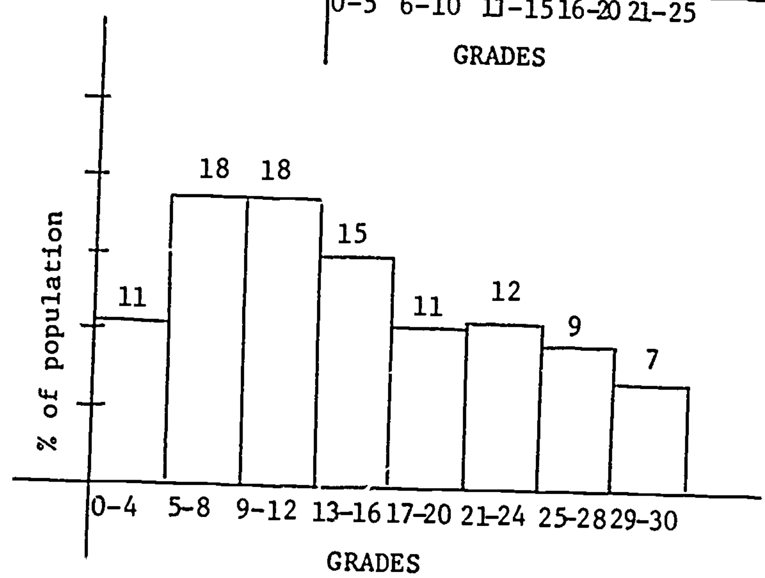
BA/1 (25 Questions)
population size 1237
average grade 13.82*
standard deviation 5.16



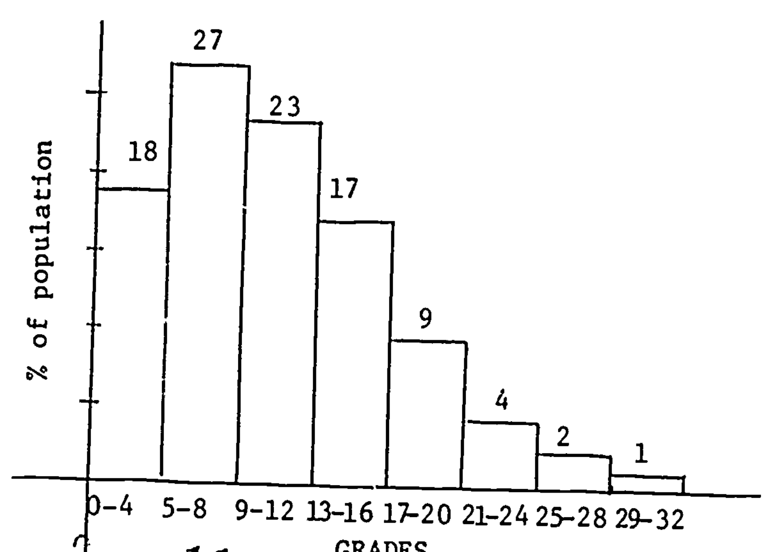
AA/1 (25 Questions)
population size 520
average grade 13.42*
standard deviation 4.70



A/3 (32 Questions)
population size 1562
average grade 14.00*
standard deviation 8.03



T/2 (32 Questions)
population size 795
average grade 10.30*
standard deviation 5.95



NEWSLETTER

news about placement testing from the
MAA PLACEMENT TEST PROGRAM

Editor: Richard H. Prosl | Volume 2, Number 1 | March 1979

REPORT: THE 1978 MODES SURVEY

In late October 1978, the MAA requested the more than 250 Placement Test Program subscribers to supply detailed information about the ways in which they were using the PTP tests. One hundred fifteen institutions responded and indicated that over 30,000 PTP tests had been administered at these institutions. Basic Algebra (BA) and combined Algebra (A) tests each account for over 10,000 of these; the advanced Algebra (AA) tests account for about 4,000. Basic Skills (SK) and Trigonometry (T) each account for about 3,000.

Responding institutions are distributed with respect to size and highest degree offered as shown in Table A. Figures in Table A represent the percent of responding population in the indicated category.

No. of Students	Highest Degree			
	Assoc.	Bach.	Mstr.	Ph.D.
≤ 1000	3	16	0	0
1000-5000	11	24	7	4
5000-10,000	4	3	8	3
≥10,000	2	1	5	8

Table A

Less than 20% of responding institutions indicate that they are using modified versions of PTP tests. It is difficult to categorize the modifications which occur. In some instances items are added to existing PTP tests; in others there are deletions. Sometimes both additions and deletions occur. Only two institutions modified tests so drastically that the resulting exam could not be identified with a single PTP test.

Very few institutions make placement mandatory on the basis of test results. Most use test scores in the advising process.

The Modes Survey requested information on cut-off scores. Practices vary considerably. Summary information on practices in five courses appears below.

Beginning Algebra: Three tests, SK, BA, and A, are in use as placement aids for this course. Most institu-

(Continued page 2, Modes Survey)

NEW AND REVISED TESTS FOR 1979

- NEW CALCULUS READINESS TEST
- REVISED TRIG/EL FUNCTIONS TEST

Calculus Readiness

The MAA Committee on Placement Examination is having a Calculus Readiness test prepared for pretesting this winter with a modified version available for next fall. This test is conceived as applicable to test readiness both for engineering and physical science type calculus and for business type calculus. It is being designed to

(continued page 2, Calculus...)

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The Committee on Placement Examinations wishes to express its appreciation to all institutions which submitted data or statistical studies.

Material which was not used in this issue of the Newsletter may appear in subsequent issues.

All information which we receive helps us in the development of policies and tests. We encourage subscribers to send us any analyses which they feel they can share. Information should be sent to: Dr. Alfred B. Willcox, Executive Director, Mathematical Association of America, 1529 Eighteenth St., N.W., Washington, D.C. 20036
*
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(Calculus, from page 1)

test both algebraic and geometric background, concept formation, elementary graphs, direction following, elementary worded problems, numerical awareness, and familiarity with notation among other topics.

Trigonometry will enter only in an optional final part of the test. The ability to handle new concepts introduced in rapid order is one of the most important characteristics of the successful calculus student. For this, the student needs innate ability as well as knowledge and experience in the types of things suggested above.

It is recognized that traditional college algebra and/or trigonometry are not usually designed just for calculus readiness and do not emphasize a background for calculus. It is hoped that the test will help identify important components of training for calculus. Panel members are: James E. Scroggs, University of Arkansas, panel chairman; Richard Anderson, Louisiana State University; Etta Falconer, Spelman College; Stanley M. Lukawecki, Clemson University; David Schneider, University of Maryland; and Gilbert Sward, Montgomery College.

<u>Trigonometry/Elementary Functions</u>

The Committee on Placement Examinations has assigned a panel to construct a completely new Trigonometry/ Elementary Functions test. The new test will reflect the needs and suggestions which subscribers have indicated to the committee. The new test will be pretested and distributed to subscribers in the Summer of 1979.

Panel Members are: Thomas Carnevale, Essex County College, panel chairman; Laurence Gilligan, Monroe Community College; John Neff, Georgia Institute of Technology; Richard Prosl, William and Mary; and Shirley Trembley, Bakersfield College.

* * *

(Modes survey, from page 1)

tions are using BA. Typically, a cut-off score between 8 and 12 is chosen. Students with scores below the cut-off are advised to stay in the Beginning Algebra course. Students with higher scores are given other options.

<u>Intermediate Algebra</u>: Four tests, SK, BA, AA, and A, are in use. However, SK and AA are used by only a few schools. BA and A are used by equal numbers of institutions. When BA is used, students with scores above a cut-off near 10 are advised to stay in the intermediate course. Where A is used, a cut-off in the very low teens is used. Students below the cut-off stay with the intermediate course, those above are urged to proceed to another course. For more general use of the A test, see below.

<u>College Algebra</u>: The test most used in College Algebra courses is BA. The second most used test is A. With BA, a cut-off of 13 or 15 is typical. Students with scores above the cut-off are urged to stay in the College Algebra course. When A is used, the situation is more complicated. If A is used to determine whether a student is to stay with College Algebra or be sent back to a lower course, typically the cut-off is very low, 6 or 8. Students with low grades are sent back. If A is used to determine whether a

(Continued page 3, Modes Survey)

(Modes Survey, from page 2)

student is to be advanced to a higher course, a high cut-off, one near 20, is used.

Precalculus: The three tests BA, AA, and A are used in connection with precalculus courses. However, three institutions indicate that they use SK here and one institution uses T in conjunction with A. The A tests are the ones most used here. Cut-off scores of 13 and 15 are common. Students with scores above the cut-off are advised to stay in the course; those with lower scores are routed back. For a more general use of the A tests, see below. Where BA is selected, relatively low cut-off scores near 10 are used. Students with low scores are advised to register for algebra courses. When the AA tests are used to separate calculus students from precalculus students, cut-offs are frequently between 11 and 15.

Calculus: The AA and A tests are the ones most frequently used with students enrolled in Calculus courses. As in the previous paragraph, when AA is used, a cut-off in mid to low teens is chosen. When the lower level A test is chosen, a higher cut-off, 15 to 20, is employed. The trigonometry test is sometimes used in conjunction with both A and AA to determine placement into calculus courses. There is no discernible pattern of cut-off scores when T is used in this way.

More General Use of the A Tests: The natural choice for determining placement into a sequence of 3 courses seems to be the A test. Oddly enough, whatever the middle course may be called (Intermediate Algebra, College Algebra, or Precalculus), the low cut-off always seems to be near 8, the high one in the (rather wide) 18-25 range.

A SMALL COLLEGE'S EXPERIENCE WITH MAA PTP

Trinity College in Washington, D.C., is a small, liberal arts college for women. Because of the size of the College and the emphasis on individualized advising, our problems with mathematics placement are different from those of large colleges and universities.

We have used the PTP tests on an experimental basis for two years and plan to use them routinely in the future. In the fall of 1977, Trinity introduced a new curriculum in which all students are required to take Fundamentals of College Mathematics (essentially a Finite Math Course), Pre-Calculus, or Calculus. Under this new curriculum we knew that it would be very helpful to freshmen advisors to have a written recommendation from the Mathematics Department for each freshman based on placement test scores as well as on the student's interests and mathematical background. As a first step in this direction we offered the PTP tests on a voluntary basis, but the results were unsatisfactory because of the low number of takers.

In the fall of 1978 we required all freshmen to take at least one of the PTP tests. Because of our lack of experience in interpreting the scores, we did not feel that we could use them for mandatory placement. However, we did use them to recommend supplementary work in the Math Lab for all students scoring lower than 50%. The Math Lab found the placement answer sheets to be helpful in diagnosing the mathematical weaknesses of these students.

Armed with the data gathered this year on placement test scores and student performance in courses, we plan to use the PTP test scores for mandatory placement in our mathematics courses starting next fall. We will continue to use them for placement and diagnosis in the Math Lab.

Dr. Marcia Sward, Associate Professor

A LARGE UNIVERSITY'S EXPERIENCE WITH PTP

Louisiana State University, Baton Rouge, has been involved with the Placement Testing Program since its earliest, experimental days (c.1974). The results of a limited follow-up

(continued page 4, Large University)

(Large University, from page 3)

study were recently passed on to the Committee on Placement Examinations and are herewith being shared with all subscribers.

For purposes of the study, three classes of students were considered.
(1) Students in the first course in calculus (n=116)
(2) Students in a college algebra course (n=50)
(3) Students in a remedial (intermediate) algebra course (n=50)

Three scores were recorded for each student:
(g) Midsemester grade (A=4, B=3, C=2, D=1, and F=0) for (1) and (2) above. Final grade in the 7-week remedial course for (3) above.
(h) Score on a slight variant of A/2.
(a) Score on Mathematics ACT test.

Placement levels for the courses were:
(1) Calculus required h>25 (and a grade above 6 on T/2).
(2) Placement in the college algebra course required a score of more than 13 on A/2.

MEANS

Students	Mean grades	Mean score on 1-16 of T/2	Mean score on var. of A/2	Mean Math ACT
Calculus (N=116)	mid-sem 2.64	9.18	36.66	29.04
College Algebra (N=50)	mid-sem 2.18	not recorded	20.06	23.38
Intermediate or Remedial Algebra (N=50)	Final (%) 65.84	not recorded	13.90	16.82

A standard correlation coefficient was computed. In the table below γ_{gh} denotes the correlation of grades to A/2 scores and γ_{ga} denotes correlation of grades to ACT scores.

Course \ γ	γ_{gh}	γ_{ga}
Calculus	0.33	0.28
College Algebra	0.26	0.17
Remedial Algebra	0.33	0.30

The committee recognizes that one interpretation of the figures above may be that on the very limited sample used, both the MAA and ACT tests are relatively inaccurate predicters of course grades. Still, studies of this sort are much needed by both test designers and test users. We wish to thank Dr. Bernard Madison of LSU for his work and good humor in producing figures which are useful to all of us who are working to develop this young program.

FOLLOW-UP STUDY -
METROPOLITAN STATE COLLEGE,
DENVER, COLORADO

We reproduce here some of the information sent to us by Frieda Holley of Metropolitan State College. The figures are developed from 1977-1978 testing experience. The information shown here was used by faculty in advising students this academic year.

Ms. Holley notes that the grade NC (no credit), which may be requested by a student until the last week of classes, is given for a wide variety of reasons, and provides an element of confusion in interpreting testing data. The heading "students who left course" is reserved for students who took the placement exam but for whom no course grade is recorded. Numerical equivalents for course grades are: A=5, B=4, C=3, D=2, F=1, NC=0.

We thank Ms. Holley for sharing her work with us.

PLACEMENT TEST SCORES
vs
GRADES in FINITE MATH:

Placement Test Used: BA/1
Mean on Placement Test = 12.2
Standard Deviation = 5
348 Students Were Tested
70 Students left the course

CROSSTABULATION

	0-7	8-10	11-13	14-17	18-25	%
NC	21	16	16	3	5	17.5
F	4	7	2	1	1	4.3
D	7	9	3	5	1	7.2
C	16	23	10	24	7	23
B	12	12	17	23	16	23
A	7	12	18	23	27	25
%	19.3	22.7	19	23.7	16.4	

Mean Grades

Placement Test Score	Mean Grade*
0-7	3.2
8-10	3.2
11-13	3.9
14-17	3.8
18-25	4.3

*NCs omitted

PLACEMENT TEST SCORES
vs
GRADES in COLLEGE ALGEBRA:

Placement test used: BA/1
Mean on Placement Test = 13.5
Standard Deviation = 4.4
388 Students
65 Students left the course

CROSSTABULATION

	0-9	10-12	13-15	16-18	19-25	%
NC	39	33	22	15	11	35.5
F	3	2	2	2	0	2.7
D	5	7	4	1	1	5.3
C	10	16	28	12	7	21.6
B	4	15	15	11	12	16.9
A	3	4	13	23	18	18
%	18.9	22.8	24.9	18.9	14.5	

Mean Grades

Placement Test Score	Mean Grade*
0-9	3.0
10-12	3.3
13-15	3.5
16-18	4.1
19-25	4.2

*NCs omitted

(Continued page 6, Follow-Up Study)

(Follow-Up Study from page 5)

PLACEMENT TEST SCORES
vs
GRADES in PRE-CALCULUS:

Placement Test Used: BA/1
Mean on Placement Test = 17
Standard Deviation = 3.7
83 Students
7 left the class

	0-13	14-16	17-18	19-20	21-25	%
NC	5	6	6	3	5	26.5
F	1	0	0	1	0	2.4
D	3	0	0	0	0	3.6
C	5	7	4	2	0	21.7
B	1	4	5	4	5	22.9
A	3	2	4	4	6	22.9
%	21.7	22.9	19.3	16.9	19.3	

Mean Grades

Placement Test Score	Mean Grade*
0-13	
0-13	3.2
14-16	3.6
17-18	4
19-20	3.9
21-25	4.5

*NCs omitted

PLACEMENT TEST SCORES
vs
GRADES in CALCULUS:

Placement Test Used: AA/1 + 7 items
Mean on Placement Test = 15.2
Standard Deviation = 5
235 Students
26 Students left the class

	0-10	11-13	14-16	17-19	20-32	%
NC	19	13	14	12	10	28.9
F	4	3	3	1	1	5.1
D	3	1	3	4	4	6.4
C	9	15	13	11	8	23.8
B	5	10	12	10	8	19.1
A	2	8	6	7	16	16.6
%	17.9	21.3	21.7	19.1	20	

Mean Grades

Placement Test Score	Mean Grade*
0-10	2.9
11-13	3.5
14-16	3.4
17-19	3.5
20-32	3.9

*NCs omitted

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PTP NEWSLETTER

news about placement testing from the
MAA PLACEMENT TEST PROGRAM

Editor: Richard H. Prosl | Volume 2, Number 2 | June 1979

WHAT IS A PLACEMENT TEST?

The author is a classroom teacher, a departmental administrator, and a user of placement tests. He has made a modest and unsystematic effort to understand how these activities fit together, and no further authority than this underlies the views which follow (in particular, the views are not necessarily original on the one hand, nor shared by the author's colleagues on the other). The interested reader should approach the assertions below as claims to be tested against his or her own experience rather than as conclusions to be accepted without question.

To answer the question stated in the title: A placement test is a means to assess students' mastery of skills prerequisite for a course or group of courses. To gain appreciation of what this definition entails we consider two of its possible competitors to see why they were discarded.

The first competitor is "a means to predict a student's success in a course." Certainly if such a means existed, if it produced accurate results for each student, and if there were no substantial difficulties in employing it, then it would have overwhelming claims to be the proper vehicle for course placement. I claim that our experience as classroom teachers settles it that several

(Cont. pg. 2, "WHAT IS A PLACEMENT..."

PTP BROCHURE

As a new service to subscribers, PTP has produced a brochure which describes the purpose of PTP and furnishes sample questions. Copies may be sent by colleges and universities to high school guidance counselors and high school students. Space will be available in the brochure for institutions to print further information on how they use the PTP tests.

Brochures will be forwarded to subscribers along with the 1979 tests. Additional brochure copies may be produced locally or may be ordered from the MAA at a nominal cost.

AMATYC STUDY STARTS

I am writing to inform the readers of the PTP NEWSLETTER of an evaluation program which will make extensive use of the SK/1 and BA/1 tests. The American Mathematical Association of Two-Year Colleges (AMATYC) has formed a committee to establish evaluation procedures and criteria for courses in basic mathematics. This committee is charged with considering many aspects of evaluation for such courses, but one of its prime concerns will be student learning as measured by performance on standardized tests. This

(Cont. pg. 4, "AMATYC STUDY...")

MATHEMATICAL ASSOCIATION OF AMERICA • 1529 Eighteenth Street, N.W., Washington, D.C 20036 • (202) 387-5200

(WHAT IS A PLACEMENT...from pg.1)
factors are involved in student success, and that a crude, badly labeled, but useful enumeration of these factors consists of: preparation, motivation, brightness, and happenstance. Preparation means a collection of fairly specific skills which can be learned of fairly quickly (a semester or so) by most of the students we are concerned with. Placement tests typically focus on this factor. Motivation is a disparate collection of traits, which would need to be further subdivided if one were trying to do anything with it. It includes study skills, mathematical self-image, level of aspiration, and methods for coping with stress. Among students of roughly equal preparation, it is probably the strongest determinant of success, but items dealing with it are wholly absent from all the placement tests I have seen. Brightness means a collection of fairly general skills which are learned slowly and whose learning is strongly influenced by genetic endowment. Conceivably this factor would be better labeled IQ, or Aptitude, or Mathematical Maturity. Almost surely it is multi-dimensional. The author has no hopes of giving it any precise boundaries, but is convinced that it is a separate factor (or bundle of factors). It is very difficult to say of any test questions "this is a brightness question" or "this is a preparation question," but it is usually easy to compare alternate versions of a question and say "this one emphasizes brightness, that one, preparation." The placement tests the author has seen all consistently opt for the version emphasizing preparation. Happenstance covers all those events arising outside a given course but affecting the success of a student in that course - illness, identity crisis, family problems, financial difficulties, etc. In any real-life attempt at success prediction, happenstance includes also the fact that the course is not taught exactly as intended, and the criteria of success are not applied exactly as intended. By definition, the occurrence of these events cannot be predicted. Their academic impact can be partially predicted, at least in some statistical sense, from a knowledge of the factors listed earlier (e.g. a week in the hospital is much more likely to lower the grade of a dull, unmotivated student than of a bright, well motivated one). The author has made various attempts to exclude the operation of happenstance from considerations of student success, but all have left the data looking less meaningful than it started, so he continues to carry it as a component of success.

If it is granted that the above is a tolerably accurate description of the factors contributing to success in a course, then quite a lot follows. First, typical placement tests are, by design, very limited predictors of course success, because they measure only one of the major factors involved. Second, undertaking to do a competent professional job in predicting grades is undertaking a very large task indeed. The range of apparently applicable expertise is wide, and expert views within the fields involved are presently in flux. Third, given the unlikelihood of predicting grades with accuracy, anyone who attempts to predict grades should not let these predictions become known to people assigning actual grades, lest the predictions contaminate the actual grades. More could be added, but these may suffice to explain why the first competitor was discarded.

To anyone who has read this far and still has a feeling that grades (or any other measure of course success) ought to be predictable, I have a final suggestion. It is that they read Chapter 13 of Book Three of The Once and Future King by T. H. White. And that they consider whether the predictability they look for is not much like the "seventh sense" discussed there. And, if this is so, whether they truly wish that their students' course success should be uniformly predictable.

A second alternative definition of a placement test is "a means of sum-
(Cont. pg. 3, "WHAT IS A PLACEMENT...")

(WHAT IS A PLACEMENT...from pg.2)
marizing a student's mathematical accomplishment." Although this is closer to the definition actually offered, it is still a much more ambitious one, which is outside the scope of typical placement tests. Placement tests are designed to last from one-half hour to somewhat over an hour, and in this period they have to sample student skills in a number of areas with some degree of reliability. These considerations constrain placement tests in the direction of "single-concept items" - i.e. questions which get at a single "concept." It is not clear that such questions exist, but it is clear that some questions require more "concepts" than others, and placement tests on the whole try to minimize the number of "concepts" per item. They try to minimize the amount of computation needed. As a result, they lack integrative questions in which the respondent must assemble diverse techniques and apply them in sequence to solve a problem. Such questions are the best measure of a student's effective accomplishments, and should be a regular feature of any math course. Since the point of a placement test is to put a student in a course, it is tolerable to sacrifice such questions on a placement test, in the interest of letting it do its intended task better.

Other, similar sacrifices occur in constructing a placement test. For instance, all its items must be speedily comprehensible to students coming from a diversity of backgrounds. This constraint again operates in the favor of relatively superficial questions. Finally, any widely used placement test concentrates on items which are hard-core prerequisites for most users - i.e. it is based on an intersection of prerequisites. This means its scope is narrower than any particular prereq course. All of which is to say that a placement exam is a very bad substitute for a course final, and a bad substitute for a general mathematics attainment exam. In the author's (limited) experience, the latter use is typically made by other (i.e. not mathematics) departments, and is fairly described as an attempt to get some kind of attainment result at minimal cost. Such departments should at least realize that their low cost stems from use of an instrument not designed for their purpose. Specifically, if they find their students unable to put it all together to solve problems, this failure stems not from a failure in placement testing but from failure to distinguish between placement exams and attainment exams.

My final point is already implicit in the preceding paragraph. I suppose that most readers of the Newsletter are actually using placement tests in the manner for which the tests are designed. But I suspect they will often have colleagues elsewhere on campus who are misusing or misinterpreting placement test results because of failure to understand their purpose. I think the interests of students and of math instruction in general would be furthered by bringing such colleagues to a better way of thinking. I hope the discussion above will inspire some of you to attempt this task from time to time.

P.S. It is argued above that the other departments should not confuse a math placement exam with a math attainment exam. But they may still find it beneficial to look at math placement scores in connection with placement into their own courses. Although the placement exam gives only partial information, that information can be very useful. At least on my own campus, there is a strong relation between math placement scores and grades in such math-using courses as Chemistry and Computer Sciences. This relation is not always what one would naively infer from catalogue statements of math prerequisites, so the information involved is not already built into the prereq system.

P.P.S. The new MAA Calculus Readiness test is an interesting step toward raising the level of skills involved in placement tests, since it involves such skills as interpretation and direction-following. Never the less,
(Cont. pg. 4, "WHAT IS A PLACEMENT...")

(WHAT IS A PLACEMENT...from pg. 3)
these skills are all specifically related to the demands of a typical first course in calculus, and the Calculus Readiness test is a preparation test (in the sense discussed earlier) rather than an I.Q. test.

--Professor Miles is a member of the Mathematics Department at the University of Wisconsin-Madison. He is also a member of the Committee on Placement Examinations of the MAA.

* * * * *

(AMATYC STUDY...from pg. 1)
summer the committee will begin to collect pre-test to post-test gain scores from basic skills (arithmetic, introductory and intermediate algebra) programs in mathematics. Roughly 30 schools will administer the appropriate MAA placement test to their students on the first day of class and readminister the same test as a part of their final examination.

The committee will collect this data, analyze it and issue a preliminary report. The committee's goal is to obtain a comprehensive data base which would enable teachers to judge whether their own courses were producing gains comparable to those produced by similar courses at similar schools. The study this summer is a preliminary one. We foresee several years of data collection and refinement of procedure before our goal is attained. In order to obtain a comprehensive data base, the committee must obtain results from a broad spectrum of schools. Any interested teachers who wish to participate in this testing program should contact Professor Matthew J. Hassett at one of the addresses below:

<u>Before 15 June 1979</u>
USAFA/DFMS
USAF Academy, CO 80840

<u>After 15 June 1979</u>
Dept. of Mathematics
Arizona State University
Tempe, AZ 85281

It is not essential that participants be teaching in two-year colleges. Teachers of arithmetic, introductory algebra, or intermediate algebra in four-year colleges and universities are encouraged to participate.

--We thank Professor Matthew J. Hasset for reporting on the AMATYC study. Professor Hassett is temporarily with the US Air Force Academy, permanently with Arizona State University at Tempe.

* * * * *

TEST REVISION: TRIGONOMETRY

The trigonometry and elementary functions test has been revised this year. Information in last year's Mode's Survey indicated that the various versions of T/2 have been used mainly to determine placement into a first calculus course. Items on the new T/3 have been written with this use in mind. Polar coordinates has been eliminated from the test content; emphasis on the inverse trigonometric functions has been reduced. Information from users has indicated that students generally do not recall trigonometric identities well and that performance on test items requiring such recall does not relate well to overall performance on the test. Consequently, in T/3, the number of items involving recall of identities is quite small. There is increased emphasis on the definition of trigonometric functions. Also, T/3 has been pretested (at six institutions) twice during its development. This new two-part test will be included in the package of tests to be distributed to 1979-1980 subscribers.

* * * * *

CALCULUS READINESS TEST

A Calculus Readiness Test, CR, developed this year, has been pretested this spring in seven different colleges and universities. The test is designed to determine readiness for placement into calculus, it is <u>not</u> designed to cover the content of traditional pre-calculus courses. It emphasizes concept formation, graphical interpretation of algebra, word problems, numerical awareness, and some symbolism and topics directly related to usage in calculus. It provides an alternative to the traditional alge-
(Cont. pg. 5, "CALCULUS READINESS...")

(CALCULUS READINESS... from pg. 4)
braic skills type test.

The Committee believes that, generally, students who perform well on the CR test will be able to perform well in algebra but that the converse is not necessarily true. For many students, the rapid assimilation of new concepts is a major difficulty of calculus. The test seeks to assess students' potentialities for this task. Some studies of the values of various placement vehicles, including the CR Test, in predicting success in calculus should be available next fall.

The test has 25 items of which the last 5 are on elementary trig. The full test can be administered in 30 to 35 minutes, the first 20 items in 25 to 30 minutes. The test is designed to be suitable for placement into either business calculus or physical sciences-engineering calculus - the test for the latter employing all 25 questions. On a 30 question preliminary version of the non-trig part of the test (from which 20 of the "better" questions as revealed by item analysis were chosen), the mean scores of beginning calculus students generally ranged from over 18 to under 14 in various colleges (i.e. near or slightly above the 50% level). For pre-calculus students the average scores were several points lower. In some schools, placement up into calculus was offered to those who scored at or above the mean (or median) of calculus students taking the test.

The Committee on Placement Examinations welcomes information and reaction from users of the test.

* * * * * * *

FOLLOW-UP STUDY: El Camino College

(This report comes to us from Dwann E. Veroda of the Mathematics Department at El Camino College, Via Torrance, California. We thank Professor Veroda for sharing the results of his study with us.)

In the Spring Semester of 1978 our Department of Mathematics administered the MAA Placement Test BA/1 to all (640) incoming Intermediate Algebra students in an attempt to determine its feasibility as a valid and reliable placement examination for our students. At the end of the semester the students' grades were provided as a follow-up measure along with their scores on an optional post-test.

The text for the course was MODERN INTERMEDIATE ALGEBRA, Hyatt, Gechtman, and Hardesty; Scott, Foresman and Company, and the post-test given was the MAA's AA/1 Test.

SUMMARY STATISTICS BA/1

BA/1 (25 items)	
Number	640
Mean	12.8
Stand. Dev.	4.4
Range	1 - 24

In addition to the above, an item analysis was run on the BA/1 Test. Three separate runs were required to analyze the data because of a maximum N (number) of 250 in our program. Two indices were given for each item: (1) a difficulty index (number correct/N), and (2) a discrimination index. An overall reliability coefficient (Kuder-Richardson) was also given for each run, along with the standard error of measurement.

(Cont. pg. 6, "El Camino...")

(El Camino...from pg. 5)

SUMMARY

Run	N	Mean (Range)	Std Dev	Diff (Quest)	Discr (Quest)	Std Err	Reliability
I	234	13.1 (4--23)	4.3	.06 - .98 (#23 #2)	.09 - .57 (#19 #16)	2.08	.77
II	217	11.9 (1-23)	4.5	.03 -.97 (#23 #2)	.13 - .53 (#6 #5)	2.02	.80
III	202	13.3 (3--24)	4.6	.10 - .97 (#23 #2)	.17 - .56 (#19 #5)	2.09	.79

SUMMARY OF GRADES EARNED

	% OF ALL GRADES	% USING ONLY A, B, C, D, F
A	8.8	16.9
B	13.7	26.3
C	20.5	39.3
D	6.8	13.0
F	2.3	4.4
W	23.5	---
NG *	24.5	---

*NG means no grade--student withdrew before the end of the first 6 weeks.

Because the AA/1 Test was allowed to be optional at the end of the Spring Semester, only 11 of 20 sections of Intermediate Algebra reported scores. This poor return along with a large number of withdrawals gave us only 186 scores to analyze.

The AA/1 Test consists of topics we cover in our Intermediate Algebra, however, since logarithms was an optional topic in the Spring Semester (for some forgotten reason) the three items covering logarithms (#4, #14, and #18) were omitted, giving us a 22 item test.

(Cont. pg. 7, "El Camino...")

(EL CAMINO... from pg. 6)

SUMMARY STATISTICS AA/1

AA/1 (22 items)

Number	186
Mean	13.9
Stand. Dev	3.5
Range	6 - 22

ANALYSIS

1. The correlation between the 25 item BA/1 Test and the post-test AA/1 was .52 (N was 186).

2. We felt that the large number of W and NG grades might possibly bias the correlation of grades and the placement exam. Because of this, 3 correlations were made using different subsets of grades.

SUMMARY OF CORRELATIONS

A, B, C, D, F, W, NG (N = 640)	A, B, C, D, F, W (N = 486)	A, B, C, D, F (N = 336)
.38	.37	.43

3. The final analysis was to attempt to determine a "cutoff" score which could be used to separate those who were "successful" (grade of A, B, or C) and those who "did not succeed" (any grade below C).

Initially, a "cutoff" score was determined by averaging the mean scores on the BA/1 Test of those who "succeeded" and those who "did not succeed." As before, the grades used were (1) all grades, (2) A, B, C, D, F, W, and (3) A, B, C, D, F. The probability of misclassifying a student using that cutoff score was also found for each grade subset.

	A, B, C,/D, F, W, NG (N = 640)	A, B, C,/D, F, W (N = 486)	A, B, C,/D, F (N = 336)
CUTOFF SCORE	13.1	13.2	12.8
PROB MISCLASS	.35	.37	.29

Note: Mean = 12.8 (first summary)

Finally, an attempt was made to find a more suitable "cutoff" score. Scores ranged from 8.10 to 17.10, and once again the 3 different grade subsets were used. (Cont. pg. 8, "El Camino...")

(EL CAMINO... from pg. 7)

	A, B, C,/D, F, W, NG (N = 640)	A, B, C,/D, F, W (N = 486)	A, B, C,/D, F (N = 336)
CUTOFF SCORES	8.10 - 14.10	12.10 - 17.10	8.10 - 17.10
PROB MISCLASS (RANGE)	.33 - .45	.33 - .45	.18 - .61

We gave the BA/1 Test to each section of Intermediate Algebra this semester. At the end of this semester our post-test will be given to all students completing the course and we will then be snooping to see what we can come up with.

-END-

HELP HELP HELP HELP HELP HELP

Two items of business on the agenda of the last meeting of the Committee on Placement Examinations have resulted in a call for help to subscribers. If you wish to help, you can supply names and information on this page of the Newsletter and mail it to Dr. Alfred B. Willcox, Executive Director, Mathematical Association of America, 1529 Eighteenth Street, N.W., Washington, D.C. 20036.

I. The three algebra Tests, BA, AA, and A are to undergo complete revision during the 1979-80 academic session. The committee must appoint a panel to undertake this task. Please indicate below the names and addresses of persons with background and inclinations appropriate for possible appointment to the revision panel.

1. ____
NAME ADDRESS

2. ____
NAME ADDRESS

II. Please suggest the test or tests which the committee should develop next. We face two suggestions and would be willing to consider others. The current suggestions are:

1. Placement test for a Math for Elementary Teachers course. If the test is to determine whether a student has sufficient skill to enter such a course, what material, other than that now offered in SK or BA, should be covered? If the test is to determine whether a student may preempt such a course, what content should be examined?

2. Calc II placement test. Is there significant demand for a test which attempts to discern whether a student knows enough of the material of a Calc I course to proceed to Calc II? In such a test is it enough to examine the concepts and applications found in most Calc I courses with references only to polynomials, rational functions and roots of these?

Your suggestions:

PTP NEWSLETTER

news about placement testing from the
MAA PLACEMENT TEST PROGRAM

Editor: John W. Kenelly   Volume 3, No. 1   June 1980

ANNOUNCING THE PTP USER'S GUIDE

As a major new service to its subscribers, the PTP has prepared a Guide to provide subscribers with information on the PTP tests and recommendations on how to develop an effective mathematics placement test program on a college or university campus.

Topics discussed in the Guide include:

- Trends in college mathematics placement
- The Placement Test Program of the MAA
- Assessing the need for local mathematics placement testing
- Designing a local mathematics placement test program
- Administering a mathematics placement test program
- Collecting and analyzing placement data
- Using PTP tests for purposes other than placement.

Detailed descriptions of the PTP tests are contained in the Guide.

The Committee on Placement Examinations hopes that this Guide will help experienced PTP users improve their on-going programs.

A copy of the Guide will be included in the 1980-81 Subscriber's Package. Comments and suggestions for improving the Guide in future editions are most welcome.

THE 1980-81 SUBSCRIBER'S PACKAGE

All 1980-81 subscribers will receive a copy of the new PTP User's Guide and the following test forms:

Basic Skills	SK/1B	A-SK/1
Basic Algebra	BA/1B	BA/1C
Advanced Alge.	AA/1B	AA/1C
Algebra	A/3B	A/3C
Trigonometry	T/3	T/3B
Calc. Readiness	CR/1	CR/1B

Subscribers are authorized by the MAA to reproduce and administer any PTP test. However, since the PTP tests are copyrighted, this authorization extends only through the one-year subscription period. If a college wants to continue using the tests it must re-subscribe each year.

1979 PTP SURVEYS

In the fall of 1979, the PTP distributed a Subscribers Survey to 205 users and a New Test Survey to 450 present and past subscribers. The results of these surveys can be easily summarized:

Most users are satisfied with the current tests on basic skills, alge-
(continued on next page)

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("1979 PTP Surveys" cont. from p. 1) *bra, trigonometry/elementary functions, and calculus readiness.*

There is only limited interest in placement tests in additional subject areas.

There were 78 responses to the Subscribers Survey (a 38% response rate). Among users responding to questions about particular tests, high percentages indicated that they are "generally satisfied with the test:"

SK	BA	AA	A	T	CR
96%	93%	93%	85%	80%	87%

Subscribers were also asked about their interest in a possible 32-question version of the basic skills test (SK) which would contain additional questions on arithmetic computations. Nearly half of the respondents indicated that such an alternate version would be useful to them and, among those respondents, 60% would prefer it to the current version of SK.

The purpose of the New Test Survey was to determine whether there is need for new placement tests in subject areas not covered by current tests. There were 174 responses to this survey (a 39% response rate). The results are as follows:

Test for placement into course	% of correspondents to whom the test would be useful
Math for future elementary school teachers	29%
Statistics (non-calculus based)	28%
Finite mathematics	15%
Second sem. calculus	30%

Because of the relatively low levels of interest in these or any other new tests, the Committee on Placement Examinations has no current plans for expansion of the PTP into any distinctly new placement areas.

* * *

THE ARITHMETIC AND BASIC SKILLS TEST: A-SK

In response to the interest expressed by users in the 1979 Subscribers Survey, the PTP has constructed a modification of the existing basic skills test called A-SK. It is an augmented version of SK which contains a 20-question sub-test on arithmetic (Part I) plus 12 questions on the other basic skills topics (Part II). Questions 8-32 on A-SK are parallel to questions 1-25 on SK.

The recommended time limits for A-SK are:

Part I . . . . . . 25 minutes
Part II . . . . . 20 minutes
Parts I and II . . 40 minutes

The topics covered on SK and A-SK are listed below.

Topic	Number of Test Items* SK	A-SK
Arithmetic of whole numbers	1	5
Arithmetic of fractions	4	6
Arithmetic of decimal fractions	4	6
Percents	2	2
Arithmetic of integers	2	4
Positive integral exponents	2	2
Square roots	2	2

(continued on p. 8)

THREE CALCULUS READINESS REPORTS

I. General Motors Institute

The CR/1 test was administered to a group of freshmen at the General Motors Institute (GMI) last Summer. The frequency distribution for the number of items missed is given below.

GMI is an accredited college of engineering and management. It operates on the cooperative plan of education in which students alternate between periods of academic study on campus and related work experience with General Motors Corporation. It is a selective admissions institution with approximately 2,200 undergraduate students.

This information was furnished by Dale Meinhold, Associate Professor of Mathematics, General Motors Institute, 1700 West Third Avenue, Flint, MI, 48502.

GENERAL MOTORS INSTITUTE CR/1 DATA:

Items Missed	Frequency	Cumulative %
0	32	6
1	45	14
2	41	21
3	48	30
4	38	37
5	49	45
6	36	52
7	43	60
8	48	68
9	43	76
10	17	80
11	27	84
12	14	86
13	18	90
14	13	92
15	15	95
16	10	97
17	2	97
18	8	98
19	8	100
20	2	100
	557	

The Mean Score (or Number of Items Missed) = 6.754.

II. University of Arkansas At Fayetteville

On the first class day in five sections of Math 2555 (first standard calculus course) in the Fall Semester of 1979, each student in attendance completed an answer sheet for the 25 items on CR/1. On the basis of those scores, some students were advised to take a pre-calculus course. Any student whose score was below 10 (out of 25) was cautioned that he or she might have difficulty with 2555. Some students with low scores did withdraw and take a pre-calculus class. Those students are not included in this report. This contains the scores of those students who had recorded grades (withdrawals included) in 2555 and a score on this CR/1.

One unusual aspect of this course is that at the end of the first six weeks, students who are not progressing in a promising manner are allowed the opportunity to "re-track," i.e., to begin the course again and earn three rather than five hours for the semester. Students who do this are usually failing, and their records for the first six weeks are forgotten, and any grade, A,B,C,D,F, or W, is possible in the subsequent three hour course. The re-tracking students are listed in separate columns in the following tabulation of scores and grades. *(Please see p. 4 for table.)*

Considering withdrawal and re-tracking as unsuccessful marks, it is noted that less than half (13 of 29) of the students scoring 8 or less were successful with a mark of D or better. Considering a mark of D as unsuccessful, one has to go up to the 13-14 row to find more than half of the students with those scores being successful in the course.

This information was supplied by Bernard L. Madison, Chairman, Department of Mathematics, University of Arkansas, Fayetteville, AR 72701.

*The third CR/1 report begins on p. 5.

("U. of Arkansas. . ." cont. from p. 3)

Score of Students on CR/1	NUMBER OF STUDENTS RECEIVING GRADE: Non-re-tracking students						Re-tracking students					
	A	B	C	D	F	W	A	B	C	D	F	W
0-4			1			3					1	
5,6	1								3		1	
7,8	1		7	3	1	4		1	1	1		
9,10		2	6	7	1	1		1	3	5	4	
11,12	1	1	7	5		1	1	2	4	3	1	
13,14	2	8	12	6	2	4		1	4	2	2	
15,16	4	7	15	4	2			1		2		
17,18	6	2	5	3		1						
19,20	2	5	9			1						1
21,22	3	7	6					1				
23-25	4	3										

*The third CR/1 report begins on p. 5.

OTHER PLACEMENT TEST PROGRAMS

As a service to its subscribers, the PTP Newsletter includes reports of other placement test programs. Readers are asked to bring their existence, along with any relevant information on services offered, to the attention of the Newsletter Editor.

JETS: Algebra/Trigonometry Diagnostic Tests

The Junior Engineering and Technology Society (JETS) is a pre-college guidance program offering students an opportunity to explore careers in engineering, technology, and science. Mathematical preparation for college programs is one of the cornerstones of the JETS program. To that end JETS offers an Algebra/Trigonometry Self-Testing Diagnostic Program developed by the College of Engineering at the University of Illinois at Urbana-Champaign. (Price is $3.00 per set.)

For further information write to:

JETS, Inc.
345 East 47th Street
New York, NY 10017.

THE COLLEGE BOARD: Descriptive Tests of Mathematics Skills

The College Board offers a series of self-scoring mathematics examinations in its series "Descriptive Tests of Mathematics Skills." Examinations are available in Arithmetic, Elementary Algebra, Intermediate Algebra, Functions, and Graphs.

Information may be obtained and test copies ordered from:

DTMS of the College Board
Box 2844
Princeton, NJ 08541.

A general unit of 25 tests, scoring sheets, and student guides costs $21.25. Exact prices will depend on specific materials ordered.

(CR/1 Report) III. Ohio State University

The Calculus Readiness Test (CR/1) was administered to more than 1,200 students on September 25, 1979 during the fourth meeting of their classes. Results from 988 students were tabulated.

The classes were all in Math 151, the first course in our "main-line" calculus sequence. Some of these are designated as Honors Calculus classes, some as Calculator Calculus classes (in which use is made of a programmable calculator), and the rest are regular classes. Almost all students in Honors and Calculator classes are first quarter freshmen while the majority of the students in regular classes have had prior training in mathematics at the pre-calculus and remedial levels.

Table I indicates the distribution of test scores (the number of correct answers) for various groups. Column A gives the distribution for students in the Honors classes; Column B, for the Calculator Classes; Column C. for the regular classes. Columns D and E refine C into the regular class students who are first quarter freshmen and those who are not. Column F gives the distribution for all the students. Thus, an entry in Column F is the sum of the entries in A, B, and C.

The average score for each column is given at the bottom.

Table II gives the frequency with which each problem on the test was missed. It (continued on next page)

TABLE I: DISTRIBUTION OF TEST SCORES

	A	B	C	D	E	F
Score	Honors	Calculator	Regular	Regular 1st Quarter	Regular Non 1st Quarter	Total
25	20	5	4	2	2	29
24	25	14	9	7	2	48
23	35	14	20	15	5	69
22	35	22	36	27	9	93
21	20	15	41	28	13	76
20	23	12	34	20	14	69
19	22	11	48	27	21	81
18	12	14	37	15	22	63
17	7	12	49	22	27	68
16	5	15	38	9	29	58
15	7	11	40	9	31	58
14	3	11	41	10	31	55
13		10	41	9	32	51
12		6	47	7	40	53
11	2	3	28	6	22	33
10		3	20	6	14	23
9	1	4	19	5	14	24
8			11	1	10	11
7		2	8		8	10
6			5		5	5
5			5	1	4	5
4		1	2		2	3
3			2		2	2
2			1	1		1
1						0
N	217	185	586	227	359	988
Aver.	21.04	18.19	15.85	18.10	14.44	17.43

("OSU" cont. from p. 5)
also gives a difficulty index for each problem. The average number of students who missed each problem was 298.24. If problem *n* was incorrect on f*n* tests, the difficulty index for the problem is given as f*n/300.* We also listed a difficulty ranking for each problem. The problem with the highest difficulty index has difficulty rank 1.

This information was supplied by John Riner, Vice-chairman, Department of Mathematics, OSU, Columbus, OH 43210.

TABLE II: FREQUENCY OF MISS AND DIFFICULTY RANK

Problem	Frequency of Miss	Difficulty Index	Rank
1	168	.56	23
2	170	.57	22
3	242	.81	17
4	256	.85	16
5	381	1.27	8
6	283	.94	12
7	395	1.32	7
8	564	1.88	1
9	255	.85	15
10	191	.64	19
11	265	.88	14
12	117	.39	24
13	187	.62	20
14	99	.33	25
15	309	1.03	11
16	354	1.18	10
17	364	1.21	9
18	181	.60	21
19	405	1.35	6
20	280	.93	13
21	435	1.45	4
22	212	.71	18
23	479	1.60	2
24	421	1.40	5
25	443	1.48	3

****

PLACEMENT TESTING OF HIGH SCHOOL JUNIORS IN OHIO

The department of mathematics at Ohio State University is developing an early placement testing program for high school juniors in Ohio. The students take an equivalent version of the OSU Math Placement Exam and the results are used for counseling purposes by the high school counselors and mathematics teachers. The early studies suggest that the program will have a beneficial effect on career choices and high school mathematics enrollments. During 1980-81, the Ohio Board of Regents, the state coordinating board for higher education, will fund the program in 100 schools and in the following year the Regents plan to fund the program at any requesting school in the state.

In 1977-78 a pilot program was initiated at Westlake High School. In the following year, they reported a 37% increase (adjusted for class size) in the 1978-79 senior math enrollments.

In the second year of the program, 1978-79, the program was administered in seven Columbus area schools and 1,008 juniors were tested. The results noted tnat 97.5% of
(continued on next page)

("...High School Juniors in Ohio" cont. from p.6)
the juniors tested who were taking no mathematics as juniors placed at the remedial level.

The project will be reported in more detail in a future issue of the PTP Newsletter and an article has been submitted to the MAA MONTHLY. Additional information is available from Professor Bert Waits, Department of Mathematics, The Ohio State University, 231 W. 18th Ave., Columbus, OH 43210. (614) 422-0694.

The student participants receive an individual computer report that details their career choices and the mathematics courses that they should anticipate in their college program at OSU as a function of their placement performance. The placement levels, courses, and majors are cross referenced on the following table.

Major	Level 5	Level 4	Level 3	Level 2
Agricultural Sciences Architecture Biological Sciences Computer Science Dentistry Engineering Landscape Architecture Mathematics Medical Technology Medicine Physical Sciences Statistics	3 Remedial courses (Math 100, 102, 103) are needed before scheduling college level mathematics required for these majors	2 Remedial courses (Math 102 and 103) are needed before scheduling college level mathematics required for these majors	1 Remedial course (Math 103) is needed before scheduling college level mathematics required for these majors	Required college level mathematics may be scheduled
Accounting Agriculture (general major) Business Administration Communications Dental Hygiene Elementary Education Home Economics Natural Resources Nursing Psychology Social Work	2 Remedial courses (Math 100 and 102) are needed before scheduling college level mathematics required for these majors	1 Remedial course (Math 102) is needed before scheduling college level mathematics required for these majors	Either mathematics requirement is satisfied or required college level mathematics may be scheduled.	

Note: Each course is a one-quarter course. Three quarters make an academic year.

Course Descriptions

Math 100: Arithmetic, Introductory Algebra and Geometry
Math 102: Elementary Algebra (roughly equivalent to Algebra I in high school)
Math 103: Intermediate Algebra (roughly equivalent to Advanced Algebra or Algebra II in high school).

("...A-SK/1" cont. from p. 2)

Ratio, proportion, & averaging	4	4
Order relation on numbers	4	4
Word problems	6	6
Areas, perimeters & volumes	2	2
Elementary linear equations & formula evaluations	3	3
Graph & table interpretation	4	4

*Some items are counted more than once.

* * * * *

COPE ACTIVITIES

The Committee on Placement Examination (COPE) has spent 1979-80 by:

- Preparing the PTP User's Guide
- Setting up the revision process for the algebra tests
- Writing parallel forms for the tests in trigonometry and elementary functions (T/3) and calculus readiness (CR/1)
- Writing the alternate version (A-SK/1) of the test in basic skills (SK/1)
- Planning activities for the next three years.

The three tests in algebra (BA, AA, and A) are being revised. The new versions of these will be in the 1981-82 subscription package. A Panel has been appointed and has begun to work. The membership is:

Donald Hill, Florida A & M Univ.
Philip Miles, U. of Wisconsin
John D. Neff (Chairman), Georgia Inst. of Technology
Jack W. Smith, Francis Marion Col.
Amber Steinmetz, Three Rivers Community College.

(more . . .)

The plans call for pre-testing of items in early Fall and having a finished product by early Spring.

Long range planning by COPE includes the revision of the schedule and procedures for test development, the providing of subscribers with information on methods for local assessment and analysis of test results, and the implementation of systematic procedures for collecting and disseminating information relative to subscriber usage oi PTP. The membership of COPE is now:

Thomas Carnevale, Essex Cty. College & Clemson U. (visiting)
John Kenelly, Clemson Univ.
Bernard L. Madison (Chairman) Univ. of Arkansas
Philip Miles, Univ. of Wisconsin
Robert Northcutt, Southwest Texas University
Marcia Sward, Trinity College.

* * * * *

LOCAL ADAPTATION AT CAL POLY

The mathematics faculty at California Polytechnic State University at San Luis Obispo initiated in the Fall of 1979 an algebra pretest for students in the business and mathematics sequence. They designed an algebra proficiency-calculus readiness test with questions taken from the MAA placement tests. To these questions they added some questions about fractions, set theory, summation, and binomial expansions. The exam was administered to students in Math 118 - Finite Math, and Math 221-222 - Business Calculus. With the collected data they established 13 as the recommended low score for enrollment in the above courses. The algebra pretest scores and the final course grades are cross tabulated below. The supplier of this material, Dr. H. Arthur Dekleine, is on sabbatical; so the contact person should be Dr. George Luna, Dept. of Math., Cal Polytechnic State University, San Luis Obispo, CA 93407. *(Please see the next two pages for the charts connected with this article...)*

Local Adaptation at Cal Poly (see article on preceding page)

MATH 121

FINAL COURSE GRADE

Average Pretest Scores	Total	A	B	C	D	F & U	Other
30							
29							
28	2	2					
27							
26	3	3					
25							
24	7	2	1	3			1
23	6	2	1	2	1		
22	9	5	2	1			1
21	12	5	1	2	1		
20	6	1	3	2			
19	9	3	2	3			1
18	9	2	4		1		2
17	6	1	1	2		2	
16	13	1	5	1	2	2	2
15	11	1	4	5	1		
14	6	1	3	2			
13	11	1	2	3		1	3
12	23	1	2	3	4	4	9
11	11		2	4	2	2	1
10	13		1	2	3	3	4
9	7			2			5
8	8				2	1	5
7	3						3
6	7				1	1	5
5	4						4
4							
3							
2	1						1
Average		20	16.8	15.7	13.3	12.6	10.4

MATH 221

FINAL COURSE GRADE

Average Pretest Scores	Total	A	B	C	D	F & U	Other
30	1	1					
29	1	1					
28	1	1					
27							
26							
25							
24							
23							
22	1						1
21	2			1			1
20	3	1	1	1			
19	8	3	4				1
18	8	3	3	2			
17	11	2	4	3			2
16	12	2	2	6	1		1
15	6	4	1		1		
14	15	3	2	6	2		2
13	10			4			6
12	11	1	4	3	1		2
11	17	3	3	3	4		4
10	11		1	5		1	4
9	4		2	1			1
8	5	1	1			3	
7	3			1			2
6	4		1		2	1	
5	1				1		
4							
3							
2							
1							
Average		16.8	14.3	13.7	11	10.1	11.5

NEWSLETTER news about placement testing from the MAA PLACEMENT TEST PROGRAM

Volume 4, No. 1 Winter 1981

IN THIS ISSUE

NEW ALGEBRA TESTS IN 1981-82 PACKAGE

New versions of the algebra tests are being readied for inclusion in the 1981-82 subscriber's packages. These tests are in basic algebra (BA/2A), advanced algebra (AA/2A), and algebra (A/4A), and are designed to serve the purposes of the previous tests in these areas.

The revision process began a year ago with the selection of a panel to oversee the test construction. The panel was chaired by John Neff of the Georgia Institute of Technology and had as members Donald Hill of Florida A&M University, Philip Miles of the University of Wisconsin

(continued on page 8)

SELF-SCORING ANSWER SHEETS INVESTIGATED

The Committee on Placement Examinations is considering the feasibility of self-scoring answer sheets for the PTP tests. The Committee must first determine the extent of interest among subscribers.

Clearly, the major factor that departments must face in deciding whether to use self-scoring answer sheets is *cost*. Preliminary estimates indicate that the cost per answer sheet will be somewhere between 20¢ and 30¢, depending on the volume ordered by the MAA from the printer.

The Committee will be conducting a marketing survey among PTP subscribers in the next month or two in an effort to determine the level of interest in self-scoring answer sheets.

If you are reasonably sure that you would order self-scoring answer sheets to a PTP ·est if they were available, you can help by contacting us first. Write to the MAA's Washington Office and indicate which tests you will be using and the number of answer sheets you would most likely order.

* * * * * * * * * * *

Some simple homemade techniques for scoring answer sheets that are neither self-scoring nor machine-gradable are described on p. 3 of this issue in the article "Easy Test Scoring Techniques".

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PTP STANDARD REPORTING FORMS MAILED

Requests for data on PTP test scores were sent out from the MAA's Washington Office on December 4, 1980 to all PTP subscribers.

The data provided by PTP subscribers will be compiled and published in the Spring PTP Newsletter. These composite statistics will also be made available to all 1981-82 subscribers in a supplement to the *PTP User's Guide*.

Data must be collected from a large percentage of all current PTP subscribers in order to ensure the quality of the composite statistics. If you used any PTP test in the summer or fall of 1980 without alteration and within the prescribed time limit, *we need your data*. Please send it in as soon as possible, if you have not already done so.

If you did not receive a copy of the PTP Standard Reporting Form, call or write Dr. Marcia Sward at the MAA's Washington Office. She will mail a copy to you immediately.

If you used PTP tests this year but altered test items or time limits, we are still interested in hearing about what you did, why you did it, and how well it worked. Send the description of your test alterations and your test data to Dr. Sward. If your account appears to be of general interest, we may ask your permission to publish it in the Spring issue of this newsletter.

The PTP Newsletter is published by the Mathematical Association of America and distributed to all subscribers of the MAA's Placement Test Program. Articles and/or information which may be of interest to PTP subscribers should be sent directly to the Editor:

Professor John Kenelly, Department of Mathematical Sciences, Clemson University, Clemson, S.C. 29631.

COMMITTEE OFFERS FREE SERVICES

As a new service to the mathematical community, the MAA's Committee on Placement Examinations is offering *free consulting services* on mathematics placement to any college mathematics department. PTP subscribers may be particularly interested in taking advantage of this offer to obtain advice on how to improve their programs.

Interested departments may write to:

MAA Committee on Placement Examinations
c/o Professor Bernard Madison
Department of Mathematics, SE 301
University of Arkansas
Fayetteville, Arkansas 72701.

Please include information on the courses into which students are to be placed, current placement policies and practices, constraints on the scheduling and duration of placement testing sessions, and any other relevant facts about the college, the department, or the students which may be useful to the Committee in formulating its recommendations. The name, address, and telephone number of a person the Committee can contact for more information should also be included.

The Committee will make every effort to respond quickly with specific recommendations.

PTP subscribers may wish to bring this offer to the attention of colleagues in nearby institutions who are contemplating starting up placement programs on their own campuses.

EASY TEST SCORING TECHNIQUES

In the absence of either self-scoring answer forms or machine-gradable forms, there are a few methods that will facilitate quick and accurate marking of multiple-choice answer sheets. Outlined below are three such methods - the template method, the light table method, and the ice pick method.

A template (= templet) for correct answers is easy to construct with a stiff material such as that in a manila folder cut to the exact size of the answer form. Cutting off one corner of the answer sheets and the template will help in proper alignment. Holes corresponding to the spots for the correct answers are cut from the template material using a hole punch with a reach of about three inches. After marking the items with multiple responses, the template is placed over the answer sheet and the correct answers are counted. If there is a penalty for incorrect answers, a four-hole template can then be used to count the incorrect responses.

The use of a light table with a correct answer template allows one to count multiple responses, correct responses, and incorrect responses in one step. A light table is a translucent surface with a light below it. The template is taped to the table and the answer form is placed on top of the template. The correct answers are lighted, and usually the incorrect and multiple responses are evident. Light tables can be rigged or can be purchased in photographic supply stores

To use the ice pick method, the answer forms are stacked and the ice pick is punched through the spots for the correct responses. The forms are then scored, and if returned to the students, the correct answers are evident.

Other useful methods of scoring will be reported here if communicated to the Editor.

WEST CHESTER STATE COLLEGE TEST RESULTS

W.H. Seybold, Jr.
Department of Mathematical Sciences
West Chester State College
West Chester, PA 19380

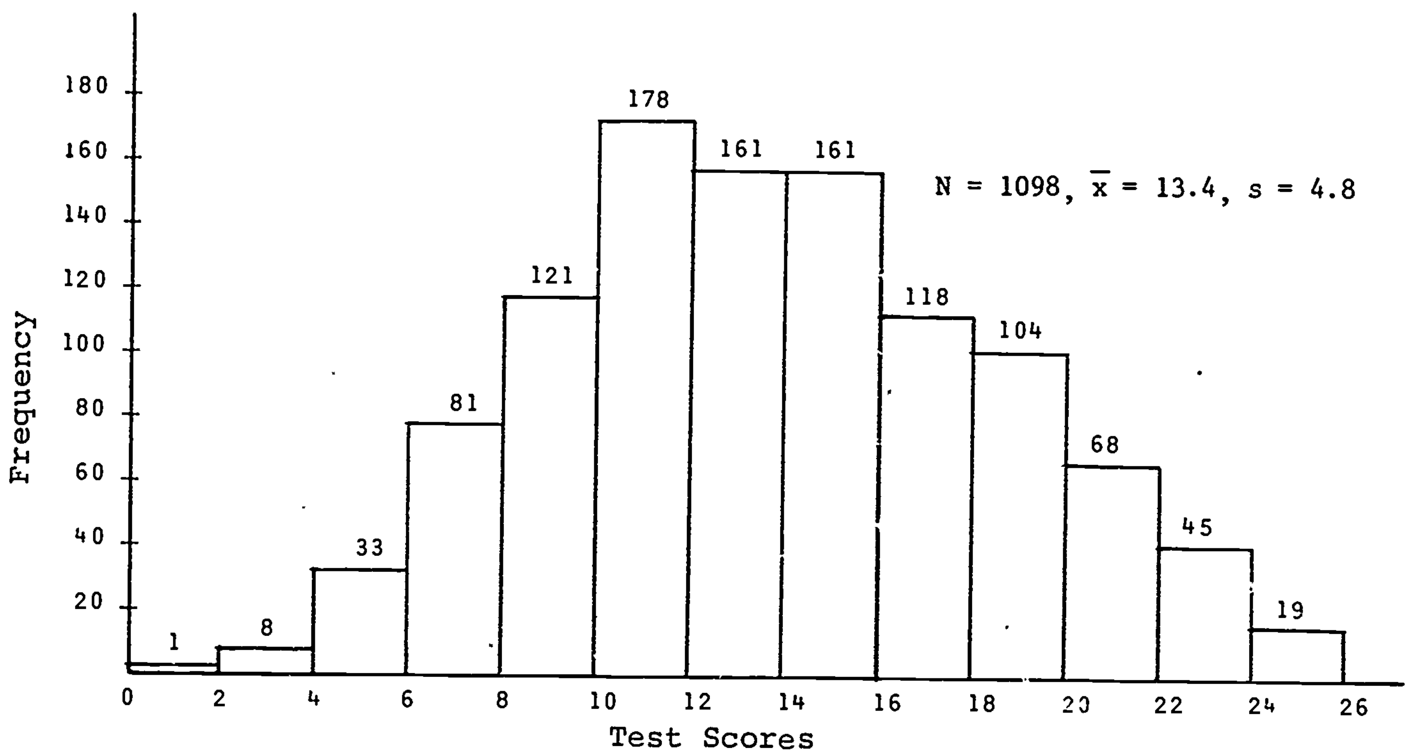
West Chester State College, located in Southeastern Pennsylvania, offers curricula encompassing the liberal arts, science programs including pre-engineering, teacher training and certification, preparation for advanced study in fields such as law and medicine, education for specific professions, and continuing education. Total enrollment at the College includes about 6,000 full-time undergraduates, about 1200 part-time undergraduates, and nearly 1,500 graduate students. The average combined SAT score for freshmen entering in the fall (1980) was about 950.

The revised general education requirements, effective June 1980, require administration of a competency test in mathematics (the combined MAA tests) to see if remediation is necessary, and one 3 semester hour course in mathematics, as designated by the major department.

During the summer of 1980 approximately 1,100 entering freshmen, who participated in the college's three-day orientation program, were given MAA-generated tests BA/1 (Basic Algebra Skills) and SK/1 (Basic Arithmetic Skills) for placement purposes. Students having SAT (Math) below 450, who scored below 60% on both of the above tests, were scheduled into a credit bearing section in the fall: MAT 00 - Fundamentals of Algebra. (The credits may not be used toward graduation.) For those students who scored above 450, performance on the placement tests influenced the recommended course in mathematics.

(Histograms and item analyses for BA/1 and SK/1 test results at West Chester State are on pages 4 and 5.)

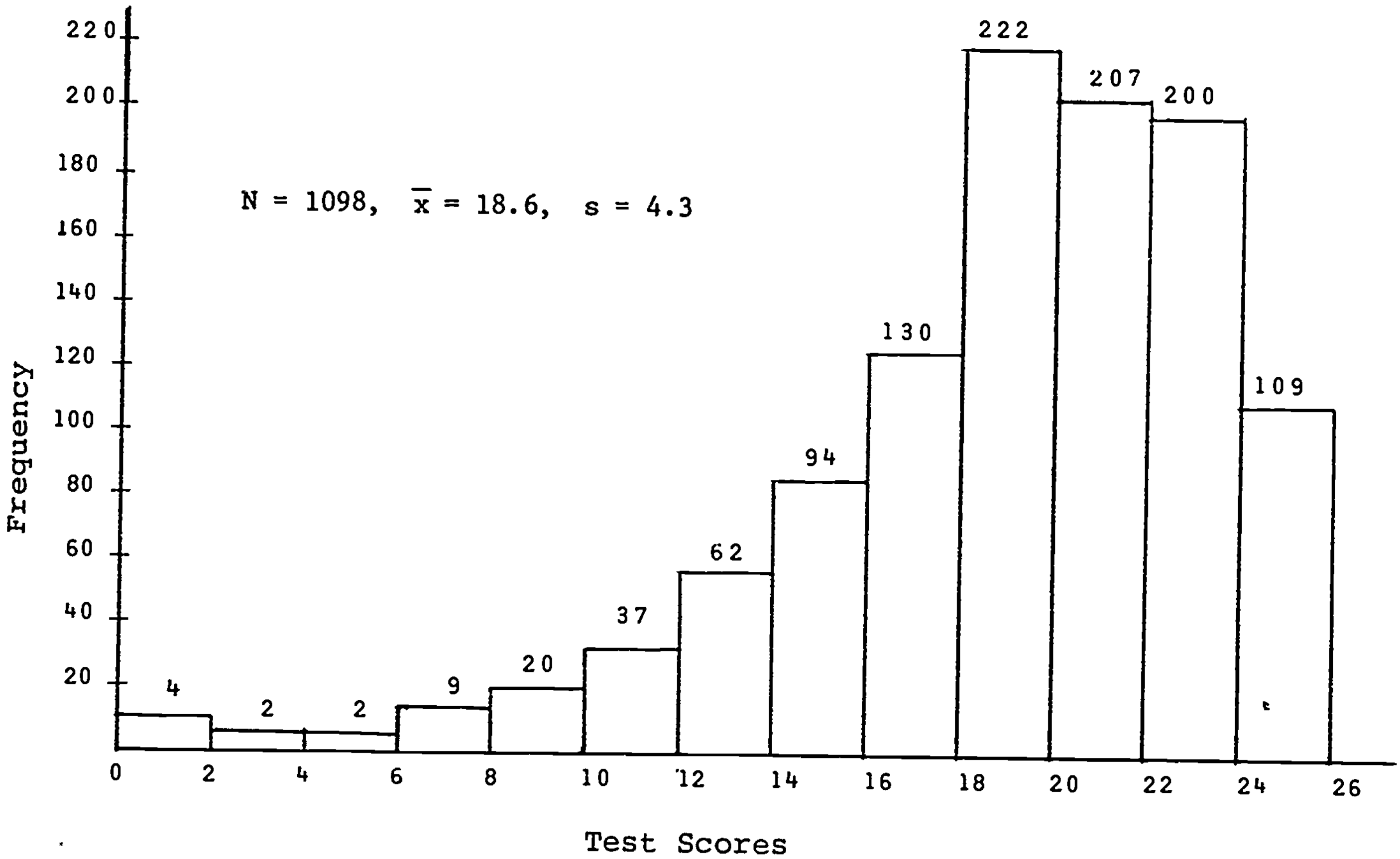
TEST BA/1
WEST CHESTER STATE COLLEGE
SUMMER 1980



ITEM ANALYSIS († = correct answer)

Item	A	%	B	%	C	%	D	%	E	%	Blank	%
1	69	6	64	6	849†	77	49	4	58	5	9	1
2	3	0	1082†	99	7	1	4	0	1	0	1	0
3	958†	87	13	1	17	2	12	1	86	8	12	1
4	1	0	12	1	181	16	10	1	893†	81	1	0
5	111	10	340	31	467†	43	80	7	96	9	4	0
6	15	1	31	3	159	14	828†	75	63	6	2	0
7	274	25	3	0	39	4	620†	56	156	14	6	1
8	133	12	867†	79	27	2	48	4	15	1	8	1
9	20	2	284	26	522†	48	265	24	7	1	0	0
10	772†	70	107	10	99	9	24	2	59	5	37	3
11	27	2	13	1	120	11	798†	73	100	9	40	4
12	237	22	161	15	163	15	413†	38	74	7	50	5
13	67	6	358	33	29	3	89	8	539†	49	16	1
14	105	10	321†	29	192	17	208	19	205	19	67	6
15	75	7	237	22	528†	48	119	11	48	4	91	8
16	47	4	268	24	507†	46	99	9	143	13	34	3
17	97	9	446†	41	162	15	163	15	158	14	72	7
18	111	10	82	7	438†	40	244	22	124	11	99	9
19	70	6	52	5	158	14	189	17	570†	52	59	5
20	86	8	301†	27	304	28	186	17	197	18	24	2
21	53	5	128	12	105	10	699†	64	62	6	51	5
22	608†	55	77	7	79	7	84	8	210	19	40	4
23	72	7	115	10	259	24	378	34	139†	13	135	12
24	412	38	84	8	82	7	109	10	326†	30	85	8
25	166	15	206†	19	343	31	131	12	148	13	104	9

TEST SK/1
WEST CHESTER STATE COLLEGE
SUMMER 1980



ITEM ANALYSIS († = correct answer)

Item	A	%	B	%	C	%	D	%	E	%	Blank	%
1	108	10	12	1	920†	84	44	4	3	0	11	1
2	13	1	1035†	94	4	0	29	3	12	1	5	0
3	9	1	133	12	860†	78	46	4	18	2	32	3
4	24	2	112	10	739†	67	150	14	49	4	24	2
5	935†	85	38	3	87	8	3	0	27	2	8	1
6	735	67	117	11	44	4	143	13	49	4	10	1
7	168	15	682†	62	124	11	44	4	73	7	7	1
8	135	12	45	4	307	28	511†	47	65	6	35	3
9	16	1	131	12	47	4	203	18	676†	62	25	2
10	56	5	76	7	88	8	821†	75	38	3	19	2
11	43	4	40	4	69	6	911†	83	17	2	18	2
12	65	6	23	2	956†	87	22	2	25	2	7	1
13	31	3	46	4	101	9	885†	81	24	2	11	1
14	19	2	45	4	27	2	24	2	974†	89	9	1
15	958†	87	48	4	24	2	20	2	29	3	19	2
16	16	1	1008	92	21	2	31	3	8	1	14	1
17	21	2	67	6	55	5	743†	68	197	18	15	1
18	207	19	386	35	52	5	27	2	391†	36	35	3
19	791†	72	108	10	87	8	48	4	16	1	48	4
20	833†	76	52	5	115	10	36	3	13	1	49	4
21	17	2	23	2	35	3	1001†	91	7	1	15	1
22	59	5	86	8	73	7	716†	65	113	10	51	5
23	105	10	104	9	233	21	58	5	560†	51	38	3
24	16	1	9	1	95	9	878†	80	76	7	24	2
25	901†	82	87	8	20	2	44	4	21	2	25	2

THE COLLEGE OF CHARLESTON'S PLACEMENT TEST PROGRAM

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The College of Charleston is currently using the Basic Algebra Test (BA/1) and the Calculus Readiness Test (CR/1) from the MAA's Placement Test Program. This is the second year we have administered the BA/1 test, and the first year we have used the CR/1 test. Prior to this time, tests developed by members of our department were given.

The counseling department scheduled three testing dates, one in June, one in July, and the last during orientation in August. Placement tests were also administered by other departments on these dates. Entering students were addressed by a member of the Math Placement Committee who explained the various mathematics courses available at the freshman level. These are as follows:

1) Math 01 - Basic Mathematics
   Credit does not apply toward the math requirement nor toward graduation.
2) Math 101 - College Algebra
3) Math 01-101 - College Algebra
   This class meets five days a week and covers the same book and syllabus as Math 101 but at a slower pace. The student receives 6 hours credit, only 3 of which apply toward the math requirement and graduation.
4) Math 103 - Applied Finite Mathematics
5) Math 139 - Algebra for Elementary and Middle School Teachers
6) Math 111 - Pre-calculus
7) Math 120 - Introductory Calculus

Students who never took algebra in high school were advised to take Math 01. Students who scored 600 or better on the mathematics portion of the SAT were advised to enroll in Math 120. It was recommended that those who had studied some algebra but no trigonometry in high school take the BA/1 test, and those who finished two years of algebra and studied trigonometry to some extent should take the CR/1 test. Taking the placement test was not required, but stress was placed on the fact that results would help each student make a better decision on an appropriate math course.

After the final test date, all tests were computer graded at the Medical University of South Carolina. Results were printed out listing students alphabetically and by class rank. Two raw scores were given for the Calculus Readiness Test; one for the algebraic portion of the test (questions 1-20), and the other for the trigonometric portion (questions 21-25).

The criteria indicated in the tables on the next page were devised by the placement committee to interpret these raw scores. This information was distributed to each mentor along with his students' raw scores by the counseling department. Mentor and student reviewed the individual's math background, discussed his intended major, and hopefully used our recommendation to make a decision.

After the placement process was completed, two points came under discussion by the committee. First we felt that some knowledge of trigonometry was necessary for calculus, but we were dissatisfied with our method for testing this knowledge. The following questions arose: Are the five questions on the CR/1 test enough to give us a valid measure? Since trigonometry depends on memorization of identities, would it be plausible to supply the students with these identities so that we would be testing understanding rather than memory? Secondly, we felt that the mentors should be better informed concerning course content and course sequence for different majors. It was suggested that a sheet could be distributed, along with the criteria for raw

(continued on next page)

scores, that explained these facts.

At the semester's end, we plan to examine the performance of students who followed our recommendations as well as those who did not. Hopefully, our statistics will give us some indication of the validity of our program. We will share our findings with you in the next newsletter along with decisions we have made for improvement of our program.

Table 1 Basic Algebra Test BA/1

Score	Recommended Course
0-6	Math 01
7-11	Math 01-101, Math 103, or Math 139
12-19	Math 101 or Math 139
20-25	Take the CR/1 Test (A time for retests was scheduled by the committee)

Table 2 Calculus Readiness Test CR/1

Algebra Score		Trig Score	Recommended Course
0-3			Take the BA/1 Test
4-6			Math 101
7-10			Math 111
11-13	and	0-1	Math 111
11-13	and	2-5	Math 120
14-20			Math 120

ALGEBRA TESTS
(continued from p. 1)

(Madison), Jack W. Smith of Francis Marion College, and Amber Steinmetz of Three Rivers Community College.

During the past year, new items have been written, analyzed, and compared to the items on the current tests. Pretesting was done at four institutions. The panel has submitted its versions of the tests to the Committee on Placement Examinations which is now refining the tests and preparing the copy for print. The revised tests are comparable to the current versions, but may require some small adjustments in scaling. Suggestions on the changes in expected scores will accompany the 1981-82 package.

The old algebra tests will continue to be available to users upon request as long as supplies last. Resubscribers may use copies from previous years' PTP packages if they wish.

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NEW MEMBERS OF COPE

Two new members to the Committee on Placement Examinations have been appointed. They are Billie Ann Rice of DeKalb Community College in Clarkston, Georgia, and Richard H. Prosl of the College of William and Mary in Williamsburg, Virginia. Professor Prosl will be serving for one year to complete a term interrupted by a year at St. Andrews, Scotland. Professor Rice will be serving a three year term. These two are replacing Philip Miles of the University of Wisconsin (Madison) and Robert Northcutt of Southwest Texas State University. Continuing members are Thomas Carnevale of Virginia Commonwealth University, John Kenelly of Clemson University, Marcia P. Sward of the MAA, and Bernard L. Madison of the University of Arkansas (Fayetteville).

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NEWSLETTER

news about placement testing from the
MAA PLACEMENT TEST PROGRAM

Volume 4, No. 2 Spring 1981

IN THIS ISSUE

LOWER PRICES FOR RESUBSCRIBERS IN 1981-82

Resubscribers to the Placement Test Program will be charged only $85 for their annual subscription in 1981-1982. This is a reduction of $15 from 1980-81 prices. The cost of a new subscription will go up to $120.

The basis for the new price structure is the desire of the Committee on Placement Examinations to encourage institutions to continue their subscriptions year after year. Only through the support of a core of faithful users can a program like this continue to thrive.

USERS REPORT 1980-81 TEST RESULTS

This issue contains a special insert, "1980-81 PTP Composite Statistics", which contains compilations of data on the scores that students earned on PTP tests and the cut-off scores that were utilized in placement decisions.

Last November all subscribers were asked to fill out the PTP Standard Reporting Form if they had administered any test *without alteration and within the prescribed time limit.* As of March 31, a total of 63 subscribers had responded to this request: 42 had returned completed forms, 11 reported that they had not used any PTP test for placement this year, 5 reported that they had used the tests but had either altered some test items or had lengthened the time limit, and 5 were unable to provide data for various other reasons. The members of the Committee on Placement Examinations wish to express their appreciation to the many subscribers who responded to this request.

Since these data were not obtained by statistical sampling procedures which might support inferences about broader student populations, they should not be regarded as "national norms". However, as a composite picture of the experience of PTP users in 1980-81 (those who volunteered their data), we hope that users will find them to be a valuable addition to the other types of data which are regularly published in this newsletter.

MATHEMATICAL ASSOCIATION OF AMERICA • 1529 Eighteenth Street, N.W., Washington, D.C. 20036 • (202) 387-5200

THE 1981-82 PTP PACKET

PTP packets will be mailed out from the MAA's Washington Headquarters to PTP subscribers by July 15, 1981. They will contain these tests (with answer keys):

Arithmetic and Basic Skills
A-SK and SK/1B (parallel and augmented forms)

Basic Algebra
BA/2A (revised form)
BA/1B and BA/1C (unrevised parallel forms)

Advanced Algebra
AA/2A (revised form)
AA/1B and AA/1C (unrevised parallel forms)

Algebra (Basic and Advanced)
A/4A (revised form)
A/3B and A/3C (unrevised parallel forms)

Trigonometry and Elementary Functions
T/3 and T/3B (parallel forms)

Calculus Readiness
CR/1 and CR/1B (parallel forms)

The packet will also contain:

- A copy of the PTP *User's Guide* with supplementary inserts on the revised algebra tests and an information sheet on scanning equipment (a general description of the capabilities of scanning devices and the names and addresses of some commercial firms that sell such equipment).
- An Official Copyright Authorization Form.
- Extra test sets (if they are ordered in time to be included in packet).

THE NEW ALGEBRA TESTS: How They Compare with the Old

The new versions of the PTP tests (BA/2A, AA/2A, and A/4A) are ready for distribution in the 1981-82 packet. The purpose of this article is to describe the alterations that were made in the tests and how users may expect test results to be affected.

DIFFICULTY

Careful comparisons with the old versions of BA, AA, and A show that the difficulty levels of BA and AA have changed very little, while that of A was lowered:

Test	Average Scores: Old vs. New
BA	Essentially no difference
A	Approximately 4 points higher on new test
AA	Approximately ½ point higher on new test

These outcomes depend somewhat on the student population used and do not necessarily indicate what results would be obtained with a different population. *Test users who need accurate comparisons between scores on prior versions and scores on the revised versions are advised to make their own comparisons using their own student populations.* This applies particularly to Test A, where a deliberate attempt was made during revision to provide a somewhat easier test.

(continued on page 7)

The PTP Newsletter is published by the Mathematical Association of America and is distributed to all subscribers to the MAA's Placement Test Program.

Editor: John W. Kenelly, Department of Mathematical Sciences, Clemson University, Clemson, S.C. 29631.

Associate Editor: Richard H. Prosl, Department of Mathematics and Computer Science, College of William and Mary, Williamsburg, VA 23185

Articles and/or information which may be of interest to PTP subscribers should be sent directly to the Editor.

REVISING A PLACEMENT TEST

Philip E. Miles
University of Wisconsin, Madison

The work of revision begins by deciding what one wishes to accomplish. In revising the MAA algebra tests, the goals were to change some items in the interest of security, to make Test A somewhat less difficult, and to provide improved versions of a few items. The content areas were kept as stable as possible since users had generally reported themselves satisfied on this score.

The next stage is the writing of new items. Each item should be an answer to the question "What do students need to know when they enter the course(s) served in order to be successful in their course work?". In answering this question, there is no substitute for the judgment of experienced teachers. The MAA algebra revision was fortunate in being able to draw on a panel of teachers with many years of classroom experience in various types of collegiate institutions

After trial items are written, they must be piloted, i.e., tried out on actual students who are typical of the population which will use the test. The heart of piloting is an item analysis, and the heart of an item analysis is a comparison of results on an individual question with scores on the whole group of questions. This comparison will identify items which are unduly easy or hard, ambiguously worded items, or items in which the wrong answer is obtained in essentially the right way or the right answer in a wrong way (this last is perhaps the most difficult to think of in advance). No a priori estimate of how an item *ought to work* can substitute for a measurement of how it actually *does* work with real students.

In piloting the algebra revision, MAA was able to secure the cooperation of four institutions which administered the pilot questions to more than two thousand students in twelve different math courses. Over a third of the new items were discarded after this testing - some because they just didn't work, some only because a better version was available.

The final stage is assembly of surviving items into a finished test which meets the original goals, and equating the new test to the previous test - that is, generating statistics which permit comparison of a score on the new test with a score on the prior version. This is discussed in detail in the article on the preceding page.

Note: The paragraphs above outline the work of revising a placement test. Unfortunately, they leave out the playful side which attends a shared effort such as the COPE algebra test revision in which I participated. I don't recommend revising a placement test solely on these grounds, but there is much to be said for an activity in which a new, plausible, outrageously wrong answer to a test question is greeted with admiration and delight. PEM

NO SELF-SCORING ANSWER FORMS THIS YEAR

A telephone survey of 30 PTP users was conducted in February and March 1981 to determine how much interest there is among subscribers to this program in the use of self-scoring answer forms.

Most of the individuals contacted indicated that they are reasonably satisfied with their current test scoring methods, and so, the Committee on Placement Examinations has decided not to pursue the development of self-scoring answer forms this year.

AMATYC STUDY RESULTS

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Tempe, Arizona 85281

In 1979 the American Mathematical Association of Two-Year Colleges (AMATYC) formed a Developmental Mathematics Committee to identify and attack the special problems of developmental mathematics course programs. "Developmental mathematics" refers to entry level courses in arithmetic and algebra. A national survey conducted by the Conference Board of the Mathematical Sciences estimated that such courses represented 40% of all two-year college enrollments in Fall 1975.

Evaluation is a major concern of developmental teachers. Formal program evaluations are required by many agencies which fund developmental programs, and public pressures for accountability in basic skills courses have made evaluation desirable even where it is not required. Thus, an Evaluation Model subcommittee was formed by the Developmental Mathematics Committee. This subcommittee was charged with the consideration of evaluation in many different areas. In particular, a comprehensive program evaluation may involve measurements of student attitude, student learning, and faculty attitude.

One goal of the evaluation subcommittee was to establish a data base which could be used to guide teachers in program evaluation. The need for such data arises in every area of program evaluation. It is easy for an evaluator to announce that student learning should reach acceptable levels, but it is very difficult to determine exactly what "acceptable level" means. The subcommittee's hope was that it might eventually be able to define "acceptable level" in terms of scores on BA/1B and SK/1. The committee proposed an evaluation study that would attempt to measure the amount of student learning.

PTP tests BA/1B and SK/1 were proposed as measurement instruments in the area of student learning for obvious reasons - they were standardized, furnished by a prestigious national organization, and inexpensive. But early in the study it became apparent that such program evaluation using BA/1B and SK/1 might be inappropriate since these tests were designed specifically as placement, not evaluation, instruments. The difference between placement and evaluation tests can be illustrated concretely by reference to the use of test BA/1B at the author's school.

(a) <u>BA/1B is a placement test</u> Our school has a developmental algebra sequence consisting of Introductory Algebra and Intermediate Algebra. These prepare a student for a course entitled "College Algebra". In relation to our courses, BA/1B contains 9 Introductory Algebra and 16 Intermediate Algebra questions. It can be used successfully as a placement test for College Algebra, since it covers a wide selection of necessary prerequisite skills from the two lower courses.

(b) <u>BA/1B as an evaluation instrument</u> BA/1B covers material from two different courses -- Introductory and Intermediate Algebra. As an evaluation instrument, BA/1B would be used to determine whether students had learned the specific content of Intermediate Algebra which can be identified - there is a list of more than 100 skill objectives which are covered in Intermediate Algebra and not in the prior course Introductory Algebra. Since BA/1B has only 16 questions pertaining to Intermediate Algebra, it can test only 16 of those objectives. In contrast, the final examination for Intermediate Algebra has 50 different questions, only 5 of which overlap with the content of Introductory Algebra.

Despite the concerns generated by this analysis, the subcommittee proceeded with its evaluation pilot

(continued on next page)

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(# OF ITEMS)		A-SK PART I ONLY (20)	A-SK PARTS I&II (32)	SK (25)	BA (25)
TIME LIMIT		25 MINUTES	40 MINUTES	30 MINUTES	30 MINUTES
NUMBER OF STUDENTS TESTED (NUMBER OF INSTITUTIONS)		365 (2)	144 (3)	2893 (9)	13,880 (25)
MEAN (RANGE OF MEANS)		16.6 (9.1-18.7)	26.6 (18.6-28.8)	13.2 (5.2-19.5)	12.8 (4.4-18.4)
RANGE OF STANDARD DEVIATIONS		4.0-5.0	2.5-6.3	3.9-5.5	2.7-5.8
	OUT	Students scoring above this cut-off are not advised (or required) to take this course			
	IN	Students scoring above this cut-off are advised (or required) to take this course			
CALCULUS- Engineering, Physical Sci.	OUT				
	IN	20 (1)			16-24 (4)
CALCULUS- Business, Intuitive, or Short	OUT				
	IN	20 (1)			15-20 (5)
PRECALCULUS	OUT	20 (1)			15-25 (4)
	IN	15 (1)			12-18 (4)
TRIGONOMETRY	OUT	15 (1)			19-24 (2)
	IN				9-16 (3)
COLLEGE ALGEBRA	OUT				14-23 (5)
	IN			16 (1)	9-16 (8)
INTERMEDIATE ALGEBRA	OUT			16 (1)	11-19 (6)
	IN		21 (1)	13 (1)	4-15 (8)
BEGINNING ALGEBRA	OUT	15 (1)	21 (1)	12-16 (4)	9-15 (5)
	IN		16 (1)	0-14 (3)	0 (1)
ARITHMETIC	OUT	11 (1)	16 (1)	14-16 (2)	
	IN		0 (1)	0 (1)	
FINITE MATH	OUT				
	IN				11-19 (2)

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OMPOSITE STATISTICS

ENT SCORES

5)	A (32)	T PART I ONLY (15)	T PART II ONLY	T PARTS I & II	CR PART I ONLY	CR PARTS I & II
MINUTES	45 MINUTES	25 MINUTES	25 MINUTES	45 MINUTES	25 MINUTES	30 MINUTES
2910 (7)	5573 (11)	342 (3)		295 (4)	449 (2)	3100 (12)
11.7 8-18.6)	9.8 (8.3-20.6)	7.2 (5.8-7.5)		9.8 (8.5-13.3)	9.4 (7.9-11.7)	13.3 (3.9-4.8)
4-5.5	4.1-6.1	3.2		2.3-6.0	4.5	4.3-4.8

OFF SCORE RANGES

R OF INSTITUTIONS)

14 (1)	14-20 (5)	6 (1)		15 (2)	8 (1)	6-20 (6)
14 (1)	14-17 (2)			12 (1)	8 (1)	14-18 (2)
13 (1)	17 (1)			15-17 (2)		12-19 (4)
5- 9 (2)	19 (1)			4- 7 (2)		5-12 (3)
		9-11 (2)		15 (1)		17 (1)
14 (1)	19-20 (4)	7 (1)		7 (1)		12 (1)
14 (2)	6-17 (3)			7 (1)		17 (1)
4 (1)	10-14 (2)					12 (1)
	9-10 (2)			5 (1)		11 (1)
	0- 9 (2)					
	0 (1)					

study using BA/1B and SK/1 in order to determine whether the anticipated problems would actually occur.

Procedures Requests for participation in a pre-test to post-test gain study were sent to 60 teachers who had expressed interest in evaluation. Responses were received from thirty schools. Each school was sent a package consisting of master copies of BA/1B and SK/1, instructions for test administration, and data sheets for return to the subcommittee. Test time was 30 minutes; the test was to be given on the first class day (no prior review) and on the last class day, or as a timed part of the final. Tests were collected and instructor graded, not self-scored. Results were requested for *all* first-day students, even if withdrawn before the post-test. This was done to prevent bias of results due to differential attrition. Schools were informed that they would not be identified in any published reports.

Results The first set of tests was administered during the summer semester of 1979 in 29 classes at 14 schools.
Summary statistics are given for each class tested in Table 1.

Table 1

Test	Class Code	Class Type	Pre-test Mean	Post-test Mean	Gain for Students Taking Both Tests	% Taking Both Tests
	A		7.0	10.3	2.6	45%
	B		8.8	16.3	7.6	90%
	C		9.1	18.0	7.2	42%
	D		9.3	12.9	3.6	100%
	E		10.5	18.0	6.8	61%
BA/1B	F	Intermed.	10.5	14.9	4.4	100%
	G	Algebra	11.7	16.6	4.6	94%
	H		12.1	21.5	7.2	60%
	I		12.2	16.9	3.8	53%
	J		14.0	18.9	4.9	100%
	K		17.3	19.3	2.0	100%
	276 students		11.2	16.8	4.9	73%
	L		7.0	15.8	7.8	94%
	M		7.8	17.7	3.3	18%
SK/1	N	Arithmetic	9.3	14.5	2.8	65%
	O		9.4	13.7	4.7	74%
	P		9.6	14.4	4.4	74%
	124 students		8.7	14.7	4.8	60%
	Q		8.4	15.4	7.0	100%
	R		11.3	17.0	4.1	50%
	S		12.1	16.4	4.3	100%
	T		12.2	17.2	5.0	100%
SK/1	U	Intro.	12.8	18.3	3.5	80%
	V	Algebra	13.2	14.5	0.2	65%
	W		14.1	19.0	4.9	100%
	X		14.7	17.4	-0.2	55%
	Y		15.2	22.5	1.5	20%
	Z		15.2	18.6	2.4	89%
	137 students		12.8	17.1	3.6	78%
SK/1	Z1	Intermed. Algebra	14.6	16.9	2.4	100%

Discussion of results Wide differences in student preparation as measured by BA/1B and in attrition from class to class on both BA/1B and SK/1 levels are immediately apparent upon inspection. The statistical significance of the differences in pre-test means for Intermediate Algebra(BA/1B) was confirmed by one-way analysis of variance and of the differences in Percent Taking Both Tests in all three cases by the chi-square test of homogeniety. It would clearly be invalid to use either post-test mean score or mean gain score as a single direct evaluation measure of how well a class had been taught.

The mean gain scores in the three main categories (Intermediate Algebra, 4.9; Arithmetic, 4.8; Introductory Algebra, 3.6) appear rather low in an absolute sense. Should a student take an entire course and gain only 4 or 5 points on a 25 point test? The answer to this question is "possibly - it depends on the test". Our previous analysis indicated that the test BA/1B simply did not test Intermediate Algebra. BA/1B asked 9 questions which students (at the author's school) *with no Intermediate Algebra background* could answer. (Students taking BA/1B as a pre-test in our study actually averaged 11.2 questions correct *before beginning instruction.*) There are only 16 questions left which appear to reflect specific Intermediate Algebra content - this does not leave much room for gain measurement. Further problems are created by the fact that some schools, due to variations in curriculum, may omit as many as 5 of the remaining skills covered in BA/1B from their courses. It is understandable that gains on BA/1B are not higher.

The correlation coefficient between post-test grade and course grade (A=4, B=3, C=2, D=1, E, W=0) for student who took BA/1B is 0.45. For students who took SK/1 it is 0.52. (Note: We have used the Pearson product-moment correlation coefficient, since it is most likely to be familiar to our readers. Given the nature of our grade scale, less familiar measures from non-parametric statistical tests may be more appropriate.) These correlations are statistically significant(α=.001), but do not indicate a strong linear relation between post-test score on PTP tests and course grade. The lack of necessary association becomes even clearer if we consider a cross-tabulation of course grades and PTP post-test grades for each test. (See Table 2 on next page)

Suppose you wish to choose a BA/1B post-test score level to determine whether or not a student should receive course credit in intermediate algebra - course credit simply being granted or denied on the basis of BA/1B score. Requiring a score of 21 or higher would deny credit to 70% (117/166) of all students who actually earned A,B, or C grades through course work. Requiring a score of 16 or higher would deny credit to 30% of all A, B, C students and would also permit 40% of all students who were unsuccessful (D,E,W) in coursework to gain credit by examination.

Conclusion Members of the Evaluation Model Subcommittee of AMATYC have used the PTP tests for placement, and have found them to be useful placement instruments. However, the results of this subcommittee's pilot studies on use of unmodified BA/1B and SK/1 indicate that PTP tests should not be used for evaluation of student learning in a course, or for awarding of credit by examination in a specific question about specific topics. Evaluation instruments should be constructed with a specific set of objectives.

Table 2

Post-test Scores Vs. Course Grades

Course Grade		Test BA/1B A,B,C	Test BA/1B D,E,W	Test SK/1 A,B,C	Test SK/1 D,E,W
Post-test Score	0- 5	0	0	1	3
	6-10	6	10	9	4
	11-15	44	18	25	10
	16-20	67	17	44	5
	21-25	49	2	19	2
TOTALS		166	47	81	41

(Algebra Tests, continued from p. 2)

Note: The effort to reduce the difficulty level of Test A does not represent any feeling on the part of the Panel that constructed the new tests or the Committee on Placement Examinations that student preparation ought to be less than formerly or is less than formerly. Rather, the change was made to provide a test that would be more useful to the majority of users by moving average scores toward the center of the possible score range.

CONTENT

One of the several ways in which the old algebra tests can be compared with the new ones is by examining the distribution of items by content code. Although the assignment of items to the various classification areas is somewhat arbitrary, efforts were made to perform the assignments consistently.

Comparisons of the content code classifications of tests A/3C with A/4A and AA/1C with AA/2A show changes of at most ± 1 item per code area. Thus, the changes in content in these tests may be regarded as quite minor.

For test BA, there was one significant shift: BA/2A contains four more items than BA/1C on "factoring and algebraic fractions" and two fewer items on "linear equations and inequalities". All other items on these tests vary by at most ± 1 item per area.

Another means of comparing the revised tests with their predecessors is to look at the number of items that they share. There are, in fact, significant overlaps in all three cases, a reflection of the attitude of the Panel and the Committee that total revision was not necessary. That attitude was supported by a survey of users that showed general satisfaction with the algebra tests. Nevertheless, *old items were selected for inclusion on the revised version only after they re-proved themselves in competition with alternatives.* The following table shows the overlaps:

Test	# Shared Items	New or Substantially Revised Items
BA	16	9
AA	17	8
A	18	14

Note: Items that are essentially the same were courted as identical items. The old tests used in this comparison are BA/1C, AA/1C, and A/3C.

(continued on next page)

(Algebra Tests, continued from p. 7)

Finally one can look at the number of items that Test A shared with Tests BA and AA in their old versions and the number that they now share in the new versions:

# of Items Shared w/Test A

Test	Old Versions	New Versions
BA	12	15
AA	10	7

The total number of shared items remains the same but in the revised versions, the sharing is more with Test BA. This reflects the efforts of the Panel to reduce the difficulty of Test A. Preliminary testing in which student scores on the old and new versions of Test A were compared verified the success of that effort.

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REMINDER TO ALL
MATH DEPARTMENTS

You can obtain the recommendations of the MAA's Committee on Placement Examinations on how to start a placement test program on your campus or how to improve your on-going program. Send details to:

MAA Committee on Placement Examinations
c/o Professor Bernard Madison
Department of Mathematics, SE 301
University of Arkansas
Fayetteville, Arkansas 72701.

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PTP NEWSLETTER

news about placement testing from the
MAA PLACEMENT TEST PROGRAM

Volume 5, No. 1 Winter 1982

IN THIS ISSUE

NUMBER OF PTP SUBSCRIPTIONS INCREASES SHARPLY

The number of PTP subscriptions increased by 43% this year. This may be due in large part to stepped-up efforts on the part of the Committee on Placement Examinations to inform the mathematical community about PTP. Another significant factor may be the change in the subscription rate whereby the cost of renewal subscriptions was reduced from $100 to $85.

Whatever the reasons for the increase, it is clear that PTP tests are filling a real need for many colleges and universities in their efforts to develop effective procedures for matching the skills of their entering students with the prerequisites of their mathematics course offerings.

(A list of current PTP subscriber institutions as of November 1, 1981 is on pages 8 and 9 of this issue.)

SAMPLE PTP TESTS IN PREPARATION

The 1982-83 packet will contain sample tests which subscribers can use to inform students about the kinds of questions that they should expect on PTP tests. With some advance warning, test results should more accurately measure the student's mathematical skills. This may be particularly true of students who have not studied mathematics for a period of a year or more.

The sample tests will be one page in length. They will contain questions which are similar to questions on the current PTP tests, but which are neither identical to nor parallel to questions on any tests.

Development of the sample tests was spurred by a suggestion from a PTP subscriber, Professor John Tobey, Jr., Chairman of the Mathematics/Physics Department at North Shore Community College in Beverly, Massachusetts.

MATHEMATICAL ASSOCIATION OF AMERICA • 1529 Eighteenth Street, N.W., Washington, D.C 20036 • (202) 387-5200

NEW COPE CHAIRMAN APPOINTED

Professor Richard H. Prosl of the College of William and Mary, Williamsburg, Virginia, has been appointed the new Chairman of the MAA's Committee on Placement Examinations (COPE). As is traditional for new MAA chairmen, he will assume his new duties immediately after the MAA Annual Meeting in January. Professor Prosl will replace Professor Bernard Madison of the University of Arkansas who has served as COPE Chairman for the past two years.

Professor Prosl's service to PTP extends all the way back to its founding days in 1975 when he participated in test construction for the Texas experiment out of which PTP later grew. He has been a member of COPE every year since 1977 except for the academic year 1979-1980 during which he was on sabbatical in Scotland.

Professor Prosl's experience in testing also includes four years of service to the College Entrance Examination Board as a member of the Advanced Placement Mathematics Examining Committee, service as an Advanced Placement Examination Reader, Table Leader, and Examination Leader, and service as a consultant on test construction for the American Council of Education.

PTP DATA COLLECTION UNDERWAY

PTP Standard Peporting Forms were mailed to all PTP subscribers on November 1, 1981 from the MAA's Washington Office. The data provided by subscribers on these forms will be compiled and published in the Spring PTP Newsletter.

PTP Standard Reporting Forms were designed and distributed for the first time in 1980 as a part of the on-going effort of the Committee on Placement Examinations to provide information about placement testing to PTP subscribers. The amount of data that was collected in 1980 varied widely from test to test - from a high of nearly 14,000 students on BA to no data at all on Part II of test T. Not unexpectedly, mean scores and cut-off scores also were highly variable (the range of mean scores on BA, for example, was 4.4 to 18.4).

The section of the 1981-82 Standard Reporting Form for cut-off scores has been reformulated to make it easier to report this information. For each PTP test, subscribers are asked to indicate the range of scores they use for placement into any of eight entry-level courses. Thus, for example, a "Placement Range" of [10, 20] on test SK for Intermediate Algebra would indicate that students scoring less than 10 points on SK would be advised that their preparation is probably inadequate for Intermediate Algebra and (perhaps) that they should enroll in a lower level course. Students scoring in the range [10, 20] would be advised to enroll in Intermediate Algebra. Students scoring more than 20 points would be advised to take a higher level course or, at least, that they need not take Intermediate Algebra.

If you used any PTP test in the Summer or Fall of 1981 without alteration and within the prescribed time limit, WE WANT YOUR DATA. Please send it in as soon as possible, if you have not already done so. If you do not have a Standard Reporting Form write or call Dr. Marcia Sward at the MAA Washington Office (1529 Eighteenth Street, N.W., Washington, D.C. 20036; 202-387-5200).

If you used any PTP test this year but altered test items or time limits, we are still interested in hearing about what you did, why you did it, and how well it worked.

RELIABILITY AND MATH PLACEMENT TESTS

Philip E. Miles
University of Wisconsin, Madison

(This is the first in a series of three articles on reliability by Professor Miles.)

When used in connection with math placement tests, the word "reliability" usually refers to a number and to a metaphor. The metaphor responds to an actual need of test users, and the number is often taken as an indication of how well the test meets this need. I will argue that there is only a weak connection between the number and the metaphor, and that the underlying need is best met by good practices of test administration.

The number in question is obtained by giving the test to a group of students, giving each student a score of "1" on each question s/he answers correctly, otherwise a "0" on that question, and plugging the resulting scores into a formula called KR-20 (found in standard texts on educational measurement). The result is a number between 0 and 1, with 0 indicating total lack of reliability, and 1 indicating perfect reliability. This definition of reliability (by far the most commonly used) is the only one dealt with by the present note. There are genuinely different definitions of reliability to which this note does not necessarily apply. There are also different formulations which, for the type of question scoring described above, are equivalent to KR-20 (see, e.g., D.J. Hoyt, "Test Reliability Measured by Analysis of Variance," *Psychometrika*, 1941, 6, 153-160. Readers wishing to pursue these distinctions further should consult a suitable text (and accept my best wishes: these texts are usually not written for mathematicians).

The metaphor can be put in various ways - length will do as well as any. We may liken our students to a collection of rods whose lengths we wish to know, and our placement test to an imperfect ruler - somewhat bowed, perhaps, with graduations somewhat blurred - a ruler which, when applied repeatedly to the same rod will give somewhat different measurements. In the metaphor, the reliability number described above is taken as indicating the degree of perfection of the ruler.

Use of this metaphor may lead to use of reliability numbers to compare different placement tests. Specifically, it may lead to questions like this: "Placement test A has been

(continued on page 10)

CONSULTING SERVICES AVAILABLE

You can obtain the recommendations of the MAA's Committee on Placement Examinations on how to start a placement test program on your campus or how to improve your on-going program. Send details to:

MAA Committee on Placement Examinations
c/o Professor Richard H. Prosl
Department of Mathematics and Computer Science
College of William and Mary
Williamsburg, VA 23185

The PTP Newsletter is published by the Mathematical Association of America and is distributed to all subscribers to the MAA's Placement Test Program.

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Articles and/or information which may be of interest to PTP subscribers should be sent to the Editor.

CALCULUS PLACEMENT AT ARIZONA STATE

Joan H. McCarter, Assistant Professor
Department of Mathematics
Arizona State University
Tempe, Arizona 85287

Arizona State University offers calculus courses for technical students and for business students which are separate from the standard calculus courses. The Technical Calculus sequence, 3 units per semester for 3 semesters, is slower paced and less rigorous than the standard calculus courses. The Business Calculus course consists of a single three-unit course. It is open to all non-science students, but it is populated mostly (75%) by business students.

To study the placement problems in these courses, tests CR/1 and T/3 were given to students in several sections of Technical Calculus and Business Calculus. Approximately equal numbers of students took the tests. The Business Calculus students were presented with the non-trigonometric items on each test:

T/3, Part II . . . . 15 items
CR/1, Part I . . . . 20 items

The Technical Calculus students were given both parts of each test:

T/3, Parts I and II . . . . 30 items
CR/1, Parts I and II . . . . 25 items

The tests were administered in the first week of classes. The students were not notified in advance of the testing. The results and an analysis follow.

BUSINESS CALCULUS

COURSE GRADE VS. SCORE ON PART I OF CR/1
(209 students)

Score (maximum 20)	Course Grade	
	Pass (A,B,C,D)	Fail (E,W,I)
0-5	6	11
6-15	99	62
16-20	27	4

COURSE GRADE VS. SCORE ON PART II OF T/3
(283 students)

Score (maximum 15)	Course Grade	
	Pass (A,B,C,D)	Fail (E,W,I)
0-5	172	98
6-7	8	6
8-15	0	0

The results of the two testings were completely different. The students were unable to do more than half of T/3 correctly, and yet the course grades reflect considerable success in passing the course.

The results from CR/1 were more attractive. All students in the highest group passed with an A or B, while only one student in the lowest group with a grade as high as B. The CR/1 scores had a correlation of 0.403 with the course grades and the T/3 scores had a correlation of 0.095 (A=5, B=4, C=3, D=2, E=W=I=1).

SUMMARY STATISTICS FROM BUSINESS CALCULUS

	CR/1 (maximum 20)	T/3 (maximum 15)
Mean Score	11.0	2.6
Standard Deviation	3.9	1.6
Highest Actual Score	19.0	7.0

From this, CR/1 is by far the preferred test for Business Calculus. Apparently, T/3 is too difficult for these students. Furthermore, a very small percentage of Business Calculus involves anything other than polynomial calculus.

The following recommendations were formulated for future students. Those with CR/1 scores of 0-7 should not be in the class. Those with scores of 8-11 should be warned of a weak background, and those with a score of at least 12 should be advised to stay in the course (70% pass rate in sample).

TECHNICAL CALCULUS

COURSE GRADE VS. SCORE ON PARTS I, II OF CR/1
(117 students)

Score (maximum 25)	Course Grade	
	Pass (A,B,C,D)	Fail (E,W,I)
0-8	6	20
9-17	48	25
18-25	15	3

COURSE GRADE VS. SCORE ON PARTS I, II OF T/3
(141 students)

Score (maximum 30)	Course Grade	
	Pass (A,B,C,D)	Fail (E,W,I)
0-7	7	19
8-16	52	43
17-30	16	4

(continued on page 12)

BA/1 AT METROPOLITAN STATE COLLEGE
1977-1980

For several years, Freida Holley of Metropolitan State College, Denver, Colorado, has kept the Committee on Placement Examinations apprised of Metropolitan State's experience with several of the PTP tests.

Reported on page 7 are Metro State's data on BA/1 test scores versus final course grades in three courses - College Algebra, Finite Mathematics, and Precalculus. BA/1 is given on the first class day in each of these courses.

Reported below are the placement recommendations based on these scores which are used at Metropolitan State.

For further information on Metropolitan State's studies of PTP tests, contact: Freida Holley, Department of Mathematics, Metropolitan State College, Denver, CO 80204.

PLACEMENT RECOMMENDATIONS BASED ON BA/1 SCORES

Score	Recommendation
For students enrolled in COLLEGE ALGEBRA:	
0-11	-Strongly recommend student switch to Intermediate Algebra
12-14	-Student should consider switch to Intermediate Algebra
15-22	-Student should stay in College Algebra
23-25	-Student should be encouraged to go to Trigonometry, Precalculus, or Calculus I
For students enrolled in FINITE MATHEMATICS:	
0-6	-Strongly recommend student switch to Intermediate Algebra
7-10	-Student should consider switch to Intermediate Algebra
11-25	-Student should stay in Finite Mathematics
For students enrolled in PRECALCULUS:	
0-11	-Strongly recommend student switch to Intermediate Algebra
11-14	-Recommend student switch to Intermediate or College Algebra
15-23	-Student should stay in Precalculus
24-25	-Student should consider switch to Calculus I

SCORES ON BA/1 VERSUS FINAL COURSE GRADES

COLLEGE ALGEBRA = CA
871 students

FINITE MATHEMATICS = FM
1061 students

PRECALCULUS = PC
245 students

Score on BA/1	Number of Students			% earned A,B, or C			% earned D,F, or NC		
	CA	FM	PC	CA	FM	PC	CA	FM	PC
3	-	7	-	-	43	-	-	57	-
4	6	16	-	0	50	-	100	50	-
5	11	16	-	9	31	-	90	69	-
6	11	39	-	0	44	-	100	56	-
7	23	53	-	22	55	-	78	45	-
8	34	68	-	47	60	-	53	40	-
9	39	65	7	23	51	29	77	49	71
10	50	76	8	22	53	50	78	47	50
11	64	82	7	42	61	29	58	39	71
12	71	96	10	49	64	40	51	37	60
13	69	64	15	55	75	47	45	25	53
14	78	87	16	54	77	56	46	23	44
15	67	70	21	64	86	71	36	14	29
16	64	58	20	69	81	55	31	19	45
17	54	51	21	67	88	67	33	12	33
18	71	37	25	75	89	80	25	11	20
19	49	49	19	82	82	79	18	18	21
20	41	46	18	76	96	67	24	4	33
21	36	31	21	81	87	86	19	13	14
22	15	26	18	87	89	72	13	12	28
23	9	24	9	100	88	56	0	13	44
25	9	-	10	100	-	70	0	-	30

PTP SUBSCRIBERS, 1981-82
(As of November 1, 1981)

ALLEGHENY Mercyhurst College, Seton Hill College, Wheeling College

EASTERN PENNSYLVANIA AND DELAWARE Cheney State College, East Stroudsberg State College, Elizabethtown College, Lafayette College, Lebanon Valley College, Lehigh University, Pennsylvania State University, Philadelphia College of Pharmacy and Science, Swarthmore College

FLORIDA Barry College, College of the Virgin Islands, Eckerd College, Embry-Riddle Aeronautical University, Florida State University, Okaloosa-Walton Junior College, Rollins College, Tallahassee Community College, University of Central Florida, University of Florida, Valencia Community College

ILLINOIS Augustana College, College of Lake County, William Rainey Harper College, Illinois Central College, Illinois State University, Joliet Junior College, Lewis and Clark Community College, Malcolm X. College, Oakton Community College, Parkland College, Thorton Community College

INDIANA Ball State University, Earlham College, Indiana University-Purdue University, Vincennes University

INTERMOUNTAIN Brigham Young University, Idaho State University

IOWA Grand View College, Morningside College, University of Dubuque

KANSAS Barton County Community College, Benedictine College, Ft. Hays State University, Johnson County Community College, Kansas State University, Tabor College, University of Kansas

KENTUCKY Centre College, Maysville Community College, University of Kentucky, Western Kentucky University

LOUISIANA-MISSISSIPPI Alcorn State University, Louisiana State University, Southeastern Louisiana University

MARYLAND-DC-VIRGINIA Paul D. Camp Community College, College of William and Mary, Essex Community College, Gallaudet College, Hampden-Sydney College, Loyola College, Marymount College, J. Sargeant Reynolds Community College, Salisbury State College, Thomas Nelson Community College, Trinity College, Virginia Western Community College, Washington College, Washington and Lee University

METROPOLITAN NEW YORK Bard College, College of New Rochelle, Dowling College, Fiorello H. Laguardia Community College, New York University/CIMS, Pace University, Polytechnic Institute of New York, SUNY-College at New Paltz, United States Military Academy, Yeshiva College

MICHIGAN Central Michigan University, General Motors Institute, Macomb County Community College, Sagenaw Valley State College, University of Michigan

MISSOURI Harris-Stowe State College, The Lindenwood Colleges, Missouri Western State College, Penn Valley Community College, Southeast Missouri State University, Southwest Missouri State University, University of Missouri-Kansas City, Westminster College

NEBRASKA Kearney State College, Nebraska Wesleyan University, University of Nebraska

NEW JERSEY Bergen Community College, Rider College, Stockton State College, Union College

NORTH CENTRAL Carleton College, St. Olaf College, Concordia College, St. Cloud State University, Lakehead University, Mankato State University, Northern State College, University of Regina

NORTHEAST Boston University, Cape Cod Community, North Shore Community College, Fitchburg State College, Maine Maritime Academy, Pine Manor College, University of Bridgeport, University of Connecticut, University of Lowell-North Campus, University of Maine, Memorial University of Newfoundland, University of New Hampshire, University of Rhode Island

NORTHERN CALIFORNIA California State University- Hayward, Chabot College, College of Alameda, Kapiolani Community College, Kauai Community College, Santa Rosa Junior College, University of California- Davis

OHIO Bowling Green State University, Denison University, Kent State University, Kent State University-Salem, Mount Union College, Oberlin College, Ohio State University, University of Steubenville, University of Toledo, Wright State University, Xavier University

OKLAHOMA-ARKANSAS Central State University, University of Arkansas, University of Oklahoma, University of Tulsa

PACIFIC NORTHWEST Eastern Montana College, Eastern Oregon State College, Ft. Steilacoom Community College, Gonzaga University, Lane Community College, Okanagan College, Pacific University, Portland State University, St. Martins College, Selkirk College, Simon Fraser University, University of Alberta, University of Lethbridge, University of Oregon, Vancouver Community College

ROCKY MOUNTAIN Aims Community College, Colorado Women's College, Mesa College, Metropolitan State University, University of Colorado- Boulder, University of Southern Colorado

SEAWAY Cambrian College, College of St. Rose, Daemen College, Mohawk Valley Community College, Nazareth College of Rochester, Niagra University, St. John Fisher College, St. Lawrence University, SUNY-Fredonia, State University College-Geneseo, State University College-Plattsburgh, SUNY-Binghamton, University of Windsor

SOUTHEAST Alabama State University, Auburn University, Berry College, John C. Calhoun State Community College, Chattahoochee Valley Community College, Coker College, College of Charleston, Columbus College, Georgia Institute of Technology, Greensboro College, Lemoyne-Owen College, Lurleen B. Wallace State Junior College, Mercer University, Newberry College, North Carolina A & T State University, North Carolina State University, Pfeiffer College, Roane State Community College, Johnson C. Smith University, Tri-County Technical College, Trident Technical College, University of Georgia, University of North Carolina-Asheville, University of Tennessee at Chattanooga Young Harris College

SOUTHERN CALIFORNIA Mesa College, Occidental College, Orange Coast College, Santa Ana College

SOUTHWEST Arizona State University, Arizona Western College, University of Arizona, New Mexico State University, Pima County Community College

TEXAS Amarillo College, Bee County College, College of the Mainland, McLennan Community College, Midwestern State University, North Texas State University, Ranger Junior College, San Antonio College, Sul Ross State University, Tarleton State University, Texas Christian University, University of Dallas, University of Houston-Central, University of Texas-Arlington

WISCONSIN Northeast Wisconsin Technical Institute

RELIABILITY (continued from page 3) administered to national sample A of students and found to have a reliability of .92, while placement test B, administered to national sample B of students, produced a reliability of .84: Isn't this a good reason to prefer test A to test B?"

This is a straightforward question, and deserves a straightforward answer, namely: "wrongo - bad thinking". I have put my answer in visceral rather than cerebral terms because I would like to see it, and the point which underlies it, appreciated viscerally rather than cerebrally. The underlying point is: *every test statistic (including reliability) represents the interaction between a particular test and a particular student group. No statistic tells about a test alone or a student group alone.* It is a constant temptation to the test designer to think of test statistics as referring only to his/her most immediate concern, the test. It is an equal temptation to the ultimate user to think of the statistics as referring only to the students. But whoever yields to the temptation loses sight of reality.

In the case of reliability, the following is true. For every reasonable math placement test there is a population which will generate a reliability greater than .95, and another population which will, for the same test, generate a reliability of less than .75 (a reasonable test is one of from 25 to 50 questions, having content matching the prerequisites of a commonly given entry level course, and having questions free from ambiguity and error).

In very crude terms, what the reliability number does is measure the extent to which the test sorts the population taking it into two groups, one of which answers essentially no questions correctly and the other of which answers essentially all questions correctly. So, a population consisting partly of eighth graders and partly of experienced teachers of the course served by the test will generate a high reliability, since it will sort out nicely into the two groups just described. And a population assembled from students who have paid sporadic attention in a course covering the content of the test will not sort well and so generate a low reliability.

The description of reliability just given is too crude to push very far. It suggests, for instance that to be reliable, a test must produce a bi-modal distribution of overall scores, which is false. But this note is not primarily about what reliability does mean. I should also confess that since, all other things being equal, reliability rises as test length does, and since a 50 question test is a long one, I would have to do some pre-testing to come up with a population giving reliability of less than .75 on a good 50 item test.

Going back to the original question, it was built on the assumption that two different populations were involved in generating the two different reliability numbers. Now in real life, test designers don't go out and assemble student populations as freakish as I have described above. In fact, a major constraint is simply getting access to the students. But it remains true that statistics derived from genuinely different populations aren't comparable. And it takes a lot of detailed knowledge [illegible]now which populations are differ[illegible], which not. For example at one school, "students taking a 12th grade math course" may be essentially the same as "12th grade students taking a math course." At another school, these may be very different groups. Test users often find it difficult (or wish to avoid) making such distinctions among the schools from which their own students are drawn (indeed, have this difficulty as one of their major reasons for being test users).

A reliability figure which may be of interest to users is one based on their own student pool - specifically, on the group of students actually being placed in courses served by the placement test. Even for this known group, the metaphoric interpretation given earlier is of doubtful value. The wider the range of developed math skills in this pool, the greater the reliability of all placement tests is likely to be. A major contributer to one test having a greater reliability than another is likely to be that from the perspective of the first test, the different preparations the students have had tend to cluster more closely around a line than they do from the perspective of the second test. This is, in general, a desirable feature in the first test - but only if it is achieved by a test content which fits the prerequisites of the course being placed into. This fit is the most important feature of a placement test. If a well-made test which has this fit yields a low reliability, it is grounds for suspicion that the prerequisites of the course served don't fit the kinds of preparation the students have had. And if this suspicion is confirmed, it is grounds for asking whether the college courses served are designed in the best possible way to articulate with previous preparation.

The question of whether student preparation can reasonably be considered a one-dimensional quantity like length may have struck you on first reading the metaphor. There are observations to be made on both sides of the question. They are not central to this note and are therefore deferred to a "Digression" which will come at the end of the final article in this series.

What we have failed to do so far is consider the underlying need of the user which evokes interest in reliability - the need to tell a student that his/her test score represents his/her developed math skills rather than being mere noise. In part, this need is met by assuring that test content fits course prerequisites. But there remains the question of repeatability of scores-indeed students dissatisfied with their score are apt to assert that if they could take the test again, their score would be different. The metaphor for reliability is of interest because it suggests that reliability number is connected with repeatability of scores for individual students. While the connection does exist, it appears to me to be a weak one, with conditions of test administration being far more important. The next segment of this note will expand that thesis.

Footnote

An an example of the dependence of the reliability number on the student pool, I include results from testing at UW-Madison in the fall of 1978 in the table below. The reliability here is computed by a different formula (KR-21) than the one discussed, but the two formulas usually are in fairly close agreement. The test involved is the 50 item test which, at that time, represented the lower end of the UW-Madison placement battery. When reliability is computed from the whole pool, with its wide range of skill levels, a respectably high number emerges. When reliability is computed from, e.g., Math 101 students - a pool with much narrower range of skill levels - the result is a number sufficiently low to be considered a priori unacceptable.

Course Number	Reliability (KR-21)	Mean Test Score	Number of Students
99	.58	21.1	154
101	.64	28.1	327
112	.77	37.1	575
113	.7[illegible]	39.2	314
221	.76	44.1	477
Total Pool	.897 (.913 by KR-20)	36.3	1847

ARIZONA (continued from page 5)

In the Technical Calculus population the two tests had comparable results. In T/3's highest group, all but four of the students that passed the course received a grade of A or B. In the lowest group all but two of the students who passed the course received a grade of C or D; however, only 21 of the 141 students (15%) earned a score of 50% or better on T/3, and this indicates that the test is too difficult for this population. On CR/1, 65 of the 117 students (45%) earned a score of 50% or better.

CORRELATIONS OF COURSE GRADE AND TEST SCORES

CR/1	
Total test	0.43
Part I (non-trigonometry)	0.43
Part II (trigonometry)	0.25

T/3	
Total test	0.42
Part II (elementary functions)	0.34
Part I (trigonometry)	0.35

When the trigonometry part of T/3 was given first, all students did not finish. Had the algebra and trigonometry parts been given in reverse order, the results could have been significantly different. Twenty years of experience here with different placement tests has shown that trigonometry is not mastered until it is used, and it is not a good predictor of success in calculus. There is not a significant difference in the correlations of the total scores to course grades on the two tests.

SUMMARY STATISTICS FROM TECHNICAL CALCULUS

CR/1	Maximum Score	Mean	Standard Deviation
Total test	25	12.2	4.8
Part I (non-trigonometry)	20	10.4	3.9
Part II (trigonometry)	5	1.8	1.4
T/3			
Total test	30	11.5	4.6
Part II (elementary functions)	15	5.7	2.7
Part I (trigonometry)	15	5.7	2.9

It was decided that CR/1 was the better test for this purpose. The average grade was 48% as opposed to 38% on T/3.

The recommendations that were formulated for future students are: students with scores 0-8 should not be in the course, students with scores 9-11 should be warned of weakness, and students with a score of at least 12 should be advised to stay in the course (60% pass rate in sample).

NEWSLETTER

news about placement testing from the
MAA PLACEMENT TEST PROGRAM

Vol. 5, No. 2 Spring 1982

IN THIS ISSUE

USER'S REPORT 1981 TEST RESULTS

This issue contains an insert, "1981 PTP Composite Statistics," that compiles data on the scores earned by students on PTP tests and the ranges of scores used by institutions in placement decisions.

All PTP subscribers were asked in November to fill out a Standard Reporting Form if they had given any PTP test **without alteration and within the prescribed time limit.** As of March 15, a total of 76 subscribers had responded to the request (up from 63 in 1980-81): 50 returned completed forms, 13 reported that they had not used any PTP tests this year, 8 reported that they used the test but had altered test items or time limits, and 5 were unable to provide usable data for other reasons.

The most dramatic change from the 1980-81 statistics occurred on the Calculus Readiness (CR) tests where the number of institutions using Part I or Part I and II jumped from 14 to 26 and the number of students tested increased from 3549 to 8889. Algebra (A) also showed a large increase in the number of students tested, from 5573 to 11,257, although the number of institutions using this test increased only slightly. 11 to 14. Basic Algebra (BA) showed a slight decline, 25 to 21 institutions and 13,800 to 9,729 students tested. Usage of the other tests did not change appreciably. Mean scores on the most frequently used

(please turn to page 6)

RELIABILITY AND MATH PLACEMENT TESTING II

Philip E. Miles
University of Wisconsin, Madison

(This is the second in a series of three articles on reliability by Professor Miles.)

We consider here the underlying need which has generated interest in the idea of reliability — the need for assurance that an individual's test score is sufficiently representative of them so it would not be greatly changed on a retest. It is my belief that this need is best met by consistently following good practices in administering the test. My list of such practices is probably incomplete — I got it simply by trying to think what *could* cause a substantial score change and then thinking of a counter-measure.

The first step is to give students, well in advance of the time they take the test, a general description of the test's form, content areas, duration, and implications for their college career. This obviously reduces the difference between taking the test for the first time and retaking it or a similar test. It helps make the first test result dependent on the student's math skills rather than his/her academic or test-taking sophistication. It provides a very telling argument when faced with a student wanting a retest which one doesn't wish to give. And if this notice is given to students while they are still in high school, it may induce them to work harder at math there, perhaps bringing us closer to that day when placement tests are no longer necessary. The article by Adcock, Leitzel & Waits in the **Monthly** (Vol. 88, No. 1) describes a very highly developed program for raising placement-test awareness in the high schools. Simply mailing a one-page description of the placement test and its purposes to high school teachers and guidance counselors can be effective.

The next step is to consider carefully what instructions are to be given to students when they take the

(please turn to page 6)

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PTP NEWSLETTER SURVEY CONDUCTED

Last December, in an effort to find out what kinds of information PTP subscribers are most interested in seeing in the *PTP Newsletter*, the Committee on Placement Examinations mailed questionnaires to all PTP subscribers. A total of 52 completed questionnaires were returned to the MAA's Washington Office. Here is a tally of the responses:

	Level of interest in each topic (% of responses)			
	High	Medium	Low	None
Descriptions of new PTP tests and/or services	65	27	6	2
Composite data from subscriber institutions	67	23	8	2
Information on how to score tests	15	40	36	10
Descriptions of placement test programs at subscriber institutions	61	31	8	2
Statistical analyses of test data from subscriber institutions	65	27	77	2
Descriptions of other types of placement test programs (eg., high school programs)	15	46	21	17

A number of subscribers also included valuable comments and suggestic .s for improving the newsletter and the Placement Test Program generally. The Committee wishes to express its appreciation to everyone who took the time to complete the questionnaire.

The PTP Newsletter is published by the Mathematical Association of An... '.a and is distributed to all subscribers to the MAA's Placement Test Program.

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Articles and/or information which may be of interest to PTP subscribers should be sent to the Editor.

THE 1982-83 PTP PACKET

The 1982-83 PTP packet will contain these tests and materials:

Arithmetic and Basic Skills Tests

A-SK/1A and A-SK/1B (parallel forms; A-SK/1B is a new test)

Note: Copies of SK/1 and SK/1B are still available and will be included in the packet if requested.

Basic Algebra Tests

BA/2A
BA/1B and BA/1C (parallel forms)

Advanced Algebra Tests

AA/2A
AA/1B and AA/1C (parallel forms)

Algebra (Basic and Advanced) Tests

A/4A
A/3B and A/3C (parallel forms)

Trigonometry and Elementary Functions Tests

T/3 and T/3B (parallel forms)

Calculus Readiness Tests

CR/1B and CR/1C (parallel forms; CR/1C is a new test)

Answer keys for all of the above tests

PTP User's Guide, Revised Edition

This new edition of the **User's Guide** incorporates current test data and recommendations. It is in a loose-leaf binder to allow for annual up-dates.

Copyright Authorization Form

This form provides official authorization from the MAA for unlimited use of PTP tests on a subscriber's campus during the 12-month period following receipt of the PTP packet. (See "PTP Subscription Year Redefined" on page 8 of this issue.)

Extra Test Sets

Extra test sets (50 tests per set) will be included in the PTP packet if they are ordered in time. The cost is $7.50 per set.

THE COLLEGE OF CHARLESTON'S PLACEMENT TEST PROGRAM — FOLLOW UP STUDY

Hope Florence
Department of Mathematics
College of Charleston
Charleston, S.C. 29401

An explanation of the placement process at the College of Charleston appeared in the Winter 1981 PTP Newsletter. At that time we promised subscribers a few statistics to validate our cutoff scores. We would like to share with you our findings for College Algebra, Pre-Calculus, and Calculus for Fall 1980 and Fall 1981.

Fall 1980

BA/1 Mean: 11.4 Standard deviation: 4.5 Number tested: 438

CR/1 Algebra Portion (quest. 1 - 20)
Mean: 8.5 Standard deviation: 3.7
Trig. Portion (quest. 21 - 25)
Mean: 1.7 Standard deviation: 1.4 Number tested: 254

BA/1 Test Scores
vs
Grades in College Algebra

	A, B, C	D, F	Withdrew W	Totals T
0-6	2	3	4	9
7-11	27	11	14	52
*12-19	75	36	12	123
20-25	5	1	0	6
Totals T	109	51	30	190

*Students who scored 12-19 on the BA/1 Test were advised to take College Algebra and followed our recommendation. All others took the algebra course even though they were advised to take a higher or lower level course. Starred groups in all the tables have a similar interpretation.

CR/1 Test Scores
vs
Grades in College Algebra

	A, B, C	D, F	W	T
0-3	5	2	0	7
*4-6	23	6	2	31
7-12	26	2	0	28
13-25	5	1	0	6
T	59	11	2	72

CR/1 Test Scores
vs
Grades in Pre-Calculus

	A, B, C	D, F	W	T
0-3	0	0	0	0
4-6	5	2	0	7
*7-12	57	15	3	75
13-25	20	1	0	21
T	82	18	3	103

CR/1 Test Scores
vs
Grades in Calculus

	A, B, C	D, F	W	T
0-3	0	0	0	0
4-6	1	0	0	1
7-12	3	0	0	3
*13-25	25	0	2	27
T	29	0	2	31

Statistics for the Calculus Readiness Test may be slightly off since our recommendations were actually based on two raw scores — one for the algebra portion of the test and one for the trig portion — but our tables are based on a combined score. We separated the scores in order to determine if a student's knowledge of trig was sufficient for Calculus. We decided that 5 questions was not enough to make such a judgement. Also the two raw scores created a great deal of confusion on the part of our mentors Therefore in 1981 only one raw score was used for this test.

Fall 1981

Cutoff scores for Fall 1981 are slightly different from those used in 1980. One change resulted from the combination of algebra and trig scores on the CR/1 Test. Other changes were based purely on the opinions of committee members for the tables above were not available to us at the time.

BA/1 Mean: 11.4 Standard deviation: 4.0 Number tested: 459

CR/1 Mean: 9.0 Standard deviation: 4.4 Number tested: 338

(please turn to page 7)

1981 PTP STANDAI

STUDEN

# of Items	A-SK PART I OᴾˡLY (20)	A-SK ᴾARTS I & II (32)	SK (25)	BA (25)
TIME LIMIT	25 MINUTES	40 MINUTES	30 MINUTES	30 MINUTES
NUMBER OF STUDENTS TESTED	197	1708	3501	9729
(NUMBER OF INSTITUTIONS)	(1)	(6)	(6)	(21)
MEAN	9.2	23.8	15.3	13.0
(RANGE OF MEANS)		(19.8 - 26.8)	(13.1 - 20 ⁰ⁿ	(9.2 - 16.0)
RANGE OF STANDARD DEVIATIONS	3.4	4.2 - 7.1	2.9 - 4.7	3.8 - 6.6

PLACEMI
(Number o

[Mean Low Scor

Students scoring in this range (inclusive)

CALCULUS — Engineering, Physical Science	[,]	[,]	[,]	(5) [20, 25]
CALCULUS — Business, Intuitive, or Short	[,]	[,]	[,]	(4) [18, 25]
PRECALCULUS	[,]	[,]	[,]	(5) [12, 24]
TRIGONOMETRY	[,]	[,]	[,]	(5) [15, 25]
COLLEGE ALGEBRA	[,]	(1) [26, 32]	[,]	(10) [10, 19]
INTERMEDIATE ALGEBRA	[,]	[,]	(1) [16, 25]	(11) [4, 11]
BEGINNING ALGEBRA	[,]	(2) [14, 25]	(2) [12, 20]	(5) [0, 7]
ARITHMETIC	(1) [0, 15]	(1) [0, 12]	(2) [0, 10]	(3) [0, 5]
OTHER	[,]	(3) [15, 25]	[,]	(3) [14, 25]

REPORTING FORM

SCORES

AA (25)	A (32)	T PART I ONLY (15)	T PART II ONLY (15)	T PARTS I & II (30)	CR PART I ONLY (25)	CR PARTS I & II (30)
MINUTES	45 MINUTES	25 MINUTES	25 MINUTES	45 MINUTES	25 MINUTES	30 MINUTES
1711	11,257	2530	573		3390	5499
(6)	(14)	(5)	(1)		(6)	(20)
10.7	11.75	5.1	6.3		10.8	11.9
8.3 - 15.7)	(9.1 - 17.3)	(2.7 - 6.2)			(8.4 - 15.6)	(5.3 - 18.1)
3.6 - 5.1	3.6 - 6.1	2.2 - 3.4			3.7 - 6.0	3.3 - 5.5

T RANGES

Institutions)

Mean High Score]

re advised or required to take this course.

(2) [15, 25]	(7) [18, 32]	(2) [6, 15]	[,]	[,]	(4) [12, 25]	(10) [12, 24]
(2) [12, 25]	(4) [18, 32]	[,]	[,]	[,]	(2) [10, 17]	(2) [15, 25]
(2) [7, 19]	(2) [13, 22]	[,]	[,]	[,]	(3) [2, 9]	(10) [4, 12]
[,]	(2) [15, 24]	(4) [0, 6]	[,]	[,]	(1) [10, 15]	(2) [6, 13]
(1) [6. 13]	(8) [13, 19]	[,]	[,]	[,]	(1) [0, 10]	(3) [4, 10]
(2) [2, 13]	(4) [2, 11]	[,]	[,]	[,]	[,]	(1) [0, 11]
[,]	(4) [5, 14]	[,]	[,]	[,]	[,]	(1) [0, 5]
([illegible] [illegible], 9]	(2) [,]	[,]	[,]	[,]	[,]	[,]
(1) [0, 4]	(1) [14, 16]	[,]	[,]	[,]	[,]	(1) [12, 16]

RELIABILITY (continued from page 1)

test, and to see that these instructions are given uniformly to all test-takers. The most difficult part of this task is finding a terse but lucid statement of the mechanical parts of the process. In a test which is to be graded mechanically, it is vital that each student understand how to do the mechanics. There are also important non-mechanical points to be covered. One is what to say about guessing at answers. A student who follows an optimal guessing strategy can usually add several points to his/her score (possible, even if there is a penalty for wrong answers, if the student can eliminate some of the alternatives offered). A second is what to say about doing the problems, rather than hunting among the alternative answers for a superficially attractive one. A student of moderate abilities who elects the latter course may, on a well made test, do worse than a student answering at random — it is the job of test designers to see that the right answer is seldom the most superficially attractive one. A third is what to say about attempting to work all the problems as opposed to working them in the order presented until one has either done the problem or satisfied oneself one can never do it. A good exam will have its problems arranged in an order which tends, on the average, from easiest to hardest. But any individual student is likely to find some problems she/he can do occurring after the first problem she/he cannot.

I have just outlined a mini-course on test-taking strategy. Academically sophisticated students may know its contents already; academically naive ones may profit from it, or may fail to master it in the very brief time they have to assimilate instructions. I have no advice on how much to say on the above points. But it is important that whatever statement is made should be uniform for all administrations of the test.

Those of you still interested in the reliability number should be aware that it is likely to be elevated if students omit answering all questions where they don't know the answer, and depressed if students follow optimal guessing strategy.

Getting back to more mechanical points, I have little doubt that Murphy discovered his law in the process of administering placement tests. It is surprising how difficult it is to assure good, and uniform conditions with respect to

* physical environment (good light, little noise, desks with writing surfaces sufficiently smooth).
* provision of pencils having both points and erasers, and scratch paper, if this is used.
* error-free tests. Every human being who transcribes a test introduces at least one error into it. Even copy machines introduce errors by filling in, or failing to copy, symbols.
* time allowed for doing the exam. Placement tests are not designed to be tests of speed as such, but it seems a fact of life that test times by short enough that students are under time pressure — so scores can be expected to reflect time allowed unless this is kept uniform.

To the above plea for uniformity should be added one for humanity. If the test administration process is kept cheerful and relaxed, the anxious, the naive, the unassured students will be more likely to show their full abilities. (I have tacitly assumed they are going into cheerful and relaxed classrooms for their course work; one must put one's faith somewhere).

If all the above practices are followed, there should be only a small fraction of students who question whether their placement score truly reflects what they could have done — so small that it should be possible to actually listen to them. And, having done so, one may expect to encounter cases where it seems likely the original test score is not representative. And in these cases it is a good idea to give a retest. There are problems with retests. If one uses the same test, the student is likely to get a higher score than she/he would have on a first attempt under good circumstances — and one can only make a rough estimate of how much higher. If one uses a different test, one must somehow equate a score on it to a score on the first test. But running a placement system that allows second chances when the first chance was genuinely unfair is worth a diminished precision in a small number of cases.

USER'S REPORT (continued from page 1)

tests were within 1.5 points of last year's means, except for SK, up to 15.[illegible] from 13.2, and A, up to 11.75 from 9.8. The mean low and high scores are given for placement ranges used by reporting institutions. The small sample size within each category and high variance make this data useful only as very general guidelines for placement ranges.

These data should not be viewed as "national norms" since rigorous statistical sampling was not observed in obtaining the data. Nevertheless, we hope that users find these statistics helpful and informative. The members of the Committee on Placement Examinations express their appreciation to the many subscribers whose response made this report possible.

(DATA TABLES on Pages 4 - 5)

CHARLESTON (continued from page 3)

BA/1 Test Scores
vs
Grades in College Algebra

	A, B, C	D, F	W	T
0-6	3	4	2	9
7-10	13	16	7	36
*11-19	85	58	10	153
20-25	6	1	0	7
T	107	79	19	205

CR/1 Test Scores
vs
Grades in College Algebra

	A, B, C	D, F	W	T
0-3	10	4	2	16
*4-6	44	13	2	59
7-13	35	6	1	42
14-25	3	0	0	3
T	92	23	5	120

CR/1 Test Scores
vs
Grades in Pre-Calculus

	A, B, C	D, F	W	T
0-3	1	0	0	1
4-6	7	4	0	11
*7-13	60	22	9	91
14-25	11	2	1	14
T	79	28	10	117

CR/1 Test Scores
vs
Grades in Calculus

	A, B, C	D, F	W	T
0-3	0	0	0	0
4-6	0	0	0	0
7-13	5	2	3	10
*14-25	17	6	0	23
T	22	8	3	33

Conclusion:

By studying these tables and their ungrouped counterparts, several items came to light. First, the entry score of 11 or 12 for College Algebra is too low. In 1981, 29 students scored a 12 on the BA/1 Test. Out of these there were 7 D's, 15 F's and 3 W's. Secondly, students scoring 4-6 on the CR/1 Test should probably take Pre-Calculus instead of the recommended College Algebra. Students were allowed to take the CR/1 Test only if they had two years of algebra and some trigonometry in high school. Their backgrounds plus the results shown in the tables suggest that most of them could successfully complete Pre-Calculus. Third, the entry score of 13 or 14 for Calculus is too high. A cutoff of 11 seems more appropriate.

Recommendations for Fall 1982:

As a result of our findings, the committee is strongly considering the following recommendations for the Calculus Readiness Test:

Score	Recommendation
0-3	Take the Basic Algebra Test
4-10	Take Pre-Calculus
11-25	Take Calculus

No similar decisions have been made as yet concerning cutoffs for the Basic Algebra Test since the results for 1980 and 1981 were not quite as clear-cut.

In addition to the author, Professors George Pothering and Elizabeth Norton are members of the College of Charleston's Mathematics Placement Committee.

NEW COMMITTEE MEMBER JOINS COPE

In January of this year Thomas W. Tucker became a member of the Committee on Placement Examinations. He joins the committee in a vacant position that resulted from Dr. Marcia Sward's being identified as a staff associate in the committee's activities. Previously, Dr. Sward was completing the tenure of her earlier appointment as an official member of the committee. Professor Tucker received his undergraduate degree at Harvard University and he received his doctorate from Dartmouth College in 1971. After teaching at Princeton University for two years as an instructor, he moved to Colgate University where he has taught since 1973. Dr. Tucker has been a visiting Lecturer for the MAA since 1974. He has been involved with various aspects of the College Board's Advanced Placement Program in Mathematics and has served on the examining committee for that program since 1979.

The committee members are:

Richard Prosl, Chairman
College of William and Mary

Thomas Carnevale
Virginia Commonwealth University

John Kenelly
Clemson University

Bernard Madison
University of Arkansas (Fayetteville)

Billie Ann Rice
Dekalb Community College

Thomas Tucker
Colgate University

MAA Staff Associate
Marcia P. Sward
Mathematical Association of America

PTP SUBSCRIPTION YEAR REDEFINED

To ensure that all PTP subscribers have use of the PTP tests for a full year, the PTP subscription year has been redefined from an "academic year" to "one year after receipt of the PTP packet." Consequently, subscribers may now specify the month in which they wish to receive their PTP packets and will then be authorized to use the PTP tests for the 12-month period following receipt of the packet.

The PTP packet of tests and materials changes annually, as old tests are "retired" and new tests and other materials are added. New PTP tests and materials are normally added to the packets in June each year.

It is expected that the majority of subscribers will continue to place their subscriptions in the spring and will elect to receive their packets in June in preparation for late summer or fall testing. These subscribers will receive a single up-dated packet. Subscribers who request their packets in months **other than June** will receive:

- a PTP packet containing currently available materials **during the month specified** and,
- an up-date packet containing any new materials **the following June.**

Renewal notices will be sent out as subscriptions run out. Subscribers will then have six months during which they can renew their PTP subscriptions at renewal rates.

PTP NEWSLETTER

news about placement testing from the
MAA PLACEMENT TEST PROGRAM

Vol. 6, No. 1 Winter, 1982-83

IN THIS ISSUE

A MULTIPLE REGRESSION APPROACH TO PLACEMENT IN MATHEMATICS AT THE UNITED STATES COAST GUARD ACADEMY

Professor Ernie Manfred
U.S. Coast Guard Academy
New London, Connecticut 06320

Introduction and Perspective

This study was designed to investigate methods by which the use of available data on incoming cadets at the United States Coast Guard Academy can be used as a guide for placement in the first year mathematics course. The purpose is to reduce errors stemming from underestimates and overestimates of a cadet's capabilities and potential achievements in mathematics. Such errors may not only lead to failure, they preclude the educational challenge in its best sense.

Each year the Mathematics Department is faced with the problem of placing into one of three freshmen calculus courses those entering cadets who do not elect and pass an advanced placement examination: The freshmen calculus courses are:

Math 3100 — Introduction to Calculus (Introductory)
Math 3101 — Calculus and Analytic Geometry (Regular)
Math 3111 — Calculus and Analytic Geometry (Honors)

(please turn to page 3)

MAA MINI-COURSE ON PLACEMENT TESTING
January 6 and 8, 1983
Denver, Colorado

An MAA Mini-Course on Placement Testing will be held in conjunction with the Joint Mathematics Meeting in Denver, Colorado, January 5-9, 1983. The schedule for the Mini-Course is as follows:

SESSION I

Thursday, January 6, 7:00 p.m. - 10:00 p.m.
"Overview of Placement Testing"
James Braswell, Educational Testing Service

"Test Development"
Richard Prosl, College of William and Mary

Workshop on Item Writing I
Organizer: Thomas Tucker, Colgate University

SESSION II

Saturday, January 8, 7:00 p.m. - 10:00 p.m.
Panel Discussion: "Administration of Placement Testing Programs"
Moderator: John Kenelly, Clemson University (visitor at the U.S. Military Academy)
Panel: Hope Florence, College of Charleston
Matthew J. Hassett, Arizona State University
Billie Ann Rice, DeKalb Community College

Workshop on Cutoff Scores
Organizer: Bernard Madison, University of Arkansas, Fayetteville

Workshop on Item Writing II
Organizer Thomas Tucker, Colgate University

Between Sessions I and II, the items produced in Workshop on Item Writing I will be assembled into tests which will be administered to students at the U.S. Air Force Academy. Item analyses from this test administration will be available to participants at Workshop on Item Writing II.

The registration fee for the Mini-Course is $15 and enrollment is limited to 30 participants. Enrollment information is available at the MAA Washington, D.C. office (1529 Eighteenth Street, N.W., Washington, D.C. 20036).

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(**RELIABILITY**, cont. from page 3)

first equation makes division a far more inviting first step. I don't propose to consider whether either of these questions are good ones for a placement test. The point is that student errors come less often from simple ignorance than from using a technique they have been taught in a situation where that technique fails to apply. This fact implies an ordering of problem difficulty which has ery little to do with what we usually consider to be logical order in mathematics.

I am able to resist a discussion of whether different teaching methods emphasizing "concepts" rather than "manipulation" would alter this situation — but unable to resist stating my belief that such a discussion would be fruitless. I don't think that, at the pre-calculus level, there is any clear distinction between "concepts" and "manipulation." At the research level, I think the distinction can be maae by application of the following Dictum: any research which is properly understood and evaluated within ten years is symbol-pushing of one order or another — possibly of a very high order indeed — rather than conceptual. In support of this Dictum I offer not mere reasoned argument, but the observation that it meets the one great test for successful Dicta — every person can see a reason why its stricture applies to most of his/her acquaintance, and each person can see a reason why this stricture does not apply to his/her self.

Conceivably I should return to my lead sentence and offer reasons for both the "yes" and the "no" which I asserted there. Actually, we have gone some distance with the case for "no." Students abilit .s to do problems reflect various interactions and interferences between the techniques which they remember. And the selection of techniques which a particular student remembers depends on personal factors almost as much as on mathematics instruction. The result is that ' n a genuine placement test (one whose content fits the prerequisites of a standard course) is given to a genuine population (a population to which some school would want to give a placement test) no genuine linear ordering of the problems will emerge. A genuine ordering of the problems is one in which, except for a few students, a student can work almost all of the problems up to some point in the order and almost none thereafter. So in this sense, the answer to the original question must be "no."

On the other hand, almost all uses of placement test results consist of taking total test scores, which are linearly ordered, and saying th-' all students whose scores fall below a certain number should (or are advised to) go to one course, with those whose scores lie above this number going to another. This amounts to behaving as though preparation were linearly ordered. Is there any sense to such behavior? I believe there is. One has some notion of how many extr hours a typical student will have to spend mastering this or that area of prerequisite material in order to succeed in the course itself, and the cut line for placement in the course comes more or less where the total number of hours exceeds that which a typical student can be expected to spend. In real life these notions are va- -, but they exist. They account for the fact that s. .e skills are represented by many placement test items and others by few. The point I want to emphasize is that this ordering does not exist directly in the current contents of the students' heads, but is an estimate concerning their future behavior. Consequently, this ordering, by required hours of deficiency study, will not be visible in placement test statistics. I hope this will be seen as an amplification, not a contradiction, of the second paragraph of this digression.

I hope also that people concerned with the betterment of placement tests will be moved to put much of their energies into refining the vague notions just mentioned. It is a common practice to recognize the vagueness of these notions by supplementing placement test results by a nolistic and subjective judgment formed during the advising process. Another useful Dictum is: these subjective judgments work out substantially less well than is supposed by the person making the judgment. The human mind seems better able to remember things that worked than things that didn't. One of the advantages of placement tests is that they generate data which can be objectively analyzed, thus providing a basis for long-term learning from experience — a process whose benefits are somewhat under-used in education.

The PTP Newsletter is published by the Mathematical Association of America and is distributed to all subscribers to the MAA's Placement Test Program.

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Articles and/or information which may be of interest to PTP subscribers should be sent to the Editor.

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(REGRESSION, cont. from page 1)

The introductory course should be more appropriately entitled "Stretch Calculus." The course used the same text as the regular course, however the pace is slower allowing more time on the fundamentals of differential and integral calculus. Math 3101 (Regular) is a typical first semester college calculus course. Math 3111 (Honors) course covers the same material as Math 3101 plus additional topics. The pace of the honors course is consistent with the ability of the class and the material is treated in greater depth. Cadets placed into Math 3100 (Introductory) take twelve semester hours to cover material taught in eight semester hours for the regular sequence.

Methodology

Prior to the fall semester, incoming cadets participate in a summer training program. Part of this program involves a non-credit Summer Mathematics Review Course. This seven-week course consists of a review of algebra and trigonometry. Using precollege data and information obtained from the Summer Mathematics Review Course, a multiple linear regression model was used to develop a model which predicts final grades in the freshmen calculus courses on the basis of a number of independent variables. The predicted grade is used as a guide and is one of several standards used in a placement procedure.

Admission to the Academy is based solely on nation-wide competition. The competition is based on the candidate's performance on the College Entrance Examination Board Scholastic Aptitude (SAT) or the American College Testing Assessment (ACT), the candidate's high school rank and leadership potential. Using the Class of 1981 as a data base, the class was divided into three categories:

Category I : Cadets having both SAT and ACT scores
Category II : Cadets having SAT scores
Category III : Cadets having ACT scores

The Admissions Division requires one but not both of the SAT/ACT scores.

The independent predictor variables are as follows:

a. **Mathematics Anxiety Text Score** (X_1). This score is obtained from the Admissions Department based on the Mathematics Anxiety Rating Scale (MARS) by Richardson and Suinn (1972).
b. **Mathematics Background** (X_2). A cadet is given a 1, 2, or 3 depending on high school background. If a cadet indicates that he has had calculus, trigonometry, and algebra in high school or college, he receives a 3; for having algebra and trigonometry, a 2; for just algebra, he is assigned a 1. Note that trigonometry is not required for admission to the Academy.
c. **Pre-Board Qualifying Score** (X_3). The Pre-Board Qualifying Score is another score received from the Admissions Department. It represents 60% of the

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RELIABILITY AND MATH PLACEMENT TESTING III

Philip E. Miles
University of Wisconsin, Madison

(This is the concluding article in a series on reliability by Professor Miles)

Digression: Is math preparation, as measured by placement tests, a one-dimensional quality? The answer is an unequivocal "yes and no." Since a digression should digress, I will not proceed directly to the answer, but rather begin by clearing some ground. The question really being asked is whether the elements of math preparation have a natural linear order. I am surprised at how often I acquiesce in the statement that they do, having in mind some deductive order, when I know perfectly well that any deductive ordering is only partial, and that the arrangement of propositions in a partial order allows great latitude for the exercise of taste (whether mathematical or pedogogical). I suppose I am merely expressing, in unconsidered form, my sense that mathematics exhibits some discernable order and that other disciplines (as they are present in the pre-college preparation of students) do not.

More to the point, I know that incoming students have not learned mathematics deductively, nor in any other linear order, and that, **for placement test purposes, what counts is what is in students' heads, rather than what is in mathematicians' heads.**

This sounds like heresy on a rather grand scale, and if taken as the complete statement of the truth, it doubtless is. As a first approximation to the truth, I think it serves better than the statement one would get by reversing the roles of students and mathematicians. A second approximation might be that where a course is at, at any given moment, is a question of what is in the students' heads, where it is going is a matter to be settled by the mathematician teaching it, and how it gets there should be determined by both the preceding considerations. Since the purpose of a placement test is to find out where students are at when a course starts, the original statement fits the second approximation fairly well.

As an example of how students' abilities may depart from mathematical logic, consider the two (equivalent) equations:

$$(\sqrt{2} - 1)\,X = \sqrt{3}$$

$$\sqrt{2}X = X + \sqrt{3}$$

At a fairly early stage in their studies, students may be able to solve both of these equations, and at a later stage, unable to solve the second. The later stage comes after they have worked on "radical equations" involving X or more generally X + c. Having learned to square both sides, perhaps repeatedly, to eliminate radicals, they will have a disposition to go after the radicals in the second equation in the same way. The

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(REGRESSION, cont. from page 3)

total score a candidate receives for admission consideration. It is the academic portion of his or her total score. This score is calculated by using

3(high school rank) + 2(SAT Math) + (SAT Verbal)

d. **High School Rank** (X_4). The high school rank of a candidate is computed as follows:

$$\frac{2 \times (\text{class standing}) - 1}{2 \times (\text{number of students in graduating class})} = \text{decimal} < 1$$

This decimal value is then assigned a number. The maximum score a cadet can receive for the high school rank is 800.

e. **SAT-Math Score** (X_5)
f. **ACT-Math Score** (X_6)
g. **Algebra Diagnostic Score** (X_7). Early in the Summer Review Course, the Mathematics Department administers the ALGEBRA III Form A Examination published by the Educational Testing Service of Princeton, New Jersey. A maximum of forty points can be earned on this exam.
h. **Trigonometry Diagnostic Score** (X_8). This test is similar to the Algebra Diagnostic Exam and is published by the Educational Testing Service. This examination is also administered early in the Summer Mathematics Review Course. A maximum of forty points may be earned.
i. Confidence Index (X_9). A value of 1, 2, or 3 is assigned to a cadet depending on where he thinks he should be placed. The variable is coded as follows: 1 — Math 3100, 2 — Math 3101, 3 — Math 3111
j. **Algebra Achievement Progress** (X_{10}). After covering the basic material in algebra during the Summer Review Course, the Algebra III, Form B Exam, published by the Educational Testing Service is given. The variable X_{10} is obtained by plotting the difference of the [(Algebra Form B) - (Algebra Form A)] vs. (Algebra Form A). The average improvement score for the class is then calculated along with the average of the Algebra III Form A. The coding for this variable is then computed using the following scheme:

IMPROVEMENT (Form B - Form A)	Algebra Form A Score: below A-average	Algebra Form A Score: above A-average
above B-A average	1	3
below B-A average but positive	0	2
negative B-A	-1	2

If a cadet has a below average score on the Algebra Form A (Diagnostic) and a below average improvement, he receives a −1 or 0. Observe that the same value is assigned to an individual who has above average on Algebra Form A but negative improvement (i.e. he hasn't shown any improvement). Those cadets who fall into this region scored near the maximum of 40 points on Algebra Form A (Diagnostic) and lost only 2 or 3 points on Algebra Form 3 (Achievement). I feel that those in this category should not be penalized since their chance for improvement is rather small. A maximum of 3 is assigned for this variable for those cadets who have shown above average improvement and above average on Algebra Form A (Diagnostic).

k. **Trigonometry Achievement Progress** (X_{11}). After the trigonometry portion of the Summer Review Mathematics Course is completed, the Trigonometry Form B (Achievement) test is administered. Coding for this variable is similar to that of X_{10}.
l. Sex (X_{12}). A 0 is assigned for male, a 1 for female.
m. **Grade in First Mathematics Course** (Y): **The Dependent Variable.** The dependent variable is the grade a cadet earns in his first mathematics course at the Academy.

	MATH 3101	MATH 3100	MATH 3111
H	4.5	4.0	
A	4.0	3.5 − 3.9	4.5
B+	3.5 − 3.9	3.0 − 3.4	4.0 − 4.4
B	3.0 − 3.4	2.5 − 2.9	3.5 − 3.9
C+	2.5 − 2.9	2.0 − 2.4	3.0 − 3.4
C	2.0 − 2.4	1.0 − 1.9	2.5 − 2.9
D	1.0 − 1.9	.5 − .9	2.0 − 2.4
F	<1	<.5	<1.9

One might inquire why the scores on the Algebra Form B (Achievement) and Trigonometry Form B (Achievement) are not included in the model. Both these exams are not open-ended. It is possible for those cadets who score very high on the Algebra Form A (Diagnostic) and Trigonometry Form A (Diagnostic) to show very little improvement, if any. I feel that the variables X_{10} and X_{11} give some indication as to the cadet's improvement performance as it relates to the rest of his class at a time when the cadet is making a transition from civilian to military life.

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(REGRESSION, cont. from page 4)

A very crucial and important aspect to the study is the control of the dependent variable Y. Cadets in each ourse take the same exam for that specific course. As an example, the cadets in Math 3101 take the same exam during a common exam period. There are anywhere from five to seven instructors teaching this course using a common syllabus. Each instructor contributes to the making of exams and each instructor grades one portion of the exam, therefore removing variability in grading. Cut-offs for final grades are determined by common agreement among the instructors teaching the course. One explanation for the lack of research in course placement based on data from grades in specific courses may be the lack of control of the instructor factor.

The R^2 values for each category are as follows:

Category	R^2
I (n = 42)	.53
II (n = 180)	.43
III (n = 38)	.60

The most useful predictors for the categories involved are: Mathematics Background (MB), Algebra Diagnostic (AD), Trigonometry Diagnostic (TD), and the Algebra Achievement Progress (AAP).

Conclusions

The importance of the Summer Mathematics Review Course is evident since our best predictors are the achievement related variables obtained from this course together with qualitative comments from instructors.

The maintenance of the model and comparison from class to class may reflect changes in the mathematical background of cadets before such changes become evident during the academic year. As an example, a considerable change in the Trigonometry Diagnostic (TD) average and Trigonometry Achievement Progress (TAP) may indicate more time is needed in this area in all courses taught in the freshman year.

When one looks at the quantitative data available separately, some information is obtained in the placement puzzle. However, it is the multivariable regression model that fits many pieces of the puzzle together. It is the responsibility of the researcher to include in a multiple regression model those variables that best related to the predictive variable. (Tables 1, 2, & 3)

(This paper describes the original model used at the U.S. Coast Guard Academy. Professor Manfred is currently using PTP scores in the construction of a revised model and readers may request detailed reports on the studies — Editor.)

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INFORMATION ABOUT TRANSLATIONS OF PTP TESTS SOUGHT

One of the problems that some PTP subscribers face is providing foreign language translations of PTP tests for some of their students. If you have a foreign language translation of any PTP test which you would be willing to share with other PTP subscribers, please send a copy of the test to Dr. Marcia Sward, MAA, 1529 Eighteenth Street, N.W., Washington, D.C. 20036.

A list of the translated tests that have been collected will be published in the Spring 1983 issue of the **PTP Newsletter.** Subscribers may then request a copy of any of the available translations from Dr Sward.

PRECOLLEGE TESTING PROJECT UNDERWAY

Two new versions of PTP tests for use in testing high school students are now being developed by a panel of three university teachers appointed by the MAA's Committee on Placement Examinations. The members of this panel are Denny Gulick, University of Maryland-College Park; Bert Waites, Ohio State University; and Bernard Madison, University of Arkansas-Fayetteville. Professor Madison is also a current member and ex-chairman of the Committee on Placement Examinations.

The purpose of the project is to provide PTP users with materials needed to develop programs for testing perspective college students during their junior year in high school. By testing at this time and giving projected placements in college mathematics, students can use the remaining year of high school for addressing, and hopefully raising, their levels of placement. Some institutions have already initiated such programs and have found that their programs have improved communications between high schools and colleges and have resulted in increased enrollments in mathematics by high school seniors.

The two tests being developed for use in high school assume only that students have completed courses in algebra and geometry. Both of these tests will include a version of the PTP test in basic algebra, BA. One will be supplemented with items from more advanced topics in algebra. Projected placement will probably not include the highest level of placement since most students will not have completed courses in trigonometry, elementary functions, analytic geometry, or calculus when they take these tests.

(REGRESSION, cont. from page 5)

TABLE 1
CATEGORY 1 INTERCORRELATIONS (n = 42)

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13
1 MARS	1	*	*	*	*	*	*	*	*	*	*	*	*
2 MB		1	*	*	.324	*	.436	.30	.465	.398	.398	*	.335
3 PBQS			1	.799	.481	.710	.390	.329	.407	*	.379	*	.413
4 HSR				1	*	*	*	*	.438	*	*	*	.357
5 SAT-M					1	.646	.416	.507	.511	*	.475	*	.499
6 ACT-M						1	.383	.407	*	*	.513	*	.343
7 AD							1	.471	.523	.642	.422	*	*
8 TD								1	.540	.467	.572	*	.437
9 CI									1	.527	.431	*	.530
10 AAP										1	.446	*	.432
11 TAP											1	*	.514
12 S												1	*
13 Y													1

* Indicates $r < .30$

The regression equation for estimating the grade (Y) in the first calculus course for cadets in category I is:

$$Y_{M_I} = -4.92 + .003X_1 + .227X_2 - .0001X_3 + .005X_4 + .006X_5 + .019X_6 - .082X_7 - .002X_8 + .254X_9 + .368X_{10} + .283X_{11} + .129X_{12}$$

TABLE 2
CATEGORY 2 INTERCORRELATIONS (n = 180)

Variables	1	2	3	4	5	6	7	8	9	10	11	12
1 MARS	1	*	*	*	*	*	*	*	*	*	*	*
2 MB		1	*	*	*	.390	*	.469	.321	*	*	.468
3 PBQS			1	.737	.582	.426	.360	*	.415	.383	*	.415
4 HSR				1	*	*	*	*	*	*	*	*
5 SAT-M					1	.535	.480	.376	.441	.457	*	.371
6 AD						1	.589	.480	.580	.547	*	.475
7 TD							1	.390	.423	.632	*	.465
8 CT								1	.333	.443	*	.443
9 AAP									1	.333	*	.452
10 TAP										1	*	.433
11 S											1	*
12 Y												1

* Indicates $r < .30$

The regression equation for estimating the grade (Y) in the first calculus course for cadets in category II is:

$$Y_{M_{II}} = -2.5011 - .005X_1 + .48314X_2 + .00047X_3 + .0013X_4 + .0002X_5 + .0041X_6 + .0299X_7 + .2063X_8 + .1589X_9 + .0677X_{10} + .0442X_{11}$$

TABLE 3
CATEGORY 3 INTERCORRELATIONS (n = 38)

Variable	1	2	3	4	5	6	7	8	9	10	11	12
1 MARS	1	*	*	*	*	*	*	*	*	*	*	*
2 MB		1	*	*	.343	.411	.338	.315	.371	.361	*	.312
3 PBQS			1	.766	.779	.564	.475	*	.407	.646	*	.353
4 HSR				1	.310	.445	*	*	*	.354	*	*
5 ACT-M					1	.652	.600	*	.454	.689	*	.372
6 AD						1	.542	*	.498	.691	*	570
7 TD							1	.325	.368	.562	*	.445
8 CI								1	*	.308	*	.311
9 AAP									1	.565	*	.589
10 TAP										1	*	.511
11 S											1	*
12 Y												1

* Indicates $r < .30$

The regression equation for estimating the grade (Y) in the first calculus course for cadets in category III is:

$$Y_{M_{III}} = 3.360 - .0033X_1 - .2381X_2 - .0014X_3 + .0048X_4 - .0153X_5 +$$
$$.0618X_6 + .0095X_7 + .4501X_8 + .4404X_9 + .0093X_{10} - .8066X_{11}$$

(Variable subscripts correspond to variables in tables 1 - 3 and not to indices in earlier text descriptions. editor)

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PTP NEWSLETTER

news about placement testing from the
MAA PLACEMENT TEST PROGR.^M

Vol. 6, No. 2 Spring 1983

IN THIS ISSUE

USE OF THE MAA PLACEMENT TESTS AT THE PENNSYLVANIA STATE UNIVERSITY

Edmond Marks
The Pennsylvania State University

For nearly half a century, the Department of Mathematics at The Pennsylvania State University has administered a program of testing and advisi..g — including placement — with respect to the several freshman-level calculus courses offered by the Department. The main features of this program are common to those of programs at many other colleges and universities. Students planning to schedule any one of the freshman-level calculus courses must demonstrate knowledge and skills in algebra adequate to "successful" performance in the course. In one case, minimal levels of trigonometry knowledge and skills are also required. Students not meeting the established levels of algebra and trigonometry knowledge and skills are advised to take one of the several sequences of pre-calculus courses patterned to students weaknesses. In general, the lower the student's test scores, the more pre-calculus courses recommended.

Until the 1982 academic year, the tests used to measure students' knowledge of algebra and trigon .try were designed, written, and continually revised by the Department of Mathematics. Throughout that period, the Department was given psychometric and statistical assistance by an office of the University charged with that responsibility.

The actual administration of the mathematics tests to all new Associate and Baccalaureate degree students each

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PTP PRE-COLLEGE TESTING PROGRAM

The 1983 PTP packet will have two new tests that represent a significant expansion of the program. The new tests are designed to allow users to test high school juniors and give projected placement in college mathematics. The idea is to make students aware of their mathematical skills while there remains time to take high school courses. Some programs of projected placement testing of high school students are already in existence. Some notable examples are in California and Ohio. Several PTP subscribers inquired about tests to be used for such a program, and the new tests were developed in response.

The two tests are both constructed around the PTP basic algebra test BA/1. One, to be designated HS-E/1A is an extension of a revised BA/1 by adding seven items in arithmetic and basic skills. The second, designated HS-I/1A, adds seven more difficult algebraic items. Both tests have 32 items and a recommended testing time of 45 minutes. It is expected that students will be tested in the second half of the high school junior year. Some will have completed or be enrolled in algebra II, while others

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PTP POLICY STATEMENT

Only postsecondary institutions are authorized to be subscribers to the PTP program and only subscribers may reproduce the copyrighted PTP tests. The tests must be administered in a manner that will not compromise the security of their contents.

The HS-series tests are for use in secondary testing programs coordinated by subscribing institutions.All postsecondary institutions participating in these programs must be current PTP subscribers.

All other PTP tests are for use in college level placement programs. These test may be given only to students enrolled in, or in the process of enrolling in, subscribing institutions.

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year — currently numbering about 12,000 — was and continues to be the responsibility of what is now known as the Freshman Testing, Counseling, and Advising Program (FTCAP). The testing portion of the FTCAP for Summer and Fall admissions is typically completed during April and May of each year at some twenty different locations throughout the state of Pennsylvania. (The FTCAP also contains placement tests in English and chemistry as well as tests of "basic skills.")

Early in 1981, the Department of Mathematics took the decision to consider replacing its test with comparable tests of the Mathematical Association of America's (MAA) Placement Testing Program (PTP). Among the desirable features of the MAA program which influenced this decision were the high quality of the PTP and its tests, the availability of alternate forms of each test, and the sharing of information and experience on a nationwide basis. A study designed to evaluate the MAA tests in the context of the freshman-level course offerings in mathematics at The Pennsylvania State University was conducted in the Fall of 1981 using a large sample of freshman students (N = 1,5?0). Based upon the results of this study, the Department of Mathematics decided to introduce the MAA tests of basic and advanced algebra (Form A/3B) and trigonometry and elementary functions (Form T/3) to the 1982 FTCAP as replacements for its own algebra and trigonometry tests. Only the first 15 items of Form T/3 were scored and used for advising and placement purposes.

Course Offerings

For the 1982 academic year, two "tracks" of fresh-

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The PTP Newsletter is published by the Mathematical Association of American and is distributed to all subscribers to the MAA's Placement Test Program.

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Continued from page 1

will have less training. The more difficult extension of BA/1, namely HS-I/1A, should apply to the algebra II students while the other is more appropriate for less advanced students.

Widespread use of the standard PTP tests in high schools would compromise their use for college placement. Consequently, COPE had previously prohibited such activity and still maintains that position for all tests except the two new ones specifically designated for this use. The new tests are similar to ones in the current PTP package. This has to be the case since users must be able to compare scores on the high school tests to scores on their usual placement tests, presumably other PTP tests. The only PTP test that will have significant overlap with the new tests is BA/1. Since that test is no longer a part of the current package, and since user testing of high school juniors in 1983-84 would not effect beginning college student placement testing until Fall 1985, users of BA/1 will have sufficient notice to assess the possibile effect and will have the forms of BA/2 for use instead of BA/1.

During development, the new tests were pretested on high school juniors who were about halfway through a course in algebra II. At the same time, two analagous versions of BA/2 were tested. The first, pretested as N1, was BA/2 plus the same seven items on arithmetic and basic skills that were added to the revised BA/1 to get HS-E/1A. The second, designated N2, was BA/2 plus same seven advanced algebra items added to BA/1 to get HS-I/1A. The results of the pretest show the mean score on N1 to be about 1.8 higher than that of HS-E/1A, and on N2 to be about 1.2 higher than that on HS-I/1A. The mean score for 221 students on HS-E/1A was 20.1 and for 261 students on HS-I/1A was 16.4. This supports the appropriateness of HS-I/1A for these students since the mean of 16.4 out of 32 possible is very near the 50% level. Although users will be advised to develop their own comparative data, this shows that mean scores on the revised BA/1 that is common to both new tests are likely to be from one to two points lower than the mean scores on BA/2. During the development of BA/2 in 1981, pretesting on college students showed no essential difference in the difficulty of BA/1 and BA/2.

Since the range of the new tests is limited, it is unlikely that projected placements given to high school students can include all entry levels at most institutions. In particular, the highest and/or lowest entry placement levels at some institutions will be outside the range of these tests. For example, there are no test items on trigonometry and few on arithmetic. Nevertheless, for many placement programs, these tests will distinguish at as many as three levels, and that is valuable information for the college bound high school junior.

The tests were developed by a panel consisting of Denny Gulick, University of Maryland, Bert Waits, Ohio State University, and Bernard L. Madison (Chairman and COPE member), University of Arkansas.

Continued from page 2

man-level differential and integral calculus courses were offered by the Department of Mathematics; a "Calculus With Analytic Geometry" sequence for majors in the colleges of Agriculture, Earth and Mineral Sciences, Engineering, and Science (to be called the "Science" track), and a "Techniques of Calculus" sequence for majors in the College of Business Administration. Based upon their scores on the two MAA tests — Form A/3B and Form T/3 — students in the Science track might be recommended for advanced placement, placed into "Calculus With Analytic Geometry," or required to take one or more of five different pre-calculus courses such as "Intermediate Algebra," "College Algebra," or "College Algebra II and Analytic Geometry." Students in the College of Business Administration track were evaluated only on Form A/3b, i.e., the basic and advanced algebra test, for purposes of placement. Business Administration students might be recommended for advanced placement, placed into "Techniques of Calculus I," or required to take one or both of two pre-calculus courses — "Intermediate Algebra" or "College Algebra."

Calibration and Replication Studies

The major purposes of the aforemention Fall 1981 calibration study were to 1) equate the two MAA tests to the corresponding algebra and trigonometry tests used through 1981 by the Department of Mathematics, 2) develop preliminary norms for both MAA tests, and 3) define a placement strategy for each calculus track using performance (grades) in "Calculus With Analytic Geometery I" or "Techniques of Calculus I" as the criterion. Parts of the 1981 calibration study were replicated on the entire population of Summer and Fall 1982 admissions to the University. The following data are taken mainly from this replication study.

Equating and Norming

If appropriate, then it is very desirable to transform the observed scores of a newer test form to the observed scores of an older test form, a process commonly referred to as test equating. Because each of the two MAA tests and its counterpart in the set of Department of Mathemathics' tests were judged to be homogeneous in content, internal structure, and question formats, it appeared quite appropriate to consider equating the two sets of tests. The process of test equating was simplified in this instance by having a single sample from the population which took all four tests. Approximately three months separated the administration of the two sets of tests — the MAA tests being given last.

The first step in the "practical" equating* of the MAA and the Department of Mathematics' tests was the computation, in the calibration sample, of a full set of summary statistics for the four tests. The means ($\overline{X}$) and standard deviations (SD) of, and intercorrelations among the four tests are reported in Table 1. (Recall that only the first 15 items of Form T/3 were scored.)

TABLE 1
Statistics for the Four Tests
N = 1,527

	MAA A/3B	PSU Algebra	MAA T/3	PSU Trig
MAA A/3B	1	.87	.65	.66
PSU Algebra		1	.62	.64
MAA T/3			1	.81
$\overline{X}$	19.9	15.4	6.1	8.8
SD	6.7	5.2	4.0	4.8
# Items	(32)	(24)	(15)	(18)

The sample correlation coefficients for the corresponding pairs of MAA and Department of Mathematics tests were considered high enough (indeed, approaching the estimated reliabilities of the tests) to warrant equating of the two sets of tests.

The cumulative distribution functions (CDF) for each test computed in the first step were smoothed using Tukey's "repeated medians of 3" procedure (Tukey, 1977). The MAA and Department of Mathematics tests were then equated by fitting the "equipercentile" equating function to the CDF's. The fits for both algebra and the trigonometry areas were extremely good, except at the tails of the distributions. In particular, the mean square errors for regressing the MAA CDF's on the CDF's of the local tests were very small. As an important practical matter, this result permits comparisions among student populations across time.

The smoothed CDF's provide the norms for the MAA tests. These data are very useful in the advising and counseling of students. Three sets of norms are offered for each MAA test — one for the entire population of students, one for students enrolled in the Science track, and one for students enrolled in the College of Business Administration. The CDF's for the total population (N = 9,834) and the Science track (N = 3,891) subpopulation of Summer and Fall 1982 admissions are reported in Table 2.

Advising and Placement

A major purpose of The Pennsylvania State University's FTCAP is to advise new undergraduate students as to courses or sequences of courses appropriate to their knowledge and skills. In mathematics, the MAA tests Form A/3B and For T/3 are the basis for advising with

Continued on page 4

*Strictly speaking, test forms of different lengths would not be considered "parallel" nor would they be equated. In practice, however, the equating of such test forms is often useful, if other criteria relating to the internal structure of the test forms are satisfied.

Continued from page 3

respect to freshman-level calculus. The statistical technique used by this University to define an advising and placement strategy is linear logistic regression. The rationale for this strategy is quite simple. First, it is posited that the lower the likelihood that a student will perform well as opposed to performing poorly in a calculus course, the greater the need for pre-calculus course work. Second, if one or some combination of the MAA tests predicts this likelihood, then the test score(s) can be used to advise and place students.

TABLE 2
Cumulative Distribution Functions
Total and Science Populations
Summer and Fall 1982 Admissions

MAA A/3B			MAA T/3		
Score	Total	Science	Score	Total	Science
0-3	.008	.002	0-1	.117	.050
4-6	.036	.012	2	.206	.105
7-9	.105	.043	3	.309	.172
10-12	.187	.099	4	.408	.255
13-15	.309	.193	5	.499	.255
16-18	.451	.316	6	.577	.429
19-21	.603	.465	7	.644	.515
22-24	.763	.696	8	.707	.605
25-27	.889	.816	9-10	.827	.742
28-31	.998	.984	11-14	.978	.975

To implement the logistic regression model, grades in the two first-level calculus courses were transformed to binary variables as follows. Grades of A, B, and C were considered to reflect adequate performance (pass), while grades of D and F were treated as inadequate performance (fail). The linear logistic model considers the log odds of "passing" as opposed to "failing" the course as being a linear function of one or more independent variables — in this case, the MAA tests. Letting $t_i = p_i/(1-p_i)$ be the odds of "passing" the course for observation i, the linear logistic regression model is

$$\ln t_i = X_i \beta \qquad (1)$$

where β is a vector of "regression" weights and X_i contains the MAA score(s) for observation i.

Equation (1) was fit to the two first-level calculus courses separately, first with Form A/3B and Form T/3 as two predictors, and then for Form A/3B alone. Based upon these analyses, the Department of Mathematics decided to use the logistic model with Form A/3B as the single predictor for both courses. However, the score of Form T/3 is used as a "treshold" the student must pass for enrollment in "Calculus With Analytic Geomtery I". As such, students are advised and placed with respect to "Calculus With Analytic Geomtery I" and "Techniques

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USERS REPORT
1982 TEST RESULTS

1982 PTP STANDARI

STUDENT

# of Items	A-SK PART I ONLY (20)	A-SK PARTS I & II (32)	SK (25)	BA (25)
TIME LIMIT	25 MINUTES	40 MINUTES	30 MINUTES	30 MINUTES 3
NUMBER OF STUDENTS TESTED	214	668	102	6994
(NUMBER OF INSTITUTIONS)	(2)	(5)	(1)	(21)
MEAN OF MEANS	17.4	24.0	15.1	13.2
(RANGE OF MEANS)	(9-25.8)	(19.5-28.0)		(4.7-18.7)
RANGE OF STANDARD DEVIATIONS	4.0	5.2-6.5		3.2-6.8

PLACEME

(NUMBER OF INSTITUTIONS)[

Students scoring in this range (inclusive)

CALCULUS — Engineering, Physical Science	[,]	[,]	[,]	(7)[19, 25]
CALCULUS — Business, Intuitive, or Short	[,]	(1)[26, 32]	[,]	(2)[16, 25]
PRECALCULUS	[,]	(1)[23, 32]	[,]	(10)[11, 19]
TRIGONOMETRY	[,]	[,]	[,]	(4)[13, 23]
COLLEGE ALGEBRA	[,]	(1)[26, 32]	[,]	(9)[12, 21]
INTERMEDIATE ALGEBRA	[,]	(1)[13, 25]	[,]	(5)[5, 12]
BEGINNING ALGEBRA	[,]	(1)[0, 12]	[,]	(8)[0, 10]
ARITHMETIC	[,]	(1)[0, 18]	[,]	(4)[7, 12]
OTHER (Specify)	[,]	[,]	[,]	(3)[20, 25]

REPORTING FORM

CORES

AA	A	T PART I ONLY	T PART II ONLY	T PARTS I & II	CR PART I ONLY	CR PARTS I & II
25)	(32)	(15)	(15)	(30)	(25)	(30)
NUTES	45 MINUTES	25 MINUTES	25 MINUTES	45 MINUTES	25 MINUTES	30 MINUTES
162	7658	889		718	4166	3401
(6)	(6)	(2)		(2)	(5)	(18)
14.4	14.9	5.8		10.9	12.3	11.4
-16.0)	(8.5-20.7)	(5.2-6.4)		(6.8-13.2)	(7.3-16.1)	(9.0-18.7)
	4.7-8.0	2.5-3.0		5.6-6.6	3.7-4.0	3.7-5.2
0-4.7						

RANGES

an Low Score, Mean High Score]

advised or required to take this course.

)[12, 25]	(5)[17, 28]	(2)[10, 15]	[,]	(1)[13, 20]	(3)[12, 23]	(13)[12, 25]
[,]	(3)[16, 32]	[,]	[,]	[,]	(3)[10, 20]	(4)[12, 25]
)[7, 11]	(6)[18, 26]	[,]	[,]	(1)[0, 12]	(3)[4, 13]	(10)[3, 11]
[,]	(2)[15, 24]	(2)[0, 9]	[,]	[,]	(1)[18, 21]	(2)[8, 14]
)[0, 6]	(2)[15, 25]	[,]	[,]	[,]	(2)[5, 12]	(1)[12, 17]
[,]	(4)[6, 14]	[,]	[,]	[,]	(1)[4, 10]	(1)[12, 17]
[,]	(4)[0, 7]	[,]	[,]	[,]	(1)[0, 3]	[,]
[,]	[,]	[,]	[,]	[,]	[,]	[,]
[,]	(2)[12, 22]	[,]	[,]	[,]	[,]	[,]

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of Calculus I" based upon their estimated odds of "passing" the particular course — these odds being estimated from the score of Form A/3B. For "Calculus With Analytic Geomtery I", this estimate is supplemented with an estimate of "minimally" required trigonometry knowledge and skill provided by Form T/3.

The various cut-off scores for Form A/3B were determined from the relation

$$x_c = (\ln c - \beta_0)/\beta_1 ,$$

where c is an arbitrary odds of "passing" the course, x_c is the corresponding score on Form A/3B, and β_0 and β_1 are the intercept term and the weight for Form A/3B, respectively. The lower x_c the lower the odds of "passing" the course, and the more precalculus course work recommended.

As an example of the results of this procedure, a reduced summary of the Summer and Fall 1982 placement actions for the Science track is given in Table 3.

Item Analysis

One final comment on some work in progress at the Pennsylvania State University involving responses to each item of not only Forms A/3B and T/3, but also Form BA/2A and Form AA/2A of the PTP. The latter two tests are being considered in relation to mathematics courses other than the Calculus.

Aside from the computation of standard psychometric indices for test items such as item difficulty and item discrimination, each item of the four MAA tests is being related to grades in at least one mathematics course. The data are arrayed as a two-diminsional contingency table, with the two rows being "pass" or "fail" the item, respectively, and the five columns being the course grades A through F, inclusive. The column variable, i.e., grade in the course, is assumed to have ordered categories. Given this assumption, the expected cell frequencies can be modelled under what is termed a "row-effects" model. By taking into account the order of the columns, the association, if any, between item score and course grade is reflected in two row parameters. Currently, both log-linear and logit (logits in the grade variable) models are being used. These analyses should provide insight into the relationship between the internal structure of the MAA tests and performance in mathematics courses.

Table 3

Summary of the Placement Actions for "Calculus With Analytic Geometry I" Summer and Fall 1982 N = 3,891

Action	Proportion
1. Recommended for advanced placement testing.	.24
2. Schedule "Calculus With Analytic Geometry I."	.40
*3. One or more review courses recommended.	.36

*There are eight different placement actions for review work prior to "Calculus With Analytic Geomtery I" contained in this category.

REFERENCE

Turkey, J. W. **Exploratory Data Analysis.** Addison-Wesley, 1977.

MAA MINI-COURSE ON PLACEMENT TESTING

The MAA Mini-Course on Placement Testing was held at the Joint Mathematics Meeting in Denver, Colorado on January 5-7, 1983. The thirty participants were from colleges in Alabama, California, Colorado, Delaware, Illinois, Iowa, Maryland, Minnesota, North Carolina, Nebraska, New Jersey, New Hampshire, Ohio, Oklahoma, Oregon, Pennsylvania, Washington, Wisconsin, and West Virginia.

The schedule for the mini-course was reported in the winter-82 issue of the **PTP NEWSLETTER** and this article is a summary of the sessions. The participants noted that the item writing workshop and the session of cutoff score selections were valuable experiences and these elements are an important part of of the mini-course. The PTP Committee is planning to repeat the course at the Joint Mathematics meeting in Anaheim, California in January, 1985.

Item-Writing Workshop

In the first session of the item-writing workshop, a 25-question calculus test was written by the thirty participants. They were broken down into small groups responsible for specific items in a distributed list of item specifications — the test syllabus detailed a cadet calculus retention requirement that needed to be measured at the United States Air Force Academy. The test was printed and administered the next day to 100 cadets at the USAFA. The test results were compiled and item analysis statistics were generated on the computing facilities at the USAFA. The statistics were discussed at the second workshop session and various aspects were noted:

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Continued from page 5

expected versus actual difficulty of individual items, effectiveness of the distractors, correlation of scores on individual items with overall test scores. Special thanks are due to the United States Air Force Academy, the faculty of the Department of Mathematical Sciences and Colonel Robert R. Lochry the department head. Without their cooperation the workshop would not have been possible.

Overview of Placement Problems

Dr. James Braswell from, the Educational Testing Service, spoke on the placement problem and noted that the placement problem in mathematics arises because of the great diversity among college students. There are younger students, older students, minorities, and those that are more or less at the "normal" age. The mathematics program must prepare students to deal with courses that have mathematical prerequisites, not just other mathematics courses. Colleges are becoming more economically aware of the advantages of proper placement. Students who are happy about the courses they have taken are more likely to remain at the institution.

A placement examination program in mathematics assumes that:

1. Appropriate placement is important.
2. Instruction is more effective if students are properly placed.
3. Most students would rather be placed too low than too high. Placement errors should be in the direction of repetition of some previously learned material.
4. Aptitude may become more of a factor as a result of the family budget squeese. A relatively higher proportion of able students may be applying to state supported public institutions.

In designing a test for placement, the purpose of the test should be kept clearly in mind. In general, questions that are nonroutine or insightful in nature are not appropriate for use on placement tests. The majority of questions should be in one of three categories:

1. Performing mathematical manipulations such as factoring and simplifying algebraic fractions.
2. Solving routine problems
3. Demonstrating comprehension of mathematical ideas and concepts.

Test Development and Item Writing

Dr. Richard Prosl spoke on test development and item writing. The development of a test usually begins with the appointment of a committee which specifies precisely the content that the test is to cover. The committee also decides on the number of test items for the test and the frequency with which each topic is to be covered. The committee should proceed to write about twice as many items as will be needed for the test. After a test is composed it should be administered to a representative group of students. A full item analysis will reveal weaknesses which the committee can eliminate. If alterations are substantial, the altered version should be pretested and a second item analysis studied. Otherwise the altered version becomes the final version of the test. The committee is also repsonsible for providing advice relative to the administration and use of the test.

Maxiums for Item Writers

1. One and only one correct answer (key) should appear in each item.
2. Keep the stem simple and short. The less English in the stem, the better. Test Mathematics, not English.
3. Stem, distractors and key should constitute a gramatically correct entity.
4. Wording and notation should be as universal as possible. Do not wed the notation/language of your test to a specific text.
5. The use of literals tends to make items more difficult. The use of numbers tends to make items easier.
6. Each item should test a single notion or skill . . . except when you make a decision to purposely test more than one idea in a particular item.
7. Keep a clear record of how each distractor was developed, you'll be glad you did. If you don't then you'll be sad you didn't.
8. Distractors like "none of the above" or "can not be determined," are always popular with students. Use them with care and caution. Never use them just because you can't easily think of another distractor.
9. If you use options like "none of the above," then sometimes they must be the key.
10. If there is a natural order for distractors and key, use it. For example, arrange all numerical answers in a consistent order.

Administration of Placement Testing Programs

The College of Charleston's Placement Test Program was discussed by Professor Hope Florence a member of the panel on "Administration of Placement Testing Programs." The College of Charleston's program has been reported in the winter-81 and spring-82 issues of the **PTP NEWSLETTER.**

Professor Matt Hassett was a member of the panel and he reported on his experiences with the large mathematical placement program at Arizona State University. "Although the technical aspects of test contruction are extremely important, they are not the only matters of importance for a placement program. Our experience at Arizona State with both advisory and compulsory placement has shown us that management and communications are essential for the successful

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placement program. In placing students for a large course, failure to manage the flow of paper and people can lead to lines, dissatisfaction, and near riots. Failure to communicate with the students to be placed, their past and future teachers, and one's own administration can also upset an otherwise well-designed program. We suggest a pragmatic and evolutionary approach to placement with the following features:

1. Make sure your technically sound test has **face validity**. Faculty, administrators and high school teachers should be able to look at it and believe in it.
2. Send letters outlining your requirements to high schools, other departments and administrators.
3. Prepare a flow chart and simulate the steps of your placement process in advance. Don't decide "everyone with a score below 10 will go to the math office to change classes" without estimating the size of the lines that might develop when the first person there starts an argument.
4. Plan, plan and plan again. Then realize that parts of your plan will not work. You will need to make on the spot adjustments and substantial alterations in your next iteration of the placement process.
5. A good program evolves over time.

(Dr. Hassett is the author of an article in the spring-81 issue of the PTP NEWSLETTER).

Workshop on Cutoff Scores

The workshop on cutoff scores was arranged by Dr. Bernard Madison from the University of Arkansas.

In the setting of cutoff scores the general situation is that students are to be sorted for alternate treatments according to some valid assessment variable. As is frequently the case, we assume that the assessment variable is a placement test score and the alternatives are either taking two sequential courses or being excused from the first course. For illustration we assume the courses are in precalculus and calculus. We discussed several ways to set the cutoff score between courses.

Ideally, one performs an experiment that measures achievement at the end of the calculus course for two groups, one taking both the precalculus and calculus courses and one taking only the calculus course. The data from both groups are plotted on the same axis system against the scores on the placement test. The cutting score is then set so that learning is maximized. This ideal method is limited because it is difficult to get good data and side effects are ignored.

A simple and quick way to set cutoff scores is to use national data, regional data, or data from comparable situations. The problem here is that one's local situation is rarely matched very well by others. Another easy way that is sometimes imposed is to set cutoff scores so that fixed quotas of the students are placed in the alternative courses. The limitations of this are apparent.

Two methods of setting cut scores were discussed: predicted performance and comparable performance. Using the predicted performance method, one tests students at the beginning of the calculus course, the students have been placed there by random choice or by some other placement scheme. One then measures the performances in the calculus course and compares those to the placement test scores, hoping to be able to choose a cutoff score so that the unsuccessful calculus students would be placed in a precalculus course. Since the "too high" placement errors show up early in a course, it is better to take the measurement of performances as early as feasible, perhaps at mid-term. Too often, final grades are used, and many other factors contribute to these.

The method of comparable performance is usually the best available. To use it, one would test students at the end of the precalculus course and determine what placement test score corresponded to a satisfactory performance in the course itself. Thus one determines what score is comparable to success in the prerequisite course. The determination of this score is not always clear. Some scores that have been used are the mean score for all students, the mean score for the "C" students, and the score that would maximize the overall accuracy of placement. it is here that the philosophy and policies of an institution will have an impact.

It is recommended that the effects of a placement scheme be evaluated as soon as feasible. In such an evaluation, one needs to assess the student attitudes, the instructor feedback, and the institutional limitations. Adjustments of cutoff scores are sometimes necessary to make the program more effective.

USERS REPORT 1982 TEST RESULTS

This issue contains the annual insert that complies data on PTP test scores and how these scores are used by reporting institutions in placement decisions.

All PTP subscribers were asked in November of 1982 to fill out a Standard Reporting Form if they had given any PTP test **without alteration and within the prescribed time limit**. As of April 1, 1983, a total of 53 subscribers had responded to the request (down from 76 last year): 44 returned completed forms that provided usable data (nearly the same at last year's 50).

Statistics on the scores for each test are given in the top half of the insert. Notice that the mean given is the mean of the mean scores reported for each test: if institution A reports a mean score of 10 for 900 students on test X and institution B reports a mean score of 20 for 100 students on the same test, then the mean given on the insert would be 15, *not 11*. This is done so that the PTP users' get some sense of the overall distribution of means from the wide variety of schools reporting.

There were no dramatic changes in the number of reporting institutions using each test, except for Algebra A, where the number decreased from 14 to 8, and SK, where it dropped from 6 to 1. The total number of students taking each test declined or remained unchanged

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except for a modest increase in CR, Part 1. Since fewer institutions reported this year, it is difficult to determine whether there is an overall drop in PTP usage.

The means of the cut-off scores used by reporting institutions for placement purposes are listed in the bottom half of the insert. As usual, different course offerings, different placement policies, and different uses of the same test lead to much contradictory data in this section. It is not unusual to have one school use the range 0-10 on BA to place into "Precalculus" while another uses 15-25 on BA to place into the same course. In addition, the small sample size within each category makes this data useful only as very general guidelines for placement ranges.

These data *should not* be veiwed as "national norms" since no rigorous statistical sampling was used in obtaining the data. Nevertheless, we hope that PTP subscribers find these statistics helpful and informative. The cooperation of those who filled out forms is greatly appreciated. Those who did not respond this year are encouraged to do so next year.

(please note data tables in center of newsletter.)

NEW COMMITTEE MEMBER APPOINTED

Professor B. E. Rhoades, Professor of Mathematics at Indiana University has joined the Committee on Placement Examinations as a replacement for Dr. Tom Carnevale from Virginia Commonwealth University. Professor Rhoades has a long record of contributions to the activities of the association. He is currently a member of the Committee on the Undergraduate Program in Mathematics (CUPM) and chairman of the MAA/NCTM Committee on Articulation.

The current committee members are:

Richard Prosl, Chairman
College of William and Mary
John Kenelly
Clemson University
(Visiting U.S. Military Academy)
Bernard Madison
University of Arkansas (Fayetteville)
Billy E. Rhoades
Indiana University
Billie Ann Rice
DeKalb Community College
Thomas Tucker
Colgate University
MAA Staff Associate
Marcia P. Sward
Mathematical Association of America

TRANSLATIONS OF PTP TEST

A Spanish translation of A/3 is being used at The American University, Washington, DC 2001[illegible] Interested readers may contact Professor Elizabeth A[illegible]ns.

THE 1983 - 84 PTP PACKET

The 1983-84 PTP packet will contain these tests and material:

Arithmetic and Basic Skills Tests
A-SK/1A and A-SK/1B (parallel forms)

Basic Algebra Tests
BA/2A and BA/2B (parallel forms; *BA/2B is a new test*)

Advanced Algebra Tests
AA/2A and AA/2B (parallel forms; *AA/2B is a new test*)

Algebra (Basic and Advanced) Tests
A/4A and A/4B (parallel forms; *A/4B is a new test*)

Trigonometry and Elementry Functions Tests
T/3 and T/3B (parallel forms)

Calculus Readiness Tests
CR/1B and CR/1C (parallel forms)

Sample Tests

College Placement Tests for High School Students
HS-E/1A and HS-I/1A.

Answer keys for all the above test

PTP User's Guide, Revised Edition, and 1983 PTP User's Guide Supplement

(Renewal subscribers will receive only the Supplement unless they request another copy of the User's Guide.)

Copyright Authorization Form
This form provides official authorization from the MAA for unlimited use of PTP tests on a subscriber's campus during the 12-month period following receipt of the PTP packet. *A policy statement with the new policy on the high school tests is on page 1.*

Extra Test Sets
Extra test sets (50 tests per set) will be included in the PTP packet if requested. The cost is $10 per set.

Note: Copies of SK/1, SK/1B, BA/1B, BA/1C, AA/1B, AA/1C, A/3B, and A/3C are still available and will be included in the packet if requested.

MAA PLACEMENT TEST PROGRAM

PLACEMENT TEST NEWSLETTER

Vol. 7, No.1 Winter 1983-84

IN THIS ISSUE

NEWSLETTER RENAMED

The **Placement Test Newsletter** has changed its coverage from announcements about the Placement Test Program to a general publication concerned with news items and articles about mathematics placement test issues. The publication is now officially called the **Placement Test Newsletter** and the masthead has been revised to reflect this change.

MATHEMATICS PLACEMENT AT WEST POINT

James W. McNulty
United States Military Academy
West Point, N.Y. 10996

The mathematics portion of the core curriculum of the United States Military Academy at West Point contains four sequential courses that cover calculus, probability and statistics, and an introduction to differential equations. Additional course selections vary with the individual cadet, but over one-third of each student's courses are in mathematics, science and engineering. The annual placement of 1400 to 1500 freshmen begins shortly after they arrive in July and it last through October. The program continually monitors a student's placement position and adjustments are made on a regular basis throughout the first three month of classes.

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A NOTE ON THE LIMITATIONS OF PREDICTIVE TESTS IN REDUCING FAILURE RATES

Matt Hassett and Harvey Smith
Arizona State University
Tempe, Arizona 85287

1. **Introduction.** Large introductory mathematics courses with successful completion rates of only 50% can be found on many campuses. In discussions of such a course on our own campus, it was recently suggested that the mathematics department could select a "good" ability or achievement pretest and bring about a dramatic improvement in success rates by screening "weak" students out of the course. We have placed the words "good" and "weak" in quotation marks because our experience in placement testing has shown us that no existing test is "good" enough to separate students who will succeed from those who will not (the "weak") with adequate precision to bring about the desired improvement in success rates **without disastrous consequences**. We find placement tests quite useful, but for different purposes. In this paper we shall discuss the theoretical limitations of presently available predictive tests, and point out useful applications which are unaffected by these limitations.

Continued on page 2

PRIVATE NEWSLETTER SUBSCRIPTIONS AVAILABLE

Individual subscriptions to the **Placement Test Newsletter** are now available at a cost of $10 for two years. In the past copies of the newsletter were distributed only to the subscriber institutions and only the designated institutional representative was assured of receiving copies on a timely basis. Copies were also inaccessible to interested faculty members at nonsubscribing institutions. Both of these problems are solved by individuals placing their private subscription orders with The Mathematical Association of America, 1529 Eighteenth Street N. W., Washington, DC 20036

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2. **Analysis Using the Bivariate Normal Model.** The strength of the linear relation between the score x on a predictor test and the score y that was to be predicted is typically described by report of the sample correlation coefficient r. Most analysis of r is done under the assumption that the pairs (x,y) are drawn from a bivariate normal population with correlation coefficient ρ. Although real world populations may not follow this model precisely, the bivariate normal model gives us a convenient framework for preliminary analysis. There is an extensive list of psychology papers on this topic (cf references (4) (5) (6) (7)). We will describe the basic method of analysis for completeness. (Further results appear in the literature.)

Since the scoring scales in various predictive tests vary, we will assume in our analysis that all scores have been reduced to standard scores (z-scores):

	Original Score	Standard Score (Mean 0, Variance 11)
Placement	x	$z_x = \dfrac{x-\mu_x}{\sigma_x}$
Course	y	$zy = \dfrac{y-\mu_y}{\sigma_y}$

Thus, our analysis may be done entirely within the **standard** bivariate normal distribution. Once this rescaling has been done, the situation of improving completion rates is easy to describe. For a course with only a 50% success rate, the "passing" grade is $z_y = 0$, since 50% of the pairs in a standard bivariate normal population have $z \geq 0$. This is pictured below. (Intuitively, the ellipse encloses a region which would contain a typical scatterplot of standardized scores (z_x, z_y).)

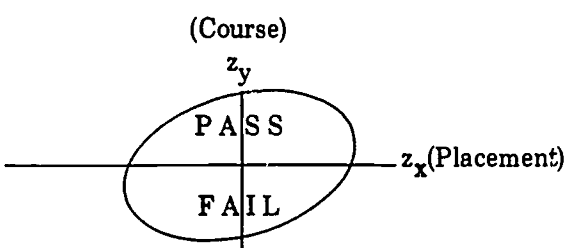

Figure 1.

If the predictor test is used to remove students from the class, bivariate normal probabilities yield adjusted pass and fail rates. For a cut-off score of $z_x = a$, where all students with scores less than a are excluded,

$$\text{Adjusted Completion Rate} = P(\text{Pass} \mid zx \geq a)$$

In scatterplot terms, we have excluded from consideration all individuals who plot in the shaded region of the scattergram in Figure 2. The adjusted completion rate is the proportion of the **remaining** population lying in the unshaded area above the z_x - axis. If we denote the numbers of individuals plotted in the unshaded regions marked PASS and FAIL by P and F respectively, the adjusted completion rate is P/(P×F).

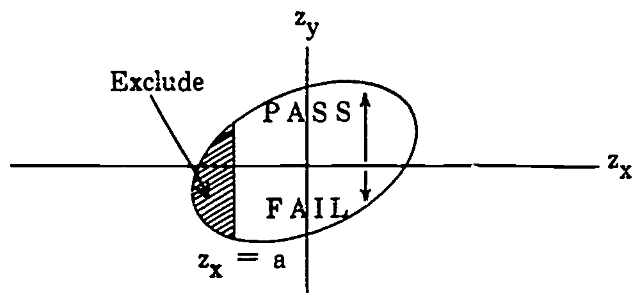

Figure 2.

The bivariate normal probabilities needed to find adjusted pass, fail and completion rates can be obtained from standard computer packages. (We obtained ours using the computer package IMSL*, and checked our results using tables and charts in references (2) and (3)). Using these probabilities, we have compiled tables indicating the results for predictive tests whose correlations with course grade are .4, .5, .6, .7, and .8. We first present results for $\rho = .4$ and .5, since these are of greatest practical interest to us. Our actual experience with four different standardized placement tests and two locally designed tests have always led to correlations with course grade in the range .35 to .5. Our results are presented in tables I and II below. In each table we have indicated the z_x-score used as a cut-off point for

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Articles and/or information which may be of interest to PTP subscribers should be sent to the Editor.

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exclusion in placement, the percent of all students excluded using this cut-off, and the resulting completion rate after that cut is made. We have also included, between cut-off points, the marginal pass rate of all students whose z_x scores lie between those points. For example, the figure of 22.5 given in table I between the z-scores of -2 and -1.5 under "Marginal Completion Rate" means that only 22.5% of all students with placement scores between -2 and -1.5 will eventually pass the course.

Table I: Exclusion and pass ($z_y \geq 0$) rates for $\rho = .4$ and selected cut levels.

z_x-score for exclusion	% of population excluded	Completion rate after exclusion	Marginal completion rate
			15.4%
-2.0	02.28%	50.8%	
			22.5%
-1.5	06.68%	52.1%	
			29.7%
-1.0	15.87%	54.6%	
			37.4%
-0.5	30.85%	58.3%	
			45.7%
0.0	50.00%	63.1%	
			54.3%
0.5	69.15%	68.6%	
			62.6%
1.0	84.13%	74.4%	
			70.3%
1.5	93.32%	79.9%	
			77.5%
2.0	97.72%	84.6%	
			84.6%

Table II: Exclusion and pass ($z_y \geq 0$) rates for $\rho = .5$ and selected cut levels.

z_x-score for exclusion	% of population excluded	Completion rate after exclusion	Marginal completion rate
			8.8%
-2.0	02.28%	51.0%	
			16.4%
-1.5	06.68%	52.6%	
			24.0%
-1.0	15.87%	55.7%	
			33.6%
-0.5	30.85%	60.5%	
			44.3%
0.0	50.00%	66.7%	
			55.6%
0.5	69.15%	73.5%	
			66.4%
1.0	84.13%	80.3%	
			76.0%
1.5	93.32%	86.2%	
			83.6%
2.0	97.72%	91.2%	
			91.2%

We can now address the issue of using a "good" test to sort out "weak" students and raise completion rates. The tests in use with $\rho = .4$ or .5 are only good enough to raise course completion rates to 80% if you are willing to exclude 84% (when $\rho = .5$) or 93% (when $\rho = .4$) of all entering students. To achieve this result you must be willing to exclude groups of students with marginal success rates of 70% or higher. However, this does not imply that such tests are of no value. A glance at the upper rows of tables I and II shows that the test may be used to give useful information to students who have virtually no chance of survival. Consider, for example, the figures in table II. In the (hypothetical) population represented here, the few students who have scores of -2 or less have less than one chance in ten of passing, and should clearly be required to do remedial prerequisite work. Similar reasoning applies to students in the range [-2,-1.5]. At our own school, the odds against the students in the ranges [-1.5,-1] and [-1,-.5] would be considered bad enough to warrant removal to lower level courses. However, the students in the range [-.5,0] have a nearly even chance of success, and would probably be permitted (with counselling) to attempt the desired course. Our own use of such a test would then be to exclude students with z_x scores lower than -.5 and allow remaining student to stay (with counseling on their chances of survival). **The most practical use of these tests which are available to us for placement now is to exclude students at serious risk and counsel those at moderate risk. This process results in the exclusion of about 30% of our students, and does not lead to a drastic rise in completion rates.** However, the process does help people, since those who are "excluded" are not excluded from school, but only sent to a remedial course for better preparation.

3. **An example using actual placement data.** In the Fall of 1977 we analyzed placement data from our course MAT 115, a college algebra and trigonometry course. A total of 245 students were pre-tested and recorded course grades. Our pretest consisted of 35 questions in basic arithmetic and algebra; it was locally designed but had been pilot-tested with previous classes and read by teachers who commented on its face validity. The results obtained from that semester were:

Placement Score	Number of Students	
	Successful	Unsuccessful
11 - 15	1	12
16 - 20	4	17
21 - 25	29	36
26 - 30	46	32
> 30	57	11
	136	109

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The overall success rate for our 245 students was 55.5%. A chart of success rates which would have been obtained with various placement cut-off requirements and marginal completion rates is given below.

Table III

Exclude if score is <:	Proportion excluded	Completion rate after exclusion	Marginal Completion Rate
			1/13 = 7.7%
16	5.3%	58.2%	
			4/21 = 19.0%
21	13.9%	62.1%	
			29/65 = 44.6%
26	40.4%	70.3%	
			46/78 = 58.9%
30	72.7%	83.6%	
			57/68 = 83.6

The analysis dictated by common sense was quite similar to that described for the normal tables in the last section. The students with great risk can be eliminated by using a cut-off score of 21. (Eliminated merely means required to take a more basic algebra course.) Only these lowest students can be fairly eliminated. Use of higher screening levels would eliminate too many potential passers and cannot be defended to deans and angry parents. Although this placement scheme helps some students to begin at a proper level, it will not improve completion rates very much - only from 58.2% to 62.1%.

4. **Further bivariate normal results.** Although our own placement data samples appear to come from populations that deviate somewhat from bivariate normality, we will present a few additional results from bivariate normal populations. The bivariate normal model does provide a convenient theoretical framework for discussion of correlations, and appears to fit data derived from extremely large populations on standardized tests. In tables III and IV below we give overall and marginal completion rates for ρ = .4, .5, .6, .7, .8.

Table IV: Completion rates using various placement scores for ρ = .4, .5, .6, .7, .8.

Placement Score z_x ρ:	.4	.5	.6	.7	.8
-2.0	50.8	51.0	51.1	51.1	51.2
-1.5	52.1	52.6	53.0	53.3	53.5
-1.0	54.6	55.7	56.8	57.9	58.8
-.05	58.3	60.5	62.8	65.2	68.9
0.0	63.1	66.7	70.5	74.7	79.5
0.5	68.6	73.5	78.7	84.2	90.0
1.0	74.4	80.3	86.1	91.7	96.5
1.5	79.9	86.2	91.9	96.4	99.1
2.0	84.6	91.2	96.0	98.7	100 -

Table V: Marginal completion rates for placement score intervals.

Placement Score z_x ρ:	.4	.5	.6	.7	.8
(-∞, -2.0]	15.4	8.8	4.0	1.3	0+
(-2.0, -1.5]	22.5	16.4	10.2	4.8	1.1
(-1.5, -1.0]	29.7	24.0	18.1	11.8	5.4
(-1.0, -0.5]	37.4	33.6	29.2	23.8	16.8
(-0.5, 0.0]	45.7	44.3	42.8	40.6	37.4
(0.0, 0.5]	54.3	55.6	57.2	59.4	62.6
(0.5, 1.0]	62.6	66.4	70.8	76.2	83.3
(1.0, 1.5]	70.3	76.0	81.9	88.2	94.6
(1.5, 2.0]	77.5	83.6	89.8	95.2	98.9
(2.0, ∞]	84.6	91.2	96.0	98.7	100 -

Tables IV and V illustrate the improvement in placement capabilities which occurs as ρ increases. A predictive test whose correlation with course grade is ρ = .8 does what people seem to believe such tests should do. Use of $z_x = 0$ as a placement score for exclusion would enable a department to increase its completion rate to 79.5% while not excluding any marginal group whose change of success exceeded .374. We are inclined to speculate that faculty who wish to use placement tests to improve courses are thinking of obtaining tests which display the behavior characteristic of ρ = .8. Unfortunately, we have found no predictors (univariate or multivariate) with r as high as .7. (Many available predictors do exhibit significant correlation with course grade - but "significant" simply means that it is likely that $\rho \neq 0$. For large sample size, a totally useless instrument with $\rho \leq .10$ may be found to exhibit a significant correlation with course grade.)

4. **Summary.** Placement tests which are currently available show correlations with course grade in the range .4-.5. Such tests are quite useful for identification and screening of students with low (.33 or less) probability of success in a course. However, there is little hope that such tests can be used to bring about a substantial increase in course completion rates. The latter task requires predictors which correlate with course grade in the range .7-1.0. Such predictors are not currently available.

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PASTING-UP A PLACEMENT TEST

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The process to be described starts with a collection of placement subtests, designed to be generally useful for placement into precalculus courses or first semester calculus. It finishes with one or more groups of subtests which constitute a test (or tests) specifically matched to a specific course sequence. The process itself consists of some simple-minded data collection, and of plugging this data into yet more simple-minded formulas.

The formuals are not magic, and they aren't derived from principles. However, they do provide a systematic way of taking some basic principles into account and a systematic way of doing this has advantages. It can be used to rationalize the decisions and it can be used by other people, at a later date.

The principles that I wished to take into account are:

(1)that placement test questions should cover material which is highly relevant to success in the course being placed into;

(2)that the questions present this material in a way which sorts students efficiently into those who should place into the course and those who should not.

In an ideal world — one in which we all understood exactly how students learn — the second principle would vanish into the first. In the real world, different questions which seem to us to cover the same material may generate very different student responses, and the second principle is needed as a separate entity.

The best way I know to act on the first principle — i.e., to determine the relevance of a question to a course — is to ask an experienced instructor in the course and ideally one who had graded large quantities of student work, who had paid attention to the results, and who had used good judgment in reflecting on them. In my own corner of the real world, such instructors exist, but very much as a proper subset of all instructors who have taught a course. It was to this proper subset that I turned for rating of relevance.

Instructors were asked to rate each question of a subtest separately. In naive terms, their rating was supposed to indicate whether ability to do this kind of question is a prerequisite to success in the course. There are problems in getting an exact version of this naive phrasing. Very few skills are so basic that the lack of a single one of them will produce failure in a course. Further, any real-world course involves some effort to repair lacking skills — these efforts running from answering the questions of individual students through the incorporation of review material into the presentation of new to actual formal review lectures. So the word "prerequisite" lacks sharp definition.

The phrase "this kind of problem" is also imprecise. Precalculus instruction often goes in a spiral fashion, with a particular concept or manipulation being studied in a particular context, then laid aside, then recurring in a new context of increased generality or complexity. Mathematicians are, on the whole, trained to see all occurrences of a single idea as representing the same kind of problem. A moderate amount of teaching experience will recall some of the spiral nature of the students' experience — e.g., that a semester intervenes between laws of exponents for positive integers and the same laws for rational exponents. Discovering that one or more semesters intervene between different presentations of the one-variable linear equation requires a lot of experience and close attention.

These difficulties must be confronted in devising a format for rating the relevance of problems. My attempt at doing so was to ask that the rating be one of four letters, as follows:

T for taught in the course, in the sense of being the subject of scheduled test and lecture exposition and problem assignments

P for prerequisite to the course, in the sense of being needed to do exam problems, but not taught in the above sense

H for helpful in the course in less definite ways than the above

I for irrelevant to the course

The intent of this list of definitions is to define T and P narrowly and use H as a catch-all for skills which are vaguely relevant.

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The ratings given by instructors had a feature which I had not anticipated — a gradient from a very extensive use of T in the lowest courses to a very extensive use of P in calculus. Some part of this gradient may stem from the difficulties mentioned above, but its major source appears to be a real difference in how courses are taught at different levels. Our lowest course (which I will call Basic Algebra) apparently assumes that incoming students have already mastered a (randomly selected) significant portion of the course material, and that they will borrow time from parts of the course covering known material to spend on parts covering new (or more likely, incorrectly known) material. The borrowing is necessary because the overall pace of the course is faster than the learning rate of its students. This view was articulated by Basic Algebra instructors. It is reinforced by an earlier study of grades versus placement scores (using an earlier version of placement tests). The study demonstrated that students have very little chance of passing Basic Algebra unless they enter with mastery of a substantial fraction of the skills which instructors consider to be taught in the course. I conjecture that there is a continuous shift, as one moves up the course ladder, from this approach to that obtaining in calculus, where there is a sharp distinction between prereq material — which students are assumed to have mastered almost in its entirety, and new material — which forms almost the entire content of the course.

The existence of this gradient caused me to change the weighting scheme used to combine the ratings of individual questions by individual instructors into an overall rating of the relevance of a subtest. This scheme amounts to no more than assigning a number to each of the letters T, P, H and I and then computing the subtest mean of the numbers so obtained.

My a priori version was T = .7, P = 1.0, H = .3, I = 0. The version actually used was T = P = 1.0, H = I = 0. Doubtless a better version could be found perhaps one which varies by course level, but the version used seemed adequate for my purposes. It generated one set of subtest ratings lying between .7 and 1.0 and another lying between 0 and .3. It was therefore easy to take .7 as a cutline and say that a subtest would be used for placement into a course only if instructors in that course had rated its relevance as .7 or higher.

As an exercise in abstract methodology, the above procedure is gravely deficient. But I believe it captures most of the information which is accessible in our present state of knowledge. And no methodology, however fair on its face, can do more than this. Certainly the above procedure is better founded than what my department has used in the past to assess relevance. It certainly revealed details of the prereq structure of our introductory sequence which had escaped me over a decade of involvement with this group of courses. Finally, it involved a substantial number of faculty, so that the resulting test is (in a limited sense) their test now. I have always found it a struggle to involve faculty actively in placement test matters, yet have felt such involvement essential to the health of what is, after all, a departmental program. So I consider this outcome a very important advantage of the procedure.

The data from students was simply their responses to the test questions — in fact, even more simply, the fraction of them who gave a correct answer to each question. This data was collected in class during the fall semester — the time at which the state of knowledge of in-class students most closely matches that of students taking tests for actual placement purposes. Getting the instructors' permission to use class time required some effort, but since this was effort-directed toward ncreasing faculty participation in the placement system, I was happy to put it forth. I wanted data from students who were already sorted by course because our existing sorting methods work reasonably well on the average — the purpose of the new placement tests can be considered as producing a tighter clustering around the average.

One purpose of the student data was to select for placement into course x questions which students already in course x could do correctly — the a priori goals were:

a) use only questions which at least 35% of students in course x answered correctly.

b) assemble a group of questions such that the cutline for placement into course x would translate into doing at least half the questions correctly.

One point of these criteria is to make it very unlikely that students can place into course x simply by random guessing. It does not seem likely that many students follow a strategy of random guessing on a placement test, but it is fairly hard to prove that no substantial group is doing so; it is easier to dispose of the possibility through the choice of questions.

Another point is to maintain some visible relation between the topics on which students are being tested and topics on which they are actually demonstrating knowledge. With a cutline of 50%, students are getting into the course with demonstrated knowledge of only half these topics, and lower cutlines obviously worsen the situation. From a naive standpoint, the obvious attack on this problem is to seek simpler versions of the problems. But in real life, one does not carry out this approach very far. In order to attain a high fraction of correct answers (say the 85% often used to define "mastery") it is necessary to pose questions in their most routine form — essentially the form of the first worked example in the textbook. A placement test composed entirely of such questions gives a disproportionate reward to what may be purely rote behavior, and makes no requirement that students use their skills in the contexts in which these skills will actually be needed. So, in practice, placement tests include a substantial number of non-routine questions, and the test

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user is asked to infer the student's ability to do a large number of routine problems from a demonstration that the student can do a smaller number of less routine problems.

I didn't achieve the a priori goals — having to accept a cutline as low as 44%. Recordkeeping considerations prevented having more than four test scores per student, and this limit forced some hard subtests to be lumped together with easier ones in one of the four tests. But in other instances, the a priori goals did settle the question of which subtests should apply to which course placement.

It has been tacit in the preceding paragraphs that there were pre-existing cutlines. This was true in the following sense. We were already using placement tests, and had established cutlines for them; we were satisfied with the average student levels which these produced. We, therefore, translated the old cut scores into equivalent scores on the new tests. This translation was done by a standard score-equating (see section by Angoff in Thorndike's **Educational Measurement**) which was the most complicated bit of statistics in the whole project. Collecting the necessary data involved readministering the old placement tests in class to half the students at the same time the new placement tests in class to half the students at the same time the new placement tests were being taken by the other half. The fact that students are taking old tests for the second time and new tests for the first time is obviously a potential source of error in the equating, but we had used the same technique previously without encountering discerabie effects form this source. Data for such an equating study should represent the full range of student abilities for which the scores will be used. In a placement test context, this may well be less than the full range of ability of students taking the test; my feeling is that three course levels is enough (my campus has the unwanted luxury of five precalculus levels).

In addition to considering fraction correct by course, it is instructive to consider the change in this fraction from one course level to the next — what can be called the discrimination of the question (or, in my case, subtest). The attainable mix for this number is about .5 (15% of students will give the right answer, and 5% the wrong answer, both for stupid reasons, to any given question). I have never seen this level of discrimination attained between successive courses. The high levels I have seen (from .5 to .6) tend to come from the most routinized version of a topic which is heavily emphasized n teaching the lower course. For non-routinized questions, a discrimination of .3 to .4 seems to be a good level. Levels below .2 suggest essentially no progression in skills, raising the question of whether the question is appropriate. Obviously these rules-of-thumb are subject to modification depending on the difference in overall levels of the courses.

SAMPLE TESTS

For the last two years, Placement Test Packets have included **eight** question samples of the various PTP tests. Responses to a recent questionnaire indicate how subscribers have been using these sample exams.

In most cases the primary use of the samples is to inform incoming students about the kind of questions they could be asked on their placement tests and, in the process, alleviate anxiety about the tests. Some institutions, such as the University of Georgia, distribute the samples to all high school students who plan to attend that institution. The University of South Carolina writes every high school mathematics department in the state, describing their placement program and enclosing sample tests for distributions to appropriate students. The University of Arkansas also sends the sample tests to high schools in the state. Some schools simply include the sample tests in orientation packages that are sent to entering freshmen. The sample tests are also used at some institutions to inform other departments of the nature and relevance of the mathematical placement tests.

It is apparent that many subscribers are finding the sample test helpful in conveying to a variety of audiences the content and level of the different PTP tests, without compromising actual tests questions. It is hoped that in the future other subscribers will find the samples equally useful.

BOWLING GREEN STATE UNIVERSITY'S MATHEMATICS PLACEMENT TEST MANUAL

The mathematics faculty of Bowling Green State University have developed a detailed and informative mathematics placement manual for use on their campus. The 25 page publication covers all the local procedures and options available to the students and their advisors. The PTP sample test are reproduced in the booklet as a guide to the different placement tests. A limited number of single copies are available on request and interested readers may contact Professor Waldemar C. Weber, Department of Mathematics and Statistics, Bowling Green State University, Bowling Green Ohio, 43402.

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STRUCTURE OF THE MATHEMATICS PROGRAM

The majority of the students enter with three of more years of mathematics. If they have a demonstrable proficiency with algebra and trigonometry, they are assigned to the standard program and it schedules the mathematics portion of the core curriculum over four semesters. If they elect to demonstrate a proficiency with differential calculus, they are placed in a moderately advanced program and they complete their core mathematics requirements in three semesters. Cadets that demonstrate a proficiency in differential and integral calculus are scheduled to complete their core mathematics requirements in two semesters. On the otherhand, some students need more work in order to meet the standards in basic mathematics and they are placed in a one semester course in algebra and trigonometry. Annually about 13% to 15% of a entering class places in the Precalculus Program and they begin the standard program in their second semester.

PHILOSOPHY OF MATHEMATICS PLACEMENT

The life of a cadet is a full and demanding one. Studies, athletics and military activities leave little discretionary time for the student. The first summer is especially taxing to the student yet many of the most critical mathematics placement activities must go on. Although participation in an Advanced Mathematics Program is strictly voluntary all students are strongly urged to seek placement at the highest level of which they may be capable. To encourage this attitude in young people who are facing an uncertain and demanding future, the mathematics programs are structured so that there are several opportunities for students who have over-reached themselves to change enrollment to a less advanced program as described below. In addition, by completing core mathematics in less than four semesters, a student is allowed to take additional elective courses which are free of any constraints that might otherwise be imposed by the demands of a major or area of concentration. Together the guarantee and the lure of extra electives seem to induce the majority to attempt their best.

INITIAL PLACEMENT ACTIVITY

During the summer training period four hours with the new frashman class are made available to the Department of Mathematics for orientation and placement. The first two hour block which students attend in groups of about 350 is used to describe the various programs, to lead the cadets through the completion of a personal mathematics background report and to administer brief multiple choice tests in algebra and trigonometry. Finally, the cadets are asked to express their own desires regarding placement. As the students generally arrive from a period of military or physical training with may things other than academics on their minds, much effort is placed on keeping the talks brief, colorful and interesting with many opportunities for movement and stretch breaks. Nevertheless, it is not uncommon to find students two months later who cannot remember the session. A period of frantic faculty activity follows this session, the result of which is a tentative placement decision for each student based on the above data, Mathematics SAT (or ACT) scores and high school class standing. A second placement session is held after the students have been informed of the tentative placement decision. All candidates for either of the advanced placement programs attend as well as marginal candidates for the precalculus program. Beyond these cadets any others who wish to appeal the tentative decisions made about them may also attend. This meeting is held in small groups and consists of discussions, explanations, interviews and the administration of two brief multiple choice tests on differential calculus and integral calculus to advanced placement candidates. All of these data as well as the results of The College Board's Advanced Placement Calculus Examinations are considered in developing the actual program placements for the start of first semester. The basic departmental outlook continues to be a generous one in that a student is allowed to begin at the highest level at which he or she has fair chance of being successful. It's probably well to mention here that the tests provided by the MAA Placement Test Program are not directly used during the summer because of time limitations and because a high degree of confidence and continuity is associated with the home-made tests. Various questions and ideas from the PTP tests have been gradually incorporated however.

PLACEMENT ACTIVITY DURING FIRST SEMESTER

The generous attitude toward placement during the summer is possible because the manner in which the various programs are actually conducted allows an iterative enhancement of initial placements. The situation is well explained in terms of the Most Advanced Program which requires the validation of two semesters of sophomore level mathematics left to complete. These semesters are 47 attendaces long. Yet, as freshmen, they are scheduled for 62 lesson semesters, the norm for freshman mathematics at West Point. The difference is 30 lessons which are available for further validation and review. (Actually only 20 lessons are available, as the rest are used for freshman topics which are not validated such as an introduction to matrix algebra.) The 20 validation lessons are used (half for differential and half for integral calculus) to permit a hurried review of each course followed by two examinations on the content of each course. Students who pass the validation examina-

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tions at the C level or better remain with the Advanced Placement group. Those who do not are returned without handicap to an appropriate program. Those who fail to validate differential calculus return to the Standard Program which is just then getting involved with preliminary fundamentals. Those who validate differential calculus but fail to validate integral calculus join the Moderately Advanced Program which has just completed its own validation of differential calculus and is beginning its detailed study of integral calculus. There is one other group to consider — the students who might well have benefited by starting with the Precalculus Program but who were "generously" allowed to begin with the Standard Program. After a seven lesson review of algebra and trigonometry, Standard Program students take a rather detailed quiz. Substandard performers are enrolled in the Precalculus Program on the recommendation of their instructors. As the semester goes on further adjustments are occasionally made for strong cause but generally course enrollments are now fixed. There is a form of fine tuning within courses which continues through the year. In large enrollment courses the students are occasionally regrouped in accordance with ability as demonstrated by their grades. Twice during a semester now sections are formed so that all students in a particular group come from the same quartile within the course. Thus, though all sections follow the same basic syllabus and take the same examinations, instructors are encouraged to adjust their presentations and demands to match them to student aptitude. With the small sections which are the rule at USMA (16 - 17 students) this effort is generally successful.

CONCLUDING OBSERVATIONS

A vast amount of effort is required to manage the placement activity described above but it is believed that goal of encouraging each cadet to reach as high as possible without the worry of being left out on a limb justifies it. There is also no Honors Program which is begun later in the year after cadets have acquired more experience with their academic and military environment. The occasional student who wishes to validate courses beyond single variable integral calculus is treated individually. But an examination is invariably a part of this validation process to insure that he or she can meet the standards of rigor and performance which will be expected of all other cadets.

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University of Pittsburgh

Eastern Pennsylvania and Delaware

Drexel University
East Stroudsberg State College
Elizabethtown College
Harcum Junior College
Lafayette College
Lebanon Valley College
Lehigh University
Millersville State College
Philadelphia College of Pharmacy and Science
Rosemont College
Swarthmore College
West Chester State College

Florida

Barry University
Broward Community College
College of the Virgin Islands
Eckerd College
Florida A & M University
Florida College
Florida State University
Florida International University
Jacksonville University
Miami-Dade Community College
Rollens College
Tallahassie Community College
University of Central Florida
University of Florida
University of South Florida
University of West Florida
Valencia Community College

Illinois

Augusta College
College of Lake Country
Greenville College
Illinois Central College
Lincoln Land Community College
Loyola University
Millikin University
Olivet Nazarene College
Prairie State College
Thornton Community College

Continued on page 10

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Indiana

Anderson College
Ball State University
DePauw University
Earlham College
Indiana State University
Indiana University
Indiana University Purdue University at Fort Wayne

Intermountain

Brigham Young University

Iowa

Clinton Community College
Graceland College
Grinnell College
University of Dubuque

Kansas

Barton County Community College
Benedictine College
Ft. Hays State University
Kansas City Kansas Community College
Tabor College
University of Kansas

Kentucky

Asbury College
Mayville Community College
Northern Kentucky University
University of Kentucky

Louisiana-Missouri

Alcorn State University
Louisiana State University
Louisiana State University at Eunice
Louisiana State University at Shreveport
Loyola University
Nicholls State University
Southeastern Louisiana University
Tulane University
William Carey College

Maryland — D.C. — Virginia

American University
Paul D. Camp Community College
College of William and Mary
Hampden-Sydney College
Harford Community College
Loyola College
Mary Baldwin College
Thomas Neson Community College
Prince George's Community College
J. Sargeant Reynolds Community College
Salisbury State College
St. Mary's College of Maryland
Trinity College
University of Maryland
University of Maryland Baltimore Campus
N.M.I.
Virginia Union College
Washington College
Washington and Lee College
Western Washington College

Michigan

Alma College
Calvin College
Ferris State College
Oakland University
Saginaw Valley State College

Missouri

Cottey College
Drury College
Harris Stowe State College
Missouri Western State College
Penn Valley Community College
Southeast Missouri State University
University of Missouri-Kansas City
University of Missouri-Rolla
Westminster College

Nebraska

Nebraska Wesleyan University
University of Nebraska-Omaha
University of Nebraska-Lincoln

New Jersey

Brookdale Community College
Fairleigh Dickinson University
Rider College
Stackton State College
Union County College

Metropolitan N. Y.

Brooklyn College
College of New Rochelle
College of Saint Rose
Hofstra University

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NYU
Pace University
U.S. Military Academy
Yeshiva College
Yeshiva University

New York-Upstate

Broome Community College
Buffalo State College
Colgate University
Daemen College
Le Moyne College
Nazareth College of Rochester
Niagra University
Paul Smith College
Rochester Institute of Technology
St. John Fisher College
St. Thomas Aquinas College
SUNY Agricultural and Technical College
SUNY Binghamton
SUNY Fredonia
SUNY Geneseo
SUNY Plattsburg
Utica College of Syracuse University

Northeastern

Amhurst College — Amherst
Boston University
Cape Cod Community College
Connecticut College
Elms College
Fitchburg State College
Hartford State Technical College
Lyndon State College
Massasoit Community College
Memorial University of Newfoundland
North Shore Community College
Pine Manor College
Roger Williams College
U.S. Coast Guard Academy
University of Bridgeport
University of Connecticut
University of Lowell
University of Massachussetts
University of Vermont

North Central

College of Saint Catherine
College of Saint Thomas
Lakehead University
Mankato State University
St. Cloud State University
St. Johns University
St. Olaf College

Northern California

CSU Fresno
Cogswell College
Foothill College
Kapiolani Community College
Leeward Community College
Santa Rosa Jr. College

Ohio

Alderson-Broaddus College
Bethany College
Bluffton College
Bowling Green State University
Denison University
Kent State University
Mount Union College
Mount Vernon Nazarene College
Ohio Northern University
Salem College
University of Steubenville
University of Toledo
Wright State University
Xavier University

Oklahoma-Arkansas

Central State University
East Central Oklahoma State University
Oklahoma Christian College
Oklahoma State University
Rogers State College
University of Arkansas
University of Arkansas-Little Rock
University of Oklahoma
University of Tulsa
Westark Community College

Pacific Northwest

Boise State University
Cariboo College
Columbia Christian College
Eastern Oregon State College
Eastern Washington University
Fort Steilacoom Community College
Gongaza University
Lane Community College
Linfield College
Okanagan College
Oregon Institute of Technology
Oregon State University
Pacific University
St. Martin's College
University of Alaska-Juneau
University of Alberta
University of Oregon
University of Peuget Sound
Washington State University

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Rocky Mountains

Colorado Mountain College
Eastern Montana College
Mesa College
Metropolitan State College
Northern State College
South Dakota State Unviersity
University of Colorado
University of Southern Colorado

Southeastern

Alabama A & M University
Alabama State University
American Muslim Teacher College
Auburn University at Montegomery
Beaufort Technical College
Brevard College
Chattanooga State Technical College
Coker College
College of Charleston
Clayton Jr. College
DeKalb Community College
East Tennessee State University
Floyd Jr. College
Fred Hardeman College
Georgia Institute of Technology
Greensboro College
Mercer University
Midlands Technical College
Newberry College
North Carolina State University
Johnson C. Smith University
Tri-County Technical College
University of Alabama-Huntsville
University of Georgia
University of North Carolina-Asheville
University of South Carolina
University of South Carolina — Lancaster

Southern California

CSU-Northridge
Chapman College
Citrus College
Marimar College
Occidental College
Pasadena Community College
San Bernadino Valley College
Santa Ana
Santa Barbara City College

Southwestern

New Mexico State University
University of Arizona

Texas

Amarillo College
College of the Mainland
East Texas Baptist College
Le Tourneau College
Lon Morris College
Midwestern State University
North Texas State University
San Jacinto College, Central
South Plains College
Southern Methodist University
Sul Ross State University
Tarleton State University
Texas Christian University
Tyler Jr. College
University of Houston, Downtown College
University of Texas-San Antonio

Wisconsin

St. Norbert College
University of Wisconsin-Oshkosh

Western New York and Canada

Dawson College
Jamestown Community College
Trent University
University of Guelph
University of Windsor

MAA PLACEMENT TEST PROGRAM

PLACEMENT TEST NEWSLETTER

Vol. 7, No. 2 Spring 1984

IN THIS ISSUE

USING THE CALCULUS READINESS TEST AT THE U. S. COAST GUARD ACADEMY

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New London, Connecticut 06320

Introduction and Perspective. In the past the Mathematics Department at the United States Coast Guard Academy has been using a multiple linear regression model as part of its freshman placement program (for a complete description of the freshman mathematics program and prior regression model see the Fall 1980 issue of this Newsletter). Several changes at the Academy have influenced our freshman programs and our placement procedure. The Mathematics Department no longer offers a Summer Mathematics Review Course and there has been a decrease in the size of the incoming class. Accordingly, our freshman program has changed. The Mathematics Department now offers for those cadets who do not advance place one of the following courses:

Mathematics 3107 — Precalculus Mathematics
Mathematics 3111 — Calculus and Analytic Geometry (Regular)

Mathematics 3107 is essentially a college algebra and trigonometry course. The objective of this course is to improve the skills needed in subsequent mathematics courses. The Dean of Academics limits the number of cadets which can be placed in Mathematics 3107 since that placement imposes a difficult situation on cadets

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MATHEMATICS PLACEMENT AT THE FLORIDA STATE UNIVERSITY

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Florida State University
Tallahassee, Florida 32306

The MAA Placement Test Program (PTP) provides a sound basis on which to build a valid local placement program. The concept arrangement on the tests, as constituted by PTP is reasonable and the norming data provided should be helpful. This paper reports, however, on use of these tests as an item bank, with items chosen from several tests to represent concepts prerequisite to specific local courses. Users are encouraged to do this in the User's Guide [4]. Accounts of the experience at other schools in the **PTP Newsletter** ([2], [5], [6], [7], [8], [10]) are helpful in the continuing process of developing the testing procedure at The Florida State University (FSU), and it is hoped that this description of a test development process may be helpful to others. Although this is primarily a report of test development at FSU, advantage was made of prior experience with PTP and the use of locally developed items at Tallahassee Community College (TCC); some data will be cited about TCC's testing experiences.

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MAA MINI-COURSE ON PLACEMENT TESTING, JANUARY 1985

An MAA Mini-Course on Placement Testing will be held in conjunction with the Joint Mathematics Meeting in Anaheim, California, January 11 - 13, 1985. The course will be a repeat of the previously well received course that was held at the Joint Mathematics Meeting in Denver, Colorado in January, 1983. (See descriptions in the Winter, 1982 - 83 and Spring, 1983 issues of the **PTP Newsletter.**) The course will include workshops on item writing and the setting of cut-off scores. It will also include group discussions on the organizational and operational problems of a placement test program in mathematics. Members of the committee and other individuals will share their wide range of experiences with the participants in the course.

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intending to major in one of the engineering/science programs. Mathematics 3111 is a typical four semester-hour calculus course.

Placement Procedure. A multiple linear regression model has been used as part of the placement procedure at the Academy for several years. Data from the Summer Mathematics Review Course provided values for important predictor variables for the regression model. Since the summer course is no longer taught, it was necessary to find other achievement-related variables to use in that model. The MAA Placement Test Program (PTP) Calculus Readiness (CR) test was chosen as one of the new achievement-related variables.

The predictor variables used in the new model are:

1. Sex (X_1). The value 1 is assigned to a female; 2 to a male.
2. **SAT-Math, ACT-Math** or both (X_2), (X_3).
3. **Pre-Board Qualifying Score** (X_4). The Pre-Board Qualifying Score is a score received from the Admissions Department. It represents 60% of the **final score** a candidate receives for admission consideration. It is the academic portion of the final score; X_4 is computed as follows: X_4 = 3 (high school rank) + 2 (SAT-Math) + (SAT-Verbal).
4. **Final Score** (X_5). This score is the sum of X_4 and the Cadet Candidate Evaluation Score. The latter score is based, for example, on extracurricular activities, leadership potential, and motivation to attend the Academy and is 40% of X_5.
5. **High School Rank** (X_6). The high school rank of a candidate is computed as follows:
   $$\frac{\text{(class standing)}\cdot 1}{\text{(number of students in graduating class)}}$$
   This decimal fraction, is assigned a number; the maximum X_6 score is 800.
6. **Mathematics Background** (X_7). The value of this variable is 1, 2, or 3 and depends on the high school/college mathematics background of the cadet.
   1 — algebra only
   2 — algebra and trigonometry
   3 — algebra, trigonometry, and calculus
   It should be noted that trigonometry is not required for admission to the Academy.
7. **Algebra Diagnostic Score** (X_8). This is the score on the Algebra III Exam (Form A) published by Educational Testing Service. The maximum score on this exam is 40.
8. **Trigonometry Diagnostic Score** (X_9). This score is from an exam similar to the Algebra III Exam. This exam is published by Educational Testing Service and has a maximum score of 40.
9. **PTP CR Test** (X_{10}). This test has a maximum score of 25.
10. **Confidence Index** (X_{11}). A value of 1 or 2 is assigned depending upon initial course placement.
    1 — Mathematics 3107
    2 — Mathematics 3111
11. **Dependent Variable** (Y). The value of Y is the grade a cadet earns in Mathematics 3111.

Data Analysis. The Admission Division requires one but not both of the SAT and ACT scores. Hence the incoming class was divided into three groups:
Category 1: Cadets having both SAT and ACT scores.
Category 2: Cadets having only SAT scores
Category 3: Cadets having only ACT scores
A multiple regression (Mischinsky, 1976) and stepwise linear regression (Miller, 1976) analysis was run for each category.

Category 1: Multiple Linear Regression (n=47). The PTP CR test had the highest correlation with the dependent variable (Y); the correlation is .547. About 5_% of the variance in cadet grades was predicted by the model ($F(11, 35) = 3.35$; $p < .01$). The observed grades will be within ±.89 of the predicted grades about 68% of the time (i.e., within one standard deviation).

An approach used to rank the contributions of the predictor variables is an examination of the beta coefficients; these coefficients are adjusted regression coefficients which all have the same units and, thus, are comparable. The beta coefficients for Category 1 indicated that ACT-Math (X_3) had the smallest negative coefficient. The largest positive coefficient was CR (X_{10}); the next largest was Final Score (X_5).

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The Placement Test Newsletter is published by the Mathematical Association of America and is distributed to all subscribers to the MAA's Placement Test Program. Individual subscriptions are also available. The views expressed in articles in this newsletter are those of the authors and do not necessarily represent policies of the Mathematical Association of America.

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The regression equation for estimating the grade (Y) in Mathematics 3111 for students in Category 1 is as follows.

$$Y = 010.2142 + .4298X_1 - .00089X_2 - .1212X_3 + .00022X_4 + .00125X_5 + .00208X_6 + .3608X_7 + .0409X_8 + .0297X_9 + .1456X_{10} + .12782X_{11}$$

Category 2: Multiple Linear Regression Model (n = 79). The PTP CR (X_{10}) test had the highest correlation (.54) with the dependent variable (Y) ($F(10, 68) = 5.29$; $p < .01$). Approximately 44% of the variance in the cadet grades is predicted by the model. The observed grades will be within ±.94 of the predicted grades about 68% of the time.

The largest beta coefficient in this category was the Pre-Board Qualifying Score (X_4) followed very closely by CR (X_{10}). The regression equation is as follows:

$$Y = -4.446 - .0347X_1 - .003X_2 + .0015X_3 - .0002X_4 - .0003X_5 - .03174X_6 + .03344X_7 + .0287X_8 + .08382X_9 + 1.1332X_{10}$$

Category 3: Multiple Linear Regression Model (n = 24). In this category the analysis indicated that CR (X_{10}) had the highest correlation (.67) with the dependent variable (Y) though this was followed closely by ACT-Math (.59 ($F(10, 13) = 2.41$); $p > .05$). About 64% of the variance in cadet grades in this category was predicted by the model; the analysis showed that the observed grades will be within ±1.07 of the predicted grades 68% of the time.

The smallest negative beta coefficient for Category 3 was the trigonometry diagnostic score (X_9); the largest positive beta coefficient was CR (X_{10}). The regression equation was the following one.

$$Y = -9.008 + .129X_1 - .008X_2 + .001X_3 + .0006X_4 - .0047X_5 - .488X_6 + .016X_7 - .104X_8 + .181X_9 + .373X_{10}$$

Conclusion. The R^2 values for the prior and present regression models are in the Table.

TABLE

	R^2	
Category	Prior Model	Current Model
1	.52	.52
2	.43	.44
3	.59	.64

In the prior model the best predictors were the achievement related variables associated with the Summer Mathematics Review Course. In the new model the MAA Placement Test Program CR test is the best predictor and correlates most highly with the dependent variable (Y).

Once the achievement information is assimilated, an interview is held with each cadet. The purpose of the interview is twofold.

1. To give the cadet our "best estimate" of how he or she ranks in his/her class.
2. To exchange information with the cadet.

In providing our best estimate for placement, it is important that the cadet interpret the results correctly. On the other hand, information gleaned by the interviewer may provide a more detailed profile of a cadet's mathematical background and attitude toward the subject. All efforts in the placement procedure involve providing each cadet with as much information as possible to assist him/her in selecting courses. The Mathematics Department rationale behind this is that motivation is a key factor in academic success and that an individual with confidence in his/her ability to complete successfully a course should have every opportunity to do so.

USER'S REPORT OF TEST RESULTS OVER LAST THREE YEARS

This issue contains an insert, "PTP Composite Statistics," which compiles data collected from the Standard User's Reporting Form over the last three years, 1981-1983. Because fewer users are returning the forms and because enough data have now been collected to make the given statistics fairly reliable, there will be no more yearly reports in the spring newsletter. Instead, a copy of this year's insert compiling data from 1981 - 1983 will be included in the packet obtained each year by registered users.

The top half of the insert contains statistics on student scores. As usual, scores are reported only for PTP tests used without alteration and within the prescribed time limit. One purpose of this report has always been to give PTP users a sense of the overall distribution of mean scores from the wide variety of different student populations at reporting institutions. For example, on the BA test the insert shows that there were reported mean scores ranging from 4.7 to 18.7. Thus, rather than have the data from many different institutions swamped by one large user, this report gives the mean of the reported mean scores: If school A reports a mean of 10 for 900 students on Test X and school B reports a mean of 20 for 100 students on the same test, then the mean for this test given on the insert would be 15, not 11.

The lower half of the insert contains information about how reporting institutions use PTP test scores for placement. Different course offerings, different placement policies, and different uses of the same test lead to much contradictory data in this tabulation of cutoff scores. It is not unusual for one school to place students scoring 0-10 on the BA test into "Precalculus" while another school used the range 15-25 on the same test to place into the same course. This, together with the small sample size within the many categories, makes this data useful only as very general guidelines for placement ranges.

PTP COMI

STUDEI

# of Items	A-SK PART I ONLY (20)	A-SK PARTS I & II (32)	SK (25)	BA (25)
TIME LIMIT	25 MINUTES	40 MINUTES	30 MINUTES	30 MINUTES
NUMBER OF STUDENTS TESTED	411	2785	5481	30,926
(NUMBER OF INSTITUTIONS)	(3)	(14)	(9)	(48)
MEAN OF MEANS	14.7	23.7	15.0	13.0
(RANGE OF MEANS)	(9-25.8)	(19.5-28.0)	(13.1-20.0)	(4.7-18.7)
RANGE OF STANDARD DEVIATIONS	3.4-4	4.2-7.1	2.9-4.7	3.2-6.8

PLACEME

(NUMBER OF INSTITUTIONS)
Students scoring in this range (inclusive)

CALCULUS — Engineering, Physical Science	[,]	[,]	[,]	(13)[19, 25]
CALCULUS — Business, Intuitive, or Short	[,]	(1)[26, 32]	[,]	(8)[17, 25]
PRECALCULUS	[,]	(1)[23, 32]	[,]	(16)[11, 20]
TRIGONOMETRY	[,]	[,]	[,]	(10)[14, 24]
COLLEGE ALGEBRA	[,]	(2)[26, 32]	(1)[13, 25]	(27)[12, 20]
INTERMEDIATE ALGEBRA	[,]	(1)[13, 25]	(2)[19, 25]	(25)[6, 13]
BEGINNING ALGEBRA	[,]	(5)[11, 20]	(4)[12, 20]	(19)[0, 9]
ARITHMETIC	(3)[0, 11]	(5)[0, 14]	(4)[0, 11]	(7)[3, 9]
OTHER	[,]	(5)[16, 27]	[,]	(7)[17, 25]

SITE DATA

SCORES

AA (25)	A (32)	T PART I ONLY (15)	T PART II ONLY (15)	T PARTS I & II (30)	CR PART I ONLY (25)	CR PARTS I & II (30)
MINUTES	45 MINUTES	25 MINUTES	25 MINUTES	45 MINUTES	25 MINUTES	30 MINUTES
2873	30,002	13,419	573	718	7967	9968
(12)	(24)	(7)	(1)	(2)	(13)	(42)
12.5	12.5	13.0	6.3	10.9	12.0	11.8
(8.3-16.0)	(8.5-23.4)	(2.7-6.4)		(6.8-13.2)	(5.7-16.1)	(5.3-18.7)
	3.6-8.0	2.2-3.4		5.6-6.6	3.7-6.0	3.3-5.5
3.6-5.1						

T RANGES

ean Low Score, Mean High Score]

e advised or required to take this course.

(6)[13, 25]	(14)[18, 31]	(5)[9, 15]	[,]	(1)[13, 20]	(10)[12, 24]	(27)[12, 24]
(2)[12, 25]	(9)[18, 32]	[,]	[,]	[,]	(7)[11, 19]	(7)[12, 23]
(6)[7, 13]	(10)[16, 25]	[,]	[,]	(1)[0, 12]	(8)[3, 11]	(21)[4, 12]
[,]	(5)[14, 24]	(6)[0, 7]	[,]	[,]	(3)[15, 19]	(5)[7, 13]
(2)[3, 9]	(14)[13, 20]	[,]	[,]	[,]	(5)[4, 12]	(5)[6, 14]
(4)[2, 13]	(13)[4, 12]	[,]	[,]	[,]	(2)[6, 11]	(2)[6, 14]
[,]	(11)[2, 10]	[,]	[,]	[,]	(2)[0, 6]	(1)[0, 5]
[,]	(2)[0, 32]	[,]	[,]	[,]	[,]	[,]
(1)[0, 4]	(3)[13, 19]	[,]	[,]	[,]	[,]	(1)[12, 16]

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At FSU, mathematics placement of any of the more than 3000 freshmen each year may be on the basis of the SAT-Math score without further testing. This satisfies the state requirement that students be placed by a test on the Florida Board of Education (BOE) "approved" list and an FSU requirement that advanced placement be conservative. Presently, the inclusion of the PTP test on the BOE list is uncertain although several colleges have requested that tests constructed from the PTP tests be included on that list.

Basic Skills Test (BST) and Advanced Placement Mathematics Test (AMPT). After arrival on campus students are encouraged to take the appropriate one of two placement tests; each of these tests is based on PTP tests. In Fall 1983 over 1500 students were tested. In 1984, more students are likely to choose testing since they are newly required, by statute, to have credit for two college-level mathematics courses; one of these two courses may be exempted by examination. The composition and status of BST and AMPT are as follows.

Basic Skills Test

The Basic Skills Test was developed in 1982 and is being revised in 1984. Presently, BST includes the following.

SK/1B 25 items: entire test (this is an earlier version of the current PTP Basic Skills Test)

BA/1B 7 items: 3, 5, 7, 8, 10, 17, 20

Local 4 items: 3 have no PTP counterparts; there is an item similar to the fourth on A PTP tests but not on BA PTP tests.

Advanced Mathematics Placement Test

This test was developed in 1984 and is based on prior experience with PTP items; it includes:

A/3B or A/3C 24* items: 1, 5-13, 15-18, 21-23, 25-28, 30-32

AA/1B or AA/1C 5* items: 2, 5, 9, 13, 18

T/3B or T/3 13 items: 3-5, 7, 9-13, 15, 16, 19, 21

CR/1 or CR/1B 13 items 1, 2 ¯, 9, 10, 13, 15, 19-21, 23-25

*Items 6, 9, 18, 25 and 27 from A have close counterparts on AA hence the total number of items used from each test is more meaningful if thought of as 5 from AA, 19 from A and 5 from both A and AA.

All FSU freshmen must take or be exempted from Basic College Algebra. (Exceptions are students who earn college calculus credit while in high school or who score 3 or more on the CEEB AP-calculus test.) Freshmen with SAT-Math scores of 420 or less must take Pre-college Mathematics (no graduation credit) prior to Basic College Algebra unless they take the BST and their score is at least 75%. Without AMPT advanced placement, freshmen with SAT-Math scores in the 430-640 range must take Basic College Algebra; those scoring at least 650 may take College Algebra and Trigonometry. (If these students do not have credit for Basic College Algebra by some other exam, that credit is awarded on the basis of their high SAT-Math score.) Both of the higher scoring SAT-Math groups may take the AMPT; in fall 1983, most students did elect to take the AMPT predecessor tests — a local exemption test for Basic College Algebra and, for higher scorers, a placement test based on the CR, T, and AA PTP tests.

A student scoring above the minimum cutoff on the AMPT who does not already have credit for Basic College Algebra is awarded credit for that course and is permitted to register in higher mathematics and computer science courses. (AMPT scores are also used by enrolled students who have completed Business Calculus to demonstrate the knowledge needed to enroll in these courses: Pascal, calculus and discrete mathematics.) Each student is told which of five AMPT placement groups, he or she is in, what "sequence" mathematics courses may be taken, and what other (business, liberal arts) mathematics courses are permissible. (College Algebra and Trigonometry is considered the first sequence mathematics course for these purposes, although it may not be included in a mathematics major or minor) Placement by AMPT is determined on a logic tree of height two with six terminal leaves. Only Group 1 and Group 2 placement is affected by the score on the trigonometry items.

AMPT Group	Sequence Mathematics Courses Permitted	Other Mathematics Courses Permitted
5	None; must first take Precalc/Bus.	Precalc. for Business; Finite Math
4	Col. Alg. & Trig.	Precalc. for Business; Finite Math
3	Col. Alg. & Trig.	Business Calculus; Finite Math
2	Col. Alg. & Trig.	Pascal I; Business Calculus; Finite Math
1	Calculus I; Discrete Math I	Pascal I; Business Calculus; Finite Math

Exemption credit and test security. Since credit is presently awarded for Basic College Algebra on the basis of SAT-Math, AP-calculus or (by statute) CLEP math general scores and was previously awarded using the score of a locally developed predecessor test, FSU awards credit for this very elementary course using a test (i.e., AMPT) containing a majority of PTP test items. However, the mathematics department cannot confidently give credit for any higher-level course using this test; the reasons for this are those cited in the **PTP User's Guide** (cf., [4], p. 15).

Since course credit is awarded using the AMPT scores, every attempt is made to prevent cheating during the test session. Several different forms of each test are used. The test sessions are held in a large elevated lecture hall so that students may be separated from each other, and there is a large number of attentive proctors at each of those sessions. Students are admit-

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ted only upon presentation of a valid photo identification card.

Item experience. The BST item analysis showed that eight of the items from PTP SK were too easy for our population (i.e., low SAT-Math scorers who wished to avoid the non-credit course). The BST is being revised during Spring 1984 so that most of its items are from a PTP BA test and some from A/SK and so that those from SK which are not reliable discriminators are eliminated. On the revised test one item from a PTP A test is being included and replaces one of four locally developed items; this item concerns fractional and negative exponents of whole numbers. Two of the three remaining locally developed items are being retained; the reasons for their retention are discussed next.

On the BST the mean score on the 7 BA items was 55% and on the 25 SK items was 73%. On all of the items being used in the revised BST the FSU point biserials were good. It is interesting, however, that two of the three highest point biserials were for locally developed items like items 3 and 4 in the table. The second highest point biserial was for an SK item, item 8 on SK/1B. (There was no statistically significant difference between the three point biserials.) When used in a predecessor Tallahassee Community College (TCC) test this item had the highest discrimination index on that test.

Items numbered 3 and 4 in the table were from a test developed at TCC. Their use there indicated that, statistically, they were good items. They were used, at FSU, in the BST because there were no items like them in the PTP tests and because the content they test is an important prerequisite to Basic College Algebra. (Note: A counterpart of item 4 is on the PTP BA Sample Test.) One locally developed item, item 5, is an example of the need to learn from your mistakes (cf., [8] and [9]). This item seems clearly above the level of the BST population and is being replaced by an easier addition of algebraic fractions item from BA.

The AMPT has pre-calculus, trigonometry and non-trigonomentry sections. All 14 of the trigonometry items were on the previous upper level test, and for each item there was a high positive correlation between correctness on that item and total test score. The 51% mean score on this test was from a select population: students who had advanced placement into Calculus I. Only one trigonometry item was not retained from the previous test; that was item 22 on CR/1B. In Fall 1983, 84% of the students answered this item correctly; it did not discriminate as well as did most of the other items (i.e., the point biserial was .276).

The 41 non-trigonometry AMPT items include 17 from a previous test and five items very similar to these 17. The mean score for these 22 items was 69%; each item had a good to excellent point biserial. Only one of these 22 items was not retained; that was item 1 from AA/1C. This item was answered correctly by 92% of the students and had a point biserial of only .102.

FSU test validity data and cutoff evaluation. Although item analysis is a necessary part of test development, assessment of the effectiveness of the testing program also involves study of subsequent student performance. This study usually implies the need to revise or change test items or to adjust cutoff scores. Some student follow-up data are available on the upper-level test used before AMPT. The population consisted of students who had exemption credit in Basic College Algebra and who wished advanced placement so that they might enroll in Calculus I or Discrete Mathematics I. The older test consisted of 40 items; 15 of those were trigonometry items. For permission to enroll in either course, students were required to make a score of at least 30 (out of 40) on the whole test and to have a score of 8 (out of 15) on the trigonometry portion.

Of the 237 students tested, 82 (34.5%) were permitted to enroll in Calculus I; a random sample (22) of these 83 students was selected for further study. Test and quiz performance through the first hour test was recorded as was final semester grade. (It was assumed that performance at the earlier point was less affected by extraneous factors.) Of these 22 students, two had registered for business calculus; both made A's. The grades of the remaining 20 students after 20 classes were: A (10), B (7), and C (3); their final semester grades were: A (8), B (4), C (5), D (1), and F (2). It seems reasonable to conclude that students above the cutoff could perform adequately; there was however no significant correlation for this sample between actual test score and course grade.

The next, obvious question was "Could the cutoff safely be lowered while maintaining under- rather than over-placement of students?" Two students, with scores of 26 and 25, had enrolled in Calculus I without permission. After 20 classes one was making a grade of C; the other, a grade of F; the final grades were D and "Withdrew," respectively. These were obviously confident students who were determined to accelerate despite contrary advice.

The five-week performance of 15 other students was also checked. These students had scores of 23 to 29 (just below the calculus cutoff) and were properly enrolled in College Algebra and Trigonometry. Their performance was: A (6), B (7), C (1), and D (1). There was not a significant correlation between test score and course performance. One cannot conclude, however, that they were improperly placed since a number of other factors could have influenced their five-week grade.

Since the 40-item test was being abandoned, the modification of the cutoff was moot and no further data were collected. The author's intuition is that the cutoff could have been lowered by a point or two. Our experience with the cutoffs on this test will be one guide in setting AMPT cutoffs.

TCC effectiveness data. In 1981, while at TCC, the author developed a 64 item test consisting of 19 SK 1/B

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items, 26 A/4A items, and 19 locally developed items. This test was used to place students into one of three TCC courses: Developmental Skills, Intermediate Algebra, or Basic College Algebra. The only data for this test were collected in January 1982. At that time 316 new students were tested. Fifty-five percent (274) were advised to take Developmental Skills; this advice was not binding. The follow-up study was of midsemester grades of the 45 students who enrolled in a section of intermediate or basic college algebra taught by a full-time faculty member. Of these students, eight had ignored the placement advice given them; seven of those had grades of D, F, or W; nine of the remaining 37 students has a grade of D, F, and W The "usual" proportions for final grades of D, F, and W at TCC in those courses was 50%; thus, a success rate of 76% at midsemester indicated the placement procedures were valid.

Future evaluation and revision plans. The newly revised BST will be tested by a predicted performance method [5] in Fall 1984 using midsemester grades for the comparison. Because the non-credit course, required of students not passing the BST is expensive to teach and is unpopular, there is a strong incentive to set the cutoff point as low as reasonable; the SAT-Math cutoff point which determines the population is already low. (For example, a 440 or 450 cut is cited [10] in a similar situation.) In order to obtain the best possible data (a) an academic "bribe" (e.g., perfect quiz scores and promises of improved facility with course material) will be given to Basic College Algebra students to get them to take the test and to work hard at it and (b) the necessary follow-up resources will be expended.

Data from two sources will be used in the predicted performance model to adjust the two major cutoff points for the AMPT. Those data will be from students who enter FSU in Fall 1984 and take AMPT and from some calculus students who earlier took College Algebra and Trigonometry at FSU and will take AMPT during their first week in calculus. The two major cutoff points to be adjusted are (a) Basic College Algebra vs. College Algebra and Trigonometry and (b) College Algebra and Trigonometry vs. Calculus/Discrete Mathematics I.

Notifying students about the program. The **User's Guide** suggests that students be informed, in advance, about the testing procedure including the nature of the test questions and provided with sample items for this latter purpose. At TCC this kind of material was sent to students as a fringe benefit, it was found to be a successful public relations device.

At FSU funds for implementation of a placement information program have been requested as has administrative cooperation so that this information can be included with other orientation materials beginning in Fall 1984. At FSU this information program will have the added advantage of helping students to determine if they should accept the placement received using the SAT-Math score or should take a specific, additional placement test.

Summary. With the availability of carefully developed and tested PTP items it is possible to develop and modify confidently a local mathematics placement program. The procedure is not static and requires continuous attention. At FSU the value of valid placement is considered to be worth the effort.

The author is indebted to colleagues in The Department of Mathematics and also R. Frost, A. Oosterhof, H. Nabi, M. Coburn, P. Elliott, M. Carraway, P. Metarko, and B. Norwood at FSU and to M. McCorvey and other faculty at TCC for their help and cooperation.

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Item/Source	FSU % Right	TCC[1] %Right 1983[1981]	FSU Point Biserial[2]	TCC Disc. Index[3] 1983[1981]
1. SK/1B #8	47%	33%	.511	.70
2. SK/1B #3	75%	54%	.490	.68
3. Local: One of the factors of $6x^2 \cdot 17x \cdot 14$ is	43%	23%[37%]	.520	.53[.43]
4. Local: The completely factored form of $10x^2 \cdot 27x \cdot 16$ is	52%	30%[43%]	.496	.64[.60]
5. Local: $\frac{5}{2x+3} - \frac{4}{2x-3} =$	8%	[28%]	.412	[.21]

[1]The 1983 TCC test population was essentially all of the new students admitted. The bracketed statistics are based on students entering in Fall 1981 who chose to participate in non-mandatory testing and counseling. It is speculated this accounts for the drop in percents of students answering items 3 and 4 correctly.

[2] The item Point Biserial (linear) Correlation is computed from the ordered pairs for each tested student (δ, c_i) where for a given studen δ is 1 or 0 according to whether that item is answered right or wrong and c_i is the number of items answered correctly by the student.

[3] The TCC Discrimination Index is computed for each item:

$$\frac{\text{\# students above test median answering item correctly} - \text{\# students below test median answering item correctly}}{(\text{\# tested students})/2}$$

MAA PLACEMENT TEST PROGRAM

PLACEMENT TEST NEWSLETTER

Vol. 8. No. 1 Fall 1985

IN THIS ISSUE

PLACEMENT IN CALCULUS at the UNIVERSITY OF ARKANSAS

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The principal placement problem for students entering the University of Arkansas (Fayetteville) is at the precalculus level, because only relatively few (less that 5%) of the approximately 2200 entering freshmen each fall have any significant course in calculus in their backgrounds. The choice for most of our students is among courses in remedial algebra, college algebra, elementary functions, trigonometry,

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PLACEMENT IN CALCULUS at FRANKLIN AND MARSHALL COLLEGE

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Franklin and Marshall is a residential liberal arts college of about 1900 students. In the class that entered in September, 1984, 72% of the students came from either Pennsylvania, New York or New Jersey. Sixty three percent of the students came from public schools. Admission to the college is highly selective, with over six applicants for each spot in the freshman class of (usually) 540.

Between sixty and seventy percent of the entering students enroll in mathematics in their first semester. For almost all students, the first course is one in our two-course calculus sequence. Each of these courses meets four times each week. A small number of students are placed in the one section of precalculus that we teach each year; about one student each year is placed in our third semester course, Linear Algebra. Thus, placement into the calculus sequence is our only sizable problem.

Our placement problem is complicated by our peculiar two-course sequence. Secondary school courses that match the first course of the normal three-course sequence do not quite match our first course. Difficult placement decisions often focus on whether or not a particular student will be able to overcome small gaps in her or his background and succeed in our second course.

The system we have devised for handling our placement problems involves the personal attention of the mathematics staff and the careful reading of student records by one member of that staff each year. We do not give placement tests for any course. From experience we have concluded that a student's record of

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finite mathematics, mathematics for liberal arts students, and two beginning calculus courses. One of these calculus courses is a three-semester-hour course taken mostly by business students; the other is for five semester hours and is the first in a three-course sequence for students of science and engineering. The following course carries five hours credit, and the third, three. It is placement in the three courses in this sequence, Calculus I, II, and III, that constitutes the placement problem in calculus.

The placement scheme for the precalculus courses does not have any provision for awarding credit. The basis for this scheme is a three-part placement test. One part is on basic algebra, one part is on trigonometry, and the final part is on calculus readiness. The test instruments are forms of the Mathematical Association of America's PTP tests on basic algebra (BA), trigonometry (half of T), and calculus readiness (CR without the trigonometry items). On the basis of a student's scores on these tests, the student is advised on initial course enrollment. If the scores are high enough that the student would not need certain courses, say college algebra, then the student is advised to consider a credit examination in college algebra. Credit examinations in college algebra and trigonometry are scheduled during the first week of classes in each regular semester. Other credit examinations are given on demand. For many students, for example mathematics or engineering majors, credit in these precalculus courses is not applicable to their degree programs; and thus many students placing beyond precalculus courses never bother with any credit examinations. The situation is quite different in the placement within the calculus sequence.

Credit in the calculus sequence, Calculus I-II-III, is applicable to all degrees, and, further, some degree programs very specifically require such credit. For example, the engineering curricula are fairly rigid in the requirement that students have credit in each of Calculus I, II, and III. All engineering students are required to have sixteen semester hours of credit in mathematics, and if the student has less than thirteen hours of credit in calculus additional courses have to be completed. Thus there is considerable pressure to achieve the normal thirteen hours of credit in Calculus I-II-III, and the placement problem in calculus becomes a placements-with-credit problem, occuring with both students entering fresh from high school and students transferring from other postsecondary institutions.

For beginning college students, there are several ways to achieve placement-with-credit in the Calculus I-II-III sequence. The most comfortable way is to score 3, 4, or 5 on either the AB Calculus or the BC Calculus examination of the Advanced Placement (AP) Program of the College Board. Those scores on AB give credit in Calculus I and placement into Calculus II, while those scores on BC give credit in both Calculus I and II and placement into Calculus III. The second way to achieve credit in Calculus I is to make a socre of at least 55 on the College Level Examination Program (CLEP) test in calculus with elementary functions. Both the AP and CLEP tests require advanced scheduling at some testing center and a fee payment. Some students with calculus in their backgrounds show up at the start of a semester and have taken neither the AP examinations nor the CLEP tests. On request, and after an interview, the Department can administer a Departmental credit examination for any of Calculus I, II, or III. A fourth possibility for placement-with-credit is really

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placement-with-conditional-credit. It may be applied to students who have taken a substantial calculus course previously, and who provide strong evidence of competence in Calculus I or II. An example of strong evidence is a score of 2 on either the AB or BC AP examinations. After an interview, the Department may agree to place a student into Calculus II and condition credit in Calculus I on the student achieving a grade of at least C in Calculus II. This, of course, is risky for the student, but experience is that most of these students are highly motivated and usually succeed. Placement-with-conditional-credit can also be effectively used after borderline performances on a credit examination.

Students transferring from other postsecondary institutions (approximately 1100 each fall) with some credit in calculus can offer thorny problems of fitting a 5-5-3 semester-hour calculus sequence to their backgrounds. The principal reason for these problems is the differing sequences in calculus at the different institutions. Some of these sequences are 3-3-3-3, 4-4-4, 5-5-5, and so forth. The student usually must try to compensate for some subject matter deficiencies by independent study or repeat some material. In cases involving engineering students who need at least thirteen hours of calculus, the choice is frequently to repeat some material. The University of Arkansas has experimented with two schemes, described briefly below, that alleviate many of these problems.

The "re-track" system was used for several years but was discontinued in 1981. After four weeks of (2/5 of the way through) the five-hour Calculus I course, the students who were clearly failing were allowed (advised, encouraged, etc.) to "re-track," that is, they were allowed to start Calculus I again and have the opportunity to pass the first three hours in the remaining part of the semester. The re-tracking students who were successful in the three hours would then register in a five-hour course that consisted of the final 2/5 of Calculus I and the first 3/5 of Calculus II. Their third course would be a five-hour course containing the final 2/5 of Calculus II and all of Calculus III. This re-tracking was repeated in the normal Calculus II classes. Administratively, this had the effect of splitting the 2 five-hour courses, Calculus I and II, into two- and three-hour courses. Thus it was much easier to fit the sequence to records of transfer students. The re-track system was discontinued because of the added administrative burden and the apparent negative effect on academic standards.

A "module system" was the precursor of re-tracking. The thirteen-hour calculus sequence was broken into 13 one-hour "modules," and students could register for a module only after successfully completing the previous ones. Having 13 one-hour courses makes it possible to have much better fits of the calculus sequence to a transfer student's record. This system was discontinued for both academic and administrative reasons.

COPE and a CALCULUS EXAMINATION

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I started my three-year term as Chairman of the Committee On Placement Examinations (COPE) in January, 1982. The Placement Testing Program (PTP), once the primary focus of Committee work and deliberations, was in fine shape. The battery of tests maintained by the program was reasonably complete. The thorough and careful revision of the series of algebra tests was finished in 1981. The time was just right for the Committee to consider the addition of new tests to PTP's packet of tests and to expand its educational and consulting services.

There had been, for some time, a number of different tests which the Committee had thought appropriate for development and inclusion in the Placement Testing Program. Some PTP subscribers had requested a test to serve entry level courses in Discrete Mathematics; others wanted a test to help with their placement problems in Elementary Probability courses. A somewhat larger, possibly just more vocal, group wanted help with the problem of placing students in the calculus course. Many students have been taking courses called calculus in their high schools. The quality of these courses varies dramatically from school to school and there is a great deal of confusion on the part of both students and their prospective college teachers as to what course a student with a high school calculus background should enter.

At its Spring meeting that year COPE focused on the possibility of developing a calculus placement

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examination. Discussion quickly disclosed that this project was going to involve consideration of more issues than had been involved in the development of any other of our tests. In particular, the question of whether the test would be used extensively as a credit examination had to be discussed.

Everyone involved with COPE programs knew that COPE writes only placement examinations, not examinations designed for the award of course credit. All the PTP literature echos this attitude; the PTP User's Guide warns against using PTP tests for award of credit. It is a sensible attitude; it is far easier to find able colleagues willing to volunteer for the preparation of placement tests than for the more rigorous and demanding task of developing exams for credit. It is the only attitude for COPE to have unless it is going to find a way to face very difficult issues of test security and the need for regular, frequent development of alternate tests to replace those whose security may be compromised.

With that COPE policy in mind, the fact that calculus is understood to be a college subject throughout the mathematics community took on new implications. Students who, as a result of taking a placement test, are placed into some pre-calculus course or even into the first calculus course, seem content with the acknowledgement that they have adequately mastered certain subject matter and are ready to proceed with different material. Students whose placement test results gain them admission into the second semester calculus course tend to want to be given college credit for the first one. It was clear that there would certainly be more pressure on PTP subscribers from students and their high school math teachers for credit to be awarded for good performance on a calculus placement exam than on a any other test in the series.

The same kind of pressure would come from other areas. It seems that the accreditation for some engineering programs hinges, at least to some small extent, on an institution's requirement that students study calculus. At most institutions this is taken to mean that engineering graduates must have credit for the calculus course on their transcripts. At such an institution, it is not agreeable to the engineering faculty for a mathematics department to tell a student that (s)he is ready to enter a second semester course in calculus unless the mathematics department is also willing to award credit for the first semester course.

The argument that a calculus placement test would necessarily be a credit examination and the clarity of the problems associated with writing such an instrument were by no means as clear during Committee discussion as I hope I have presented them above. As Committee discussion continued, it was clear that we needed to discuss issues with a wider audience. The MAA - College Board Committee on Mutual Concerns was chosen as an appropriate forum into which to expand the discussion. That standing committee of the MAA and the College Board looks at issues which jointly affect the activities of the MAA and the mathematical programs of The College Board. Since any view of our proposed calculus test as credit examination was a view of our test in competition with the Board's Advanced Placement Examination in Mathematics, our problems were certainly to be of interest to the Mutual Concerns group. Their opinions would be important to us.

The Mutual Concerns Committee discussed the issues which COPE raised when that Committee convened at the Winter Meetings in Denver in January, 1983. The Committee managed to restate our problem at least as well as we had done. More than that, it established, in the minds of the members of COPE, that wide use of a test, developed by members of the professional association, would tend to threaten the AP Program. No specific recommendation was returned to COPE. Members of the Mutual Concerns Committee made the suggestion that a yet wider audience be engaged in the discussion.

COPE responded first by sifting through the reported diliberations of its sister committee and merging those deliberations with its own, and second by polling the PTP subscribers as to whether they would encourage the development of the test. The results of the poll contained both good news and bad. Which news was which depends on the side with which you align yourself. Subscribers responded to the poll in record numbers. Well over sixty percent of the subscribers responded. Further, the subscribers strongly supported advancing with the project. On the other side, in its attempt to make responding to the pole as simple as possible, COPE had simply asked the question, "Should we develop this test?" None of the arguments, pro or con, were detailed in the scant reading material accompanying the questionnaire. There were those who interpreted the results as strong endorsement for handing out free apple pie.

At its next meeting COPE examined all of the relevant information and reached its conclusion on the matter. The members decided that the test really

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would be used as a credit examination. They assessed that no credit examination could be administered within the current PTP format and that it would be both difficult and expensive to change that format. They agreed that the College Board's Advanced Placment Program in Mathematics had served the mathematical community very well over a long period of time, that high school mathematics departments should be encouraged to develop to the point of participating in The Board's very high quality program, and that any efforts, even well-intentioned ones, that would serve to undermine that program were ill-advised. COPE decided not to enter the credit examination business.

COPE'S CURRENT AGENDA ITEMS

The Committee on Placement Examinations (COPE) has a wide variety of activities on its current agenda and we would like to invite interested subscribers to comment on these projects. We also solicits your suggestions for additional things that we should consider.

Under the label "routine business", we have under development test forms that will be added to the series as AA/2C, T/3C, and CR/1D. These are parallel forms to some existing tests and they will be added to the subscription packets as they reach their final versions. MAA mini-courses are also being planned.

COPE also has underdevelopment parallel forms for the HS-series (high school) and this activity is closely linked with a proposal for a national conference and network for people with experience and interest in the prognostic use of college placement tests in the high schools. The conference and subsequent network will require outside funding and proposals are being written to solicit that support.

In "future projects" section, we have started exploring two separate areas -- discrete mathematics and calculators. We are trying to determine the interest and need for a placement test for an introductory discrete mathematics course and we are discussing this with the MAA's Panel on Discrete Mathematics in the First Two Years. There is a strong feeling in the mathematics community that the denied use of calculators on standardized exams retards the effective development of calculator usage in mathematics instruction. If that is the case, then we should try to make available multiple choice tests that require and encourage the use of calculators. COPE is taking a serious look at this question and the possible development of a series of "calculator based" examinations.

PLACEMENT IN CALCULUS at CLEMSON UNIVERSITY

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The College Board's Level II Mathematics Achievement Test and the Advanced Placement (AP) Calculus Examinations are central to the mathematics placement policies at Clemson. Students are expected to take one of these examinations during their senior year of high school and no test are given at Clemson. (We use our PTP membership in an inservice Math-Ed program.) With two single exceptions -- elementary education and agricultural mechanization -- failure to take an examination will result in the student having to take M-105 (algebra and trigonometry). In the two exception cases, the students are automatically placed in the first course in their major, M-115 (Mathematics for Elementary Education Majors) and M-105 respectively.

Two or more courses offered by the Department of Mathematical Sciences are included in every curriculum offered at Clemson and the programs typically start with either M-101 (Finite Probability) or M-106 (Calculus I). The Level II examination scores are used to control entry into the initial courses. In the case of deficiencies, the students are required to take the single course that is available for additional background in mathematics, M-105. The algebra and trigonometry course carries five academic credits, but the credits may not be used outside of the College of Agriculture in the total hours that a students needs for graduation.

A Level II score of 440 or above is required for placement into the M-101 and a score of 550 or above is required for placement into M-106.

In case a student takes one of the AP calculus examinations in high school, the Level II examination requirement is waived and placement is established by the calculus examination score. Scores of 3, 4 or 5 on the AB examination automatically assign M-106 credit to the student and placement into M-108 (Calculus II). Likewise, scores of 3, 4 or 5 on the BC examination automatically assign M-106 and M-108 credit and placement into M-206 (Multivariable Calculus). Students with a 5 on the AB examination may elect to be placed in M-206 and attend a special 5 session seminar on series and through it receive M-108 credit. Papers with a 2 are individually examined, and "high 2's" are offered the option of higher placement with credit in the skipped courses contingent on success in the higher course.

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past achievements probably reflects her or his ability better than an examination given after a summer's lay off and immediately upon arriving on campus. Of course, we are dealing with relatively small numbers of students from a fairly homogeneous population. This uniformity plus our ability to correct mistakes allows us to evaluate secondary school transcripts with a sense of security.

Our placement procedure begins with the student's academic record. Franklin and Marhsall recommends as preparation "...four years of mathematics resulting in a readiness for beginning college calculus..." [*The Curriculum*, 1984-1985, Franklin and Marshall College]. A recent study by the Admissions Office revealed that the mean number of years of mathematics study per applicant was 3.96. That is, most of our entering students are prepared to take calculus. In fact, a number of them have had some exposure to at least the rudiments of calculus, either in a pre-calculus course or in a calculus course in secondary school.

Entering freshman at Franklin and Marshall register by mail during the summer. As part of their registration materials each matriculant receives a questionnaire (see Appendix on page 7) designed by the mathematics department. If an entering student requests a mathematics course or if, in the opinion of the Registrar, the student ought to be enrolled in a mathematics course (because of her or his projected major), the Registrar looks at question 1: "Have you studied some calculus...?"

If the answer to this question is "no," the student is usually enrolled in Calculus I. The exception occurs when he or she has not completed a pre-calculus course. A significant number of our students are terminating their secondary school mathematics at the end of the Junior year. Frequently, however, they have taken a pre-calculus course or its equivalent (Algebra 3 and Trigonometry, Mathematical Analysis, etc). To discover this may require a knowledgeable examination of the student's records.

When the Registrar is uncertain about the appropriate course for a particular student, the student's file is examined for possible assignment to pre-calculus by the member of the mathematics staff who is in charge of placement. If the answer to question 1 is "yes," the file is examined by that faculty member for placement in the appropriate calculus course. The Registrar estimates that 60% of the entering freshman pass through the faculty member's screen.

The faculty member who is placing students uses the questionnaire and the courses the student has taken, along with the grades received, SAT and Achievement test scores and any other information that might be available (knowledge of the secondary school, intended major, etc.) to place the student in either Calculus 1 or Calculus 2. Although in some years we have used a regression formula such as that used by the Coast Guard Academy [see this *Newsletter*, vol. 7, no. 2], we generally rely on the experience and intuition of the faculty member doing the screening. We have, however, developed some guidelines.

The most important guideline is that students placed in Calculus 2 must have studied all of the topics covered in our first course. These include the derivatives and integrals of the trigonometric functions and of the logarithmic and exponential functions. We sometimes place students in Calculus 2 who have not studied one of the sets of transcendental functions if we see strength in other places.

As a rule, we expect grades of A or B in mathematics courses and, secondarily, an SAT sum of at least 1100 for placement in Calculus 2. Better grades, exceptional SAT or Achievement Test scores or other evidence of high motivation or ability may induce the screener to place a student with a slight gap in her or his background in the second course. Evidence that a student has completed an Advanced Placement course in calculus with a high grade will generally suffice for placement in Calculus 2. (Since the screening is done in June and July, Advanced Placement scores are not available.) Students who select Calculus 2 are also placed in it unless there is clear evidence that they have not covered all of the required topics.

Students who are placed in Calculus 2 but who did not request that course are "invited" by letter to enroll in the course. The invitation contains a request for a response and carries the presumption that a student who does not respond to the invitation will remain in Calculus 2. A student who declines the invitation is assigned to Calculus 1. This is the first of several escape mechanisms a student unhappy with her or his placement may use.

One of the major annual headaches of the mathematics department is caused by students who are prepared for Calculus 2 but who do not want to be placed there. Many Franklin and Marshall students believe that they will be applying for admission to

please turn to page 8

Franklin and Marshall College
Mathematics Questionnaire

In order to insure your proper placement in mathematics, the following form should be filled out as carefully as possible, preferably with the help of your mathematics teacher.

1. Have you studied some calculus, including the definition of the derivative of a function (i.e., $\frac{dy}{dx}$, $f'(x)$, or y') and the integral of a function (i.e., $\int_a^b f(x)\,dx$)? ☐ YES ☐ NO

   If your answer is "No," please disregard the rest of this page. If your answer is "Yes," please answer the following questions.

2. The title and author(s) of the textbook from which I studied calculus are ____________________

   ____

   and the chapters covered in this textbook were ____________________

   ____

   (You may need to consult your mathematics teacher to answer this question.)

3. My grade in the course was ____________

4. I took the advanced placement test in calculus:

   AB____________BC____________No____________

5. We realize that an introductory course in calculus does not make one an expert and that many topics covered in calculus escape from memory very rapidly. We do not expect instant recall of the topics listed below. However, check a topic below if (1) the topic was covered in your study of calculus and (2) after a brief in-class review you probably would be reasonably familiar with the topic.

   ☐ A. Formulas for finding the derivative of a sum, product, or quotient of functions

   ☐ B. An equation of the tangent line to a curve

   ☐ C. The Mean Value Theorem

   ☐ D. The chain rule

   ☐ E. Maxima and minima of a function

   ☐ F. Differentials

   ☐ G. The Fundamental Theorem of Calculus; i.e. if $F'(x) = f(x)$, then $\int_a^b f(x)\,dx = F(b) - F(a)$

   ☐ H. The derivative and integral of $f(x) = \sin x$______, $f(x) = \log_e x$______, $f(x) = e^x$______, $f(x) = x^n$______

   ☐ I. Integration by parts

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professional school after college and that they must obtain very high cumulative averages in college to gain admission. Some of those students want to repeat a course they have already taken, hoping to get "an easy A." Other students feel unprepared for a second calculus course, although they have successfully completed the equivalent of our first course. Such students create a morale problem in Calculus 1 classes, at least initially, when other students realize that these classmates have studied the material before. We use credit as a carrot to entice the prepared but reluctant student into Calculus 2.

Students who pass Calculus 2 with a grade of C- or better automatically receive credit (but no grade) for Calculus 1. (Students who receive a grade of 3 or better on either Advanced Placement Examination in calculus also receive credit for Calculus 1.) This small inducement, the procedural flexibility discussed below and our students' general desire to excel usually persuade the prepared student to remain in Calculus 2. Students who are adamant about registering for Calculus 1 generally get their way.

The progress of freshmen enrolled in the calculus courses is carefully monitored by the instructors. Teachers of all sections of Calculus 1 and Calculus 2 ask at the first class meeting about any placement problems. In this way we usually locate several students who have been misassigned, some incorrectly to Calculus 1 and others incorrectly to Calculus 2.

During the semester, Calculus 2 students who believe they are in over their heads may request reassignment to a Calculus 1 section. Less frequently, a student in Calculus 1 may seek reassignment to Calculus 2. Such requests are initially handled by the instructor, who counsels the student. If the teacher believes the request is justified, the student is sent to the faculty member who made the original placement. After additional consultation he may make a reassignment and notify the Registrar. Students reassigned start in the new course with a clean slate. Although most reassignments are made before the middle of the semester, we have permitted students to "drop back" as late as the tenth week of the term.

As a small undergraduate college, Franklin and Marshall is able to run a relatively informal placement program in mathematics. Most sections of calculus are taught by experienced members of the faculty. The Registrar's office is willing and able to tolerate late changes in a student's schedule. Help sessions run by upperclassmen and generous faculty office hours provide additional sources of aid for students who find gaps in their backgrounds. In addition to the institutional characteristics, the program depends on the willingness of a staff member to spend many hours from mid-June to mid-July doing the screening. We are fortunate to have both the institution and the staff that allow such a program to work.

MAA SECTION LIAISON OFFICERS FOR PLACEMENT TESTING

The Committee on Placement Examinations (COPE) has asked each MAA section chairman to appoint a Placement Test Representative for their section. COPE feels that its work would be greatly facilitated if there were a formal link with each MAA section and they made this request to the section chairmen in a September letter. These 29 individuals should be interested in and knowledgable about placement in college mathematics and a list of the PTP subscribers contact persons was included with the request.

The duties of the representative could include, but would not be restricted to, disseminating information from COPE to the Section, transmitting requests and suggestions from the Sections to COPE, and arranging for sessions or minicourses on placement at Section meetings. It is not intended that the representative be a "salesperson" for PTP.

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MAA PLACEMENT TEST PROGRAM

PLACEMENT TEST NEWSLETTER

Vol. 9, No. 1 Fall/Winter 1986

IN THIS ISSUE

SYMPOSIUM ON CALCULATORS AND MATHEMATICS TESTING

Calculators in the Standardized Testing of Mathematics was the title and subject of a one-day symposium held in New York City in September 1986. The Symposium was jointly sponsored by The College Board and the Mathematical Association of America (MAA). Invited participants included the members of The College Board's Mathematical Sciences Advisory Committee (MSAC) and the MAA's Committee on Placement Examinations (COPE). Other participants included representatives from Educational Testing Service, the National Council of Teachers of Mathematics, the American Mathematical Association of Two-Year Colleges, and the Mathematical Sciences Education Board. Donald Kreider, MAA Treasurer, Alfred Willcox, MAA Executive Director, and COPE's members represented the MAA.

At the morning session four papers were presented and discussed. John Kenelly, the chair of COPE, presented a paper on prior uses of calculators in standardized mathematics testing. Jim Wilson and Jeremy Kilpatrick of the University of Georgia read a paper on theoretical issues in the development of calculator-based mathematics tests. Ohio State faculty members Joan Leitzel and Bert Waits discussed the effects of calculator use on mathematics course and state-wide

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CALCULATOR-BASED PLACEMENT TESTS

In September, the MAA Committee on Placement Examinations instituted the Calculator-Based Placement Test Program (CBPTP) project and appointed John Harvey project director. Initially, the CBPTP project will develop six tests which will correspond to the present PTP placement tests. The content of the new tests and their abbreviations will be:

1. arithmetic and basic skills (C/A-SK),
2. basic algebra (C/BA),
3. algebra (C/A),
4. advanced algebra (C/AA),
5. trigonometry (C/T), and
6. calculus readiness (C/CR).

The calculator-based tests developed by this project will not supplant the placement tests presently in the Placement Testing Program (PTP) package. Instead, as completed, the CBPTP tests will be added to the present PTP subscriber package. Thus, when completed, the Calculator-Based Placement Testing Program will permit colleges and universities to choose traditional or calculator-based PTP tests.

Texas Instruments and CBPTP

For several years the members of COPE had discussed the possible need for and ways of developing calculator-based placement tests. After obtaining permission from MAA's Executive and Finance Committee, early in 1986 a CBPTP project proposal was written. That proposal was sent to the Texas Instruments Corporation (TI); subsequently, John Kenelly and John Harvey met in Dallas with

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placement test scores. John Harvey explored the development of calculator-based mathematics placement tests.

During the afternoon session each Symposium participant joined one of three discussion groups. One group discussed theoretical issues in the development of calculator-based mathematics tests; one group, the changes in test data that may be needed; and one group, the implementation of calculator-based testing.

The Symposium participants developed recommendations (a) endorsing the use of calculators throughout mathematics instruction and testing, (b) urging both The College Board's MSAC and MAA's COPE to develop calculator-based achievement tests, and (c) cautioning test developers of the need to (i) measure achievement and ability of mathematical content that is becoming more important as a result of new technologies, (ii) not confuse measuring calculator skills and mathematics achievement, and (iii) consider the use of new item types and testing techniques when developing calculator-based tests.

The proceedings of the Symposium will be published early in 1987; this volume will include the four invited addresses, the discussants' remarks about the papers, and the Symposium recommendations. Individual copies will be available at a modest price from the MAA. A copy of the Symposium proceedings will be included in the 1987 PTP subscriber packet.

PT Newsletter in ERIC

Issues of the *Placement Testing Newsletter* missing? Where are Bernie Madison's papers on placement testing at the University of Arkansas? Help is coming!

A cumulative index of the first eight volumes of the *PT Newsletter* has been prepared, and copies of all eight volumes have been sent to ERIC (Educational Resources Information Center) and will soon be available in microfiche form. Both the index and the

Continued on page 3

representatives from TI's Consumer Products Division. In August, the Consumer Products Division funded the 1986 CBPTP activities. At COPE's September meeting in Washington, TI representative Michael Chrobak presented the grant check to MAA.

CBPTP Policy Group Meets

The procedures used to develop the present PTP tests will be used to develop CBPTP tests. But, when calculator use is expected during testing, many new testing issues arise. In order to help resolve those issues and to oversee the work of the individual test panels, COPE has created a CBPTP Policy Group that consists of COPE members Linda Boyd, John Harvey, John Kenelly, Mary McCammon, and Al Willcox, TI representative Michael Chrobak, and the chairs of three test panels: Mary Lindquist (C/A-SK), Thomas Tucker (C/CR), and Bernard Madison (C/BA).

The CBPTP Policy Group met at MAA Headquarters on October 24-25, 1986. At that meeting the Policy Group discussed issues and problems related to the development of the CBPTP tests including (a) the kind(s) of calculators for which the tests will be developed, (b) the "fit" between the traditional and calculator-based PTP tests, and (c) the use of alternative items formats in the calculator-based tests.

Test Panels

Two of the first three test panels have been consituted. The first two CBPTP tests developed will be C/A-SK and C/CR.

The C/A-SK test panel consists of Linda Boyd, Mary Lindquist (Chair), and Bert Waits. Linda is at DeKalb College, Clarkston, Georgia; Mary, Columbus College, Columbus, Georgia; and Bert, at Ohio State. The C/A-SK test panel will hold its first meeting in late November, 1986. Three additional meetings of the C/A-SK panel are being planned for 1987.

The C/CR test panel consists of John Kenelly, Tom Tucker (Chair), and Paul Zorn.

Continued on page 3

PT Newsletter microfiche will be in the 1987 issue of the *PTP User's Guide*.

PTP UPDATES

New Forms

A continuing, important COPE activity is the development new forms of PTP tests. As we develop these new forms we carefully check the items on the present forms for consistency and develop or refine the formulas that generate the incorrect response (i.e., the foils). These procedures enable us to produce new items that are parallel to their parent items and to be confident the new forms are equivalent to those that are already a part of PTP. Recently, COPE has developed new forms for four tests. Two new forms (i.e., BA/2C and A/4C) were included in the 1986 PTP subscriber packet. The new forms AA/2C and T/3C will be in the 1987 subscriber packet. New versions of A-SK and CR will be in the 1988 packet.

PTP User's Guide

The *PTP User's Guide* will have a new look in 1987. In addition to a thorough editing and an updating of the present content of the *Guide*, desktop publishing techniques have permitted COPE to add new information and data. As the calculator-based placement tests are added to the PTP subscriber packet, the *PTP User's Guide* will be further amended and expanded to include information about these tests and ways of using them in placement testing.

Test Statistics

During the initial development of the PTP tests, a variety of test and item data were gathered; COPE members called them "The Box." Even though the data were not collected from a nationally representative sample, these data were useful in COPE minicourse instruction on good and bad items and when generally describing the quality of items to PTP subscribers. Unfortunately, "The Box" was lost or inadvertently put in

Continued on page 4

John is a member of Clemson's faculty; Tom, of Colgate's faculty; and Paul, of St. Olaf's faculty. Each of these panel members participated in the 1986 Sloan Conference on Calculus Instruction. The C/CR panel will meet for the first time during the 1987 AMS/MAA meetings in San Antonio; there will be three additional meetings of this test panel in 1987.

Tentative plans for meetings of both the C/BA and C/A test panels in 1987 have been made. The last two test panels (for C/AA and C/T) would begin their work in 1988 or 1989. By 1988 both C/A-SK and C/CR may be a part of the PTP subscriber packet.

Correspondence about the Calculator-Based Placement Test Program should be sent to John G. Harvey, Department of Mathematics, University of Wisconsin, 480 Lincoln Drive, Madison, WI 53706.

PT MINICOURSE

The bi-annual MAA placement testing minicourse will be held in conjunction with the January 1987 AMS/MAA meetings in San Antonio. If you want to refresh or extend your knowledge of placement testing, consider enrolling in this minicourse. Enrollment information can be found in the October 1986 issue of *Focus* under Minicourse #15.

PT NEWSLETTER

Papers Needed

This issue of the *Newsletter* is four pages too small. The missing four pages are ones that *should* be filled with papers authored by you--the *Newsletter* subscribers. So, get out your word processors and write down your experiences and ideas. Any paper dealing with placement testing will be considered; we, the editors, are particularly interested in papers about prognostic testing, statewide placement testing programs, and test scoring.

The *Placement Test Newsletter* is published by the Mathematical Association of America

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the trash. At present COPE members are collecting similar test data. So, soon, COPE will be again able to help PTP subscribers when they seek data about item and test reliabilities.

COPE Consulting Service

Have questions about a particular PTP test? Need some help with cut-and-paste? Find the *PTP User's Guide* unclear? COPE has established a Consulting Service. Send your questions to the COPE Consulting Service by writing to John Harvey; his address can be found elsewhere in this *Newsletter*.

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and is distributed to all subscribers to the MAA's Placement Test Program. The views expressed in articles in the *Newsletter* are those of the authors and editors and do not necessarily represent policies of the Mathematical Association of America.

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Send three copies of the articles you want considered to the editor.

In the Next Issue

For the past couple of years publication of the *PT Newsletter* has been irregular. While publication will continue to depend on the articles submitted and favorably considered, the editors hope that a twice-yearly publication schedule can be restored. In the Spring 1987 issue of the *Newsletter* there will be an article on the early (prognostic) testing program in Ohio, a report on the new Calculator-Based PTP project, and ??? If you have ideas for articles that you would like to see in the *Newsletter* and suggestions about the authors of those articles, please write to either of the editors.

COPE SECTION REPS

Many MAA sections have now appointed Placement Test Section Representatives. These persons are *not* "salespersons" for the MAA Placement Test Program. But they do disseminate information from COPE to the MAA Sections, transmit requests and ideas from the Sections to COPE, and can arrange for sessions on placement testing minicourses at Section meetings.

MAA PLACEMENT TEST PROGRAM

PLACEMENT TEST NEWSLETTER

Volume 9, Number 2 Spring/Summer 1987

IN THIS ISSUE

QUESTIONNAIRE RESULTS

by Judith Cederberg
St. Olaf College
John G. Harvey
University of Wisconsin-Madison

In May 1986 a User Questionnaire was sent to each PTP subscriber; about 30% (84) of the subscribers completed and returned the questionnaire. We thought you might be interested a summary of the data that we gathered.

Who Supervises Math Placement?

If your mathematics department supervises mathematics placement, then your institution is typical. Eight-two percent of our responses stated that the mathematics placement program was supervised by the mathematics department of that college or university.

What PTP Tests Are Used?

Almost all (93%) of the schools responding reported that they had used some PTP test within the previous year. The test most frequently used was Basic Algebra; 77% of our respondents indicated they had used this test or items from it. The reported use of the other PTP tests was: Calculus

Questionnaire Results *(Continued)*

Readiness, 69%; Arithmetic and Basic Skills, 57%; Algebra, 33%; Trigonometry, 20%; and Advanced Algebra, 18%.

What Determines Placement?

A large majority (85%) of the responding institutions used other kinds of information in addition to placement test scores when making their placement recommendations. The kinds of additional information used were:

1. the number and kind of previous mathematics courses (62%),
2. grades in previous mathematics courses (58%),
3. SAT quantitative score (39%),
4. ACT mathematics score (37%),
5. SAT qualitative score (17%),
6. high school rank in class (17%),
7. high school grade point average (14%), and
8. ACT verbal score (8%).

[Readers who are interested in using added information in placing students may want to review the *PT Newsletter* papers by Hassett & Smith (1983, Winter) and by Manfried (1984, Spring).]

What Mathematics Courses?

In our survey we asked the PTP subscribers to identify the courses students were placed in by their placement testing program. Those who responded reported their placement tests were used to place students into:

1. calculus (73%),
2. business calculus (27%),
3. engineering calculus (23%),

Questionnaire Results *(Continued)*

4. precalculus (20%),
5. trigonometry (39%),
6. college algebra (64%),
7. intermediate algebra (49%),
8. basic algebra (39%),
9. basic arithmetic (31%), and
10. finite mathematics (29%).

More than half of those returning the questionnaire indicated that they checked the accuracy of their placement process. The most common practice was to correlate course grades with placement recommendations.

User Satisfaction

The Committee on Placement Examinations (COPE) is always exploring ways in which it can improve the Placement Testing Program. So, one question asked subscribers to tell us of their satisfaction or dissatisfaction with the PTP tests. Seventy-six percent of those responding indicated that they were very satisfied or satisfied with the PTP tests; only 3% indicated that they were dissatisfied or very dissatisfied.

The respondents made many suggestions for improvement of the test package; we include a few of those suggestions here. Two subscribers requested additional forms of each test. Three institutions requested that there be more trigonometry questions on the Calculus Readiness (CR) test. And two institutions suggested the need for an introductory composite exam. Several institutions expressed interest in having national norms for the PTP tests. [Because of the intended use of PTP tests, national norms are inappropriate. Statistics compiled from user data are in the PTP User's Guide. At present COPE is gathering statistics that will include the *r*-biserial coefficient and difficulty index for each test item and the overall reliability of each PTP test.]

Testing with Calculators and Prognostic Testing

Questionnaire Results *(Continued)*

Recently, several national organizations have urged the use of calculators both during instruction and when testing. However, only 4% of the subscribers responding indicated that they require students to have a calculator during placement testing; an additional 20% permit the use of calculators on placement tests. Seventy-two percent of the institutions responding indicated they were not interested in PTP tests that are calculator-based. One respondent said "requiring a calculator would be to insist on skills most of them [the students] don't have." Those who expressed interest in PTP tests that are calculator-based were most interested in having calculator-based Calculus Readiness (CR) and Trigonometry (T) tests.

Some universitites and states have begun, or are planning, to administer placement tests to high school juniors (i.e., prognostic testing). Among the states are Ohio (where 80% of the high schools participate in the Ohio Early Mathematics Placement Test program), California, and Oregon. Only 8% of the responding PTP subscribers had similar programs though 21% indicated they were interested in prognostic testing. While only 13% said they were definitely not interested in becoming involved in prognostic testing, another 39% said they were probably not interested.

Who Reads the PT Newsletter

Twenty-one percent of the persons responding indicated that they read all of the PT Newsletter; 25% said they read most of each issue. However, 23% said they read little or none of the Newsletter. The remaining 29% sample portions of each issue. Over half of the suggestions for *Newsletter* articles asked for descriptions of placement test programs at other institutions.

CALCULUS RECOMMENDATIONS

[Editor's Note. The following was sent

to over 35,000 people including secondary school principals and teachers and College Board Advanced Placement Coordinators. *Newsletter* readers will be interested in the recommendations made.]

MEMO

TO: Secondary School Mathematics Teachers

FROM: The Mathematical Association of America
The National Council of Teachers of Mathematics

DATE: September 1986

RE: Calculus in the Secondary School

Dear Colleagues:

A single variable calculus course is now well established in the 12th grade at many secondary schools, and the number of students enrolling is increasing substantially each year. In this letter we would like to discuss two problems that have emerged.

The first problem concerns the relationship between the calculus course offered in high school and the succeeding calculus courses in college. *The Mathematical Association of America (MAA) and the National Council of Teachers of Mathematics (NCTM) recommend that the calculus course offered in the 12th grade should be treated as a college-level course.* The expectation should be that a substantial majority of the students taking the course will master the material and will not then repeat the subject upon entrance to college. Too many students now view their 12th grade calculus course as an introduction to calculus with the expectation of repeating the material in college. This causes an undesirable attitude on the part of the student both in secondary school and in college. In secondary school all too often a student may feel "I don't have to master this material now, because I can repeat it later;" and in college, "I don't have to study this subject too seriously, because I have already seen most of the ideas." Such students typically have considerable difficulty later on as they proceed further into the subject matter.

Calculus Recommendations *(Continued)*

MAA and NCTM recommend that all students taking calculus in secondary school who are performing satisfactorily in the course should expect to place out of the comparable college calculus course. Therefore, to verify appropriate placement upon entrance to college, students should either take one of the Advanced Placement (AP) Calculus Examinations of the College Board, or take a locally-administered college placement examination in calculus. Satisfactory performance on an AP Examination carries with it college credit at most universities.

The second problem concerns preparation for the calculus course. *MAA and NCTM recommend that students who enroll in a calculus course in secondary school should have demonstrated mastery of algebra, geometry, trigonometry, and coordinate geometry.* This means that students should have at least four full years of mathematical preparation beginning with the first course in algebra. The advanced topics in algebra, trigonometry, analytic geometry, complex numbers, and elementary functions studied in depth during the fourth year of preparation are critically important for students' later courses in mathematics.

It is important to note that at present many well-prepared students take calculus in the 12th grade, place out of the comparable course in college, and do well in succeeding college courses. Currently the two most common methods for preparing students for the college-level calculus course in the 12th grade require students to take secondary year algebra and geometry concurrently. Students beginning with algebra in the 9th grade who take only one mathematics course each year in secondary school should not expect to take calculus in the

Calculus Recommendations *(Continued)*

12^{th} grade. Instead, they should use the 12^{th} grade to prepare themselves fully for calculus as freshmen in college.

We offer these recommendations in an attempt to strengthen the calculus program in secondary schools. They are not meant to discourage the teaching of college-level calculus in the 12^{th} grade to strongly prepared students.

[Signed]

Lynn Arthur Steen
President
Mathematical Association of America

John A. Dossey
President
National Council of Teachers of Mathematics

CBPTP PROJECT UPDATE

The MAA Calculator-Based Placement Test Program (CBPTP) project was first described in the last issue of the *PT Newsletter*. Since then considerable progress has been made. The following is a summary of recent CBPTP activities.

1987 Activities Funded by TI

Texas Instrument's Consumer Products Division has renewed its grant to the MAA for the CBPTP project. The 1987 TI renewal funds these activities:

* Three meetings each of the C/A-SK (i.e., Calculator Arithmetic and Basic Skills) test panel and the C/CR (i.e., Calculator Calculus Readiness) test panel.

* An initial meeting of both the C/BA (i.e., Calculator Basic Algebra) test panel and the C/A (i.e., Calculator Algebra) test panel.

CBPTP Project Update *(Continued)*

* Two additional meetings of the C/BA test panel.

Led by Michael J. Chrobak, the staff of TI's Consumer Products Division continues to supply both calculator information and sample calculators to the test panels.

C/A-SK Test Panel Meets

The first meeting of the C/A-SK test panel was held on November 21-22, 1986; those attending this meeting were Linda Boyd, John Harvey (CBPTP project coordinator), Mary Lindquist (C/A-SK panel chair), and Bert Waits. During their first meeting the C/A-SK test panel:

1. decided to recommend that a scientific calculator be used by students when taking the C/A-SK test,

2. examined the present A-SK test and tentatively identified the items on that test that might be included and should not be included on C/A-SK,

3. identified new content areas that may be tested by C/A-SK, and

4. wrote new calculator-active items.

At the completion of their meeting the members of the C/A-SK panel had plans to tryout their new items, to gather data on the present A-SK test, and to collect information about the kinds of calculators students have and the test items on which students elect to use their calculators.

The C/A-SK panel will meet again in mid-June. At that meeting they will continue development of the C/A-SK test; they intend to pilot a first draft of that test in September.

C/CR Test Panel Meets

The test panel for C/CR met for the first time during the Joint AMS/MAA Meeting

CBPTP Project Update *(Continued)*

in January 1987. Those attending this meeting were John Kenelly, John Harvey, Tom Tucker (C/CR panel chair), and Paul Zorn.

At their meeting, the C/CR group first spent a considerable amount of time discussing the philosophy of the present CR test and how that test was constructed so as to represent that philosophy. From there they moved on to a discussion of the "least capable" calculator that would be used to respond to the calculator-active items on C/CR; scientific, programmable scientific, graphics, and symbolic manipulation calculators were all considered. It was decided that C/CR would be developed so that the calculator-active items could be answered using the "least capable" of the calculators considered--a scientific calculator.

The remainder of the January C/CR panel meeting test panel was spent developing calculator-active items. These items have been refined and given to a small sample of students. The data from this tryout will be discussed when the test panel next meets on May 15-16, 1987.

At its May meeting the C/CR test panel plans to develop an initial version of the C/CR test for pilot testing in September 1987.

Two New Test Panels

The CBPTP project has constituted two new test panels. One test panel will develop the C/BA test; that test panel will consist of Philip Curtis (University of California-Los Angeles), Bernard Madison (Panel Chair; University of Arkansas-Fayetteville), and Mary McCammon (Pennsylvania State University). The C/BA test panel is scheduled to hold three meetings during 1987; the first meeting is planned for late July.

Another new test panel will develop the C/A test. Thus far, only two panel appointments have been; they are Judith Cederberg

CBPTP Project Update *(Continued)*

(St. Olaf College) and Robert Northcutt (Panel Chair; Southwest Texas State University). The C/A test panel is scheduled to meet once during 1987.

EMPT PROGRAM PROVIDES REMEDIATION FORUM

by Franklin Demana
The Ohio State University

[Editor's Note. About 80% of Ohio high schools presently participate in the Early Mathematics Placement Testing (EMPT) program. The following paper is reprinted from the *EMPT Newsletter* with the permission of the author and the editor. The original title was "News from the Campuses: The Ohio State University."]

The mathematics preparation of our entering freshmen has shown steady improvement in recent years. The percentage of the freshman class with remedial mathematics placement has dropped from 43% in 1979 to 25% in 1985. There are many reasons for this improvement in mathematics preparation. *The OHIO EMPT Program has provided the forum for high school and university cooperation to address and reduce the need for remediation* [emphasis added]. A statewide commission dealing with the academic preparation of Ohio college freshmen led to the current conditional-unconditional admissions policy of state supported colleges and universities. Autumn Quarter 1984 was the first quarter this policy went into effect at Ohio State. The percent of freshmen with remedial mathematics placement dropped from 34% in 1983 to 25% in 1984. A mathematics course (*Transition to College Mathematics*) that permits students to correct mathematical deficiencies while still in high school is in place in many schools throughout Ohio.

To be unconditionally admitted to The Ohio State University, a student's high school program must include the following coursework: 4 units of English, 3 units

Remediation Forum *(Continued)*

of mathematics, 2 units of a foreign language, 2 units of science, 2 units of social studies, 1 unit of fine arts, and 1 additional unit in any of the previously mentioned areas. Only 9% of the Ohio State Autumn Quarter 1985 freshmen failed to meet the mathematics requirement of three or more years of college preparatory mathematics. All of the above efforts and the strong support of high school teachers and administrators have resulted in this drastic improvement in the academic preparation of our entering freshmen.

Students should be aware of several issues related to taking the mathematics placement exam at Ohio State. Calculators *are permitted* on the multiple-choice placement exams (they are also permitted on *all* EMPT exams). OSU students that need to start with college level calculus must be eligible for the OSU "D" placement test. This means they must score a 25 or higher on the mathematics portion of the ACT test or 55 or higher on the SAT test. Students can take the ACT test at OSU the day befosre orientation to try to improve their mathematics placement. More information about the OSU placement exams, as well as sample problems, are found in the OSU Bulletin, *Preparing for Ohio State*, which should be available in all high schools.

We are delighted by the drop in percentage of remedial students entering OSU and look forward to continued improvement in the academic preparation of university freshmen. Working together we can solve this complex problem.

ADDITIONAL INFORMATION ABOUT EMPT

If you would like additional information about the Ohio EMPT program, you can write to Prof. Bert Waits, The Ohio EMPT Program, Room 202 Mount Hall, 1050 Carmack Road, Columbus, Ohio 43210.

EMPT Information *(Continued)*

The following papers describe some of the effects of the Ohio EMPT program and of the *Transition to College Mathematics* course:

Adcock, A., Leitzel, J. R., & Waits, B. K. (1981). University mathematics placement testing for high school juniors. *American Mathematical Monthly*, *88*(1), 55-59.

Leitzel, J. & Osborne, A. (1985). Mathematical alternatives for college preparatory students. In C. R. Hirsch & M. J. Zweng (Eds.). *The Secondary School Mathematics Curriculum*. 1985 Yearbook of the National Council of Teachers of Mathematics. Reston, VA: National Council of Teachers of Mathematics.

Waits, B. K. & Leitzel, J. R. (1985, Spring). An update on university mathematics placement testing for high school juniors in Ohio. *Mathematics in College*.

COPE ACTIVITIES

January 1987 Meeting

The MAA Committee on Placement Examinations (COPE) met in San Antonio in January during the Joint AMS/MAA Meeting. Part of that session was attended by some of the PTP Section Representatives; they and COPE members discussed the MAA/CEEB calculator symposium, the CBPTP project, a proposed prognostic testing conference, the 1987 PTP Subscriber's Packet, and ways in which COPE might improve its services to PTP subscribers.

During the remainder of the San Antonio meeting COPE members dealt with these agenda items:

1. the development of a proposal to fund a computer-generated placement test project,

2. the proposed prognostic testing conference,

3. the 1987 revision of the *PTP User's Guide*, and

4. the possibility of developing a discrete mathematics placement test.

April 1987 Meeting

The Spring 1987 COPE meeting was held in Dallas on April 24-25, 1987. The meeting was preceded by a one-day "pre-session" during which four COPE members (Linda Boyd, John Harvey, John Kenelly, & Mary McCammon) met with representatives from TI to discuss the CBPTP project.

COPE members had a full agenda and a busy two days in Dallas. Some information from and outcomes of the meeting are:

* the Placement Testing Program now has 379 subscribers.

* COPE will continue to seek funding for a computer-generated placement test project, a national prognostic testing conference, and the development of a discrete mathematics placement test.

* final content revisions on two new test forms: A-SK/2C and CR/1D. These new forms will be in the 1989 PTP Subscriber's Packet.

* production of new forms of the high school tests, HS-E and HS-I. These forms will appear in the 1989 PTP Subscriber's Packet.

* a decision to begin producing new forms of *three* PTP tests each year beginning in 1989. The new forms produced in 1989 will be BA/2D, A/4D, and AA/2D.

* a decision to offer the PTP Minicourse each year instead of every other year.

COPE Activities *(Continued)*

COPE will hold its Fall 1987 Meeting in Washington, D. C. on September 25-26.

If you have issues or problems that you think COPE should consider, please send them to John W. Kenelly, COPE Chair, Department of Mathematical Sciences, Clemson University, Clemson, SC 29634-1907.

1987 PTP SUBSCRIBER'S PACKET

Beginning in June 1987, the PTP Subscriber Packet will contain three new items. One item will be a new form of the Advanced Algebra test, AA/2C. A second item will be a new form of the Trigonometry test, T/3C. The third new item will be a revised version of the *PTP User's Guide*.

COPE CONSULTING SERVICE

If you have questions about a particular PTP test, need some help making your own placement testing by cutting-and-pasting PTP tests, or find the *PTP User's Guide* unclear, then write to the COPE Consulting Service. The Consulting Service will attempt to help you solve these problems and any others that you have in using the PTP Program. Send your questions to the COPE Consulting Service by writing to John Harvey; his address can be found on page 9.

COPE SCHEDULES PANEL AT 1987 SUMMER MEETING

At the Summer Joint Meetings in Salt Lake City, COPE is sponsoring a panel discussion on *Using placement examinations to create order in freshman placement.* The session will take place at 2:30 P.M. on Saturday, August 8. The moderator is John G. Harvey, University of Wisconsin.

COPE Panel at Summer Meeting *(Continued)*

The other members of the panel will be Linda H. Boyd, DeKalb College, Joan R. Hundhausen, Colorado School of Mines, Bernard L. Madison, University of Arkansas-Fayetteville, and Billy Rhoades, Indiana University-Bloomington.

PLACEMENT TESTING MINICOURSE GIVEN IN SAN ANTONIO

by Linda H. Boyd
DeKalb College

Members of the Committee on Placement Examinations (COPE) presented the 1987 version of their minicourse "Constructing Placement Examinations" during the Joint AMS/MAA Meeting in San Antonio. The 29 participants, representing a wide range of institutions from community colleges to state universities, gave this minicourse high marks for meeting its published goals and for providing useful information. They seemed particularly impressed by the way the minicourse was presented and by the expertise of the presenters.

Using "Dime-Store" Statistics

The four-hour minicourse was divided into six segments; different COPE members were responsible for each one of the sections. John Kenelly of Clemson University and COPE chair, began the sessions by explaining the MAA Placement Testing Program (PTP) and the benefits to institutions that subscribe. He then described what could be done with "dime store" statistics so as to begin evaluating tests and test items before test center results arrive. He concluded with a discussion of the most important item and test statistics obtained by using statistical packages.

Development of Multiple-Choice Items

The second presentation, by John Harvey of the University of Wisconsin, discussed the characteristics of a good multiple-choice

San Antonio Minicourse *(Continued)*

test item and led the group through a step-by-step plan for constru .ting good items. He also emphasized the importance of documenting the "generic form" of items so that parallel versions of them can be easily generated.

Test Item Workshop

The first minicourse session concluded with an item writing workshop that was led by Mary McCammon, Pennsylvania State University. She divided the participants into small groups, assigned each group the task of preparing a test item, and specified the content domain for the assigned item. COPE members worked with the small groups and led the discussions of the items that were generated. Each group selected one of the items they had generated to be presented at the next session.

Items Discussed

Between the initial and last sessions, Billy Rhoades, Indiana University, reviewed the items that the groups had chosen. At the beginning of the last session he discussed both the weak and the strong points of several of those items.

The Parade

The fifth presentation was by the COPE "parade." Members of the parade were John Kenelly, Joan Hundhausen of the Colorado School of Mines, and Jack Robertson of Washington State University. The parade presented both good and bad it^ms and described the item statistics for `h one. This presentation concluded with a.. examination of the uses of the r-biserial statistic, of the quintile distribution, and of the item difficulty index.

Setting Cut-Off Scores

Linda Boyd of DeKalb College explained several ways of setting cut-off scores once a placement test has been chosen or con-

San Antonio Minicourse *(Continued)*

structed. She divided the participants into small groups so that they might have an opportunity to use test data and to select a cut-off score using the methods she presented.

Wrap-Up

Billy Rhoades led the concluding question-and-answer session. Many of the questions that arose during that session were about the actual implementation and administration of a placement testing program and about the interpretation of test statistics. As a result the members of COPE are presently revising the minicourse so as to devote more time to these topics. The newly revised course will be given during the 1988 Joint AMS/MAA Meeting in Atlanta. In addition, individual COPE members are available to give the complete or a portion of the minicourse at individual institutions or at MAA section meetings or to consult with colleges and universities planning to institute a mathematics placement testing program.

[Editor's Note. The recent user survey revealed that only 2% of those responding had participated in a COPE placement testing minicourse. I hope that you will consider attending the one being given in Atlanta.]

PTP SUBSCRIBERS

COPE thought that you might be interested in knowing *who* present PTP subscribers are or in talking with some other institution in your area that is a PTP subscriber. Thus the list of present PTP subscribers is in the last part of this *Newsletter*.

PTP SECTION REPRESENTATIVES

PTP Section Reps *(Continued)*

PTP Section Representatives disseminate information from COPE to their MAA Section, transmit requests and suggestions from the MAA Sections to COPE, and arrange for sessions or minicourses on placement at MAA Section meetings. The members of COPE are pleased tha. 16 of the 29 Sections presently have PTP Section Representatives. COPE thought you would like to know who they are; a list of them can be found near the end of this *Newsletter*.

PTP NEWSLETTER

The *Placement Test Newsletter* is published by the Mathematical Association of America and is distributed to all subscribers to the MAA's Placement Test Program.

If you submit an article for consideration, *and we hope you will*, please send three copies of it to the Editor or the Associate Editor. Here are the names and addresses of both persons.

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Associate Editor

Jack M. Robertson
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PTP SUBSCRIBERS

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PTP Subscribers *(continued)*

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Manhattan College
Marist College
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New York University
Polytechnic University
SUNY-Farmingdale
SUNY-New Paltz
SUNY-Old Westbury
SUNY-Purchase
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St. Thomas Aquinas College
Suffolk County Community College
Touro College
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PTP Subscribers *(Continued)*

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South Dakota State University
St. Cloud State University
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University of Minnesota-Morris
University of North Dakota
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Maryville College
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Penn Valley Community College
Southeast Missouri State University
St. Louis Community College-Florence
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State Fair Community College
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Keene State College
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Middlesex Community College
North Adams State College
Pine Manor College
Plymouth State College
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PTP Subscribers *(Continued)*

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Walsh College
Wright State University
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University of Central Arkansas
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Columbia Christian College
Columbia College
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Medicine Hat College
North Slope Higher Education Center
Okanagan College
Olympic College
Oregon Institute of Technology
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University of Idaho
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PTP Subscribers *(Continued)*

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MAA PLACEMENT TEST PROGRAM

PLACEMENT TEST NEWSLETTER

☞ **Please note the call for papers on page 9.**

This is Volume 9, Number 2 of the Placement Test Newsletter. It is being sent to a large number of nonsubscribers as well as to the subscribing institutions that are listed geographically on pages 10-15 of the Newsletter. We are sending this special issue to help strengthen and extend the existing PTP network. Subscribers are encouraged to be in touch with other subscribers to help each other find better ways to use the program.

Needs vary in different locations and by type of school, so for an indication of what PTP can do for your school, the best thing to do is to get in touch with a similar department that is already using the program.

We urge nonsubscribers to write for sample materials care of:

PTP
The Mathematical Association of America
1529 Eighteenth Street, NW
Washington, DC 20036

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PLACEMENT TEST NEWSLETTER

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