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OEA Report 10-02

Intermediate Mathematics Placement Test (MPT-I): Version 11 Development

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July 2010

INTRODUCTION

This report describes the development of Version 11 of the Intermediate Mathematics Placement test (MPT-I). The MPT-I is composed of 35 three-alternative multiple-choice items and places students into first-year, college-level, mathematics courses. At any given time, two versions of the exam are in use: a 'primary' version used for the first administration to all students, and a 'secondary' version used for retests.

We ordinarily anticipate introducing a new version of the MPT-I every two to four years, to prevent test content from becoming generally known. New versions are introduced as the 'secondary' or retest version; the previous retest version then becomes 'primary,' and the previous 'primary' version is retired. By introducing new versions in the 'secondary' position, we are able to observe the performance of the complete test under actual testing conditions before using it for widespread placement.

We followed an accelerated schedule in developing and introducing MPT-I Version 11 due to theft of a Version 9 test booklet in September 2009. Immediately following the theft, we retired Version 9, moved Version 10 to 'primary' status, and directed testing centers to begin using MPT-G Version 9 for retests. We subsequently followed an abbreviated development plan to create and pretest a new MPT-I version, and to compare the performance of the newly created MPT-I Version 11 with the existing Version 10.

This report summarizes the development process and results of an instrument pilot test conducted during winter quarter 2010 at the University of Washington. A variety of analyses were carried out to address the following specific questions:

- Are total test scores on the MPT-I Version 11 similarly reliable to scores on Version 10?
- Is the overall difficulty of the MPT-I Version 11 statistically equivalent to that of Version 10?
- Are the MPT-I Version 10 and Version 11 equally predictive of course grades?

METHOD

Test development and pilot testing were conducted October 2009 through January 2010.

Test Development

The standard MPT development cycle consists of: 1) faculty workshops to create and review new items during summer and autumn, 2) initial item pretests in classrooms during winter, 3) final item pretesting during APTP statewide testing in May and June, 4) finalization of the new test version over summer, and 5) introduction of the test at the beginning of the new testing season October 1. We abbreviated this process in creating the MPT-I Version 11 in order to make the test available earlier than would normally be the case. In particular, items parallel to those of the stolen MPT-I Version 9 were created by a member of the math faculty who serves on the Academic Placement Testing Program (APTP) Governing Board. Items were then reviewed and modified by an OEA research scientist based on existing test and item specifications, as well as the results of previous APTP item analysis studies. Where necessary, item stems were made clearer and more concise, graphics were edited for inter-test consistency, and response alternatives were changed in an effort to increase their plausibility and attractiveness.

Pilot Test

The performance of MPT-I Version 11 was compared to that of Version 10 during a pilot test conducted at the University of Washington (UW) during the first week of winter quarter 2010 (January). An OEA staff member met with all teaching assistants (TAs) at the beginning of the quarter to discuss the purpose of the pilot test and to review standardized administration procedures. TAs were given testing kits that included an administration script, test count verification forms, numbered test booklets, answer sheets, scratch paper, number 2 pencils, and a labeled envelope to return materials for each section (see sample materials in Appendix B).

Three test booklets (A-C) were formed from blocks of items taken from MPT-I Versions 10 and 11 (Table 1). Each booklet contained 25 items: eleven or twelve items from Version 10, a similar number from Version 11, and one or two experimental items. Although test versions 10 and 11 were very similar to one another, three of the 35 pairs of items were not strictly parallel — reflecting differences between Version 9 (on which Version 11 was modeled) and Version 10.

Test booklets were limited to 25 items (rather than the usual 35) so that students could complete them within a 50-minute class period.

Table 1. Test booklet design.

Booklet A	Booklet B	Booklet C
MPT-I, version 10: Items 1-12	MPT-I, version 10: Items 13-24	MPT-I, version 11: Items 1-12
MPT-I, version 11: Items 13-24	MPT-I, version 11: Items 25-35	MPT-I, version 10: Items 25-35
One Experimental Item	Two Experimental Items	Two Experimental Items

Tests were administered to students in all quiz sections of MATH 111 (Algebra with Applications) and MATH 112 (Application of Calculus to Business and Economics) by their respective TAs. Booklets A-C were randomly assigned to students within each quiz section.

A total of 547 students participated in the pilot test as shown in Table 2. Twelve students did not indicate their test booklet, and 20 cases were excluded from analysis either because the student arrived late to class or because the total test score was below chance level (33%).

Table 2. Number of examinees by math course and test booklet.

	All Examinees					Included Examinees			
Math Course	Book. A	Book. B	Book. C	Missing	Total	Book. A	Book. B	Book. C	Total
MATH 111	95	98	102	8	303	92	94	99	285
MATH 112	81	78	81	4	244	77	76	77	230
Total	176	176	183	12	547	169	170	176	515

RESULTS

Test Reliability

Total score reliabilities (Cronbach's *alpha*) were computed for each of the six item blocks shown in Table 1. Six pairs of parallel items were excluded from the analyses due to inconsistent item ordering. Reliability coefficients were attenuated due to the low number of items (8-12 items vs. 35 items for complete tests), but application of the Spearman-Brown prediction formula indicated that total scores based on 35 items would be sufficiently reliable. As shown in Table 3, estimated reliability coefficients did not vary significantly by test version. The average predicted reliability for Version 10 was $\alpha = .76$, and the average predicted reliability for Version 11 was $\alpha = .74$.

Table 3. Reliability coefficients by test booklet and MPT-I version.

Test booklet	MPT-I Version	N items	α	α^*
A	10	12	.58	.80
C	11	12	.58	.80
B	10	9	.58	.82
A	11	9	.31	.63
C	10	8	.30	.65
B	11	8	.42	.76

Note. α^* is the predicted reliability of total test score for a test 35 items in length.

Test Difficulty

Total test scores on Version 11 were not significantly different than those on Version 10 (see Table 4). Descriptive statistics for all items are presented in Appendix A. As expected, MATH 112 students scored higher on average than MATH 111 students, $F(1,509) = 27.2$, $p < 10^{-7}$.

Table 4. Average total score by math course and MPT-I version.

	MATH 111						MATH 112					
	MPT-I Version 10			MPT-I Version 11			MPT-I Version 10			MPT-I Version 11		
Test booklet	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*	*M*	*SD*	*n*
A	7.8	2.3	92	8.5	2.0	92	8.7	2.0	77	8.8	1.7	77
B	7.5	2.2	94	7.2	1.9	94	8.9	2.1	76	8.2	1.7	76
C	7.7	1.7	99	7.5	2.3	99	8.2	1.7	77	8.0	2.0	77
Overall	7.7	2.1	285	7.7	2.2	285	8.6	2.0	230	8.3	1.8	230

Course Grades

Final course grades were collected at the end of the quarter. Grades were not available for 23 examinees who dropped or withdrew from their course or received a non-numeric course grade (e.g., Satisfactory). As shown in Table 5, course grades and MPT scores were significantly correlated with one another: 23 of the 24 correlation coefficients were significantly different from zero (at $\alpha = .05$). Moreover, tests for differences between the two coefficients (i.e., Version 10 *vs.* Version 11) within each course by booklet group yielded no significant differences. In other words, scores from Version 10 and Version 11 were equally predictive of final course grade.

Table 5. Correlations between math grades and MPT scores by math course.

	Course Grade			Correlation with MPT score			
Course and Booklet	*M*	*SD*	*n*	Ver. 10	Ver. 11	*t*[a]	*p*[a]
MATH 111							
A	2.90	.93	84	.29**	.43**	-1.21	.23
B	3.10	.65	89	.43**	.38**	0.55	.58
C	3.00	.72	93	.24*	.13	0.95	.35
Overall	3.03	.78	266	.31**	.26**	0.71	.48
MATH 112							
A	3.19	.66	76	.31**	.38**	-0.60	.55
B	3.30	.68	75	.33**	.39**	-0.55	.58
C	3.29	.59	75	.22**	.34**	-0.88	.38
Overall	3.26	.64	226	.29**	.35**	-0.85	.40
Total							
A	3.04	.82	160	.32**	.42**	-1.21	.23
B	3.24	.67	164	.39**	.39**	-0.01	.99
C	3.13	.68	168	.25**	.22**	0.35	.73
Overall	3.13	.73	492	.32**	.31**	0.25	.80

Note. [a]Test for difference in magnitude of the two correlation coefficients.
*$p < .05$. **$p < .01$.

SUMMARY

Item and total score statistics indicate that MPT-I Version 11 is acceptable for use in the Academic Placement Testing Program. In particular:

- Total test scores were statistically reliable for both MPT-I versions.
- Overall test difficulty did not differ by test version.
- On both MPT-I versions, students in the higher level MATH 112 performed better, on average, than students in MATH 111.
- Final course grades and test scores were significantly related to one another, and the magnitude of the relationship was the same across test versions.

MPT-I Version 11 will be released at the beginning of the next testing season (October 2010). We will continue to monitor its performance under actual testing conditions.

APPENDIX A. ITEM DESCRIPTIVE STATISTICS

	MPT-I, Form 10				MPT-I, Form 11			
Item Number	Mean	SD	n	r_{IT}	Mean	SD	n	r_{IT}
1	.86	.35	167	.35	.87	.34	175	.24
2	.73	.45	167	.43	.68	.47	171	.18
3	.67	.47	163	.36	.66	.48	170	.42
4	.90	.30	167	.20	.85	.36	175	.31
5	.82	.39	167	.11	.90	.30	176	.14
6	.92	.28	168	.10	.88	.33	176	.19
7	.49	.50	156	.22	.27	.44	166	.28
8	.63	.49	166	.25	.57	.50	175	.19
9	.26	.44	167	-.08	.24	.43	176	.23
10	.78	.42	169	.36	.72	.45	176	.28
11	.75	.44	163	.26	.49	.50	166	.21
12	.57	.50	164	.30	.69	.46	170	.19
13	.47	.50	166	.18	.50	.50	158	.07
14	.50	.50	168	.31	.60	.49	165	.15
15	.81	.39	170	.10	.95	.21	169	-.07
16	.84	.37	170	.22	.70	.46	168	.07
17	.91	.28	170	.19	.83	.37	168	.24
18	.85	.36	169	.41	.53	.50	163	.12
19	.55	.50	165		.38	.49	166	
20	.38	.49	157		.58	.50	168	
21	.58	.50	170		.60	.49	169	
22	.81	.39	168	.26	.80	.40	167	.23
23	.67	.47	170	.39	.93	.26	169	.18
24	.83	.38	167	.15	.72	.45	169	.06
25	.71	.45	168	.33	.88	.33	176	.15
26	.71	.46	166	.13	.78	.41	171	-.02
27	.73	.45	166	-.11	.84	.36	173	.11
28	.68	.47	173	.03	.71	.46	170	.22
29	.48	.50	167	.12	.80	.40	169	.13
30	.62	.49	159	.13	.76	.43	169	.31
31	.89	.31	176	.08	.64	.48	168	.22
32	.90	.30	176	.16	.95	.23	166	.25
33	.51	.50	175	.00	.62	.49	170	.02
34	.74	.44	176	.24	.76	.43	169	.23
35	.74	.44	174	.23	.92	.28	168	.15
Overall	.69	.18	515		.68	.17	515	

APPENDIX B. TA ADMINISTRATION MATERIALS

Instructions to Administer Math Pilot Test – Kit 1 of 8

Please count all test booklets before administering the test. You should have 48 test booklets. Enter the number and your initials on the Test Count Verification form.

1) Ask students to be seated and quiet. Read the following aloud:

Before we begin today's test, I have been asked to read the following directions. The purpose of this test is to create a new math placement test to be used in college level math courses. Your answer to each item will be compared to your final math grade to show how well the test works. However, your individual results will be confidential, and this test will not affect your course grade in any way. Participation is voluntary. However, the test will give us a better idea of your level of mathematical preparation, so it is important that you do your best on it. Your score will be available during next Thursday's quiz section.

Please clear your desk of all materials. For this test, you may NOT use calculators, calculator watches, laptops, or other similar aids. You must use a #2 pencil to mark on the answer sheet – I have extras if you need one. I will also be providing scratch paper which you will be asked to return at the end of the period. You are NOT allowed to use your own scratch paper. I will now pass out the testing materials. Please do not open the test booklet or make any marks on the answer sheet until you are told to do so.

2) Hand out one test booklet, answer sheet, and two pieces of scratch paper to each student. Read the following aloud:

On Side 1 of the answer sheet, print the name of your math course and your section designation above the "Name" box, then print and bubble in your full name.

Next, print and bubble in your student number under "Identification Number" starting in column "A".

Finally, print and bubble in the test version in column "K" under "Special Codes." The test version is printed on the top right hand corner of your test booklet.

You do not need to fill in any of the other identification boxes. Please do NOT make any marks in the test booklet. If you find that your test booklet has been written on, raise your hand and we will give you another copy.

You will have until the end of the class period to complete the test. Be sure that you answer all 25 items carefully. If you do finish early, check over your work and remain quietly seated. Are there any questions?

You may open your test booklets and begin work now.

3) Several minutes before the end of the class period, read the following aloud:

Please stop work immediately, put your pencil down, and close your test booklet. Turn over your answer sheet and double-check that you have filled in all the required information. Remain seated while I collect a test booklet, answer sheet, and scratch paper from each of you.

4) Collect materials as described above.

5) Count all test booklets and enter the count and your initials on the Test Count Verification form.

6) Put the completed answer sheets and used scratch paper in the envelope marked with the appropriate section.

►► Students who arrive late may be allowed to take the test. However, if a student begins the test more that 10 minutes late, please mark the "16" bubble in the "Grade or Educ" box on side 1 of the answer sheet.

***** Because this is a secure test, it is very important that all test booklets be accounted for. *****

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Test Kit Contents

TA#1	**Math 111**	**BLM 306**
	SECTION AA	**9:30-10:20**
	AB	**10:30-11:20**

Please pick up your test materials from […] in Padelford C-36. […] will be in her office by 7:30AM on January 5th, if you wish to pick the materials up the morning of the test.

Please hand them directly to the TA (TA#2) teaching the section following yours. Do not leave test materials unattended.

Contents:

- TA information sheet(s) (this form)
- Test Count Verification form
- 48 test booklets
- answer sheets
- scratch paper
- number 2 pencils
- one envelope for each of several sections: 111AA, 111AB, 112BC, 112BD

Thank you for helping with this administration of the Math Pilot Test. Students should ideally be given 50 minutes to complete the test, so begin the administration as close to the beginning of the class period as possible. You will need to allow several minutes to collect materials at the end of the test. Please read the *Instructions to Administer Math Pilot Test* all the way through before beginning.

Note that because this is a secure test, we are asking you to count the number of test booklets both before and after each test administration.

If you have any questions, please contact Jon Peterson at xxxxx@u.washington.edu or nnn-nnn-nnnn. If you need to contact Jon the day of testing, please use his emergency cell at nnn-nnn-nnnn.

Test Count Verification Form

Test Batch: 1

Location: BLM 306

Please count the test booklets immediately before and after each section. Enter the number of booklets and your initials after each count.

			Before test session		After test session	
Section	**Time**	**TA**	**Count**	**Initials**	**Count**	**Initials**
111AA	9:30-10:20	TA#1 (*name omitted for privacy*)				
111AB	10:30-11:20	TA#1				
112BC	11:30-12:20	TA#2				
112BD	12:30-1:20	TA#2				