

2011-12 Early Mathematics Placement Tool Program Evaluation

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1 BACKGROUND

Beginning with the 2008-2009 academic year, the Early Mathematics Placement Tool (EMPT) became available to Wisconsin high school mathematics teachers and their students. A small group of teachers participated during Fall 2008, and the entire program was made live, for any teacher, in January 2009. The program is free-of-charge for all Wisconsin participants and provides teachers with the option for a paper-and-pencil and an online version, with a choice of secure and non-secure format. Teachers receive feedback letters which indicate the mathematical preparedness of students and an online resource guide lists the mathematics requirements of majors at UW campuses. Teacher recruitment during the pilot year was primarily word-of-mouth with staff also presenting at the annual meeting of the Wisconsin Mathematics Council in Green Lake.

During the 2011-2012 academic year, the structure of the EMPT remained the same as in previous years: (1) The program still uses retired items from the University of Wisconsin Mathematics Placement Test (MPT) to indicate to teachers, students, and parents how prepared the student is for undergraduate mathematics at UW campuses and (2) an online resource guide outlines the mathematics requirements needed for all undergraduate majors at UW four- and two-year campuses and the Wisconsin Technical Colleges. Recruitment during 2011-2012 was expanded beyond word-of-mouth to include outreach through continued contact and marketing oriented toward mathematics faculty at all Wisconsin private colleges; high school counselor outreach during the Wisconsin School Counselors Association annual meeting; submissions to the Department of Public Instruction's e-mail blast, as well as the Wisconsin Mathematics Council conference agenda; and, continued participation in the annual Wisconsin Mathematics Council meeting. Since the pilot year, the EMPT has gained acknowledgement under different websites as a reliable resource (e.g. UW Help, the Wisconsin DPI website and the Wisconsin

Ide@s website) through the work of our continued outreach. To elaborate, the Ide@s website is a searchable database of high quality education resources for Wisconsin’s PK-16 educators to access for integration into curriculum and classroom instruction. Our program receives credit as the creator of the EMPT every time the resources are viewed on the Ide@s website.

The success of the EMPT continued into the fourth year as we experienced increases in the total number of participating schools (by 7% over the previous year), teachers (by 10.5%), classrooms (by 5.2%), and students (by 14.8%). The changes in the numbers of schools, teachers, classrooms, and students from the 2008-2009, 2009-2010, 2010-2011, and 2011-2012 school years are illustrated in Figure 1.

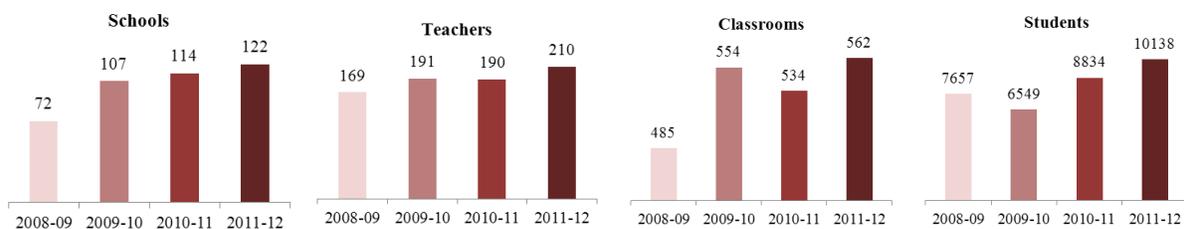


FIGURE 1. Trends of total number of participating schools, teachers, classrooms, and students over last four years.

The number of participants who took the EMPT as sophomores, juniors, and seniors is shown in Figure 2. The percentage of students who took the EMPT at each grade level has been highly consistent from the 2008-2009 school year to the 2011-2012 school year. It is interesting to note that although the program was originally developed with high school juniors in mind, fewer than half the participants are juniors. High school teachers have elected to use the EMPT with large numbers of sophomores and seniors. Approximately 61% of the students took the EMPT using the computer-based version and 39% took the EMPT using the paper-based version.

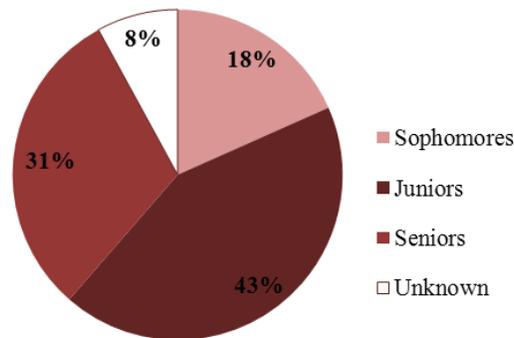


FIGURE 2. Percentage of students taking the EMPT by class level in 2011-12.

The number of EMPT participating students with different curricula background is summarized in Figure 3.

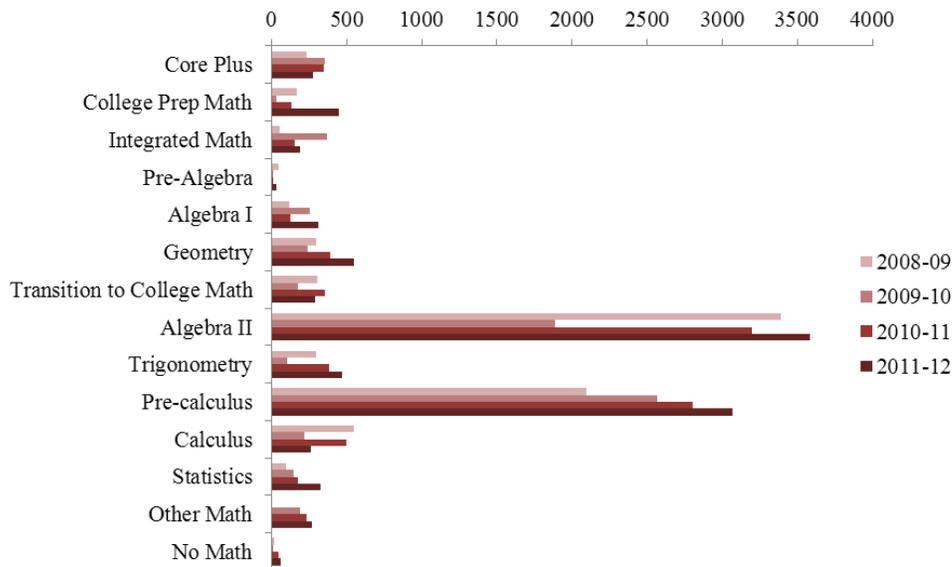


FIGURE 3. Number of participating students by curricula background for previous four years.

The general pattern of EMPT usage has remained similar within different curricula. In the four years the EMPT has been in existence, approximately 70% of participants have been students enrolled in either Algebra II or Pre-calculus. For the second straight year, Algebra II was the most common course of enrollment (35.3% of students in 2011-12). Pre-calculus was the second most common course of enrollment (30.3% of students). The other curricular choices remained fairly stable at low percentages as compared to Algebra II and Pre-calculus.

Lastly, the number of teachers and students who used the EMPT for pre-post testing was investigated. Pre-post testing was defined as having taken the EMPT on more than one occasion with at least 45 days in between the two test administrations. It was found that 43 teachers and 963 students used the EMPT in a pre-post manner.

2 EVALUATIONS

In terms of evaluating the performance of the EMPT program in the 2011-2012 academic year, we have two main types of evaluations. First and foremost, we quantified the impact of the EMPT program on students' improvement of their 2012 MPT placement levels via both descriptive statistics and statistical tests. Second, we communicated with high school teachers through several conferences. The EMPT program staffed an information table and gave

presentations on the program at annual meetings for the Wisconsin Math Council (WMC). Additionally, the EMPT staff exhibited at an information table at the Wisconsin School Counselors Association (WSCA). Our attendance at these different events will be continued in our outreach efforts. Furthermore, the EMPT staff also engaged in teleconferences with UW-Superior, UW-Fond du Lac, and UW-Fox Valley to discuss how to expand the usage and different methods for high school instructors to employ the EMPT inside their classrooms. The communication we have undertaken with instructors across the state has been extremely valuable in searching for ways to improve the program and we plan on continuing our outreach efforts to gather feedback and make the appropriate adjustments.

2.1 Findings via Statistical Analysis

For the first part of the evaluation, we tracked the students who participated in the EMPT as juniors in the 2010-2011 academic year and followed them until they took the actual MPT in spring, 2012. Table 1 uses the 9-point EMPT scale (shown in Appendix A) to show the change in placement level that resulted over the students' senior year.

TABLE 1: Comparison of placement levels. Note the bold black numbers along the diagonal represent individuals whose MPT matched their EMPT levels.

2012 MPT Levels	2010-2011 EMPT Levels									Total	Avg. Level
	1	2	3	4	5	6	7	8	9		
1	20	6	14	1	4	1	1	0	0	47	2.36
2	15	8	11	2	4	0	0	0	0	40	2.3
3	21	14	39	10	17	4	3	1	1	110	3.21
4	34	26	82	31	54	25	6	11	2	271	3.78
5	11	7	50	33	64	36	13	19	5	238	4.75
6	3	5	29	26	65	36	16	20	12	212	5.31
7	0	0	7	2	15	12	7	10	5	58	6.03
8	1	0	7	10	21	25	8	31	27	130	6.65
9	0	3	8	16	34	52	25	91	176	405	7.56
Total	105	69	247	131	278	191	79	183	228	1511	5.37
Avg. Level	3.14	3.77	4.38	5.48	5.64	6.60	6.75	7.64	8.52	6.02	

Of the 1,511 juniors who completed the EMPT in 2010-2011 and the MPT in 2012, 50.2% saw their placement levels increase (compared to 48.3% in 2009-10): 21.2% improved one level, and 29% of students increased at least two math levels. Among the 1,283 students who scored below Level 9 on the EMPT (and therefore able to improve on the MPT), 59.1% improved their placements. Of the equivalent group from last year's evaluation, 58.3% improved their placements, again indicating a high degree of consistency with previous results. In limited cases, there were students who placed into Level 1 or 2 on the EMPT, but then Level 8 or 9 on the MPT. Conversely, 22.6% of the students received lower placement levels on the MPT than on the EMPT: 11.3% of the students dropped one level on the MPT while 11.3% dropped at least two levels. Among the 1,406 students who scored above Level 1 on the EMPT (for whom it was possible to receive a lower MPT placement), 24.3% saw their placements decrease. Again, this percentage was comparable to the percentage from last year, where 24.7% of students from last

year saw their placements decrease. Finally, 27.3% of the students received the same placement level on the MPT as they received on the EMPT.

On average, students performed much better on the MPT than on the EMPT. The MPT saw a dramatic decrease in the percentage of students scoring at the remedial level. Approximately 11.5% of the students scored at Levels 1 or 2 on the EMPT during their junior year, compared with only 5.8% on the MPT, a decrease of 49.6%. Similarly, 43.7% more students placed into Level 9 on the MPT than on the EMPT (26.8% compared with 15.1%).

The last row of Table 1 shows the average placement level on the MPT for students scoring at each of the nine different placement levels on the EMPT. For example, of the students who placed into Level 1 on the EMPT, the average MPT placement was Level 3.14, an increase of 2.14 placement levels. For students placing into EMPT Level 2, the average MPT placement was 3.77, an increase of 1.77 levels. In contrast, the average MPT placement level for students earning a Level 6 on the EMPT was 6.60, an increase of just 0.6 placement levels. These data show very clearly the EMPT has the largest impact for students in the lowest levels. Because EMPT is specifically intended to reduce the amount of remediation and serve as a wake-up call to those who are ill-prepared for college-level math, these results strongly suggest that the program is working as intended.

Finally, the last column of Table 1 shows the average EMPT placement levels for students placing into each of the nine levels on the MPT. These data also show an upward trend (i.e., students placing higher on the EMPT tend to place higher on the MPT). Because the achieved MPT level is less than the average EMPT level for MPT Levels 1, 2, and 3, this suggests that students earning MPT placements of 3 or less tended, on average, to score somewhat higher on the EMPT. This result, though counter-intuitive, is expected at the low end of the scale, where it is difficult to score lower than the MPT. As an example, students who placed into Level 1 on the MPT cannot possibly have scored lower on the EMPT. To the extent that any individuals received an EMPT score other than Level 1, such differences will necessarily involve EMPT scores above 1, thereby raising the average EMPT level above 1. This is referred to as a floor effect. A similar situation, known as a ceiling effect, occurs at the upper end of the scale, where students receiving an MPT level 9 were unable to receive EMPT scores that were higher. As a result of these floor and ceiling effects, the data in the last column should be interpreted with caution. The most interesting piece of information from that column is the overall average EMPT level for all students, 5.37. When compared with the average MPT Level of 6.02, we see

that the typical EMPT participant increased 0.65 placement levels over the course of their senior year. In comparison, the average EMPT participant from last year's evaluation increased by 0.62 placement levels from their junior to senior year.

Another interesting pattern relates to the impact of EMPT for different curricula. As part of the EMPT, instructors are asked to indicate the curriculum being taught in each class. Table 2 shows the change in average placement level (EMPT vs. MPT) for students, broken down by curricular area. Note that the curricula reflect the courses the students completed as juniors, but do not capture what type of course, if any, the students completed as seniors. Sample sizes for each of these tests are also included in Table 2, denoted as N. When sample sizes were sufficiently large (i.e., $N \geq 20$), the change was evaluated using a two-tailed matched-pair t-test. Results that are statistically significant at $\alpha = .05$ level are identified with an asterisk.

According to Table 2, most of the participating students showed significant growth from the 2010-11 EMPT to the 2012 MPT, usually between about half a level and one full level. Students enrolled in the Core Plus curriculum demonstrated the largest growth, with MPT scores increasing an average of 0.90 levels. The curricula not showing gains in scores were Transition to College Math and Calculus, though the decrease for Calculus was not statistically significant. As expected, students with higher levels of high school math tended to place higher on the MPT. Students taking Pre-calculus or Calculus as juniors earned higher MPT placements than other students.

TABLE 2: Comparison of 2010-11 EMPT and 2012 MPT average levels for students with different curricula backgrounds.

High School Curricula Background	2010-11 EMPT Average Level	2012 MPT Average Level	Changes from 10-11 EMPT to 2012 MPT
Core Plus (N=48)	2.71	3.60	0.90 [*]
College Preparatory Math (CPM) (N=17)	6.47	6.82	0.35 [#]
Integrated Math (N=18)	4.61	5.78	1.17 [#]
Algebra I (N=4)	5.50	6.50	1.00 [#]
Geometry (N=15)	2.67	3.27	0.60 [#]
Transition to College Math (N=22)	5.18	4.45	-0.73 [*]
Algebra II (N=559)	4.28	5.14	0.87 [*]
Trigonometry (N=93)	4.80	5.57	0.77 [*]
Pre-calculus (N=639)	6.47	7.02	0.55 [*]
Calculus (N=51)	7.90	7.43	-0.47
Statistics (N=9)	6.44	6.78	0.34 [#]
None (N=1)	3	9	6.00 [#]
Other Math (N=35)	5.09	5.63	0.54 [*]
Total (N=1500)	5.37	6.01	0.64 [*]

*Note * $p < .05$; # represents that the matched-pair t test is not conducted due to small sample size.*

Next, we compared the 2012 MPT levels for those students who participated in the 2010-11 EMPT with those who did not participate in the EMPT to further examine the impact of the EMPT on the MPT scores. Table 3 shows the distributions of MPT levels for the 1,511 students who participated in the EMPT as high school juniors and went on to take the MPT versus the 21,870 incoming UW students who did not participate in the EMPT program as high school juniors.

TABLE 3: Comparison of MPT placement levels for students who took EMPT with those who did not

Actual 2012 MPT Placement Level	Participated in 2010-11 EMPT	Did Not Participate in 2010-11 EMPT
1	3.1%	10.0%
2	2.6%	3.8%
3	7.3%	12.7%
4	17.9%	17.7%
5	15.8%	12.0%
6	14.0%	10.6%
7	3.8%	3.0%
8	8.6%	7.9%
9	26.8%	22.2%

Table 3 indicates that the percentage of the students placing into Levels 1 or 2 (which correspond to remedial math levels) was 58.7% lower among those participating in the EMPT (5.7%) than for those not participating (13.8%). There was a larger decrease in remedial placements for EMPT participants versus non-participants this year (58.7%) than compared to last year (52.6%). Also, the percentage of students placing into Calculus (Level 9) was 20.7% higher for the EMPT participants than for non-participants (26.8% of students who took the EMPT vs. 22.2% of students who did not take the EMPT). This difference is smaller compared to last year where the percentage of students placing into Calculus was 34.9% higher for EMPT participants than for non-participants. Overall, the average placement level for EMPT participants was 6.02, compared with 5.35 for non-participants. This average difference of 0.67 levels is both statistically significant (i.e., non-zero; $t=10.635$, $df = 1,784$, $p \leq 0.001$) and sufficiently large as to be quite meaningful.

While the EMPT was created to give high school juniors a preview of what skills are required on the MPT and to help them realize the benefits of taking a math class as a senior, the EMPT has been used by teachers for other purposes as well. There are a large number of seniors already enrolled in a math course who took the EMPT in 2011-12 and then went on to take the MPT in 2012. Table 4 below shows comparisons between how these seniors scored on the EMPT and the MPT (also shown graphically in Figure 5). On average, this group of students improved 0.23 placement levels on the MPT compared to their score on the EMPT (5.56

compared to 5.33). The average score gain for the seniors who took the EMPT during the 2011-12 year was 0.42 placement levels lower than the average score gain for the juniors who took the EMPT during the 2010-11 school year. This result was expected, because students who took the EMPT during their junior year would have had a chance to receive more math instruction that could lead to a score increase. We would not expect as much of a score gain for students taking the EMPT as seniors because there is little difference in their math instruction between when they take the EMPT and the MPT. The average score gain of 0.23 for the 2011-12 seniors who took the 2012 MPT could be due to students performing more optimally under higher stakes testing conditions of the MPT. Or, alternatively, we could be seeing a practice effect where students perform better on the MPT after being exposed to a similar test and having a more clear idea of what to expect. It is important to note that while a primary goal of the EMPT is to increase the number of juniors who go on to take senior-level math, there will inevitably still be some students who opt out of math their senior year. To the extent that these students are included in Figure 4, the average increase from EMPT scores to MPT scores for the juniors may be suppressed. The students represented in Table 4 all took senior-level math, whereas students represented in Table 1 may or may not have gone on to take another math course, thus any comparisons between these two groups may not be directly parallel.

TABLE 4: Comparison of placement levels. Note the bold black numbers along the diagonal represent individuals whose MPT scores matched their EMPT level.

2012 MPT Levels	2011-12 EMPT Levels									Total	Avg. Level
	1	2	3	4	5	6	7	8	9		
1	26	14	6	6	4	1	0	1	1	59	2.36
2	5	3	7	6	2	2	0	0	0	25	3.12
3	20	13	41	27	19	6	1	1	0	128	3.30
4	30	17	65	54	61	29	5	6	5	272	3.98
5	12	14	31	34	62	43	17	19	12	244	4.98
6	4	3	26	13	51	45	19	30	18	209	5.74
7	0	0	0	3	7	15	6	10	13	54	6.96
8	1	0	4	3	25	29	15	25	18	120	6.59
9	2	0	2	2	14	14	21	50	124	229	8.00
Total	100	64	182	148	245	184	84	142	191	1340	5.33
Avg. Level	2.06	3.36	4.20	4.23	5.10	5.91	6.82	7.20	8.06	5.56	

3 FURTHER DIRECTIONS

By all accounts, the 2011-2012 EMPT was hugely successful. However, we are intent on continuing to make the EMPT even better as we move forward. For those students who tested in 2011-2012, several enhancements were implemented. At the request of some teachers that were experiencing a delay after students submitted their answers to the online system, we have reconfigured the database in a manner that has greatly sped up the submission process and the time required before receiving feedback. Also, we have developed a PowerPoint presentation that is designed to walk teachers through the registration process and the student statistical output information. In addition to these already-implemented improvements, we are also working on the following:

- Expand the exposure of the EMPT program to school counselors and sponsors in Wisconsin, not just limited to math teachers.

- Expand the application of the on-line timer to Firefox and maybe other popular internet browsers.
- Add related resource links in our website, such as DPI (Wisconsin Department of Public Instruction).
- Invite Wisconsin private colleges to participate.
- Automate the reassignment of passwords when a teacher has forgotten his/hers.
- Continue use of teacher surveys for feedback and also explore the idea of constructing a student survey.
- Develop more questions for multiple forms of the EMPT.
- Continue our outreach efforts to raise awareness of the program.
- Work with the UW Math Placement Test Development Committee to evaluate the alignment of the EMPT to the Common Core Mathematics Standards.
- Improve the tracking of students to (a) identify the mathematics courses taken (or not taken) by EMPT participants during their senior year, and (b) evaluate the differential success of EMPT participants and non-participants in their college math courses, so as to further tease apart the improved math effect from the practice test effect.
- Explore the sale of the EMPT to other states.
- Explore the use of different delivery software that will improve the cohesion of the EMPT and MPT programs, will facilitate development of additional EMPT forms, and will make the computer-based EMPT experience more comparable to that of the computer-based MPT.
- Develop a survey to receive feedback on how the students find value in the EMPT.

Appendix A:

DESCRIPTION OF EARLY MATHEMATICS PLACEMENT TOOL LEVELS

Level 1	Students have a weakness in basic mathematics and are greatly disadvantaged in all programs. They start the mathematics course sequence at the lowest level and will pay for credits which do not count towards their degree
Level 2	
Level 3	Students have minimal algebra skills and are substantially disadvantaged. On some campuses, students at this level may start with a course which does not carry degree credit but does have a course fee.
Level 4	
Level 5	Students have basic algebra skills and are usually ready for a college algebra course. Further strengthening of these algebra skills is required for most university programs
Level 6	
Level 7	Students have the algebra skills to take courses at the pre-calculus level, but need to develop better algebra and trigonometry skills to take calculus
Level 8	
Level 9	Students have the skills required for the calculus sequence