

2015-16 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 two different forms. 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 2015-2016 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 2015-2016 included 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. Furthermore, the EMPT also continued its partnership with UW-La Crosse and their College Readiness Math MOOC program. The MOOC program is designed to prepare traditional and non-traditional students for credit-bearing mathematics courses and uses the EMPT to evaluate the progress of students after they complete a series of voluntary mathematics-based short courses. Finally, the EMPT utilized resources from the UW-System to garner a letter of support with signatures from UW-System President, Ray Cross and WTCS President, Morna Foy that was distributed to every high school principal and math department in the state of Wisconsin.

We experienced some growth in the EMPT program during the 2015-2016 school year, similar to what we experienced in the first four years. The increased percentages compared to the previous year (2014-2015) are 3.6% in the total number of participating schools, 5.9% of teachers, 7.5% of classrooms, and 9.1% of students. The changes in the numbers of schools, teachers, classrooms, and students from the 2008-09 to the 2015-16 school years are illustrated in Figure 1.

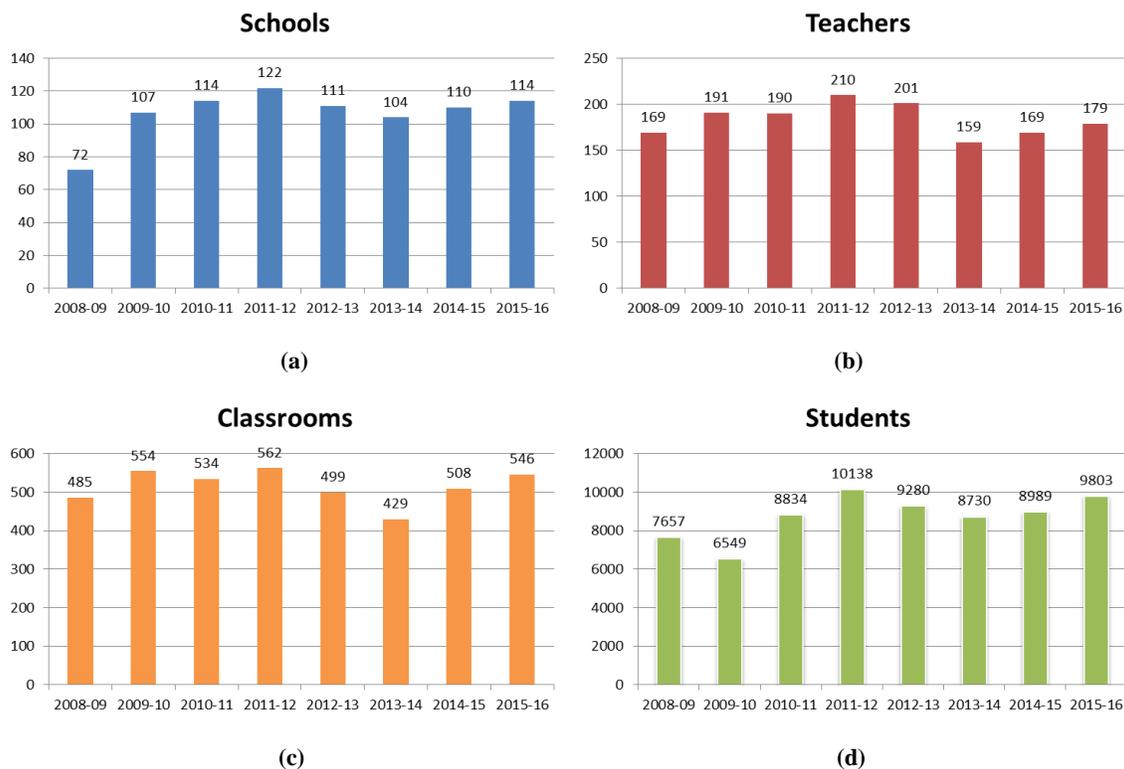


FIGURE 1. Trends of total number of participating schools (a), teachers (b), classrooms (c) and students (d) over the last eight years

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 2015-2016 school year. It is interesting to note that although the program was originally developed with high school juniors in mind, less than half the participants (45%) are juniors. High school teachers have elected to use the EMPT with large numbers of sophomores and seniors (34% and 15%, respectively). Approximately 88.7% of the students took the EMPT using the computer-based version and 11.3% took the EMPT using the paper-based version.

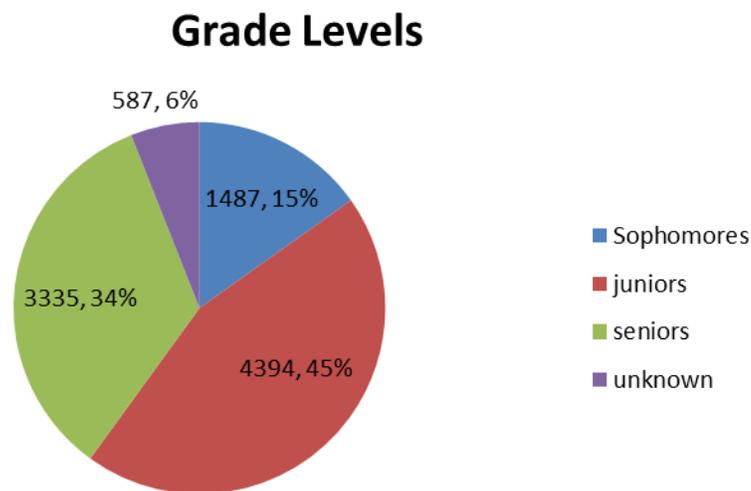
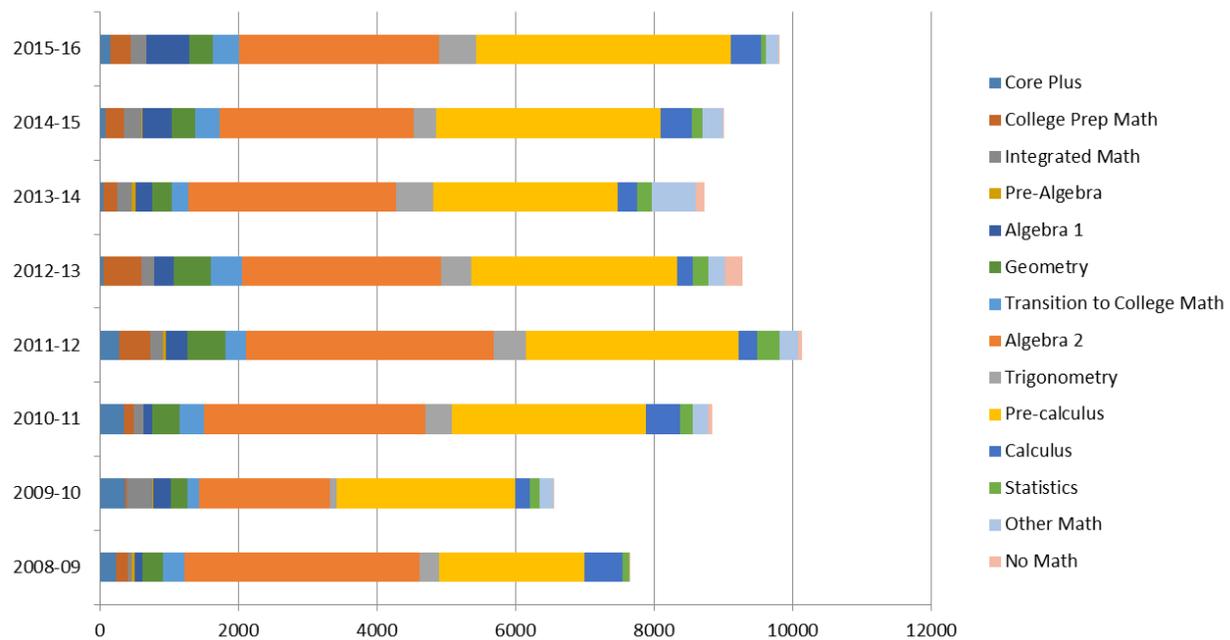
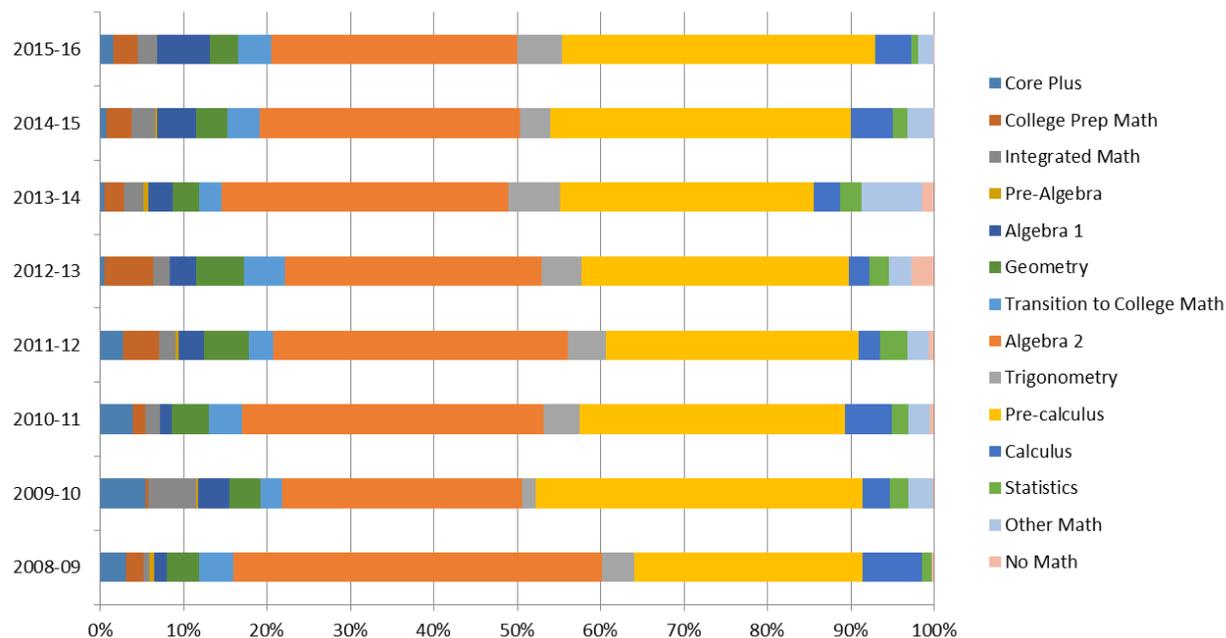


FIGURE 2. Percentage of students taking the EMPT by grade level in 2015-16

The number and percentage of EMPT participating students with different curricula background is summarized in Figures 3a and 3b.



(a)



(b)

FIGURE 3. Number (a) and percentage (b) of participating students by curricula background for previous eight years

The general pattern of EMPT usage has remained similar within different curricula. In the seven years the EMPT has been in existence, over 60% of participants have been enrolled in either Algebra II or Pre-calculus. Pre-calculus was the most common course of enrollment (37.6% of students in 2015-16). Algebra II was the second most common course of enrollment (29.5% of students in 2015-16). The other curricular choices remained fairly stable at low percentages 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 70 teachers and 2,285 students used the EMPT in a pre-post manner. These numbers represent an increase in the

both number of teachers and the number of students who used the EMPT as a pretest-posttest last year (57 and 1,534, respectively).

2 EVALUATIONS

In terms of evaluating the performance of the EMPT program in the 2014-2015 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 2015 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 continue the partnership with UW-La Crosse's College Readiness Math MOOC program. 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 2014-2015 academic year and followed them until they took the actual MPT in spring, 2016. 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.

2016 MPT Levels	2014-2015 EMPT Levels									Total	Avg. Level
	1	2	3	4	5	6	7	8	9		
1	16	7	3	2	3	2	0	0	0	33	2.24
2	27	12	10	7	2	1	1	0	0	60	2.20
3	31	24	32	13	17	6	0	4	4	131	3.18
4	30	25	40	34	53	26	3	12	5	228	4.03
5	12	10	50	39	62	37	17	23	19	269	5.00
6	3	11	23	14	27	53	11	33	16	191	5.70
7	1	1	5	4	8	11	4	10	8	52	6.15
8	1	1	4	12	16	25	17	37	29	142	6.82
9	0	4	7	9	36	43	27	82	232	440	7.81
Total	121	95	174	134	224	204	80	201	313	1546	5.63
Avg. Level	3.11	3.89	4.58	5.04	5.58	6.34	7.15	7.35	8.30	6.09	

Of the 1,546 juniors who completed the EMPT in 2014-2015 and the MPT in 2016, 44.0% saw their placement levels increase (shown in red; compared to 47.8% in 2014-15): 17.3% improved one level, and 28.9% of students increased at least two math levels. Among the 1,233 students who scored below Level 9 on the EMPT (and therefore were able to improve on the MPT), 55.2% improved their placements. Of the equivalent group from last year's evaluation, 58.9% 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, 24.8% of the students received lower placement levels on the MPT than on the EMPT (shown in blue): 11.0% of the students dropped one level on the MPT while 13.8% dropped at least two levels. Among the 1,425 students who scored above Level 1 on the EMPT (for whom it was possible to receive a lower MPT placement), 26.9% saw their placements decrease. Again, this percentage was comparable to the percentage from last year, where 23.6%

of students from last year saw their placements decrease. Finally, 31.2% of the students received the same placement level on the MPT as they received on the EMPT (shown in black).

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 developmental level. Approximately 13.97% of the students scored at Levels 1 or 2 on the EMPT during their junior year, compared with only 6.02% on the MPT, a decrease of 56.9%. Similarly, 28.9% more students placed into Level 9 on the MPT than on the EMPT (28.46% compared with 20.25%).

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 level was 3.11, an increase of 2.11 placement levels. For students placing into EMPT Level 2, the average MPT placement level was 3.89, an increase of 1.89 levels. In contrast, the average MPT placement level for students earning a Level 6 on the EMPT was 6.34, an increase of just 0.34 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 on average, students earning MPT placements of 3 or less tended to score slightly 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 on the EMPT than on 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, 5.63. When compared with the average MPT Level

of 6.09, we see that the typical EMPT participant increased 0.46 placement levels over the course of their senior year. In comparison, the average EMPT participant from last year's evaluation increased by 0.63 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 were 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, including each sample size (N). 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. We excluded math-unrelated areas (i.e., no math with N=1, here); thus the total sample size for Table 2 became 1,545 (compared to 1,546 in Table 1). When sample sizes are too small to create reliable average scores ($N < 5$), we did not compute them. 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, the participating students showed growth from the 2014-15 EMPT to the 2016 MPT by 0.46 levels on average, and depending on high school curricula background, most of them increased, usually between about half a level or one full level. When we take into account only the courses with sufficient sample size ($N \geq 20$), students enrolled in the College Preparatory Math curriculum demonstrated the largest growth, with MPT scores significantly increasing an average of 0.91 levels. For the courses with sufficient sample size, the curriculum showing the smallest gain in scores was Calculus. In addition, as expected, students with higher levels of high school math (EMPT) 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 2014-15 EMPT and 2016 MPT average levels for students with different curricula backgrounds.

High School Curricula Background	2014-15 EMPT Average Level	2016 MPT Average Level	Changes from 14-15 EMPT to 15 MPT
College Preparatory Math (CPM) (N=58)	4.72	5.64	0.91*
Core Plus (N=8)	6.50	5.63	-0.87 [#]
Integrated Math (N=27)	6.33	6.56	0.22
Pre-Algebra (N=1)	–	–	–
Algebra I (N=33)	5.39	5.88	0.48
Geometry (N=5)	2.80	4.60	1.80 [#]
Transition to College Math (N=31)	3.74	4.45	0.71*
Algebra II (N=447)	3.74	4.61	0.87*
Trigonometry (N=87)	5.82	6.36	0.54*
Pre-calculus (N=788)	6.70	6.91	0.21*
Calculus (N=36)	7.86	7.78	-0.08
Statistics (N=6)	5.83	7.00	1.17 [#]
Other Math (N=18)	6.22	6.39	0.17 [#]
Total (N=1,545)	5.63	6.09	0.46*

*Note * $p < .05$; [#] represents that the matched-pair t test is not conducted due to small sample size (gray shaded cases)*

Next, we compared the 2016 MPT levels for those students who participated in the 2014-15 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 1,546 students who participated in the EMPT as high school juniors and went on to take the MPT versus the 22,941 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 2016 MPT Placement Level	Participated in 2014-15 EMPT (N=1,546)	Did Not Participate in 2014-15 EMPT (N=22,941)
1	2.1%	5.8%
2	3.9%	7.5%
3	8.5%	13.3%
4	14.7%	17.6%
5	17.4%	15.1%
6	12.4%	9.4%
7	3.4%	3.1%
8	9.2%	7.1%
9	28.5%	21.1%
Mean	6.09	5.31

Table 3 indicates that the percentage of the students placing into Levels 1 or 2 (which correspond to developmental math levels) was 54.89% lower among those participating in the EMPT (6.0%) than for those not participating (13.3%). Also, the percentage of students placing into Level 9 was 35.07% higher for the EMPT participants than for non-participants (28.5% of students who took the EMPT vs. 21.1% of students who did not take the EMPT). This difference is larger compared to last year where the percentage of students placing into Level 9 was 27.5% higher for EMPT participants than for non-participants. Overall, the average placement level for EMPT participants was 6.09, compared with 5.31 for non-participants. This average difference of 0.78 levels is both statistically significant ($t = 8.311$, $df = 1,791.546$, $p < 0.001$) 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 2015-16 and then went on to take the MPT in 2016. Table 4 below shows comparisons between how these seniors scored on the EMPT and the MPT. On average, this group of students improved 0.31 placement levels on the MPT compared to their score on the EMPT (5.52 compared to 5.21). The average MPT score

gain for the seniors who took the EMPT during the 2015-16 year (0.31) was 0.15 placement levels lower than the average score gain for the juniors who took the EMPT during the 2015-16 school year (0.46). 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 0.31 for the 2015-16 seniors who took the 2016 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 Table 1, 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.

2016 MPT Levels	2015-16 EMPT Levels									<i>Total</i>	<i>Avg. Level</i>
	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>	<i>7</i>	<i>8</i>	<i>9</i>		
<i>1</i>	18	3	3	1	2	1	1	0	1	30	2.30
<i>2</i>	16	4	16	7	5	2	2	0	0	52	2.90
<i>3</i>	29	14	32	13	12	4	0	1	0	105	2.83
<i>4</i>	27	20	58	30	40	24	6	5	1	211	3.77
<i>5</i>	13	15	28	27	65	35	7	17	4	211	4.70
<i>6</i>	5	1	12	10	35	22	11	27	12	135	5.86
<i>7</i>	0	1	3	5	10	8	4	3	11	45	6.22
<i>8</i>	0	1	1	4	5	15	3	30	15	74	7.19
<i>9</i>	0	1	0	3	15	12	11	39	121	202	8.11
<i>Total</i>	108	60	153	100	189	123	45	122	165	1065	5.21
<i>Avg. Level</i>	3.15	3.97	3.95	4.63	5.23	5.72	6.24	7.23	8.38	5.52	

3 FURTHER DIRECTIONS

By all accounts, the 2015-2016 EMPT was largely successful. However, we are intent on continuing to make the EMPT even better as we move forward. For starters, we worked diligently to improve the appearance of the EMPT website, while including further information with the inclusion of past program evaluations. Also, we have revamped our PowerPoint presentation that is designed to walk teachers through the registration process and the student statistical output information. Finally, the new registration system that provides instructors with NetIDs for security in log in processes has been streamlined and shown significant improvements in ease of access. 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.

- Add related resource links in our website, such as DPI (Wisconsin Department of Public Instruction).
- Improve the EMPT marketing through redesigned informational brochures and conference signage.
- Invite Wisconsin private colleges to participate. Particularly through fostering our ongoing relationship with Edgewood College.
- 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.
- Conversations began with UW-System to increase our outreach and the functionality of the EMPT program.
- Continue conversations with the DPI and State Superintendent, Tony Evers to gain the inclusion of his signature on the EMPT letter of support.

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