Charting Progress toward Outcomes: Analyzing the Role of Professional Development in Early Implementation of Tennessee's Mathematics Standards

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Table of Contents

List of Tables and Figures ..... p. iii
Executive Summary ..... p. vi
SECTION
I. INTRODUCTION AND BACKGROUND ..... p. 1
Definition of Issue
Project Questions
Project Design and Methodology
Contextual Analysis
II. RESULTS: FINDINGS, INTERPRETATION, AND DISCUSSION: PROJECT QUESTION 1 – ACHIEVEMENT OF REVISED TENNESSEE MATH STANDARDS IMPLEMENTATION OUTCOMES ..... p. 15
K-8 Math Teacher Survey Respondent Demographic Findings
Outcome 1: Awareness of Revised Math Standards Findings
Outcome 2: Understanding of Revised Math Standards Findings
Outcome 3: Alignment of Instructional Materials to Revised Math Standards Findings
Outcome 4: Alignment of Common Assessments to Revised Math Standards Findings
Outcome 5: Alignment of Instruction to Revised Math Standards Findings
Closer Look: Knox County Schools Outcomes 1-5 Findings
III. RESULTS: FINDINGS, INTERPRETATION, AND DISCUSSION: PROJECT QUESTION 2 – EFFICACY OF REVISED MATH STANDARDS IMPLEMENTATION PROFESSIONAL LEARNING .... p. 45
District Revised-Math-Standards Professional Development Choices
School Revised-Math-Standards Professional Development Choices
Teacher Revised-Math-Standards Professional Development Choices
Closer Look: Metro Nashville Public Schools Revised-Math-Standards Professional Development Choices
IV. RECOMMENDATIONS AND CONCLUSION ..... p. 58
Recommendation 1: Increase Use of High-Quality Math Instructional Materials
Recommendation 2: Revisit and Leverage TERA's Policy Brief
Recommendation 3: Attend to Effective Characteristics of Professional Learning
Recommendation 4: Deliberately, Explicitly, and Realistically Assess State Standards Implementation Efforts
References ..... p. 66
Appendices ..... p. 70

List of Tables and Figures

TABLES

Table 1: *Descriptive student statistics for school districts surveyed*..... p. 14
Table 2: *K-8 Math Teacher Survey respondents' personal characteristics*..... p. 98
Table 2.1: *Amount and frequency of revised-Math-standards professional development by participating district*..... p. 99
Table 2.2: *K-8 Math Teacher Survey respondents' revised-Math-standards professional development attendance by form and combination of forms*... p. 99
Table 3: *Survey respondents by grade level*..... p. 100
Table 3.1: *Survey respondents by grade level by participating district*..... p. 100
Table 3.2: *Survey respondents by number of Math periods taught per week by participating district*..... p. 101
Table 4: *Survey respondents by Math specialization*..... p. 101
Table 4.1: *Survey respondents by Math specialization by participating district*..... p. 101
Table 5: *Survey respondents' number of Math-designated preparation periods among respondents who have preparation period(s)*..... p. 102
Table 5.1: *Survey respondents' number of Math-designated preparation periods by participating district*..... p. 102
Table 6: *Survey respondent report of how schools monitor alignment of Math instruction to Math standards*..... p. 103
Table 7: *Survey respondents by district*..... p. 104
Table 8: *Survey respondent self-reported revised-Math-standards awareness level prior to attending revised- Math-standards professional development by form attended*..... p. 104
Table 9: *Survey respondent awareness of revised-Math-standards implementation timeline*..... p. 104
Table 10: *Survey respondent classification of revised Math standards*..... p. 104
Table 10.1: *Survey respondent classification of revised Math standards by district*..... p. 105
Table 10.2: *Survey respondent classification of revised Math standards by years of teaching experience*..... p. 105
Table 11: *Survey respondent self-reported revised Math standards depth of understanding before and after attending revised Math standards professional development by form*..... p. 105
Table 12: *June 2017 TDOE Math session teacher training knowledge of revised Math standards expectations before and after training*..... p. 106
Table 13: *Descriptive statistics of survey respondents by K-8 Math standards content knowledge level*..... p. 107
Table 14: *Survey respondents' level of revised Math standards major-work knowledge for grade level(s) taught in school year 2017-18*..... p. 108
Table 15: *K-8 Math Teacher Survey respondents' composite teacher objective skill knowledge (TOSK) level by respondent characteristics*..... p. 109
Table 15.1: *K-8 Math Teacher Survey respondents' composite teacher objective skill knowledge (TOSK) level by participating district*..... p. 110

Table 15.2: *K-8 Math Teacher Survey respondent composite teacher objective skill knowledge (TOSK) level by forms of revised Math Standards PD attended* …… p. 110
Table 16: *Survey respondents' self-reported knowledge and understanding of how to align Math instructional materials to the revised Math standards before and after March 2017 TDOE training by participating district*…….. p. 111
Table 17: *Extent to which districts mandate state- or district-adopted Math instructional material use by participating district*……... p. 111
Table 18: *Frequency with which survey respondents use state- or district-adopted Math instructional materials by participating district*…….. p. 112
Table 19: *Frequency with which survey respondents use district-developed Math instructional materials by participating district*……... p. 112
Table 20: *Frequency with which survey respondents use self-developed Math instructional materials by participating district*……... p. 113
Table 21: *Frequency with which survey respondents use Math instructional materials developed in collaboration with colleagues by participating district*…… p. 113
Table 22: *Frequency with which survey respondents use "other" Math instructional materials by participating district*……. p. 113
Table 23: *Survey respondents' trusted sources for teacher-developed Math instructional materials*…….. p. 114
Table 24: *Extent to which survey respondents' own Math assessments are aligned to revised state Math standards*……. p. 114
Table 25: *Extent to which common Math assessments exist in respondents' schools by participating district*……. p. 115
Table 26: *Types of common Math assessments in use in respondents' schools*…… p. 115
Table 27: *Extent to which survey respondents report common Math assessments are aligned to the revised state Math standards*…….. p. 115
Table 28: *Topics of 2017-18 district and school revised-Math-standards professional development by district*……. p. 116
Table 29: *Primary focus of revised-Math-standards professional development by district*…… p. 116
Table 30: *June 2017 TDOE Math teacher training attendees' likelihood of redelivering revised-Math-standards-implementation professional development*……... p. 117
Table 31: *June 2017 TDOE Math teacher training attendees' self-reported level of preparedness to redeliver revised-Math-standards-implementation professional development*…….. p. 117

FIGURES

Figure 1: *Initial CORE-identified effective PD Districts*…….. p. 3
Figure 2: *CORE-identified effective PD districts fielding the K-8 Math Teacher Survey*…… p. 3
Figure 3: *TSBE's revised academic standards review and implementation timelines*. p. 8
Figure 4: *Revised standards implementation professional development components*. p. 11
Figure 5: *K-8 Math Teacher Survey response rate by participating district*…… p. 17

Figure 6: *Respondent classification of revised Math standards*…….. p. 19
Figure 7: *K-8 Teacher Math Survey respondent self-reported levels of revised Math standards understanding before and after attending forms of PD*…… p. 20
Figure 8: *Knowledge and understanding of revised standards before and after January 2017 TDOE training* …… p. 21
Figure 9: *Math teachers' revised Math standards understanding after June 2017 state teacher training* ……... p. 21
Figure 10: *Teacher revised Math standards knowledge by teaching experience*…….. p. 23
Figure 11: *Teacher revised Math standards major work knowledge level by teacher specialization*……. p. 24
Figure 12: *Self-reported level of knowledge of how to align instructional materials to revised Math and ELA standards*…….. p. 30
Figure 13: *Types of teacher-developed Math instructional materials used by survey respondents*…… p. 31
Figure 14: *State-approved Math textbooks (available for 2015-16 adoption)*……... p. 33
Figure 15: *March 2017 TDOE training participants' self-reported knowledge of aligning assessments to revised Math and ELA standards*……... p. 34
Figure 15.1: *March 2017 TDOE training participants' self-reported knowledge of aligning assessments to revised Math and ELA standards by CORE region* ……. p. 34
Figure 16: *Types and alignment of common Math assessments in use in respondents' schools*……... p. 35
Figure 17: *Math teacher revised Math standards instructional shifts knowledge and understanding*…… p. 37
Figure 18: *Demographics of K-8 Math Teacher Survey respondents in Knox County Schools compared to respondents in other participating districts*…… p. 39
Figure 19: *Revised Tennessee K-12 Math and ELA standards implementation professional development model*……... p. 46
Figure 20: *Amount of professional development respondents attended to support their implementation of revised Math standards*……... p. 49
Figure 21: *Teacher assessment of 7 characteristics of effective PD in state-led revised Math standards professional development*……... p. 51
Figure 22: *Teacher assessment of 7 characteristics of effective PD in district-led revised Math standards professional development*……... p. 51
Figure 23: *Teacher assessment of 7 characteristics of effective PD in school-led revised Math standards professional development*……... p. 51
Figure 24: *Individual characteristic means for revised Math standard professional development*……... p. 54
Figure 25: *Ideal and Tennessee distributions of characteristics of effective professional development*…….. p. 55
Figure 26: *Usefulness of "Reimagining State Support for Professional Learning: A Practice Brief to Inform a Research Agenda" by CORE region*…….. p. 60
Figure 27: *Standards implementation path forward*……... p. 65

Executive Summary

"Strong Standards are a protection against the injustice of low expectations."
- Dr. Vicki Kirk, Chief Academic Officer, Tennessee Department of Education, Keynote address at the 2016 LEAD conference (Kirk, 2016)

Tennessee has set ambitious student achievement goals for itself that include increasing students' levels of achievement and decreasing achievement gaps. A strategic plan, Tennessee Succeeds, codified these goals in October 2015 and identified rigorous state academic standards as a powerful lever for improving teaching practice and student outcomes. In April 2016, a four-year-long collaborative revision process culminated in the adoption of the K-12 Tennessee Academic Standards for Math and English Language Arts, which were expected to be in use in classrooms at the start of school year 2017-18. Since early 2016, the Tennessee Department of Education (TDOE) has been engaged in an implementation process relative to these revised academic standards at the direction of the Tennessee State Board of Education (TSBE). This process has included state-led professional development to support districts and schools in implementing the revised standards in their classrooms.

TSBE now seeks to learn more about progress teachers and districts have made toward achieving the five standards-implementation outcomes it identified relative to K-12 Tennessee Academic Standards for Math and English Language Arts. This project explored implementation of Tennessee Academic Standards for Math only in grades K-8 and only from January 2017 through March 2018. In this project, we sought to answer two project questions:

PROJECT QUESTION 1
Achievement of Revised Tennessee Math Standards Implementation Outcomes: As of April 2018, what progress have K-8 Math teachers in a subset of Tennessee school districts made toward achieving the five key implementation outcomes that the Tennessee State Board of Education has identified for the recently revised Tennessee Academic Standards for Math:

1. awareness of revised standards;
2. understanding of revised standards;
3. alignment of instructional materials to revised standards;
4. alignment of common assessments to revised standards; and
5. alignment of instruction to revised standards?

PROJECT QUESTION 2
Professional Learning Efficacy: To what extent has state-, district-, and school-level professional development related to revised Tennessee Math standards implementation from Summer 2017 through March 2018 been effective?

Project Question 1 - Implementation Outcomes Findings

Our quantitative and qualitative analyses revealed that TSBE's five standards-implementation outcomes have been achieved to varying degrees among K-8 Tennessee Math teachers and districts as they have been engaged in implementing Tennessee Academic Standards for Math in K-8 (hereinafter, revised Math standards) from Summer 2017 through March 2018.

Outcome 1: Standards Awareness

Near universal awareness of the revised Math standards existed, with almost 99% of all teachers who responded to our K-8 Math Teacher Survey indicating an awareness of the revised standards and the requirement that they be implemented in classroom instruction during school year 2017-18. Approximately 40-60% of survey respondents also reported that they were aware of the revised Math standards prior to attending revised-standards-implementation professional development, and only 2-4% of attendees reported no awareness of the revised state Math standards. However, when asked which Math standards Tennessee currently uses, only about half of surveyed teachers correctly classified the current standards as TN-specific, rather than as Common Core State Standards.

Outcome 2: Standards Understanding

Roughly 70% of district team members, who included many K-8 Math teachers, self-reported possessing from "a lot" to a "mastery" level of understanding of the revised Math standards after attending state-led professional development regarding revised Math standards implementation. The majority of K-8 Math Teacher Survey respondents possessed a medium level of standards content knowledge based on how accurately they identified differences between the revised Math standards and previous versions of Tennessee Math standards. When these survey respondents were asked to identify the major work contained in revised Math standards for grade level(s) they teach Math this school year, respondents were roughly evenly split between low, medium, and high major-work knowledge levels. When examined by teaching specialization, Semi-Math Specialists, who teach Math and one additional subject, were most represented at the high major-work knowledge level.

Outcome 3: Standards-Aligned Instructional Materials

After attending the March 2017 TDOE training, attendees reported an increased level of understanding of how to align Math instructional materials to the revised Math standards and roughly 85% reported possessing "a lot" to a "mastery" level understanding of how to align these instructional materials to the standards. The K-8 Math Teacher Survey revealed that 87% of Math teachers use teacher-created Math instructional materials at least one to five times per week. The survey also revealed low levels of districts requiring teacher use of Math materials adopted, approved or selected by the state or districts.

Outcome 4: Standards-Aligned Common Assessments

Nearly 84% of March 2017 TDOE training attendees reported high levels of understanding of how to align Math assessment materials to the revised Math standards after attending that training. K-8 Math Teacher Survey respondents reported that common assessments exist in just less than half of respondents' schools at all grades, and in only one-third of their schools at some grades.

Outcome 5: Standards-Aligned Instruction

Following the K-8 Math sessions of June 2017 TDOE training, K-8 Math teachers self-reported an increase in their understanding

of the instructional shifts required by the revised Math standards. Their average level of knowledge increased from 4.1 (some) to 5.7 (a lot) out of 7 (mastery), and this increase was found to be statistically significant.

Project Question 2 -Professional Learning Efficacy Findings

We found that each form (state-, district-, and school-led) of revised-Math-standards professional development that was offered from Summer 2017 through March 2018 exhibited some, but not all, of the characteristics of effective professional development. Responses to our K-8 Math Teacher Survey established that varying levels of the seven characteristics of effective professional development existed in the three forms of professional development that surveyed K-8 Math teachers attended. Content focus and collaboration were the characteristics that teachers reported to be most prevalent, while sustained duration was the characteristic that was reported to be least prevalent for all three forms of professional development. Relatively low levels of modeling and feedback also were reported in all three forms of professional development.

RECOMMENDATIONS

We recommend the following for TSBE and TDOE's consideration:

1. Increase the use of high-quality, standards-aligned Math instructional materials throughout Tennessee by:
   - improving the state's textbook approval process;
   - incentivizing districts to adopt and use high-quality Math instructional materials; and
   - embedding high-quality instructional materials into Math standards-implementation professional development and all Math professional development.

2. Reimagine the state's role in professional learning by:
   - revisiting and leveraging TERA's policy brief, "Reimagining State Support for Professional Learning" in planning all future professional learning opportunities; and
   - encouraging better collaboration between state- and local-level human capital and financial resources that support standards implementation.

3. Increase attention to the characteristics of effective professional learning by:
   - ensuring duration of professional development reflects the amount of time required for quality standards implementation; and
   - considering mixed-modality (in-person and online) professional development models.

4. More granularly assess the revised standards implementation effort by:
   - focusing on the seven characteristics of effective professional development as organizing principles for standards-implementation professional learning; and
   - using K-8 Math Teacher Survey questions and other existing surveys to more robustly examine the revised standards implementation process and outcomes it achieves at all levels (state, regional, district, and school).

Section I - Introduction and Background

Definition of Issue

After the adoption of the K-12 Tennessee Academic Standards for Math and English Language Arts (ELA) in Spring 2016, TDOE, in partnership with TSBE, needed to prepare educators to implement these revised Math and ELA standards at the start of the 2017-18 school year. Due to changes in funding, TDOE could not use the TNCore professional development model that had proven successful in preparing Tennessee educators to implement Common Core State Standards in the past. Leveraging learnings from TNCore and mindful of fiscal and capacity constraints, TDOE created a new professional development model to support districts' revised-standards implementation. This new model provided initial TDOE-led training regarding the revised Math and ELA standards and then offered districts autonomy to choose whether to deliver district-level professional development relative to standards implementation using only state-led training, only district-led training, or a hybrid that included a combination of state-and district-led training.

TDOE and TSBE now seek to learn the impact that this new professional development model has had on teachers' achievement of TSBE's five key standards-implementation outcomes: (1) awareness of revised standards; (2) understanding of revised standards; (3) alignment of instructional materials to revised standards; (4) alignment of common assessments to revised standards; and (5) alignment of instruction to revised standards. These state agencies also seek to inform their upcoming implementations of additional revised state academic content standards starting in school year 2018-19 with these learnings.

Project Questions

This capstone project sought to discover the extent to which revised-Math-standards implementation outcomes have been achieved in Tennessee and to examine how effective professional learning related to that implementation effort has been to date. More specifically, we sought to answer the following project questions:

Project Question 1 – Achievement of Revised Tennessee Math Standards Implementation Outcomes: As of April 2018, what progress have K-8 Math teachers in a subset of Tennessee school districts made toward achieving the five key implementation outcomes that the Tennessee State Board of Education has identified for the recently revised Tennessee Academic Standards for Math:

1. awareness of revised standards;
2. understanding of revised standards;
3. alignment of instructional materials to revised standards;
4. alignment of common assessments to revised standards; and
5. alignment of instruction to revised standards?

Project Question 2 – Professional Learning Efficacy: To what extent has state-, district-, and school-level professional development related to revised Tennessee Math standards implementation from Summer 2017 through March 2018 been effective?

Project Design and Methodology

This project utilized a mixed-methods non-experimental design to examine early implementation and professional development relative to the revised Tennessee Math standards in grades K-8. Our research included: a survey of K-8 Math teachers; qualitative interviews and focus groups with revised-Math-standards professional development facilitators and CORE Math Consultants; a review of participant survey data from TDOE's 2017 standards-implementation trainings; and a review of 2017 Tennessee Educator Survey results. This research was supported by a review of extant literature in the areas of teacher professional learning, policy implementation, and Mathematics curriculum practices. In addition, this project team conducted an extensive review of state-, CORE region-, and district-created professional development materials related to revised K-8 Math standards implementation. This project design allowed for triangulation of findings across the foregoing data sources for both project questions as set out in the project's Data Construct Map (Appendix A). For example, knowledge gleaned from survey responses was strengthened by qualitative interviews and TDOE document review.

Quantitative Analysis

This project included quantitative analysis of two distinct data sets. Data set one consisted of the results from a K-8 Math Teacher Survey developed and fielded by the project authors. The second data set consisted of results from surveys administered by TDOE at TDOE revised-Math-standards trainings. This project also relied upon survey results from the 2017 Tennessee Educator Survey, which provided a valid and reliable source for triangulating this project's other survey data.

K-8 Math Teacher Survey

We created a K-8 Math Teacher Survey (Appendix B) that would provide context and actionable insight regarding the level of teacher knowledge of the recently revised Math standards and the extent to which outcomes TSBE has set for teachers and districts relative to revised-Math-standards implementation have been met to date. This survey was distributed to K-8 Math teachers in a subset of Tennessee districts that CORE identified as "effective PD districts." The survey sought to ascertain details about district- and school-level K-8 revised-Math-standards professional development in surveyed districts and the extent to which that professional development incorporated characteristics of effective professional learning as identified by the extant literature. The survey also was designed to identify structures and practices in district-level and school-level professional development related to early implementation of the revised Math standards.

K-8 Math Teacher Survey Development

Survey questions focused on state-led, district-led, and school-led revised Math standards professional development in Summer 2017 and school year 2107-18, as well as teacher knowledge of revised Math standards and the instructional, content, and assessment shifts the standards required. To provide the highest degree of reliability possible, the project team included previously-developed and scaled questions in its K-8 Math Teacher Survey whenever possible. The 54-question survey included items from the Trends in International Mathematics and Science Study (TIMSS), the Mathematics Teachers' Efficacy and Expectancy Beliefs Instrument (MTEEBI), and the Rand Education American Teacher Panel (ATP) survey. Surveying teacher knowledge about

the revised K-8 Math standards also required the creation of new survey questions that probed understanding of specific standards revisions adopted in April 2016. These questions were responsive and appeared in a given survey based on a respondent's indicated grade level. For example, only a teacher who indicated s/he taught Kindergarten this school year would see the following Kindergarten-standards-specific question:

Math content standards emphasize particular topics or work (called "major work") in each grade. Which of the following is major work found in Tennessee's revised Math standards for Kindergarten? (Check all that apply.)

1. *Fluently add and subtract within 5*
2. *Fluently add and subtract within 10*
3. *Identify the penny, nickel, dime, and quarter and recognize the value of each*
4. *I don't know*

The K-8 Math Teacher Survey was approved by the Vanderbilt University IRB and the TSBE research team. A survey construct map and individual survey items are included in Appendix B.

K-8 Math Teacher Survey Administration

TDOE asked the director of each Center of Regional Excellence (CORE) in Tennessee to identify districts that had effectively implemented revised Math standards to date and that would be willing to field the K-8 Math Teacher Survey to their K-8 Math teachers. Initially, six of the eight CORE offices identified a total of 12 "effective PD" districts within their respective regions that would field this survey (Figure 1), and the Southwest and Upper Cumberland Region directors indicated that their districts would not participate.

Ultimately, these seven school districts located in four CORE regions (highlighted in red in Figure 2) fielded the survey to K-8 Math teachers: Knox County Schools in the East

Figure 1. Initial CORE-identified effective PD Districts.

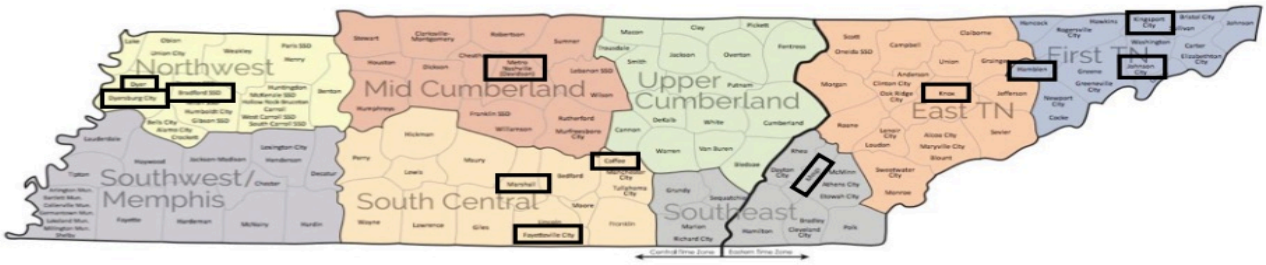


Figure 2. CORE-identified effective PD districts fielding the K-8 Math Teacher Survey.

Tennessee region; Johnson City and Hamblen County in the First Tennessee region; Coffee County Schools, Fayetteville City Schools, and Giles County Schools in the South Central region; and Meigs County Schools in the Southeast region.

K-8 Math Teacher Surveys were administered using Qualtrics. A district contact received an email from the project team that included information about our project, the survey link, stock text for the district contact to use when emailing the survey to the district's K-8 Math teachers, and stock text for a reminder email to be sent to teachers after the survey was open (Appendix C). The role held by our district contact varied across school districts and included Math supervisors, curriculum and instruction directors, and school superintendents. Each district contact emailed the stock survey email either directly to their K-8 Math teachers or to their building principals, who then emailed it to appropriate teachers. District contacts also received a reminder email from the project team to send the stock reminder email to teachers.

After a low initial response rate, district contacts were again asked to send the stock reminder email to their K-8 Math teachers to encourage participation in the survey. In a final round of outreach that sought to boost survey participation, the project team offered teachers a small incentive for completing the survey. All teachers who completed the survey at any point could enter into a random drawing to win one of four $25 Amazon gift cards. The survey remained open for eight weeks and yielded a 15.3% response rate.

Final survey results were exported from Qualtrics into an Excel spreadsheet and then imported into SPSS for data analysis. In addition, after testing in SPSS confirmed internal reliability, two composite variables were created to measure teachers' objective standards knowledge and characteristics of effective professional development (Appendix D). Findings from these statistical analyses will be presented in the sections that follow.

TDOE Survey Responses

This project also relied on data from surveys TDOE administered to attendees of its 2017 revised Math standards trainings. This data set included responses from:

- 584 attendees of TDOE's January 2017 State District Team Training (focused on knowledge/understanding of revised Math and ELA standards);
- 532 attendees of TDOE's March 2017 District Team Training (focused on knowledge/understanding of aligning instructional materials to revised standards); and
- 1,113 Math teacher attendees of TDOE's June 2017 State Teacher Training (focused on understanding revised Math standards expectations and instructional shifts they require).

TDOE provided this information to the project team in electronic format, and the team imported data into Excel and SPSS for data analysis.

2017 Tennessee Educator Survey

This project also relied on data from the 2017 Tennessee Educator Survey. The Tennessee Educator Survey is administered by TDOE and the Tennessee Education Research Alliance at Vanderbilt University. This data set includes responses from approximately 38,000 educators from the state of Tennessee, representing 56% of the state's teachers and 60% of the state's administrators.

Qualitative Analysis

Since districts were given choice in how they trained teachers to implement the revised K-8 Math standards, we developed a semi-structured interview protocol to explore and address anticipated gaps in information about district choices that would remain after we analyzed survey responses. Such data were

more readily obtained through the flexibility of open-ended questions as part of an in-depth interview. Interview protocols for district- and region-level Math professional development facilitators are included in Appendix E. This project included a qualitative element because it allowed for acquisition of contextual information through interviews, observations, and review of documents (Patton, 2015). This data supported the quantitative information the project team gathered, and it produced a vivid depiction of and insight into the experiences of the selected interview population (Shulman, 1981).

Interviews

The K-8 Math Teacher Survey provided information about teachers' awareness and understanding of the revised K-8 Math standards, as well as their professional development experiences related to revised Math standards implementation. Qualitative interviews were conducted to glean information related to these issues from the perspectives of district-level administrators and Math professional development facilitators, as well as region-level Math professional development facilitators.

We utilized a stratified purposeful sampling model in selecting district, school, and CORE region personnel to be interviewed. A total of six interviews, including nine interviewees, were conducted. Interviewee roles included Curriculum Instructor, Elementary Supervisor of Instruction, CORE Math Consultant, and Director of Teacher Development. Each of the CORE regions that participated in this study was represented in the qualitative interview process. A semi-structured interview design minimized variation across our three project team members, while also allowing for further questioning and examination of relevant themes during the course of an interview.

Focus Groups

Two focus groups of revised-Math-standards professional development facilitators in the Metro Nashville Public School System (MNPS) in the Mid Cumberland Region were convened. The project team selected MNPS to participate in focus groups because of its size and because it was one of only 24 districts that utilized a district-only professional development model for revised-Math-standards training and implementation. Appendix E contains the focus group protocol utilized.

Limitations

The K-8 Math Teacher Survey response rate presents limits to the generalizability of project findings due to the potential self-selection bias of survey respondents. The districts that participated in the survey were selected by CORE Region offices based on their opinion that a district had effectively implemented revised Math standards to date and based on the district's willingness to participate in the survey. In addition, the relatively low overall survey response rate of 15.3%, and individual participating school districts' response rates that ranged from 5% to 35%, limit the generalizability of findings to both the broader Tennessee elementary and middle school populations and to all schools within participating districts. We are careful not to make unfounded recommendations for all schools in Tennessee or in a district based solely on the survey data collected.

The voluntary nature of the K-8 Math Teacher Survey also required some level of intrinsic motivation among teachers who choose to complete it. This could increase the likelihood that teachers who took the time to complete the survey had strong feelings they wanted to share about the revised Math standards and associated professional development that are not necessarily representative of the norm.

The fact that some principals distributed our survey to K-8 Math teachers in their buildings poses a threat to internal validity, because some teachers may have felt pressure to complete the survey or been concerned that their principal would see their responses. While our introductory survey email assured teachers that survey data would be confidential and that assurance of confidentiality was reiterated at the beginning of our survey instrument, some teachers may have continued to have doubts because the survey request came from their principal. This same threat to internal validity exists for TDOE training surveys, which TDOE administered to training attendees to learn about their experiences at TDOE-led training. This construct could have caused TDOE-survey respondents to feel pressured to provide positive feedback about TDOE training.

While revised K-8 Math standards implementation was required in schools starting in August 2017, many of the valid and reliable measures of teacher knowledge, teacher practice, and student learning relative to school year 2017-18 that exist in Tennessee will not be available until Summer or Fall 2018. Because these measures that could be used to evaluate the efficacy of the revised K-8 Math standards implementation to date do not yet exist, this project used available self-reported outcomes as indicators of outcomes achievement and professional development effectiveness. It is important to note that this self-reporting may result in social-desirability bias and reference bias due to the lack of a common comparison point.

This project also attempted to create several "objective" indicators of teacher knowledge to inform its efficacy analysis of revised K-8 Math- standards-implementation professional learning. One such indicator, the teacher objective standards knowledge (TOSK) composite variable that we created to more holistically measure teachers' standards knowledge, is vulnerable to possible variability and error variance, because this composite variable combined survey questions that contained different types of response scales.

More robust, and likely more accurate, teacher knowledge and revised-Math-standards-implementation professional learning efficacy indicators will become available at the end of school year 2017-18 once student assessment and teacher evaluation data are collected and released. These may provide additional and better measures of the quality or outcomes of the revised-Math-standards implementation process than those found in this project.

Contextual Analysis

*"It benefits our whole community when **all students learn and progress each year** to become knowledgeable thinkers, good citizens and valuable members of our community. Academic standards are an important part of that mission"* (Tennessee State Board of Education, n.d.).

Tennessee State Academic Standards Revision Mandate

Tennessee state statue charges TSBE with the responsibility of approving academic standards. TSBE policy requires a review of academic standards at least every six years. In 2015, in response to Tennessee Governor Bill Haslam's recommendation and state statute, TSBE embarked on a process to review and revise content area standards for Pre-Kindergarten through 12th grade education in Tennessee and to replace the Common Core State Standards with Tennessee Academic Standards (Tennessee State Board of Education, 2017b). Identifying standards as a key policy lever for school improvement, TSBE committed to "(ensuring) that Tennessee instructional standards are among the very best in the world, and reviewed regularly, with a focus on continuous improvement" (Tennessee State Board of Education, 2017). TSBE created a timeline for standards review, revision, and implementation for all four core subjects, as well as World Language, Fine Arts, Health, Career & Technical Education, and Physical Education (Figure 3). It prioritized revised Math and ELA standards for implementation in school year 2017-18.

Math and English Language Arts Standards Review and Revision Process

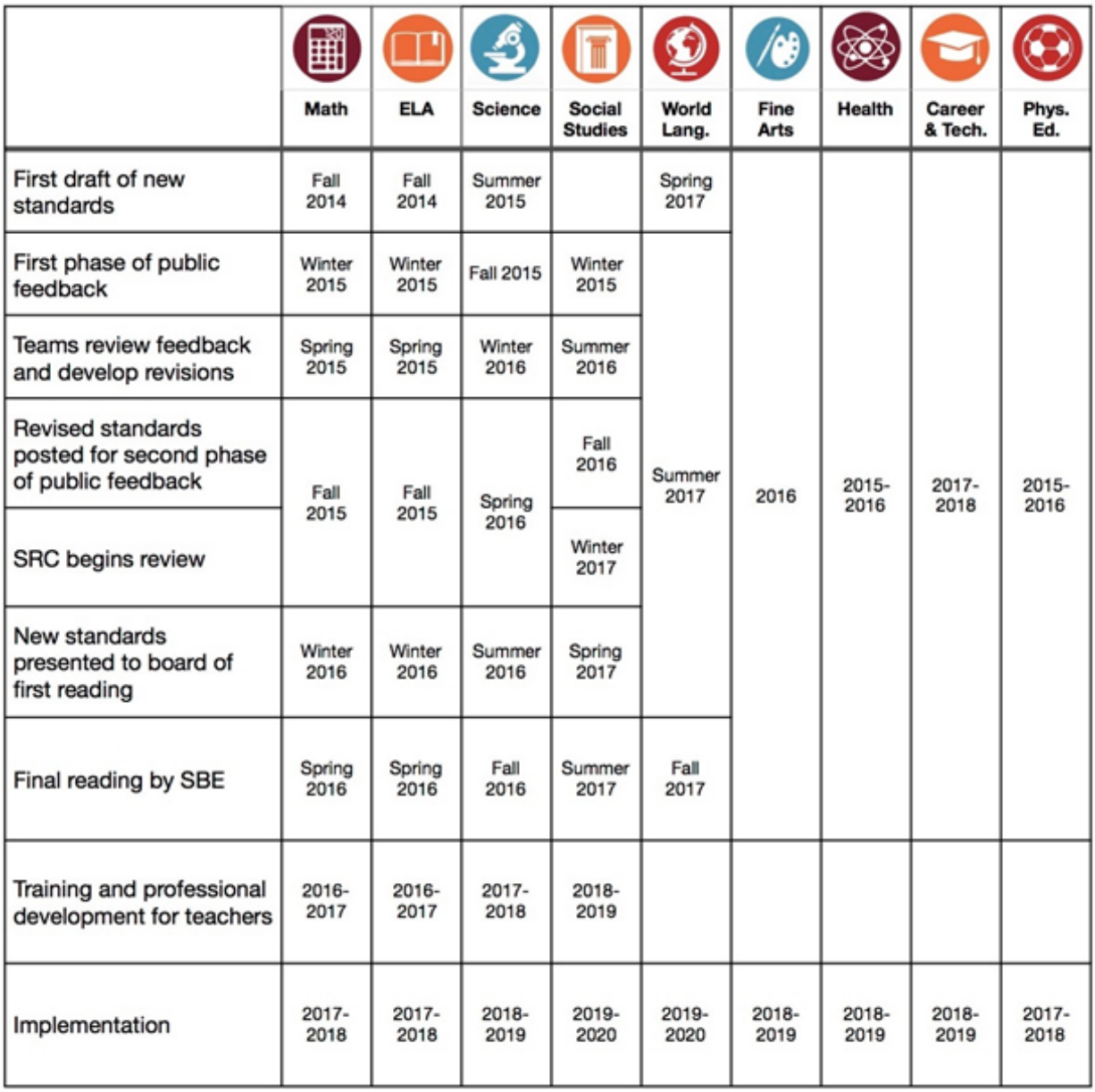
Following an education summit in September 2014, Governor Bill Haslam proposed a review of then-current state academic standards. A cornerstone of Governor Haslam's standards-revision directive was the creation of a website and a process that offered the public an opportunity to review and provide feedback about then-current state academic standards.

Several entities participated in the governor's standards review process that sought to develop high-quality K-12 instructional standards and quality measures, including:

- a 10-member appointed Standards Recommendation Committee (SRC);
- a 22-member ELA Educator Advisory Team, organized by grade level (K-5, 6-8, and 9-12) and consisting of six K-12 educators and one higher education faculty member per grade level band;
- a 22-member Math Educator Advisory Team, organized by grade level (K-5, 6-8, and 9-12) and consisting of six K-12 educators and one higher education faculty member per grade level band; and
- the Southern Regional Education Board (SREB), which partnered with TSBE to collect and analyze public feedback data from its website.

The SRC was responsible for reviewing and evaluating the work of the Educator Advisory Teams and for issuing final recommendations for revised academic standards to TSBE. The Educator Advisory Committees, which were

Figure 3. TSBE's revised academic standards review and implementation timelines.



	Math	ELA	Science	Social Studies	World Lang.	Fine Arts	Health	Career & Tech.	Phys. Ed.
First draft of new standards	Fall 2014	Fall 2014	Summer 2015		Spring 2017				
First phase of public feedback	Winter 2015	Winter 2015	Fall 2015	Winter 2015					
Teams review feedback and develop revisions	Spring 2015	Spring 2015	Winter 2016	Summer 2016					
Revised standards posted for second phase of public feedback	Fall 2015	Fall 2015	Spring 2016	Fall 2016	Summer 2017	2016	2015-2016	2017-2018	2015-2016
SRC begins review				Winter 2017					
New standards presented to board of first reading	Winter 2016	Winter 2016	Summer 2016	Spring 2017					
Final reading by SBE	Spring 2016	Spring 2016	Fall 2016	Summer 2017	Fall 2017				
Training and professional development for teachers	2016-2017	2016-2017	2017-2018	2018-2019					
Implementation	2017-2018	2017-2018	2018-2019	2019-2020	2019-2020	2018-2019	2018-2019	2018-2019	2017-2018

created by TSBE and authorized by the Tennessee General Assembly, were tasked with reviewing feedback collected during the public review period and drafting recommended standards revisions utilizing their content and professional expertise.

From November 2014 through April 2015, over 2,300 public reviewers completed 122,000 reviews and provided 19,000 comments about then-current Math and ELA standards including rating them as "keep," "review" or "remove." Educator Advisory Teams drafted recommended, revised K-12 Math and ELA standards after reviewing this feedback. The SRC reviewed these draft revised standards and sought additional public feedback about them from October to December 2015 via the public website, public roundtable discussions, and an external review of the draft revised standards commissioned by

SREB. After considering all relevant feedback, SRC drafted a final set of recommended Tennessee Academic Standards for Math and ELA and presented them for a first reading at TSBE's January 2016 meeting. Working with Board members, TSBE staff made minor revisions to the final recommended Tennessee Academic Standards for Math and ELA before TSBE adopted these revised K-12 standards in April 2016.

Following TSBE's April 2016 adoption of the revised Math and ELA standards, TSBE charged TDOE with revised-standards implementation, training, materials adoption, and assessment alignment. In order to prepare districts to implement these revised K-12 Math and ELA standards beginning at the start of the 2017-2018 school year, TDOE planned and facilitated standards-implementation training beginning in January 2017. This professional development sought to prepare Tennessee educators and school leaders to achieve five key standards-implementation outcomes articulated by TSBE: (1) awareness of revised standards; (2) understanding of revised standards; (3) alignment of instructional materials to revised standards; (4) alignment of common assessments to revised standards; and (5) alignment of instruction to revised standards.

Remaining Standards Review, Revision and Implementation Process

Tennessee Science, Social Studies, World Language, Fine Arts, Health, and Career & Technical Education standards are currently undergoing review or revision following processes similar to those described for Math and ELA, and as mandated by Tennessee state statute and TSBE policy. Implementation of some of these standards is expected as early as school year 2018-19 (Figure 3). TSBE and TDOE seek to inform these upcoming implementations of revised state academic standards with learnings from the Math and ELA implementation process currently underway. Through this project, they seek to identify early outcomes of the revised-Math-standards implementation process.

Current Implementation Process for Tennessee Academic Standards for Math and ELA

At the conclusion of a nearly four-year-long collaborative revision process that created the revised Tennessee Math standards, a deliberate and effective professional development effort was needed at the state, region, district, and school levels throughout Tennessee in order to fully implement the revised standards.

TNCore training, an innovative professional development model that TDOE used when implementing the Common Core State Standards (CCSS) beginning in 2012, and as an early awardee of Race to the Top funding, was no longer available to the state (Tennessee Department of Education, 2013). Through that training effort, approximately 900 Math and Literacy Core Coaches were trained to lead CCSS implementation training for more than 30,000 Tennessee educators. TNCore Math training had a positive impact on the instructional practices and student test scores of teachers who participated in it. While this training model appeared to be appropriate to use to support implementation of the revised Math and ELA standards in 2016, fiscal and capacity constraints caused by the unavailability of continued Race to the Top funding in Tennessee required TDOE to choose or create a new approach to professional development to support revised standards implementation.

TDOE's approach to creating revised-standards-implementation professional development in 2016 reflected its knowledge that districts possess different levels of human capital resources and internal capacity related to curriculum, instruction, and professional development. In creating its new two-phase

standards-implementation professional development approach (Figure 4), TDOE and TSBE assumed that giving districts autonomy to choose a particular professional development model to train district teachers, leaders, and personnel regarding the recently revised Math and ELA standards would increase the efficacy of professional development that was delivered to district teachers, and thereby increase the quality of revised Math and ELA standards implementation required in the 2017-18 school year.

Phase One Revised-Standards-Implementation Professional Development

Phase One of TDOE's Revised-Standards-Implementation Professional Development (described in Figure 4) included state-led training for school leaders, district teams, and teachers about the revised standards, aligned assessments, and instructional shifts required by the revised standards. TDOE shared initial training plans relative to the revised standards with superintendents at the Superintendents' Study Conference in September 2016 and with school leaders at the October 2016 LEAD Conference. During Fall 2016, TDOE contracted with educators from the Math and ELA Educator Advisory Teams that had participated in the standards review process to develop content for educator training slated for Summer 2017. In January and March 2017, TDOE offered professional development for school district teams to orient them to TSBE and TDOE expectations regarding revised Math and ELA standards implementation. Each district had latitude in selecting which district personnel would attend a particular TDOE training. Approximately 900 participants representing 144 of 146 local education agencies attended TDOE's district team trainings.

TDOE's initial one-day January 2017 training was designed for district teams and provided a review of the standards revision process, an overview of the newly revised Math and ELA standards, discussion of how assessment and instructional materials align to the revised standards, and time for district teams to analyze how district-level systems and structures impacted their ability to implement the revised standards (Tennessee Department of Education, n.d.c). At this training, TDOE also informed districts that they could choose one of three types of professional development models to deliver Phase Two Revised-Standards-Implementation Professional Development at the district level: entirely state-delivered professional development; entirely district-delivered professional development; or a hybrid model that allowed a district to combine state- and district-delivered professional development. Each school district could choose the professional development model that would best suit its professional development needs given local context and available resources.

At the two-day March 2017 TDOE trainings, district teams focused more specifically on aligning assessment and instructional materials to the revised standards, previewed the school leader and educator training scheduled for Spring and Summer 2017, and began to develop standards implementation action plans using a diagnosing and designing protocol (Tennessee Department of Education, n.d.c).

As districts finalized decisions regarding their chosen professional development model for Phase Two professional development that would occur at the district level, TDOE offered additional professional learning and support related to the revised Math and ELA standards through CORE offices and made all TDOE training materials available on the TDOE website.

In March and April 2017, TDOE offered an Integrated Leadership Course on curriculum and standards that roughly 1,000

school leaders attended. TDOE webinars in May 2017 provided additional training for districts that opted to use the district-delivery professional development model, and 668 individuals representing over 100 local education agencies participated in these webinars. Finally, in June 2017, roughly 6,000 teachers attended TDOE-led ELA and Math trainings to deepen their understanding of the instructional shifts and changes in academic expectations required by the revised standards and to learn more about how to evaluate instructional materials for alignment to the revised standards.

All Phase One TDOE revised-Math-standards training and materials maintained a recurring emphasis on instructional shifts in focus, coherence, and rigor that were required by the revised standards and that had been introduced during the implementation of the previous Math standards. In all grades, increased focus was made possible by a smaller number of standards topics and by a requirement to build a stronger mathematical foundation based in fluency at the early grades (Tennessee State Board of Education, n.d.b).

Figure 4. Revised-standards-implementation professional development components.

Phase 1 TDOE State-led Professional Development	
Fall 2016	• Initial training plans shared with superintendents and school leaders at in-person state meetings and conferences • TDOE contracted with expert educators to develop Summer 2017 educator Tennessee Academic Standards for Math and ELA training content
January and March 2017	Training for district teams to assess current systems and structures to allow for creation of revised-standards implementation plans
March/April 2017	Integrated Leadership Course-training for school leaders on curriculum and standards alignment
May 2017	TDOE-led webinars for districts opting to deliver revised standards training using the district-only PD model
June 2017	Two-day teacher training to deepen understanding of instructional shifts, changes in academic expectations, and modifications to instructional materials required by revised standards
Phase 2 District-led Professional Development	
Summer 2017	District-level training to support revised Math and ELA standards implementation
School Year 2017-18	• Implementation of revised Math standards and assessments required • Ongoing district training and support about instructional material and assessment alignment required by revised Math standards

Greater coherence in the standards was achieved through increased linkages between major topics—that included an expectation for a balanced approach to teaching conceptual understanding, procedural skill and fluency, and application—being made within and across grade levels. These changes and the inclusion of literacy skills for Math proficiency together increased the rigor of the revised Math standards.

Emphasizing these instructional shifts required by the revised Math standards throughout the state's Phase One standards implementation training and related materials reinforced their importance. It also reinforced the need to include discussion of these shifts in all subsequent professional development related to aligning Math instruction, instructional materials, and assessments to the revised Math standards. Phase One's multi-stage approach was designed to provide school districts with the information and tools necessary to support their chosen Phase Two Revised-Standards-Implementation Professional Development model.

Phase Two Revised-Standards-Implementation Professional Development

District-level Phase Two Revised-Standards-Implementation Professional Development using one of three professional development models began as early as Spring 2017. Two Tennessee school districts chose to use the entirely-state-delivered professional development model, in which the district's revised-standards professional development consisted of simply attending TDOE trainings. Twenty-four districts chose to use the entirely-district-delivered professional development model, and 113 districts selected the hybrid professional development model in which district staff attended TDOE training and then re-delivered content in their respective districts using a combination of state-provided and district-modified resources.

Content of Revised Math Standards

The revised Math standards Tennessee adopted in 2016 maintained K-12 Learning Progressions, which are traditional and integrated pathways for Math instruction, and Standards for Mathematical Practice, which reflect a research-informed consensus regarding what constitutes effective Math teaching practice that enhances student learning at all grades. These practices are "at the heart of the work of teaching that are most likely to affect student learning" and describe the essential and necessary components of the work that Math teachers should do on a daily basis (Ball & Forzani, 2010, p. 45). The revised Math standards also continued to place a high priority on the need for shifts in instructional practice.

Overarching changes in the revised K-12 Math standards included a changed structure for the cluster heading categories. Previous standards had three cluster heading categories: major work of the grade, supporting work of the grade, and additional work of the grade. The revised standards retained the category of major work of the grade and collapsed the old categories of supporting and additional work into a single category called "supporting work of the grade." Public feedback during the revision process informed this change that sought to address the misconception that supporting and additional work were superfluous components of the standards to be tackled after the state assessment took place or only if time permitted.

The inclusion of Literacy Skills for Mathematical Proficiency constituted another overarching change to the revised K-12 Math standards. These newly defined literacy skills addressed the need for students to be able to effectively communicate about Math. Identified reading, vocabulary,

speaking, listening, and writing skills for mathematical proficiency included: using multiple reading strategies, understanding and using correct mathematical vocabulary, discussing and articulating mathematical ideas, and writing mathematical arguments (Tennessee State Board of Education, n.d.b).

In this project, only K-8 revised Math standards and implementation were examined. At the K-5 level, only a small number of standards were revised to strengthen coherence across grade levels, and most of the major work of the grade levels remained the same. The primary changes to the K-5 Math standards consisted of refining language in the standards for clarity, increasing fluency expectations by including a larger range of numbers at earlier grades, and revising examples within the standards. At the 6th-8th grade level, major work of the grade was refined, supporting work of the grade was revised, and a small number of standards were condensed, removed or expanded to strengthen coherence. Statistics and probability standards were most affected by the 6th-8th grade standards revisions.

Centers of Regional Excellence (CORE) Role in Revised Math Standards Implementation

TDOE has divided the state into eight geographic regions. From west to east these regions are: Northwest, Southwest, Mid Cumberland, South Central, Upper Cumberland, Southeast, East Tennessee, and First Tennessee (see Figure 1). In each region, a Center of Regional Excellence (CORE) acts as a TDOE field office for the region's districts and serves as an intermediary between the state and district levels. CORE offices work closely with districts containing priority, focus, and Title I schools to build the capacity of their educators. Each CORE office is led by an Executive Director and staffed with specialists in the areas of English Language Arts, Math, data, evaluation, intervention, Career and Technical Education, and school nutrition. The CORE Math specialist is known as the CORE Math Consultant. As of March 2018, seven of the eight CORE Regions had a Math Consultant in place, and that position was vacant in the Southeast Region. Among other duties, Math Consultants support revised Math standards implementation in their respective districts and also collaboratively created common forms of this implementation support that are used across all regions in Tennessee (CORE Region Interview 1).

In 2017, CORE Math Consultants created four Math Standards Implementation Modules to support districts in their revised-standards-implementation efforts. The CORE Math Module series was developed to provide district and school instructional leaders with a high-level vision of effective Math instructional practice through the lens of academic standards and instructional shifts that the standards require. It also sought to create readiness for revised-Math-standards implementation by building instructional leaders' capacity to set the conditions in their district and/or buildings for standards-aligned Math instruction (CORE Region Interview 1).

CORE Module 1: Culture of Readiness and Growth Mindset explored features of readiness for students, teachers, and instructional leaders. CORE Module 2: The Tennessee Math Standards and Instructional Shifts made connections between the revised Math standards, instructional shifts (in focus, coherence, and rigor) the revised Math standards require, and the ready student model. It also engaged attendees in using an inquiry tool to uncover the current state of implementation of the revised Math standards and required instructional shifts in their districts or schools. CORE Module 3: Planning and Delivering Effective Instruction explained the National Council of Teachers of Mathematics' eight Mathematical Teaching Practices and how they connect to purposeful planning and delivery of effective Math

instruction. The module also examined strategies that support the implementation of these eight practices. CORE Module 4: Assessing Rigorous Instruction and Student Learning engaged attendees in exploring how best to meet the needs of all students they serve.

Math Consultants planned to present all four modules to all districts located in their CORE Region during school year 2017-18 and then to follow up by facilitating differentiated Math professional development that individual districts identified a need for and at districts' invitation (CORE Region Interview 1; Core Math Modules Series Outline, 2017).

Demographics of Districts Participating in the K-8 Math Teacher Survey

Background about K-8 Math Teacher Survey Population: Figure 1 highlights the location of the 12 districts that CORE offices initially identified as effective professional development districts in Tennessee for purposes of this project. These were districts that had shown indicators of effective implementation of revised Math standards to date and willingness to field our project survey. These districts were located in six of the eight CORE Regions, with the Southwest and Upper Cumberland CORE regions not identifying any districts for participation. All K-8 Math teachers in each of these 12 districts were to receive an invitation to complete the K-8 Math Teacher Survey designed by the project team. Due to changes in district leadership and district priorities, five of the initially identified districts (Kingsport City, Dyer County, Dyersburg, Bradford Special School District, Metro Nashville Public Schools, and Marshall County) did not distribute the K-8 Math Teacher Survey to their teachers.

Demographics of Districts Participating in K-8 Math Teacher Survey: Figure 2 highlights the seven CORE-identified districts that ultimately fielded this project's K-8 Math Teacher Survey. One newly-identified district (Giles County) joined the six districts that CORE identified to field the survey at the outset of this project. These seven participating districts are located in the south central and eastern areas of the state and represent four of the state's eight CORE regions. Table 1 below contains descriptive student statistics for each participating school district. Participating districts included: 129 K-12 school buildings; a K-12 enrollment of 88,173 students; and 5,905 K-12 teachers. Participating districts constitute: 4.8% of Tennessee's 146 school districts; 7.4% of Tennessee's 1,742 K-12 school buildings; 9.1% of its 972,704 student K-12 enrollment; and 9.1% of its 65,091 K-12 teachers (Tennessee Department of Education, 2017b).

Table 1

Descriptive student statistics for school districts surveyed

Variable	Coffee County	Fayetteville City	Giles County	Hamblen County	Johnson City	Knox County	Meigs County
Enrollment (PreK-12)	4,473	1,502	3,949	10,423	7,981	60,356	1,754
% Econ. Disadvantage	35.9	45.3	37.1	43.3	33.9	28.3	34.0
Special Education	657	219	482	1,468	1,121	8,686	354
% Special Education	14.7	14.6	12.2	14.1	14.0	14.4	20.2
EL/LEP	60	23	53	1,364	434	3,094	
% EL/LEP	1.3	1.5	1.3	13.1	5.4	5.1	
Per-pupil Expenditure	9,506.50	9,022.10	9,473.00	8,818.40	10,282	9,238.60	9,544.4
% Asian	0.9	0.7	0.9	1.1	3.5	2.7	0.0
% African American	3.2	33.9	17.7	7.0	15.1	17.0	1.8
% Hispanic	6.3	5.1	3.2	25.1	9.8	8.7	1.7
% American Indian	0.0	0.0	0.4	0.4	0.3	0.4	0.0
% White	89.1	59.9	77.7	66.0	71.1	70.9	95.9

Districts fielding the K-8 Math Teacher Survey ranged in size from small to large with PreK-12 enrollments between 1,502 and 60,356 students. These districts also served both rural and urban communities. For example, Fayetteville City Schools, the smallest participating district, ranks 112 of 146 in terms of size in the state with a PreK-12 enrollment of 1,502 students. This district is located in Southern Middle Tennessee and serves Fayetteville City, which had a population of 6,827 in 2010 (U.S. Census Bureau (n.d.), accessed February 17, 2018). Hamblen County Schools is a mid-size, rural participating district that ranks 18th largest in the state with a PreK-12 enrollment of 10,423 students. It serves Hamblen County, which ranks 21 of 95 in terms of size in the state with a 2010 population of 62,544, and is located in northeast Tennessee. Morristown is the county's only incorporated city. (U.S. Census Bureau (n.d.), accessed February 18, 2018). Knox County Schools, the largest participating district, is the third largest school district in Tennessee with a PreK-12 enrollment of 60,353. Knox County is the state's third largest county with a 2010 population of 432,226 (U.S. Census Bureau (n.d.), accessed February 18, 2018).

The percentage of K-12 students classified as economically disadvantaged in participating districts ranged from a low of 28.3% in Knox County to a high of 45.3% in Fayetteville City. In 2016-17, the state average was 34.7% (Tennessee Department of Education, 2017c). Per-pupil expenditure in the seven participating districts ranged from $8,818 in Hamblen County to $10,282 in Johnson City with a mean of $9,402. In 2016-17, average K-12 per-pupil expenditure in Tennessee was $9,958 (Tennessee Department of Education, 2017c).

The sub-population in participating districts that is most relevant to this project consists of 2,721 K-8 Math teachers working in 103 elementary, middle, and junior high school buildings. The K-8 Math Teacher Survey was distributed to 1,209 (44.4%) of these 2,721 K-8 Math teachers. While six of the seven participating districts distributed the survey to all K-8 Math teachers in the district, Knox County Schools inadvertently only distributed the survey to 337 of its eligible 1,849 K-8 Math teachers. These 337 Knox County Math teachers teach Math in grades 3-8 in the current 2017-18 school year.

Section II – Results: Findings, Interpretation, and Discussion - Project Question 1

K-8 Math Teacher Survey Respondent Demographic Findings

Respondents' Personal Characteristics

Table 2 found in Appendix F captures K-8 Math Teacher Survey respondents' personal characteristics in the aggregate and disaggregated by each school district that fielded the survey. Findings relative to each of these personal characteristics are highlighted below.

Gender: Most K-8 Math Teacher Survey respondents were female with 89.7% of survey respondents identifying as female and 8.7% identifying as male. This gender distribution of K-8 teachers who responded to the survey is similar to the gender distribution of K-12 teachers in Tennessee (79% female and 21% male) and in the United States (76% female and 24% male) (U.S. Department of Education, NCES, SASS, 2012).

Age: The ages of K-8 Math teachers responding to the survey were distributed as follows: 13.5% of respondents were under 30, 57.3% were age 30-49, and 29.2% were 50 or older. This age distribution of survey

respondents is similar to the age distribution of K-12 teachers in Tennessee (18% under 30, 49% age 30-49, and 49% age 50 or older) and closely mirrors the distribution in the United States (15% under 30, 54% age 30-49, and 31% 50 or older) (U.S. Department of Education, NCES, SASS, 2012).

Teaching Experience: Survey respondents were experienced both as teachers and as Math teachers. 149 (80.6%) of 185 respondents have taught six or more years, and 140 (75.8%) of 185 respondents have taught Math six or more years.

Amount of Revised Math Standards Professional Development: Survey respondents were asked how much professional development they received this year to support their implementation of the revised Math standards. 12.6% of respondents reported they attended no professional development related to the revised Math standards. 44.3% of respondents reported attending 1-4 hours of such professional development, 24.0% reported attending 5-8 hours, 13.8% reported 9-16 hours, and 5.4% reported attending more than 16 hours of such professional development. Table 2.1 disaggregates these findings by participating district.

Frequency of Revised Math Standards Professional Development: When asked about the frequency with which they engaged in professional development that supports implementation of the revised Math standards, 22.2% of survey respondents reported never engaging in such professional development, 40.7% reported engaging quarterly, 23.4% reported engaging monthly, 12.0% reported engaging weekly, 1.8% reported engaging several times per week, and no one reported engaging in such professional development daily. Table 2.1 disaggregates these findings by district.

Form of Revised Math Standards Professional Development: 49.7% of K-8 Math Teacher Survey respondents reported attending state-led professional development on the topic of revised state Math standards. 73.5% of survey respondents reported attending district-led professional development on this topic, and 31.4% of survey respondents reported attending school-led professional development on this topic. Table 2.2 disaggregates revised-Math-standards professional development respondents attended by each form and combination of forms of this professional development that they could have attended from Summer 2017 through March 2018.

Respondents' School Characteristics

Findings relative to K-8 Math Teacher Survey respondents' school characteristics are highlighted below. Tables capturing descriptive statistics for each of these characteristics in the aggregate and disaggregated by each school district that fielded the survey can be found in Appendix F.

Math Grade Levels: Survey respondents included teachers of Math in all grades from Kindergarten through high school. When asked to identify the grade levels they teach in the current 2017-18 school year, 123 (66.5%) of surveyed teachers reported teaching Math in grades K-5, 55 (29.7%) reported teaching Math in 6th-8th grades, and 7 (3.8%) reported teaching high school Math. The highest number of surveyed teachers (37) taught 4th grade Math (Table 3). Table 3.1 disaggregates these findings by participating district.

Math Specialization: Teachers who responded to the survey were classified by three categories that reflected how much of the instruction they deliver this 2017-18 school year is Math instruction (Table 4). Math

Specialists (*n*=86), who teach only Math, constituted 46.5% of survey respondents. Semi-Math Specialists (*n*=46), who teach Math and one other subject, made up 24.9% of survey respondents. Generalists (*n*=53), who teach several core classes in addition to Math, constituted 28.6% of survey respondents. Table 4.1 disaggregates these findings by participating district.

Number of Math Periods Taught: The mean number of approximately 45-minute-long Math classes taught per week by all survey respondents in the current 2017-18 school year was 7.6 (Table 3). However, large variation in the number of Math classes respondents teach per week existed, with respondents teaching as few as one Math class per week (*n*=4) and others teaching 21 or more classes (*n*=16). The mean number of Math classes taught weekly by K-5th grade teachers was 7.2, and the mean number of Math classes taught by 6-8th grade teachers was 8.8. Table 3.2 disaggregates these findings by participating district.

Number of Math Preparation Periods: 96% of survey respondents indicated that their schedule contains teacher preparation periods in the current 2017-18 school year. Of teachers with preparation periods, 88.7% indicated that they have teacher preparation periods designated specifically for Math, and 11.3% indicated that they have zero Math-designated preparation periods (Table 5). Table 5.1 disaggregates these findings by participating district.

School Monitoring of Instructional Alignment to Math Standards: When asked how their school monitors alignment of Math instruction to Math standards, 39.6% of teachers responding to the K-8 Teacher Math Survey reported monitoring was accomplished via informal or formal observations; 28.1% reported via teacher team meetings; 11.0% reported via collection of unit or lesson plans; 12.2% reported via review of student assessments; 6.4% reported via professional development; and 2.0% reported their school did not monitor Math instructional alignment in the current 2017-18 school year (Table 6).

Respondents' District Characteristics

Response Rate: The response rate for the K-8 Math Teacher Survey was 15.3%, with 185 (15.3%) of 1,209 K-8 Math teachers who received the survey in participating districts responding. This response rate varied by participating district from a high of 35% in Knox County to a low of 5% in Hamblen County. Survey respondents included 185 (6.8%) of the 2,721 eligible K-8 Math teachers in districts fielding the survey. Table 7 details response rates for each school district that fielded the survey, and Figure 5 offers insight into participation rates based on the relevant K-8 Math teacher sub-population in each district.

Figure 5. K-8 Math Teacher Survey response rate by participating district.

DISTRICT	RESPONDENTS	K-8 MATH TEACHER POPULATION
Coffee County	7 (3.9%)	107 (3.9%)
Fayetteville City	7 (3.9%)	33 (1.2%)
Giles County	17 (19.2%)	115 (4.2%)
Hamblen County	14 (7.6%)	289 (10.6%)
Johnson City	17 (9.2%)	258 (9.5%)
Knox County	118 (63.8%)	1849 (68.0%)
Meigs County	5 (2.7%)	70 (2.6%)
TOTAL	185	2721

Project Question 1 – Achievement of Revised Tennessee Math Standards Implementation Outcomes: As of April 2018, what progress have K-8 Math teachers in a subset of Tennessee school districts made toward achieving the five key implementation outcomes that the Tennessee State Board of Education has identified for the recently revised Tennessee Academic Standards for Math:

1. awareness of revised standards;
2. understanding of revised standards;
3. alignment of instructional materials to revised standards;
4. alignment of common assessments to revised standards; and
5. alignment of instruction to revised standards?

Implementation Outcome 1 - Revised Math Standards Awareness Findings

Subjective Teacher Standards Awareness

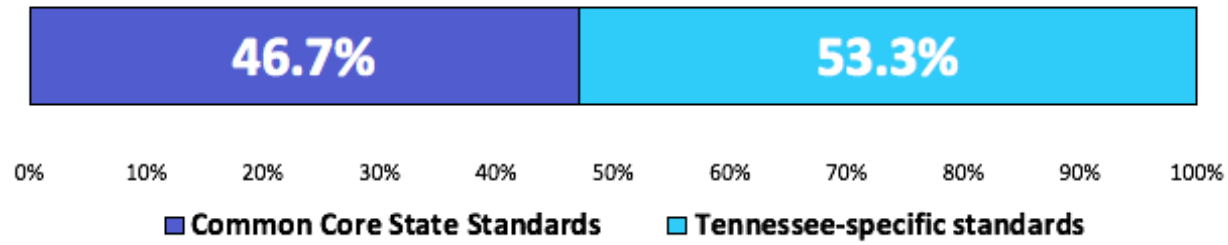
Three questions in the K-8 Math Teacher Survey sought to measure Math teachers' awareness of the K-8 revised Math standards.

Self-rating of Revised Math Standards Awareness: K-8 Math Teacher Survey respondents who indicated they had attended state-, district- or school-led professional development were asked a follow-up question about whether they were aware that Tennessee had revised its Math standards prior to attending that form of professional development. For each form of professional development, approximately 40-60% of attendees reported being aware of the revisions but not about revision specifics. Only about 1-4% of attendees reported no awareness of the state Math standards revisions having occurred. Another roughly 40-60% of respondents reported having a clear understanding of the state Math standards revisions, a finding that will be explored in more depth in a later section of this paper. Table 8 contains survey respondents' self-reported awareness levels disaggregated by form of professional development (state-, district- or school-led) they attended.

Revised Math Standards Implementation Timeline Expectations Awareness: When responding to the K-8 Math Teacher Survey in February or March 2018, almost all (98.1%) survey respondents correctly identified that teachers were expected to begin addressing revised state Math standards in their instruction in school year 2017-18. The remaining 1.9% of respondents indicated that this expectation would go into effect in school year 2018-19, and none indicated that the expectation begins in school year 2018-19 or beyond (Table 9). This data suggests that districts have been effectively communicating the revised standards implementation timeline to teachers.

Common Core State Standards vs. Tennessee Academic Standards Awareness: While teachers were almost universally aware that revised Math standards needed to be reflected in Math instruction in school year 2017-18, some confusion existed among them about the substance of those standards. Only slightly more than half (53.3%) of K-8 Math Teacher Survey respondents correctly classified the type of Math standards currently in place in Tennessee (Table 10). 46.7% of respondents classified current Math academic standards as Common Core State Standards, rather than Tennessee-specific Math standards. Correct classification rates varied among participating districts from 50% in Meigs County to 70.6% in Johnson City (Table 10.1). This level of misclassification of the current state Math standards was surprising given the multi-year, transparent, and public standards revision process that has been ongoing in Tennessee since 2014 and given that implementation of

Figure 6. Respondent classification of revised Math standards.



the Tennessee Academic Standards for Math was required in schools for more than six months prior to the start of survey distribution.

Disaggregating these results by number of years teaching revealed that 34.3% of responding teachers with one to five years of teaching experience, 50% of teachers with 6-14 years of experience, and 65.8% of teachers with 15 or more years of experience correctly classified the current state Math standards as Tennessee-specific rather than Common Core (Table 10.2).

All Tennessee teachers who have taught for six or more years would have experienced teaching under both the Common Core State Standards (CCSS) and the Tennessee Academic Standards for Math, because CCSS were incorporated into instruction in Tennessee in the 2012-13 school year and remained in place until the 2017-18 school year when the revised Tennessee Academic Standards for Math were expected to be implemented in classroom instruction. Only 57.9% of all surveyed teachers with six or more years of teaching experience correctly classified the state academic standards that are currently in place as Tennessee-specific.

A chi-square test of independence was performed to examine the relationship between years of teaching experience and correct classification of the current Tennessee standards. The relationship between these variables was statistically significant, X_2 (1, n=180) = 6.33, p=.012. Teachers with six or more years of teaching experience were statistically more likely to classify the current standards as Tennessee-specific. When the 57.9% of teachers with six or more years of teaching experience who correctly classified the standards as Tennessee-specific were compared to the 34.3% of teachers with one to five years of teaching experience who correctly classified the current standards as Tennessee-specific, the difference was statistically significant at the p<.05 level.

Results of the 2017 Tennessee Educator Survey also supported this finding. Early career teachers were asked the extent to which their education preparation program prepared them to understand the Tennessee-specific standards. 10% of respondents indicated "not at all prepared," 17% indicated "somewhat unprepared," 39% indicated "somewhat prepared," and 34% responded "well prepared" (Tennessee Department of Education, 2017b). A combined total of 27% of early career teachers self-identified as feeling unprepared to understand the Tennessee-specific standards. Interestingly, 34% self-identified as feeling "well prepared," which is roughly the same percentage of newer teacher respondents from the K-8 Math Teacher Survey who correctly classified the current Math standards as Tennessee-specific.

Implementation Outcome 2 - Revised Math Standards Understanding Findings

Subjective Teacher Standards Understanding

Several questions from both the K-8 Math Teacher Survey and TDOE state training surveys sought to measure Math teachers' understanding of the revised Math standards by asking them to rate their own depth of understanding of these standards.

Depth of Standards Understanding Before and After Attending Forms of Revised Math Standards Professional Development: Teachers responding to the K-8 Math Teacher Survey were asked to rate their level of understanding of the revised Math standards both before and after they attended state-, district-, and/or school-level professional development related to those standards. Based on their rating, teachers were categorized into three groups reflecting their depth of standards knowledge: understanding the standards (excellent or very good rating); aware of the standards (good or fair rating); and unaware of the standards (poor rating)(Table 11).

K-8 Math Teacher Survey respondents who attended school-led professional development were most frequently categorized as understanding (59.6%) compared to 48.1% of district-led professional development attendees and 39.6% of state-led professional development attendees. Fewer than 5% of attendees of any form of professional development were categorized as unaware of the revised Math standards.

After attending revised-Math-standards professional development, most K-8 Math Teacher Survey respondents reported an increase in their depth of understanding of those standards. Most also reported a similar depth of post-professional-development understanding regardless of which form of professional development they had attended; approximately 60-63% of attendees of state-, district-, and school-led professional development reported understanding the revised standards, and 37-40% of those attendees reported awareness of the standards.

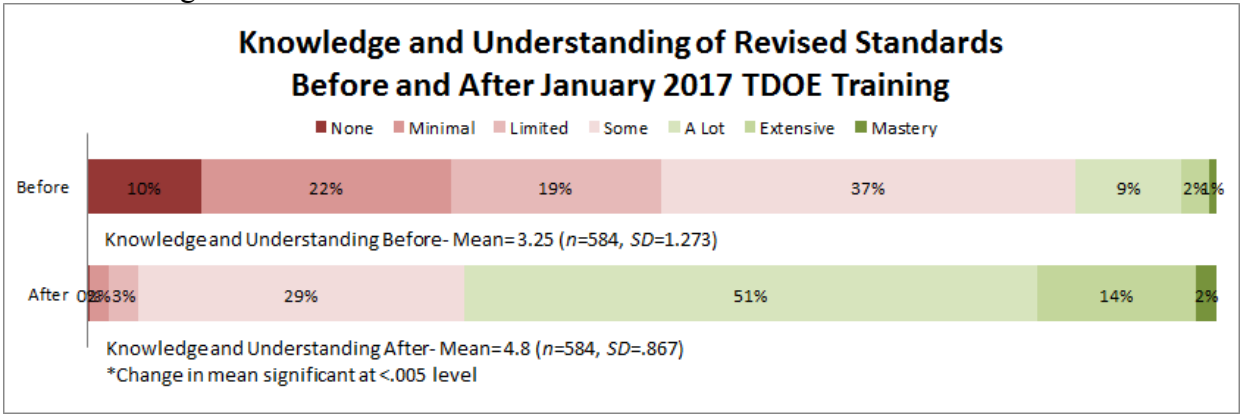
Before- and after-professional-development standards understanding levels for K-8 Math Teacher Survey respondents were quantified on a one to five point Likert scale with one representing poor understanding and five representing excellent understanding (Figure 7). Before attending professional development, respondents who attended state-led professional development had the lowest understanding mean score (2.8), while district- and school-led professional development attendees had mean scores of 3.0 and 3.3 respectively. All K-8 Math Teacher Survey respondents had an understanding mean score of 3.7 after attending professional development regardless of which form they attended. A paired-samples t-test was used for state-, district-, and school-led professional development, and a statistically significant difference in before and after mean understanding was found for all three forms of professional development ($p<.0005$).

Figure 7. K-8 Teacher Math Survey respondent self-reported levels of revised Math standards understanding before and after attending forms of PD.

Understanding of Revised Standards		
	Before	**After**
State-led PD	2.8	3.7*
District-led PD	3.0	3.7*
School-led PD	3.3	3.7*

*Significant at <.0005 level

Figure 8: Knowledge and understanding of revised standards before and after January 2017 TDOE training.



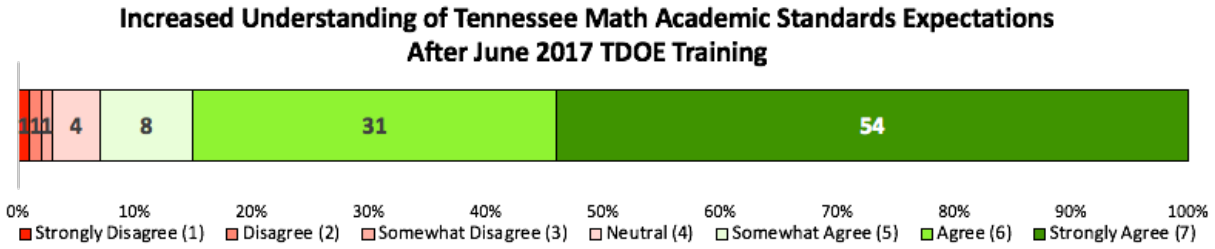
Similar results were seen in the January 2017 TDOE state training survey findings that captured ratings from 584 of 811 training attendees (response rate =72%) (Figure 8). Respondents' average level of revised-Math-standards knowledge and understanding increased from 3.3 (limited) before attending training to 4.8 (some) after attending training, or 1.5 levels (where 1 is none and 7 is mastery on the 7-point Likert scale). These results indicate a statistically significant increase in attendees' self-reported knowledge and understanding of the revised Math standards, M=11.54, 95%CI [-1.634, -1.465], t(583) = .34.091, p<.0005.

June 2017 TDOE state training survey results also correspond to these K-8 Math Teacher Survey results (Table 12); 85.7% of the 1,113 Math teachers attending the June 2017 state training reported they strongly agreed or agreed that it increased their understanding of the revised Math standards' expectations (Figure 9). ***Overall, these statistics provide an indication that attendees perceived TDOE's state trainings to be effective. However, the fact that 85.7% of teachers reported agreeing or strongly agreeing that the June training increased their understanding of the revised Math standards also suggests that many attendees still had a lot to learn about the revised standards and their implementation as of June 2017.***

Objective Teacher Standards Understanding

Seeking to move beyond merely subjective measures of K-8 Math teachers' understanding of the revised Math standards, several K-8 Math Teacher Survey questions also explored more objective indicators of teachers' revised-standards knowledge. These questions asked teachers to identify discrete pieces of information that were related to the

Figure 9. Math teachers' revised Math standards understanding after June 2017 state teacher training.



revised Math standards as a whole and information that was related to major work of the grade in grades that a teacher indicated teaching this 2017-18 school year.

Previous vs. Current Math Standards Content Knowledge: K-8 Math Teacher Survey respondents were asked to identify how the content of the revised Math standards differs from the previous K-8 Math standards. Respondents were presented eight choice statements and asked to select all they believed to be true. Of the eight content statements, four were true and four were false. In analyzing these responses, respondents received one point for each true statement selected and one point for each false statement not selected for a total of eight possible points. Respondents earning 1-4 points were labeled "low content knowledge," respondents earning 5-6 points were labeled "medium content knowledge," and respondents earning 7-8 points were labeled "high content knowledge" with regard to knowledge of revised Math standards content.

Analysis revealed that 33.5% of survey respondents had low content knowledge, 61.1% had medium content knowledge, and 5.4% had high content knowledge (Table 13). 77.8% of high content knowledge respondents worked in Knox County. Respondents from Johnson City and Fayetteville City were most represented in the medium content knowledge category (80% and 85.7% of respondents from those districts, respectively).

When revised Math standards content knowledge level was examined by school type (elementary, middle/junior high, combined, other), the medium content knowledge level was most common across all school types with 54.2%-71.9% of teachers in a given school type represented in this knowledge level. Analyzing the small subset of teachers who had high levels of content knowledge of revised Math standards revealed that the majority (66.7%) work in elementary schools, and 33.3% work in middle/junior high schools (Table 13).

When disaggregated by teacher specialization, the majority of teachers still possessed medium revised Math standards content knowledge (Table 13). 60.4% of Generalists, 56.1% of Semi-Math Specialists, and 64.1% of Math Specialists possessed medium levels of revised Math standards content knowledge. In the high content knowledge category, the majority (66.7%) were Math Specialists, 22.2% were Generalists, and 11.1% were Semi-Math Specialists. In the low content knowledge group, Generalists and Semi-Math Specialists were equally represented (30.4% each), and Math Specialists constituted 39.3% of the group.

Respondents' revised Math standards content knowledge level also was examined in the context of years of teaching experience (Table 13). Newer teachers (1-5 years' experience)(n=31) constituted 17.8% of the low content knowledge group, 19.6% of the medium content knowledge group, and 11.1% of the high content knowledge group. Experienced teachers (6+ years' experience)(n=136) constituted 82.1% of the low content knowledge group, 80.3% of the medium content knowledge group, and 88.8% of the high content knowledge group (Figure 10).

The biggest difference between newer teacher and experienced teacher content knowledge was seen in the high knowledge group where respondents needed to answer a minimum of seven of eight questions about revised Math standards content correctly; many newer teachers were only able to answer 5-6 of those questions correctly, landing them in the medium content knowledge category. While this discrepancy in content knowledge presented an expected pattern, difference in n sizes should be noted,

Figure 10. Teacher revised Math standards knowledge by teaching experience.

	Low Content Knowledge	Medium Content Knowledge	High Content Knowledge
Newer Teachers (1-5 years' experience)	17.8%	19.6%	11.1%
Experienced Teachers (6+ years' experience)	82.1%	80.3%	88.8%

Note: Figures do not all equal 100% because of rounding.

as the *n* size for newer teachers was 31, and the *n* size for experienced teachers was 136.

Major Work of the Grade Knowledge: The revised Math standards emphasize particular topics or "major work" in each grade level. Survey respondents were asked to identify major work contained in the standards for each grade level they indicated teaching Math this 2017-18 school year. Respondents answered a minimum of one grade-level major work question. When we analyzed these results, survey respondents were awarded points for each correct choice selected and for each incorrect choice not selected. The number of points earned out of the total possible number of points was calculated to give each respondent a percentage out of 100. Scores of 0-49% were labeled "low major work knowledge," scores of 50-99% were labeled "medium major work knowledge," and scores of 100% were labeled "high major work knowledge." "I don't know" was an available answer choice for each grade-level major work question. Any respondent who selected "I don't know" was automatically labeled low knowledge.

With respect to knowledge of grade-level major work, 34.1% of survey respondents were low knowledge, 28.0% were medium knowledge, and 37.8% were high knowledge. The majority of low-knowledge respondents (60.7%) worked in middle/junior high schools, and 37.5% of low-knowledge respondents worked in elementary schools. Among medium-knowledge respondents, 58.7% worked in elementary schools, 30.4% worked in middle/junior high schools, and 8.7% worked in combined schools. The majority of high-knowledge respondents (75.8%) worked in elementary schools, while 14.5% reported working in middle/junior high schools and 4.8% in combined schools (Table 14).

Knowledge of grade-level major work also was examined by teacher specialization (Generalist, Semi-Math Specialist, and Math Specialist) (Table 14). Generalists were most represented in the medium major-work knowledge level (39.1%), 32.6% of them were categorized high knowledge, and the remaining 28.3% were categorized low knowledge. Most Semi-Math Specialists were represented in the high major-work knowledge level (63.4%), 22% of them were categorized low knowledge, and the remaining 14.6% were categorized medium knowledge. Math Specialists were most represented in the low major-work knowledge group (44.2%), 28.6% of them were categorized medium knowledge, and 27.2% were categorized high knowledge. Interestingly, of the three teacher roles, Semi-Math Specialists constituted the largest percentage of the high major-work knowledge group (41.9%), and Math Specialists constituted the largest percentage of teachers in the low major-work knowledge group (60.7%) (Figure 11).

Figure 11. Teacher revised Math standards major work knowledge level by teacher specialization.

	Low Major Work Knowledge	Medium Major Work Knowledge	High Major Work Knowledge
Generalist (Math + 2 or more subjects)	23.2%	39.1%	24.2%
Semi-Specialist (Math + 1 other subject)	16.1%	13.0%	41.9%
Specialist (Math only)	60.7%	47.8%	33.9%

Note: Figures do not all equal 100% because of rounding.

Among teachers at the low major-work knowledge level, 23% were newer teachers (1-5 years' experience), and 77% were experienced teachers (6+ years' experience). Medium-knowledge respondents consisted of 13% newer teachers and 87% experienced teachers. In the high major-work knowledge group, 19% were newer teachers, and 81% were experienced teachers (Table 14). Newer teachers scored at the high knowledge level for knowledge of grade-level major work at a higher rate than they did for knowledge of revised Math standards content. Again, *n* size must be considered as a contextual factor. The *n* size for newer teachers was 31, and the *n* size for experienced teachers was 136.

Teacher Objective Math Standards Knowledge (TOSK) Composite Variable

TOSK Composite Variable Methodology: The K-8 Math Teacher Survey included several questions intended to reveal survey respondents' objective knowledge of the revised Math standards. More specifically, respondents were asked which academic standards Tennessee currently uses for Math (Common Core or Tennessee-specific standards) and when districts expected them to implement these standards in the classroom (this 2017-18 school year, next school year, or the 2019-20 school year). Respondents also were asked to identify how revised Math standards content differs from content found in the previous version of the standards by accurately identifying four changes to the revised standards from a list of eight possibilities. Lastly, survey respondents were asked to answer questions about the major work found in the revised Math standards for the specific grade level(s) they indicated teaching. The first two questions regarding standards awareness and the next two about standards understanding allowed a respondent to demonstrate objective knowledge about the revised Math standards. Findings for each of these questions were detailed in the previous section.

Responses to these four individual survey questions were analyzed descriptively by various respondent characteristics represented in the survey but provided only a limited indication of respondent K-8 Math teachers' objective knowledge of the revised standards. To capture a more comprehensive indicator of teachers' revised Math standards knowledge at this relatively early stage of the standards implementation process and to be able to more robustly analyze survey results, we created a composite variable representing "teacher objective Math standards knowledge." A composite variable is a variable made up of two or more variables or

measures that are highly related to one another conceptually or statistically (Ley, 1972).

The composite teacher objective Math standards knowledge (TOSK) variable was created by grouping responses to the four K-8 Math Teacher Survey questions described above. In creating this composite TOSK variable from the four individual survey questions that revealed objective teacher knowledge of the revised Math standards, each of these four component variables was weighted equally and scored out of eight points. Additional information about the methodology used to create the composite TOSK variable can be found in Appendix D.2.

The TOSK composite variable presented a mean of 5.07 and median of 5.25 (out of 8.0) for K-8 Math Teacher Survey respondents. Standard deviation for the TOSK composite variable was 1.971 (Table 15). More specific TOSK findings and analysis by respondents' personal, school, and district characteristics that follows are captured in Tables 15 and 15.1 in Appendix F.

TOSK by Respondents' Personal Characteristics—Age, Teaching Experience, and Professional Development Amount, Frequency, and Form

TOSK by Teacher Age: Predictably, the youngest surveyed teachers, those under age 25, had the lowest TOSK mean (3.15). The oldest respondents, those 60 and older, had the highest mean (6.67). The age 60+ mean of 6.67 is among the highest means generated across any variable where TOSK was concerned. A one-way analysis of variance indicated that the effect of age on TOSK mean score was significant (p=.012) for teachers who identified as under 25 years old (n=5) and those who identified as 60 and over (n=7). These higher TOSK scores in the 60+ group may be attributable to the group's greater number of years teaching or attending professional development, rather than its greater age. It also may also reflect a difference related to whether these groups had experience teaching during the time when the initial CCSS roll out occurred in Tennessee and the CCSS were in effect in Tennessee, rather than age itself.

TOSK by Number of Years Teaching and Years Teaching Math: Teachers with one to two years teaching experience presented the lowest TOSK mean at 3.80 (n=12) while teachers with 15-19 years of experience presented the highest TOSK mean of 5.65 (n=25). Table 15 sets out the TOSK mean for each teaching experience year bracket. A one-way analysis of variance showed that the effect of number of years teaching experience on TOSK mean score was not significant $F(5,182) = 1.719$, p=.132. Reclassifying teachers into two groups, newer teachers with five or fewer years of teaching experience (M=4.59, n=35, SD=2.19) and experienced teachers with six or more years of teaching experience (M=5.19, n=148, SD=1.91), and comparing them via an independent-samples t-test also did not indicate a statistically significant difference in TOSK means, $t(181) = -1.638$, p=.103.

When survey responses examined years teaching Math, TOSK means shifted slightly. Teachers with three to five years of Math teaching experience presented the lowest mean of 4.41 (n=27), and teachers with 15-19 years of Math teaching experience remained the group with the highest mean of 5.43 (n=26). A one-way analysis of variance showed that the effect of years teaching Math on TOSK mean was not significant $F(5,177) = 1.230$, p=.297. When years of experience teaching Math were regrouped into three age brackets of roughly equal size and range, TOSK mean scores increased from 4.45 for teachers with one to five years Math teaching experience (n=36), to 5.19 (n=67) for teachers with six to 14 years Math teaching experience, and 5.35 (n=72) with 15 or more years of Math teaching experience. A one-way analysis of

variance indicated a slight statistical significance at the $p<.05$ level, $F(2,180) = 3.071$, $p=.049$. Post-hoc Tukey HSD tests showed statistically significant differences between the one to five years' Math teaching experience and the 15 or more years' Math teaching experience groups at the $p<.05$ level.

TOSK by Professional Development Amount, Frequency, and Form: As survey respondents' number of reported revised-Math-standards professional development hours attended increased, so did their TOSK, but that value peaked earlier than might have been expected. Respondents indicating zero hours of professional development had the lowest TOSK mean (4.22), while respondents indicating one to four hours of professional development had the highest (5.78). Respondents reporting between five and more than 16 hours of professional development attendance had TOSK mean values between 4.22 and 5.78.

A one-way analysis of variance was conducted to determine the effect of hours of revised-Math-standards professional development attended on TOSK mean score. It revealed a statistically significant difference at the $p<.05$ level, $F(4,162) = 4.606$, $p=.002$. A post-hoc Tukey HSD test indicated a statistically significant difference between the group that attended zero hours of professional development ($M=4.22$, $n=21$, $SD=2.06$) and three of the other groups (those attending one to four PD hours, five to eight PD hours, and nine to 16 PD hours). The difference between the groups attending zero hours and 16 or more hours of professional development was not statistically significant.

When asked about the frequency of their revised-Math-standards professional development attendance, teachers who reported never having attended such professional development had the lowest TOSK mean (5.05), while teachers who attended such professional development several times per week had substantially higher TOSK values, with a mean of 6.86. However, when a one-way analysis of variance was conducted to determine the effect of professional development frequency of TOSK mean, the result was not statistically significant $F(4,162) = 1.906$, $p=.112$.

Survey respondents indicated attending anywhere from zero to three forms of revised-Math-standards professional development. Specifically, respondents indicated attending professional development sessions led by either the state, their district, their school, some combination of two of those forms, or all three forms of professional development. Respondents who attended no professional development had the lowest TOSK mean (4.05). Of respondents who attended only one form of professional development, those attending district-led professional development had the highest mean (5.20), followed by state-led professional development (5.00), and then school-led professional development (4.65).

Calling into question the belief that more professional development is better, respondents who attended all three professional development forms (state-, district-, and school-led) had a TOSK mean of only 4.75 (out of 8.0). Describing the district-level professional development, one district-level curriculum facilitator stated, "The goal was to highlight what changed and what stayed the same. There was no deeper dive into the standards and what it would look like for the child." (District Interview 3). This statement reinforces the importance of the effectiveness of the professional development beyond its frequency and form.

TOSK by Respondents' School Characteristics—Grade Band and Levels, Math Specialization, Math Periods Taught, Math-designated Preparation Periods, and School Monitoring of Instructional Alignment

TOSK by Grade Band: The Math grade levels that K-8 Math Teacher Survey respondents indicated teaching this year (survey question four) were cross-referenced with teacher-identified building type (survey question nine) to create three teacher-grade-band groupings, elementary for grades K-5 (n=120), middle school/junior high for grades 6-8 (n=63), and other (n=2). An independent-samples t-test was conducted to compare TOSK mean scores for elementary and middle school/junior high Math teachers. No statistically significant difference existed in TOSK scores for elementary Math teachers (M=5.2, SD=2.03) compared to middle school/junior high Math teachers (M=4.9, SD=1.78); t (179)=.834, p = 0.405. These results suggest that grade-band taught did not have an effect on TOSK.

TOSK by Teacher Math Specialization: Survey respondents varied with respect to how much of their instruction this school year was Math instruction. Mean TOSK variable score increased from Generalists (M=4.96, SD=2.1) to Specialists (M=5.04, SD=1.9) to Semi-Math Specialists (M=5.27, SD=2.0), however, a one-way analysis of variance showed that the effect of teachers' differing levels of Math specialization on TOSK variable scores was not significant $F(2,180) = .324$, p=.724.

This finding offers an area of potential further research, as one would anticipate that Math Specialists and Semi-Math Specialists, who spend more time with the Math standards and Math content than Generalists, would have statistically higher TOSK scores than Generalists. While the Generalists' lowest TOSK mean was logical given the many knowledge demands placed on classroom teachers responsible for teaching all content areas, a mean TOSK score that was higher for Semi-Math Specialists than for Math Specialists is more difficult to explain. It would stand to reason that a teacher responsible for only Math instruction would have a greater capacity to acquire knowledge of the revised Math standards than a teacher responsible for teaching Math and another subject.

Some Math Specialist survey respondents indicated teaching responsibility across a number of grade levels. It is possible that the Semi-Math Specialists, although responsible for two content areas, focus on one or fewer grade levels, allowing them greater ability to master the revised Math standards content. ***This finding suggests that teachers' objective Math standards knowledge may be more related to explicit standards-related professional development and collaborative opportunities rather than teaching assignment.***

TOSK by Number of Math Periods Taught: Survey respondents who taught one period of Math per week had the lowest TOSK mean of 4.33. That figure jumped to a mean of 6.29 for respondents who taught three periods of Math per week, and this group of teachers had the highest TOSK mean. Respondents reporting teaching schedules of 11-15 and 16-20 Math teaching periods had TOSK means of 5.17 and 5.21 respectively.

Analyzing surveyed teachers' TOSK means did not reveal a statistically significant difference when examined either by number of Math classes taught (five or fewer vs. six or more) or by grade-level band in which those Math periods were taught (K-5 vs. 6-8). When TOSK scores of elementary school teachers who teach five or fewer periods of Math (M=4.7, SD=2.20) were compared to TOSK scores of elementary teachers teaching six or more periods of Math (M=5.3, SD=1.98), no statistically significant difference in their respective TOSK scores was found (t(117) = -1.37, p=.174). Similarly, no statistically significant difference in TOSK scores was found when middle school and junior high teachers who teach five or fewer periods of Math (M=4.4, SD=2.26) were compared to

middle and junior high school teachers teaching six or more periods of Math (M=5.1, SD=1.65) (t(60) = -1.11, p=.272).

Additionally, no statistically significant differences (t(181) = -1.64, p=.103) in TOSK means were found when comparing all teachers responding to the survey who teach five or fewer periods of Math weekly (M=4.6, SD=2.19) and those who teach six or more periods of Math weekly (M=5.2, SD=1.91). These findings indicate that neither the grade band taught nor number of Math periods taught each week impacted teacher knowledge of the revised Math standards among K-8 Math Teacher Survey respondents. ***This data suggests that merely teaching additional periods of Math content does not guarantee use of and exposure to standards in a manner that would reflect increased knowledge of the revised standards.*** Again, objective Math standards knowledge appears to be more related to explicit standards-related professional development a teacher has attended and collaborative opportunities she has engaged in rather than number of Math periods taught. The previously discussed finding that only slightly more than half of survey respondents correctly classified the current Math standards used in Tennessee reinforces that teaching in the content area does not guarantee knowledge of said standards.

TOSK by Math-designated Teacher Preparations: Teachers who reported having no Math-designated preparation periods had the lowest TOSK mean (4.79), while teachers with 11 or more Math-designated preparation periods per week had the highest TOSK mean (7.50). There was no consistent pattern of TOSK increase or decrease between the lowest and highest means based on number of Math-designated preparation periods.

A series of independent-samples t-tests were conducted to determine if any statistically significant difference in TOSK means existed between teachers with different numbers of Math-designated preparation periods teachers per week. A t-test comparing the TOSK mean score of teachers with one or more Math-designated preparation periods per week (n=156)(M=5.2, SD=1.88) to those with no designated Math preparation periods (n=19)(M=4.8, SD=2.13) showed no statistically significant difference in TOSK mean score, t(173)=-.904, p = 0.367. A t-test comparing teachers with no Math preparation periods to teachers with five or more Math-designated preparation periods per week (n=38)(M=5.1, SD=1.95) also showed no statistically significant difference in TOSK mean score, t(55)=-.496, p=.622. Teachers with five or more Math-designated preparations per week could have one or more Math-designated preparation periods daily leading to an expectation that additional Math-specific planning time would yield a higher TOSK mean score, however, these results suggest that having Math-designated preparation periods did not have an effect on TOSK.

TOSK by School Monitoring of Instructional Alignment to Math Standards: Survey respondents were asked how their schools monitor alignment of Math instruction to the state Math standards. Respondents selected all monitoring mechanisms that applied from a list that included: collection of unit plans; collection of lesson plans; walkthroughs; formal observations; review of student Math assessment outcome data; professional development sessions; grade-level team meetings; Math-teacher team meetings; a designated team of teachers on a Math Standards Alignment team; and no school-wide system for monitoring alignment. Survey respondents whose schools used the Math Standards Alignment team monitoring mechanism had the lowest TOSK mean (4.5) and a very low n, with only two respondents indicating that mechanism of school alignment monitoring (SD=1.41). The

second lowest TOSK mean was found for respondents working in schools with no school-wide monitoring system (M=5.33, N=13). Survey respondents whose schools used collection of unit plans to monitor Math instructional alignment had the highest mean of 5.8 (*n*=13, SD=1.31).

TOSK mean for respondents whose schools monitor instructional alignment by reviewing student Math assessment results was 5.7 (*n*=78, SD=1.45) and 5.5 for those whose schools monitor by professional development (*n*=42, SD=1.42). The relatively high TOSK means for these two monitoring mechanisms warrant further attention given the importance of assessments and professional development in the state's standards implementation plan.

TOSK by Respondents' District Characteristics - Participating Districts

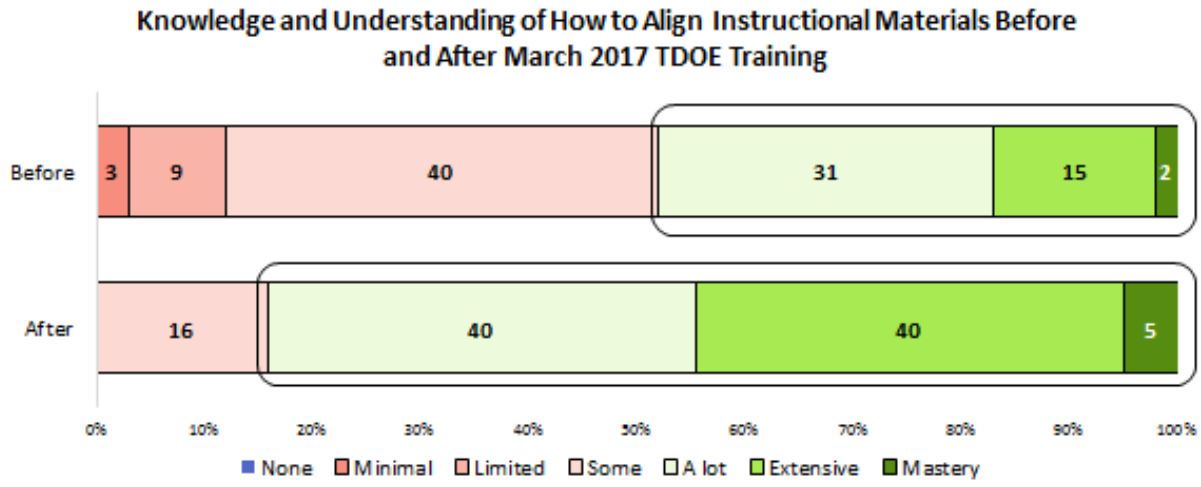
TOSK by School District: When examined across participating school districts, TOSK mean values ranged from 4.06 in Meigs County (*n=4)* to 5.51 in Johnson City (*n=17)*(Table 15.1). While TOSK mean values ranged from 4.06 to 5.51 among participating districts, these differences in TOSK means were not statistically significant, $F(6,176) = .591$, $p=.737$. However, a small *n* of under 10 respondents for three of the seven participating districts may have skewed this result.

Implementation Outcome 3 - Instructional Materials Alignment to Revised Math Standards Findings

Teacher knowledge and use of standards-aligned, high-quality Math instructional materials are crucial to achieving full Math standards implementation in the classroom (Chingos & Whitehurst, 2012; Kane, Owens, Marinell, Thal, and Staiger, 2016; Kane, 2016). This project documented varying degrees of teacher access, use, and knowledge of such instructional materials in participating districts.

March 2017 Instructional Materials Alignment Knowledge: Attendees at TDOE's March 2017 revised Math and ELA standards training for district teams rated their knowledge and understanding of how to align instructional materials to revised state academic standards before and after attending that training. These district teams included K-8 Math teachers, as well as other K-12 Math and ELA teachers, school and district administrators, and district personnel charged with redelivering revised Math or ELA standards-implementation professional development in the district. Before attending the training, 11.7% of 532 attendees reported they had no to limited understanding of how to align instructional materials, 71.8% reported they had some to a lot of understanding, and 16.5% reported they had extensive or mastery-level knowledge. After attending the training, only 0.6% of attendees continued to report having little to no understanding of how to align instructional materials to revised standards. The percent reporting they had

Figure 12. Self-reported level of knowledge of how to align instructional materials to revised Math and ELA standards.



some to a lot of understanding fell to 55.8%, and the percent reporting they had extensive or mastery-level knowledge increased to 43.6% (Figure 12). Table 16 disaggregates these self-reported alignment knowledge ratings by CORE region.

This data suggests that widespread, and sometimes extensive, knowledge of how to align Math and ELA instructional materials to revised state academic standards existed as of March 2017 among those responsible for standards implementation at the district level. However, these high levels of self-reported instructional materials alignment knowledge do not align with findings from more objective measures of teachers' knowledge found in the K-8 Math Teacher Survey relative to this outcome and others.

District Math Instructional Materials Mandates: With respect to state- or district-adopted Math instructional materials, only 24% of teachers indicated that their district required use of these adopted materials in school year 2017-18. Most (62%) teachers reported that their district merely recommended use of these materials, and 14% indicated that their district remained silent about use of these materials. According to surveyed teachers, districts have behaved very similarly with respect to district-developed or selected Math materials this school year. Only 21% of teachers indicated that their district required use of the district's own developed or selected Math instructional materials. Again, 62% of teachers reported that their district merely recommended use of these materials, and 18% indicated that their district remained silent about use of these materials. Table 17 disaggregates these mandates by participating district.

Types and Frequency of Math Instructional Materials Used: K-8 Math Teacher Survey respondents indicated that they have drawn upon a variety of types of Math instructional materials this 2017-18 school year. Teachers reported using the following types of Math instructional materials frequently (one to five or more times per week): materials they have developed or selected themselves (86% of teachers); materials they have developed in collaboration with other teachers (65%); district- or state-wide adopted materials (50%); district-developed or selected materials (46%); and "other instructional materials" (65%). ***62% of***

surveyed teachers reported using Math instructional materials that they developed or selected themselves three to five times per week; this percentage was the highest reported for any type of Math instructional material used three to five times per week. Tables 18, 19, 20, 21, and 22 disaggregate the types and frequency of Math instructional materials survey respondents reported using during the 2017-18 school year.

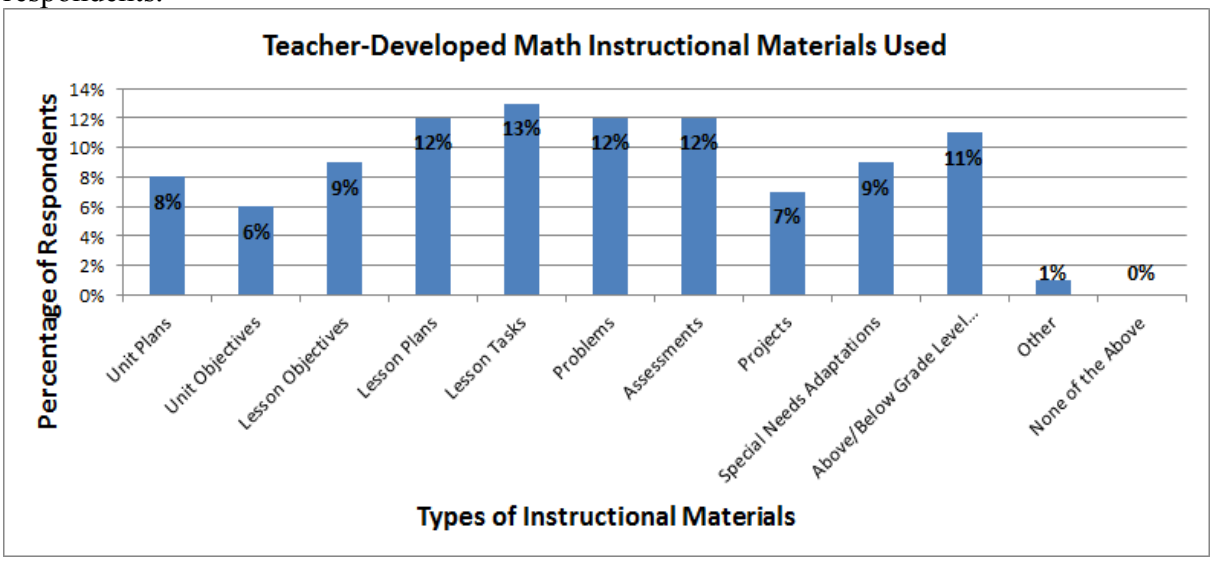
Types of Teacher-Developed Math Instructional Materials Used: With respect to Math instructional materials that teachers developed or selected themselves, 15% reported developing or selecting unit or lesson objectives, 13% developed or selected student tasks, and 12% developed or selected assessments. Figure 13 details all types of teacher-created instructional materials survey respondents have used during the 2017-18 school year.

Two respondents selected "other" when indicating the type of Math instructional materials they self-developed. One of these respondents went on to state, "Our district chose not to use curriculum so teachers have had to create their own materials to use.", and the second explained, "We do not use the adopted text as it is not sufficient to meet the TN standards. We develop all of our own rigorous materials." (K-8 Math Teacher Survey, Question 33 responses).

Trusted Sources for Teacher-Developed Math Instructional Materials: When developing or selecting Math instructional materials they will use in their classrooms, K-8 Math Teacher Survey respondents most frequently consulted with other teachers in their school (35% of teachers). The second most frequently consulted source was a Math instructional coach (18% of teachers). District or school curriculum specialists were teachers' third most frequently consulted source (10% of teachers). Table 23 sets out all sources that surveyed teachers reported collaborating or consulting with when developing or selecting Math instructional materials they used in their classrooms during the 2017-18 school year.

Overall, survey respondents' use of adopted or district-developed Math instructional materials was low, as was the percent of districts that mandated the use of

Figure 13. Types of teacher-developed Math instructional materials used by survey respondents.



such materials. On a daily or almost daily basis, only 30% of K-8 Math Teacher Survey respondents used state- or district-adopted materials in their classroom instruction so far this school year. Only 24% of survey respondents reported that their districts required teachers to use these adopted instructional materials; these 41 respondents teach in Fayetteville City (*n*=1), Giles County (*n*=6), Johnson City (*n*=3), and Knox County (*n*=31). On a daily or almost daily basis, only 28% of survey respondents used district-developed/selected Math instructional materials in their instruction; these 47 respondents teach in Giles County (*n*=9), Hamblen County (*n*=2), Johnson City (*n*=1), Knox County (*n*=34), and Meigs County (*n*=1) (See Table 18). Low reported rates of adopted Math instructional materials use and of district mandates regarding use of adopted Math instructional materials combine to render the state textbook adoption process an ineffective mechanism for ensuring standards-aligned Math instructional materials use in Tennessee.

Tennessee Textbook Adoption Process May Fall Short: The statutory requirements that govern the textbook adoption process in Tennessee empower TSBE to approve a list of textbooks and instructional materials available for use in the state after receiving recommendations from the State Textbook and Instructional Materials Quality Commission (Commission). TSBE also is empowered to prescribe use of items on its approved list and to adopt policies regarding their funding. TDOE provides administrative assistance and training to the Commission, which manages the mechanics of textbook adoption in the state, as well as to State Textbook Advisory panels (aka Textbook Review Committees), which advise the Commission on textbook and instructional materials selections after screening those materials for alignment to the state academic standards. In Tennessee, a school district is solely authorized and required to adopt textbooks and instructional materials from the state-approved list to be used in its public schools. Districts may request a waiver to use other instructional materials not on the list.

While Tennessee appears to have an effective and robust process for selecting and approving standards-aligned instructional materials, low levels of teacher use of state-approved and district-adopted Math materials reported by this project's survey respondents blunt any impact this process may have on encouraging use of high-quality, standards-aligned Math instructional materials. In addition, a review of state-approved Math instructional materials suggests that some of the approved materials may not be tightly aligned to state academic standards (Figure 14).

Consulting EdReports' current curriculum ratings—which are based on educator-led, evidence-based reviews of instructional materials that evaluate CCSS alignment and high-quality curricular attributes—reveals that three of the five curricula on Tennessee's approved Elementary Math materials list Meet Expectations (Green rating) for standards alignment; two Partially Meet Expectations (Yellow); and one Does Not Meet Expectations (Red). A review of EdReports alignment ratings for approved Middle School Math curricula reveals two Red, two Yellow, and two Green curricula, as well as two that have not yet been rated (EdReports (n.d.)).

Many K-8 Tennessee districts have adopted iReady published by Curriculum Associates (rated Green), Eureka Math (rated Green) or EnVision (rated Red) for use in their Math classroom instruction. Districts that fielded this project's survey have adopted iReady (Green), GoMath (Yellow), and Carnegie Learning (Yellow) as their Math instructional materials in K-8. One district chose not to adopt an Elementary Math textbook (CORE Region 1, personal communication, April 13, 2018).

Figure 14. State-approved Math textbooks (available for 2015-16 adoption).

	Elementary	Middle School	Used by Districts Fielding the K-8 Math Teacher Survey
iReady	✓		✓
GoMath	✓	✓	✓
Bridges in Mathematics	✓		
Eureka Math	✓	✓	
EnVision	✓		
My Math		✓	
Common Core Coach		✓	
Big Ideas		6th: ✓ 7th: ✓ 8th: ✓	
Carnegie Learning		✓	✓
Spring Board		✓	
Agile Mind		✓	

*Reported by districts as iReady but appears on state-approved list as Ready TN Core

Current edReports Curriculum Alignment Rating (April 2018)
Does not meet expectations
Partially meets expectations
Meets expectations
Not yet rated

Better leveraging EdReports ratings or including more core Math instructional materials that are rated "Green" by EdReports represent opportunities Tennessee has to improve the standards-alignment of its Math instructional materials, especially as it begins work in support of its upcoming 2021 adoption cycle for Math materials. Greater alignment of Math instructional materials to standards has substantial potential to support teachers and students in acquiring the knowledge and skills demanded by the revised Math standards. Increasing teachers' use of those aligned materials also promises to improve both Math instruction and student outcomes.

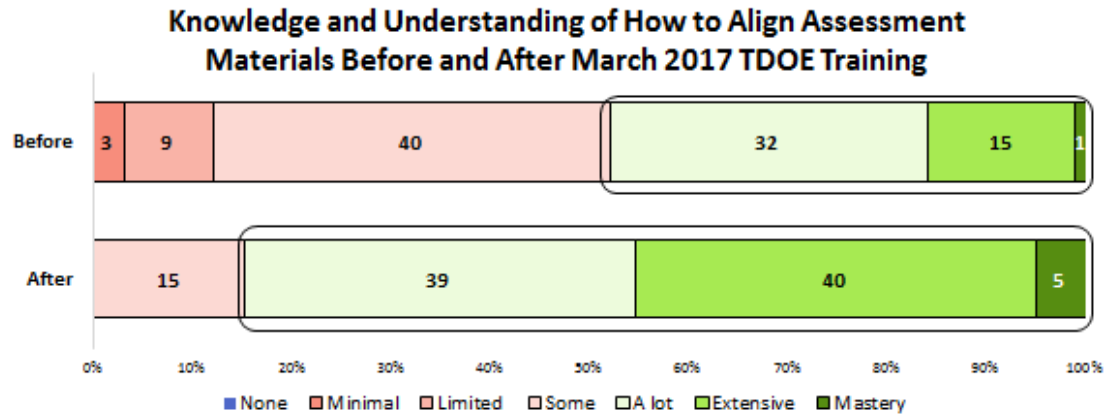
Rather than use state- or district-adopted or district-developed Math instructional materials, 86% of surveyed teachers use Math instructional materials they develop or select themselves on a daily or almost daily basis. When creating their own Math instructional materials, teachers consult other teachers almost twice as frequently as they consult with Math instructional coaches and over three times as often as they consult with school or district curriculum specialists. Reported high rates of teachers developing and selecting Math instructional materials themselves, coupled with low rates of teacher consultation with district or regional Math specialists when creating these materials, make it even more crucial that professional learning regarding revised Math standards content and alignment be effective.

Implementation Outcome 4 - Alignment of Common Assessments to Revised Math Standards Findings

March 2017 Math Assessment Alignment Knowledge: Attendees at TDOE's March 2017 revised Math and ELA standards training for district teams rated their knowledge and understanding of how to align assessment materials to revised state standards before and after attending that training. These district teams included K-8 Math teachers, as well as other K-12 Math and ELA teachers, school and district administrators, and district personnel charged with redelivering revised Math or ELA standards-implementation professional development in the district.

Before attending the training, 12% of 532 attendees reported they had no to limited understanding of how to align assessment

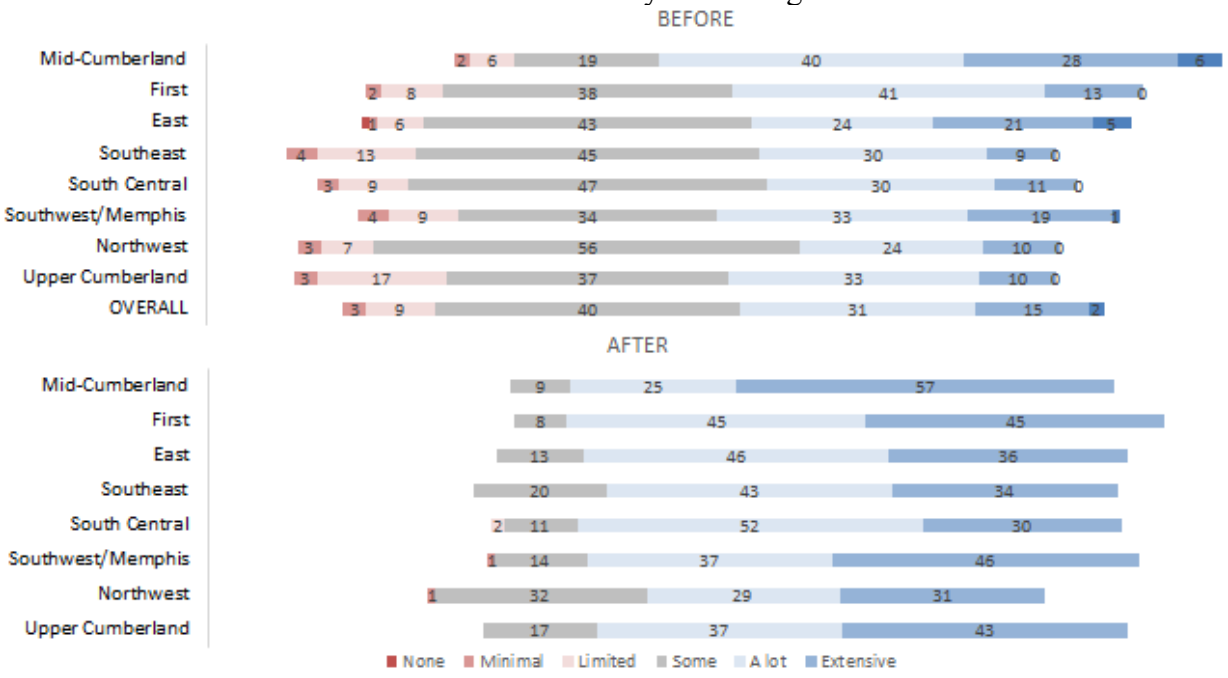
Figure 15. March 2017 TDOE training participants' self-reported knowledge of aligning assessments to revised Math and ELA standards.



materials, 71% reported they had some to a lot of understanding, and 17% reported they had extensive or mastery-level knowledge. After attending the training, the percent reporting some to a lot of understanding fell to 56%, and the percent reporting extensive or mastery-level knowledge increased to 45% (Figure 15). Figure 15.1 captures these same self-reported knowledge level ratings disaggregated by CORE region.

On a seven-point scale, the mean assessment alignment knowledge score increased from 4.5 (*n*=532, SD=1.00) before the training to 5.3 (*n*=532, SD=.82) after the training. Participation in TDOE's March 2017 training elicited a statistically significant increase in the mean score of respondent knowledge regarding aligning assessment materials to the revised Math standards,

Figure 15.1. March 2017 TDOE training participants' self-reported knowledge of aligning assessments to revised Math and ELA standards by CORE region.



M=.808, 95%CI [.875, .742], *t*(531) = 23.850, *p*<.0005.

Several questions in the K-8 Math Teacher Survey also provided insights into the extent to which individual teachers' Math assessments and common Math assessments in use during the 2017-18 school year were aligned to the revised Math standards.

Individual Teacher Math Assessments: Teachers reported that assessments they used in their own Math instruction to date in school year 2017-18 aligned to the revised Math standards to a great extent. Extensive alignment was reported by 68% of teachers. 28% of teachers reported some alignment, and only 4% reported minimal alignment. Table 24 shows the extent to which survey respondents perceived their individual Math assessments to be aligned to revised state Math standards by participating district.

Common Math Assessments: Common Math assessments existed only in some of respondents' schools and only at some grades this school year. While 78% of teachers reported that common Math assessments existed in their school, only 46% of teachers reported that common Math assessments existed at all grades in their school. 22% of teachers reported that their school did not use any common Math assessments. Table 25 disaggregates these findings by participating district.

Types of Common Math Assessments: Teachers reported the following types of common Math assessments existed in their school this 2017-18 school year: unit and lesson assessments (35% of survey respondents), benchmark assessments (25%), district- and school-mandated assessments (21%); and formative assessments (18%). Table 26 details use of each type of common Math assessment in respondents' schools this school year. ***Interestingly, a statistically significant difference in TOSK means existed when comparing teachers who reported formative assessments existed in their school during the current school year to those who reported they did not (t(166)=2.963, p=.003).***

Standards Alignment of Common Math Assessments: When asked if the types of common Math assessments that existed in their school this year are aligned to the revised Math standards, approximately 75-90% of survey respondents reported that these common assessments were aligned, and roughly the same number of the remaining respondents reported either that the assessments were not aligned or that they did not know if they were aligned (Figure 16). Depending on the type of common assessment, 73-92% of responding teachers indicated that the common assessment was aligned to the revised Math standards, 1-14% indicated that the assessment was not aligned, and 6-14% did not know. Table 27 details survey respondents' knowledge of common Math assessment alignment to the revised standards by each type of common Math assessment.

Figure 16. Types and alignment of common Math assessments in use in respondents' schools.

Types of Common Math Assessments	Exist in School in 2017-18	Common Math Assessments Aligned to Revised Standards	
		Yes	No/Don't Know
Unit and lesson plans	35%	92%	8%
Benchmark assessments	25%	73%	27%
District- and school-mandated assessments	21%	85%	15%
Formative assessments	18%	89%	11%

While approximately 70% of respondent teachers reported that the assessments they use in their individual Math instruction extensively aligned to the revised Math standards, determining the accuracy of that self-reported data point is difficult, especially given that roughly 90% of

respondent teachers also reported using Math instructional materials that they developed or selected themselves one to five or more times per week. A review of assessments contained in state- or district-adopted Math instructional materials cannot provide an "alignment" comparison point either, because these instructional materials were so infrequently used by respondent teachers. The difficulty of determining whether alignment between individual teachers' assessments and the revised Math standards actually exists also is compounded by the fact that only 46% of respondents' schools use common Math assessments in all grades and 22% of their schools use no common Math assessments at all.

While common benchmark Math assessments were reported to be in use in 25% of respondent teachers' schools, this type of assessment received the lowest percentage of teachers indicating that alignment to the revised Math standards exists. Only 73% of teachers indicated that benchmark assessments in use at their schools were aligned to the revised Math standards, compared to 85-93% who indicated alignment existed for each of the other types of common Math assessments (Table 27). Further exploration of this finding, and possibly a targeted teacher education effort at the state or regional level seeking to improve teachers' knowledge of Math benchmark assessments' alignment levels to the revised Math standards, seems warranted. This exploration could result in both increased teacher clarity about actual benchmark assessment alignment and decreased unnecessary student testing if any benchmark assessments currently in use are found not to be tightly aligned with the revised Math standards.

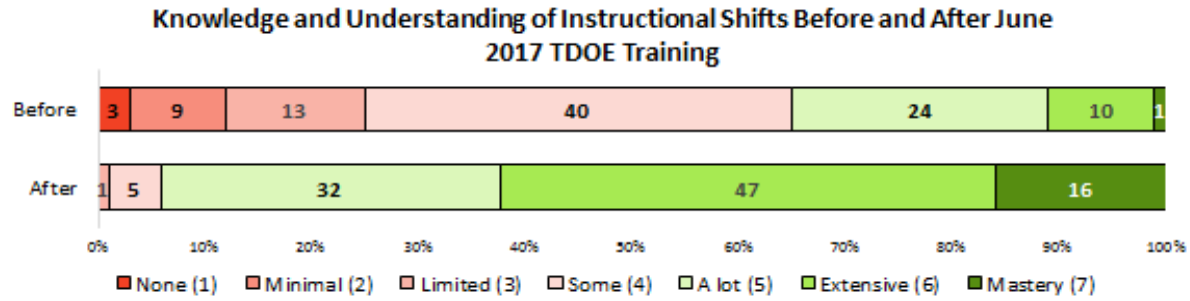
Given the relatively low rates of common Math assessment use in survey respondents' schools, it also would be beneficial for TDOE to consider designating, creating or supporting the creation of common Math assessments that are aligned to the revised K-8 Math standards. TDOE could designate standards-aligned assessments found in state- or district-wide adopted Math instructional materials as options for common Math assessments. TDOE also could support districts in creating common Math assessments by deliberately networking districts for this purpose. In these networks, districts would share and compare their existing assessments with one another in order to expedite the process of developing high-quality, standards-aligned common Math assessments.

This type of inter-district collaboration was highlighted during a focus group. "We actually divided that work up through our work in the Mid-Cumberland Math Collaborative. We looked at the standards and the revised standards so we could represent for teachers what was a major change and wasn't. I still reference that document when I get questions about the standards" (Focus Group Participant 4). In addition to facilitating collaboration among districts, TDOE also could support the creation of common Math assessments by incentivizing districts and schools to use common Math assessments in all grades.

Implementation Outcome 5 - Instructional Alignment to Math Standards Findings

Instructional Shifts: Teachers who attended TDOE's June 2017 Teacher Training K-8 Math sessions were asked to rate their knowledge and understanding of the instructional shifts required by the revised Math standards before and after attending that training (Figure 17). Of the 1144 teachers who responded, 12.7% reported mastery or extensive understanding before attending the training, 60.7% reported a lot or some understanding, 20.4% reported limited or minimal understanding, and 2.7% reported no understanding. When rating their level of knowledge and understanding of required instructional shifts after attending the training, the number reporting mastery or extensive

Figure 17. Math teacher revised Math standards instructional shifts knowledge and understanding.



understanding increased to 61.9%, those reporting a lot or some understanding dropped to 35.7%, and only 0.7% reported limited, minimal and no understanding.

Respondents' average level of knowledge increased from 4.1 (some) before attending training to 5.7 (a lot) after attending training, or 1.6 levels (where 1 is none and 7 is mastery on the 7-point Likert scale). Participation in the TDOE June 2017 training elicited a statistically significant increase in the mean score of respondent knowledge of instructional shifts required by the revised Math standards, M=-1.64, 95%CI [-1.715, -1.564], $t(1004) = -42.621$, $p<.0005$.

These positive findings of high self-reported levels of understanding of instructional shifts and statistically significant knowledge growth related to June TDOE training attendance are tempered by district-level administrators' observations that: "As I go out into classrooms, I'm seeing that we are still at the surface level. If the standard says 'explain' or 'describe,' I'm not sure I'm seeing that level of rigor." (District Interview 2).

Altered Math Instruction: When K-8 Math Teacher Survey respondents were asked how frequently the revised state Math standards have caused them to alter their Math instruction this school year, 17.4% reported changing their instruction one to five times per week, 72.5% reported changing instruction one to three times per month, and 10.2% reported never changing their instruction due to the revised standards. ***It remains unknown if the decision made by approximately 83% of respondents to never or only occasionally alter instruction this year due to the revised Math standards was an appropriate one that reflects existing tight instructional alignment to revised Math standards or not.***

School Math Instructional Alignment: When asked how their school monitors alignment of Math instruction to Math standards, 39% of teachers responding to the K-8 Teacher Math Survey indicated monitoring was accomplished via informal or formal observations, 28% indicated via teacher team meetings, 12% indicated via collection of unit or lesson plans, 12% indicated via review of student assessments, 6% indicated via professional development, and 2% indicated their school did not monitor instructional alignment (Table 6). ***This data indicates that the majority of instructional alignment efforts have been episodic, rather than continuous and job-embedded.***

Correspondingly, the 2017 Tennessee Educator Survey asked teachers to indicate the degree to which they needed more professional learning, training, mentorship, or other support in a variety of areas. "Aligning standards, curriculum, and student learning outcomes" was one of the topics most frequently chosen by teachers for continued professional learning, with 20% of respondent teachers

indicating they needed to focus on this topic extensively or completely. This same professional development topic was listed as a personal priority by 37% of respondents and was the second-most common selection among survey respondents (Tennessee Department of Education, 2017a).

Closer Look: **Knox County Schools Revised-Math-Standards Implementation Outcomes**

As part of our project's efforts to explore the extent to which TSBE's five standards-implementation outcomes have been achieved to date, we next highlight project findings for one participating district, Knox County Schools (KCS).

Because KCS is the third largest school district in Tennessee and because its demographics are similar to state demographics, more closely examining KCS revised-standards-implementation findings offers an opportunity to gain insights that may be useful at the state level, as well as at the district level.

KCS Student Demographics: With an enrollment of 60,536 students, KCS is the largest school district that fielded this project's K-8 Math Teacher Survey. KCS teachers represented 63.8% of all survey respondents, with 118 K-8 Math teachers responding. Compared to the other six districts fielding the K-8 Math Teacher Survey, KCS has the lowest percentage of economically disadvantaged students (28.3%), ranks fourth with 14.4% of students with disabilities, and ranks second in number of English Learners or Limited English Proficiency students (5.1%). KCS has the fifth highest per-pupil expenditure of $9,239 per student and ranks fourth for ethnic diversity with 29.1% of KCS students identifying as non-White.

Compared with overall student characteristics in the State of Tennessee, KCS has 6.4% fewer students who are economically disadvantaged, 7.5% less diversity based on ethnicity, and spends $719 less annually per pupil. KCS' EL/LEP population is slightly lower than the state average of 5.3%, and KCS has 0.5% more students with disabilities than the state average.

KCS Survey Respondent Demographics: The demographics of KCS K-8 Math Teacher Survey respondents also were similar to the demographics of survey respondents overall. As set out in Figure 18, the largest age group of responding teachers in KCS was 40-49 years old (31.4%), and the age group with the fewest number of respondents was teachers under the age of 25 (2%). As in all other participating districts, the vast majority (86.4%) of KCS teacher respondents identified as female.

While fewer KCS teacher respondents (3%) than respondents in other participating districts (13%) were in their first or second year of teaching, KCS respondents' Math teaching experience mirrored that found in other districts (approximately 60%). Also like in other participating districts, about one-quarter of KCS teachers have taught Math for 20 or more years.

KCS had the third largest number of Math Specialists (59.3%). This finding was likely influenced by the fact that KCS inadvertently distributed the survey only to 3rd-8th grade Math teachers, and thereby surveyed teachers in a grade band that is more likely to contain departmentalized teachers than the K-8 grade band of Math teachers that was surveyed in other participating districts.

Because KCS is the third largest district in the state, has a sizable Curriculum & Instruction department, and chose the hybrid model of standards-implementation professional development, the project team expected to find evidence of significant

Figure 18. Demographics of K-8 Math Teacher Survey respondents in Knox County Schools compared to respondents in other participating districts.

	Respondents in Knox County Schools	Respondents in other participating districts
Gender		
Female	102	64
Male	13	3
Prefer not to respond	3	0
Age		
25 and under	2	3
25-29	12	8
30-39	27	21
40-49	37	21
50-59	35	12
60 plus	5	2
Years Teaching		
1-2	3	9
3-5	17	7
6-9	23	9
10-14	30	11
15-19	15	10
20 plus	30	21
Years Teaching Math		
1-2	4	13
3-5	24	4
6-9	22	9
10-14	25	12
15-19	13	13
20 plus	30	16

progress toward TSBE's five implementation outcomes in KCS when examining K-8 Math Teacher Survey findings. Instead, KCS findings were mixed and implementation beyond the norm was not found.

KCS Outcome 1 - Revised Math Standards Awareness: KCS K-8 Math Teacher Survey respondents' answers indicated a level of awareness of the revised Math standards that was slightly lower than awareness levels found in other participating districts. All KCS teachers correctly responded that the district expected them to implement the revised Math standards in classroom instruction during school year 2017-18, compared to 98.1% of all respondents. However, only 50% of responding KCS teachers correctly classified the Math standards currently used in Tennessee as Tennessee-specific, while 50% of them incorrectly classified them as Common Core State Standards. In other participating districts, 58.5% of responding teachers correctly classified the standards and 41.5% incorrectly classified them. As was the case with overall survey response rates for these questions, KCS teachers awareness levels indicated clear communication from the state or district regarding the implementation timeline had occurred, as well as some confusion among teachers regarding which standards are currently used in Tennessee.

KCS Outcome 2 - Revised Math Standards Understanding:

KCS Previous vs. Current Math Standards Content Knowledge: The K-8 Math Teacher Survey assessed understanding of the revised Math standards by asking teachers to identify differences between the previous and current Math standards. Thirty-four percent of KCS teachers were classified as low content knowledge, 59% as medium content knowledge, and 7% as high content knowledge. Having a majority of teachers classified as medium content knowledge was consistent with overall findings for all participating districts, as well as findings across most teacher classifications.

KCS Major Work of the Grade Knowledge: The survey also assessed understanding of the revised Math standards by examining teacher knowledge of the major work of the standards at each grade level a teacher indicated teaching this 2017-18 school year. Based on the accuracy of their responses to these questions, 38.5% of KCS teachers were classified as having low major-work knowledge, 26.9% were classified as having medium major-work knowledge, and 34.6% were classified as having high major-work knowledge. Again, the distribution of KCS responses among levels of major work knowledge mirrored levels of knowledge of major work possessed by respondents overall.

KCS Teacher Objective Math Standards Knowledge (TOSK) Composite Variable:

KCS TOSK by Respondents' Personal Characteristics—Age, Teaching Experience, and Professional Development Amount, Frequency, and Form

TOSK by KCS Teacher Age: Similar to teacher respondents from all non-KCS districts, KCS teachers under the age of 25 had the lowest TOSK mean of 2.5 (SD=3.536, n=2), and teachers 60 years of age or older had the highest TOSK mean of 6.71 (SD=.860, n=5). A one-way analysis of variance indicated that the difference in TOSK mean between these two groups was not significant, p=.175, likely because of the small n size for each of these groups. Though not statistically significant, the increase in TOSK mean based on years of teaching experience warrants further study, because age could simply be a proxy for the cumulative impact of teaching experience and professional development attendance on TOSK mean.

TOSK by KCS Number of Years Teaching and Years Teaching Math: When examining TOSK values by years of teaching experience, we grouped KCS teachers by one to five, six to 14, and 15 or more years of teaching experience. A one-way analysis of variance indicated a statistically significant difference in TOSK mean between teachers with six to 14 years of experience and teachers with 15 or more years of experience ($F(2, 114) = 3.803$, p=.037), with a post-hoc Tukey test at p=.015 between the means of these two groups.

Examining years of Math teaching experience, the TOSK mean increased from 4.0 for responding teachers with one to two years of Math teaching experience (n=4, SD= 2.865) to 5.52 for teachers with 20 or more years of Math teaching experience (n=30, SD= 1.917). Again, grouping teachers into these three experience bands of one to five years, six to 14 years, and 15 or more years that reflected number of years teaching Math also revealed no statistically significant difference in TOSK.

These results indicate that neither years of teaching experience nor years of Math teaching experience had a clear relationship to teachers' revised Math standards understanding.

TOSK by KCS Professional Development Amount, Frequency, and Form: When examining the hours of revised-Math-

standards-implementation professional development surveyed KCS teachers attended from Summer 2017 through March 2018, those attending zero hours of professional development had the lowest TOSK mean of 4.80 (n=13, SD=1.584). KCS teachers who reported attending 16 or more hours of such professional development had the highest TOSK mean, but only four respondents existed in that group (6.15, SD=1.464). A one-way analysis of variance indicated no statistically significant difference between the hours of revised-Math-standards-implementation professional development KCS teachers attended and their TOSK mean. However, these findings may be influenced by the small sample sizes of groups compared. Despite no finding of statistical significance, the observed increase in TOSK mean by number of professional development hours attended was expected and warrants further examination with a larger sample size.

KCS teachers also reported the frequency of revised-Math-standards-implementation professional development they attended in the district. While TOSK mean varied by frequency of professional development attended, a one-way analysis of variance revealed this variation was not statistically significant.

KCS TOSK was also analyzed by form of professional development attended. KCS teachers who reported attending no professional development had the lowest TOSK mean (3.9, n=10, SD=2.218), as did teachers from non-KCS responding districts (M=4.2, n=13, SD=2.313). The TOSK means for KCS teachers attending only one form of professional development (state-, district- or school-led) ranged from 4.5 for school-led professional development to 4.8 for state- and district-led professional development. For non-KCS teachers, the TOSK means were higher and ranged from 5.0 for school-led professional development to 5.5 for state-led to 5.8 for district-led professional development.

The TOSK means for KCS teachers who reported attending two forms of professional development were higher than the TOSK means of teachers who reported attending only one form of professional development. KCS teachers who attended two forms of professional development had a TOSK mean of 5.5-6.1. Unlike in other participating districts, KCS teachers who attended two forms of PD had a higher TOSK mean that those who attended only one form. KCS teachers who attended all three forms of professional development had a TOSK mean of 4.6 (n=17, SD=2.32).

It is reasonable to expect that attending additional forms of professional development might lead to increased understanding of the revised Math standards and therefore increased TOSK mean, however, a one-way analysis of variance indicated no statistical significance between the KCS TOSK means based on any forms of professional development attended, F(7,109)=1.335, p=.241. This finding supports further study of the content contained in, and the extent to which characteristics of effective professional development are present in, the different forms of professional development examined in this project.

KCS TOSK by Respondents' School Characteristics—Grade Band and Levels, Math Specialization, Math Periods Taught, Math-designated Preparation Periods, and School Monitoring of Instructional Alignment

KCS respondents' grade levels taught, teacher specialization, number of Math periods taught, and number of Math-designated preparation periods also were analyzed to determine their potential impact on TOSK mean. Statistical analyses examining the relationship of each of these characteristics to differences in TOSK means revealed no statistically significant relationships. These findings are similar to the findings for survey respondents as a whole. The failure to find any

statistically significant relationships was surprising given the expected impact of these characteristics on teachers' exposure to and interaction with the revised Math standards.

TOSK by KCS School Monitoring of Instructional Alignment to Math Standards: KCS survey respondents whose schools used collection of unit plans to monitor Math instructional alignment had the highest TOSK mean of 6.4 (n=6, SD=1.242). The lowest TOSK mean of 5.5 (n=47, SD=1.533) existed for respondents working in schools that monitor instructional alignment by reviewing student Math assessment results. The remaining five mechanisms used by KCS to monitor Math instructional alignment—walkthroughs, formal observations, professional development sessions, grade-level team meetings, and Math Standards Alignment team—had a TOSK mean of 5.6. Given the focus on assessment and professional development in the state's standards implementation plan, further review of the comparatively low TOSK means for these mechanisms of monitoring Math instructional alignment in KCS seems warranted.

KCS Outcome 3 - Instructional Materials Alignment to Revised Math Standards: All four KCS survey respondents who attended TDOE's March 2017 training self-reported high knowledge and understanding levels (a lot, extensive, or mastery) of how to align instructional materials to the revised Math standards, both before and after the March training. KCS' use of iReady Math instructional materials, which are rated Green/Meets Expectations for Alignment by EdReports, may contribute to these high levels of knowledge and understanding (CORE Region Interview 1).

About 30% of KCS K-8 Math Teacher Survey respondents reported the district required use of state- or district-adopted Math instructional materials in classroom instruction this year, compared to about 15% reporting this requirement in other participating districts. 65% of KCS teachers reported that the district recommended use of such materials, 7% more than in other participating districts. Only 6% of KCS teachers reported that the district remained silent on the issue of district- or state-adopted materials use, compared to 27% of respondents in other participating districts. These findings indicate that KCS has more frequently and explicitly required or recommended use of state-approved or district-adopted materials this 2017-18 school year than other participating districts have. Interestingly, these more frequently reported district mandates and recommendations, which should have resulted in increased use of Math-standards-aligned instructional materials among KCS teachers, did not equate to an increase in KCS teacher respondents' TOSK mean.

To probe this unexpected TOSK finding further, we isolated the portion of the TOSK composite variable that reflects standards understanding from the portion that reflects standards awareness. An analysis of the understanding-only portion of the TOSK composite variable, which constituted 50% of the composite variable, revealed that KCS survey respondents' understanding-only TOSK mean was 4.5 (n=117, SD=2.136). This understanding-only TOSK mean was lower than KCS's composite TOSK mean score of 5.0 (n=117, SD=1.990) at a statistically significant level (p<.001). This more granular TOSK finding again prevented the authors from making a link between increased district mandates to use arguably standards-aligned instructional materials and teachers' standards understanding level in KCS.

In addition, when an understanding-only TOSK mean was calculated for respondents in all other participating districts and compared to KCS respondents' understanding-only mean using an

independent samples t-test, no statistically significant difference was found (p=.672). Again, this analysis would not allow links to be drawn between KCS respondents' levels of standards understanding and either their district's increased mandates regarding instructional materials or KCS respondents' own slightly higher rates of reported use of district-adopted and developed Math instructional materials (Tables 18 and 19). Both of these things should have resulted in increased KCS Math teacher exposure to and use of standards-aligned Math instructional materials, which the authors hypothesized would positively impact KCS teachers' understanding of the revised Math standards. Further study of this issue with larger sample sizes is warranted in order to unravel whether any linkages exist between: (1) districts' instructional-materials-use mandates and teachers' use of mandated materials; (2) alignment of mandated instructional materials to the revised Math standards; and (3) teachers' use of mandated materials and increased standards understanding.

With respect to district-selected or developed Math instructional materials, 23% of KCS respondents reported the district required their use, and 66% reported that the district recommended their use. This is higher than in other participating districts (19% and 53%, respectively). Fewer KCS survey respondents reported the district remained silent on the use of district-selected or developed instructional materials compared to other participating districts (11% KCS, 28% others). KCS findings regarding district requirements for using district-selected or adopted Math instructional materials indicate KCS was more likely to require or recommend their use than other participating districts.

KCS Outcome 4 - Alignment of Common Assessments to Revised Math Standards: All four KCS survey respondents who attended TDOE's March 2017 training self-reported high knowledge and understanding levels (a lot, extensive, or mastery) of how to align assessments to the revised Math standards, both before and after the March training. Again, KCS' use of iReady Math instructional materials, which are rated Green/Meets Expectations for Alignment by EdReports, may contribute to these high levels of knowledge and understanding (CORE Region Interview 1).

K-8 Math Teacher Survey results indicate that common Math assessments exist in all grades at higher rates in schools within KCS than in other districts (51% KCS, 39% others). The percentage of respondents indicating that common Math assessments existed only at certain grades in their school was lower for KCS than for other districts (31% KCS, 34% others). A smaller percentage of KCS teachers indicated that common Math assessments did not exist in their schools compared to respondents from other districts (19% KCS, 27% others).

Compared to survey respondents in other participating districts, fewer KCS teachers reported that all types of common Math assessments—except unit and lesson assessments—existed in their schools. KCS survey responses indicated a greater prevalence of common lesson and unit assessments in KCS compared to other districts (43% KCS, 31% others). This result makes sense given KCS' more frequent and explicit mandates and recommendations regarding district-adopted and district-recommended Math instructional materials.

When asked if existing common Math assessments were aligned to the revised Math standards, KCS teachers responded yes at higher rates than did teachers in other districts for all types of common Math assessments, including: district- and school-mandated assessments (88% KCS, 81% others), benchmark assessments (76% KCS, 68% others), unit and lesson assessments (94%

KCS, 88% others), and formative assessments (91% KCS, 86% others).

Findings from the K-8 Math Teacher Survey indicated common Math assessments were more likely to exist, and more likely to be reported to align to the revised state Math standards, in KCS than in other participating districts. The existence and standards-alignment of common Math assessments in an instructional model that utilizes data for instructional decision making should lead to improved student Math outcomes. This is an area of recommended further study in future research regarding revised-Math-standards implementation.

KCS Outcome 5 - Alignment of Instruction to Revised Math Standards: When asked on the K-8 Math Teacher Survey how frequently the revised state Math standards caused them to alter their Math instruction this school year from never (scored as one) to daily (scored as five), KCS teachers had a mean of 2.8 (n=105, SD=.993) and non-KCS teachers had a slightly lower mean of 2.7 (n=62, SD=62). An independent samples t-test found this difference in means was not statistically significant (p=.408).

When asked if school-level monitoring of alignment of Math instruction to the state Math standards occurred at their schools in school year 2017-18, KCS teachers responded yes at lower rates than did teachers in other districts for the following methods of monitoring: informal or formal observations (54% KCS, 71% others); collection of unit or lesson plans (14% KCS, 32% others); review of student assessments (40% KCS, 46% others); and professional development (21% KCS, 25% others).

KCS teacher respondents had an overall TOSK mean of 5.0 (n=118, SD=1.99), which ranked KCS in the middle of the seven responding districts, and KCS's overall TOSK mean of 5.0 was lower than the overall TOSK mean of 5.2 for all respondents in other districts (n=65, SD=1.95). A one-way analysis of variance indicated no statistically significant difference between these two overall means, $F(6,176)=.591$, $p=.737$.

KCS demonstrated similar findings to other districts with its relatively high level of awareness of the revised Math standards and varying levels of understanding of the revised Math standards. In KCS, the only characteristic with a statistically significant difference in TOSK mean was years of teaching experience between mid-career teachers (six to 14 years) and experienced teachers (15 or more years). No statistically significant differences in TOSK mean were identified in KCS based on any other characteristics examined.

KCS respondents reported higher levels of district expectation of use of district- and state-adopted and district-selected or developed Math instructional materials than in other participating districts. KCS respondents also reported that common assessments existed in their buildings and were aligned to the revised Math standards at higher levels than in other participating districts. Further research should be conducted to determine what structures and systems within KCS may exist that increase the expectation for use and alignment of Math instructional materials and common assessments, as both may be beneficial to other Tennessee districts. In addition, a deeper exploration of why this large district that used the hybrid model for revised-Math-standards-implementation, which should have allowed it to effectively combine state- and district-level resources to positively impact progress toward implementation outcomes, did not result in greater teacher revised-standards knowledge seems warranted.

Section III – Results: Findings, Interpretation, and Discussion - Project Question 2

Project Question 2 – Professional Learning Efficacy: To what extent has state-, district-, and school-level professional development related to revised Tennessee Math standards implementation from Summer 2017 through March 2018 been effective?

Teacher development is critical to successful implementation of revised standards in any content area, and yet, providing professional development does not ensure that professional learning actually happens (Fullan, 2007; Feiman-Nemser, 2001). In fact, according to Fullan (2007), professional development offerings too often miss the mark and are rarely, "...powerful enough, specific enough, or sustained enough to alter the culture of the classroom and school" (p. 35).

In this project, district, school, and individual teachers' choices about professional development related to early stages of Tennessee Academic Standards for Math implementation are explored, and the efficacy of Math-standards-related professional development is examined by analyzing several objective and subjective indicators of professional development effectiveness.

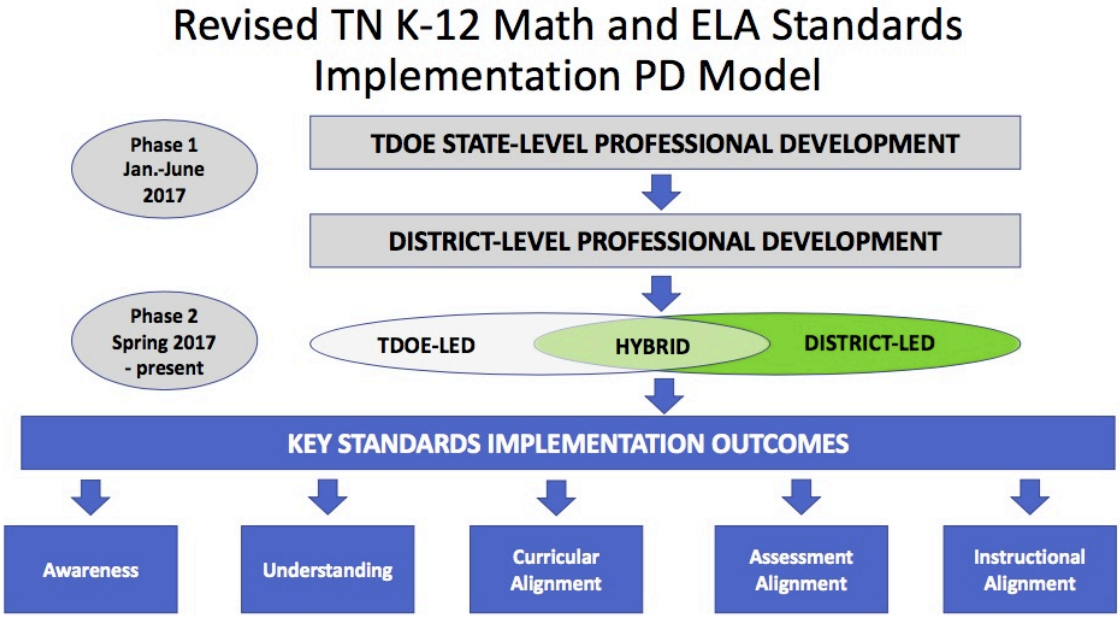
District Revised-Math-Standards Professional Development Choices

Delivery Model of District Revised-Math-Standards Professional Development: TSBE/TDOE offered each school district in Tennessee autonomy to choose the model of professional development that it would use to educate its teachers about revised Math and ELA standards. TSBE/TDOE hypothesized that giving districts autonomy to choose an appropriate professional development model would increase the efficacy of the professional development districts delivered to their teachers and thereby increase the quality of revised Math and ELA standards implementation in the 2017-18 school year (Figure 19).

This deference to school district choice is supported by the extant policy implementation literature, which emphasizes the importance of individuals, rather than institutions, as it examines implementation efforts. Although many policies feel global in scope, it is important to examine policy implementation from the smallest unit possible, because policies are transformed as individuals interpret and respond to them. As McLaughlin (1987) states, "Organizations don't innovate or implement change, individuals do" (p. 174).

Two Tennessee school districts chose the state-led professional development model, described more fully in earlier sections of this paper, and relied solely on the state to train their personnel about revised state academic standards. Twenty-six districts (18%) chose the district-led professional development model in which they led all or most of standards implementation professional development themselves. These districts included the following districts that participated in this project: Metro Nashville Public Schools (Mid-Cumberland Region), Hamblen County and Johnson City (First Tennessee Region), and Meigs County (Southeast Region). Approximately 80% of Tennessee school districts (114) relied on the hybrid professional development model in which a subset of district personnel attended state-led training and then led professional development redelivery in the district. These districts included the following districts that participated in this project: Coffee County, Fayetteville City, and Giles County in the

Figure 19. Revised Tennessee K-12 Math and ELA standards implementation professional development model.



South Central CORE region (CORE Region offices, Individual/Summary Reports).

While TDOE hypothesized that choice of professional development model would be a crucial lever for improved revised-standards-implementation professional development and outcomes, the fact that most districts chose the hybrid model potentially undercuts that hypothesis. Interview evidence also suggests that logistics and practicalities, rather than particular competencies regarding professional development delivery, seem to have been the predominant concerns driving district decision making about which professional development model to choose. For example, one district professional development facilitator stated, "It was the only way we could do it given the number of schools we have. No way we could get it rolled out to everyone without doing train the trainer" (District Interview 5).

In other cases, the decision to adopt the hybrid professional development model was a matter of district preference and efficiency. One interviewee indicated, "...We just decided for us to get the most out of it that we would redeliver ourselves…..We were able, as supervisors, to tailor our revised standards PD to suit the specific needs of our buildings and teachers" (District Interview 2). In another district, human capital and capacity influenced the choice of the hybrid model. "Having the expertise or teams to roll that out is often challenging in small districts. It was difficult to have the needed expertise to come back and share" (District Interview 3). The desire among school districts to utilize professional development to simultaneously train teachers on revised standards while working toward other district goals was also clear in interviews and spoke to district inclination toward the hybrid model choice.

This project was not able to establish any linkages between district choice of professional development model and increased efficacy of professional development delivered. Perhaps further study, as well as student assessment and teacher evaluation data

that will be collected later in school year 2017-18, will provide better insights into or indicators of these linkages.

Continuous Nature of District Revised-Math-Standards Professional Development: As of September 2017, 113 Tennessee school districts had written revised-standards implementation plans in place, and 95 of those plans included professional development work that extended beyond Summer 2017 into school year 2017-18 (CORE Region Offices, Individual/Summary Reports). Plans that included professional learning that continued into the school year reflected district-level understanding that sustained, rather than episodic, professional development efforts are required in order to achieve Math-standards-implementation outcomes. As one district-level administrator commented, "Our [Math PD] re-delivery was not really a one-time standards training. It is total collaboration and it is ongoing" (District Interview 1). As will be discussed further in a later section of this paper, one important characteristic of effective professional learning is that is continuous in nature (Darling-Hammond, Hyler, and Gardner, 2017).

Content Focus of District Revised Math and ELA Standards Professional Development: The areas that Tennessee school districts chose to emphasize in their professional development relative to revised Math and ELA standards implementation varied. As of September 2017, 69 districts (41.8%) were focusing their professional development solely on understanding the revised standards; 56 districts (33.9%) were focusing on aligning instructional materials to the revised standards; and 40 districts (24.2%) were focusing on aligning assessments to the revised standards (CORE Region offices, Individual/Summary Reports). Data reflecting professional development foci for only revised Math standards implementation was not available to the project team. As will be discussed further in a later section, content focus is an important characteristic of effective professional learning (Darling-Hammond et al., 2017).

Topics of District Revised-Math-Standards Professional Development by Standards Implementation Outcome: K-8 Math Teacher Survey respondents were asked to identify topics of district-level revised Math standards professional development offered in their respective districts from Summer 2017 through March 2018. Topic choices that respondents selected from in the survey were phrased in a way that corresponded to TSBE's revised-standards-implementation outcomes. 58.1% of respondents indicated their district's professional development addressed TSBE outcome 2 (increasing understanding of Math standards). 40.7% of respondents indicated their district's professional development addressed TSBE outcome 3 (evaluating instructional materials for alignment to Math standards). 49.7% of respondents indicated their district's professional development addressed TSBE outcome 4 (aligning assessments to Math standards), and 46.1% indicated their district's professional development addressed TSBE outcome 5 (identifying instructional shifts required by Math standards). 7.2% of respondents indicated the topic of their district's professional development was "other", and 14.4% responded "I don't know." Analysis of professional development topics by district revealed similar results; TSBE outcomes 2 and 4 were the first or second most prevalent across the majority of the seven districts surveyed (Table 28).

Primary Focus of Revised-Math-Standards Professional Development: When asked to identify the primary focus of their district's revised-Math-standards professional development this 2017-18 school year, 34.1% of K-8 Math Teacher Survey respondents chose TSBE outcome 2 (standards focus); 16.2% chose TSBE outcome 3 (instructional materials focus); 22.2% chose TSBE outcome

4 (aligning assessments focus); and 16.2% chose TSBE outcome 5 (aligning instruction focus). 11.4% of respondents indicated a primary focus other than one of the TSBE standards-implementation outcomes (Table 29). ***Within districts, considerable variation existed among respondents' selections of their respective districts' primary revised-Math-standards-implementation professional development focus. This could represent variation among respondents' perceptions of professional development emphasis or actual confusion regarding district professional development priorities.***

School Revised-Math-Standards Professional Development Choices

Topics of School Revised-Math-Standards Professional Development by Standards Implementation Outcome: The K-8 Math Teacher Survey also sought to identify the topics of school-level revised-Math-standards-implementation professional development offered from Summer 2017 through March 2018. Again, professional development topic choices that respondents selected from in the survey were phrased in a way that corresponded to TSBE's standards-implementation outcomes.

40.1% of respondents reported that their school's professional development addressed TSBE outcome 2 (increasing understanding of revised Math standards). Outcome 2 was the most frequently identified professional development topic at both the school and district levels. 35.9% of respondents reported their school's professional development addressed TSBE outcome 3 (evaluating instructional materials for alignment to the revised Math standards). 34.1% of respondents reported their school's professional development addressed TSBE outcome 4 (aligning assessments to the revised Math standards), and 31.7% reported their school's professional development addressed TSBE outcome 5 (identifying instructional shifts required by the revised Math standards). 12.6% of respondents reported their school's professional development focused on "other." Additionally, 37.1% of respondents reported that their school's Math-related professional development included work on creating common assessments aligned to the revised Math standards (Table 28).

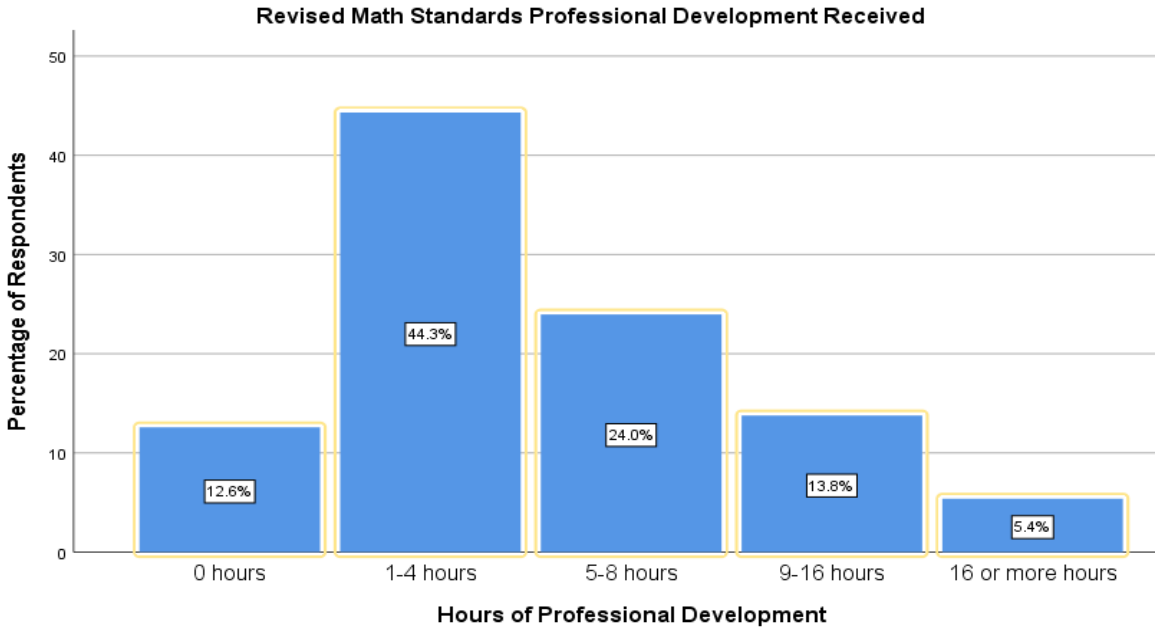
Individual Teachers' Revised Math Standards Professional Development Choices

Individual Teacher Revised-Math-Standards Professional Development Attendance Amount and Frequency: The K-8 Math Teacher Survey inquired about the amount of and frequency with which respondents attended professional development from Summer 2017 through March 2018 to support their implementation of revised Math standards. These questions sought to gain insight into the sustained duration of professional development teachers attended.

When asked how much professional development they attended this year to support their implementation of the revised Math standards, 12.6% of survey respondents reported they attended no such professional development, 44.3% reported attending one to four hours, 24% reported attending five to eight hours, 13.8% reported attending 9-16 hours, and 5.4% reported attending more than 16 hours of such professional development (Figure 20).

When asked about the frequency with which they engaged in professional development to support implementation of the revised Math standards, 22.2% of survey respondents reported never engaging in such professional development, 40.7% reported quarterly, 23.4% reported monthly, 12.0% reported weekly, 1.8% reported several times per week, and no respondents reported engaging in such professional development daily. ***These data points regarding amount***

Figure 20. Amount of professional development respondents attended to support their revised Math standards implementation.



and frequency of revised-Math-standards implementation professional development offer scant support for finding that survey respondents' Math-standards professional learning has been sustained in duration to date. Nor does Table 2.1, which disaggregates amount and frequency of professional development attended by participating district, reveal a particular district as a bright spot with respect to these findings.

Revised-Math-Standards Professional Development Types by Facilitator (Trusted Sources): K-8 Math Teacher Survey respondents also reported on who facilitated or participated in the revised-Math-standards professional development that they attended inside and outside of their schools. Respondents were asked to indicate the types of professional development they have engaged in from Summer 2017 through March 2018 by selecting all types attended from a list of eight professional development types.

Almost all revised-Math-standards professional development occurred within respondents' schools (91.3%), and only a small percentage (8.7%) occurred with colleagues from other schools. Survey respondents engaged in revised-Math-standards professional development conducted with peers (64.1%), led by supervisors (22%), and led by Math specialists (8.5%). Grade-level team meetings were the most common form of Math-standards professional development attended (52.1%). Between 43.1% and 46.7% of respondents reported attending revised-Math-standards professional development in the form of Math-teacher-team meetings, meetings with Math teacher colleagues in their school, and school-wide professional development. The least-selected professional development categories were meetings with Math teacher colleagues from other schools, Math instructional coaches, and principals, with only 14.4%-22.8% of respondents choosing those options.

These findings are supported by similar results from the 2017 Tennessee Educator Survey. When teachers were asked who they prefer to go to most for advice about refining their teaching practices, 56% of respondents

indicated colleagues from their subject area, and 54% indicated colleagues from their grade level. These preferred sources of advice were chosen at dramatically higher rates than instructional coaches, more experienced teachers, principals, assistant principals, or district central office administrators, who were selected by between 2% and 19% of respondents (Tennessee Department of Education, 2017a).

Subjective Indicators of Revised-Math-Standards Professional Development Efficacy

June 2017 Teacher Self-Reported Professional Development Redelivery Preparedness: The TDOE training survey question that most directly sought to measure the effectiveness of professional development related to revised Math standards inquired about how likely training attendees were to redeliver training content in their district or school. Of the 1,022 Math teachers who attended TDOE's June 2017 Teacher Training K-8 Math sessions and responded to that survey question, 38.1% reported they were very likely to redeliver training content, 27% reported likely, 16% reported somewhat likely, and 18.9% reported unlikely to redeliver training content (Table 30).

This survey question also inquired about how prepared attendees believed they were to redeliver this training. Differences existed in reported levels of preparedness. Of the 65.1% indicating they were very likely or likely to redeliver content, 83% considered themselves well-prepared (very well or quite well) to redeliver the training. Of the 27.4% indicating they were only somewhat likely to redeliver content, 38% considered themselves well-prepared (very well or quite well) to do so. None of the 18.9% of respondents who were unlikely to redeliver content considered themselves well-prepared to redeliver.

These differences in self-perceptions of preparedness were statistically significant. A chi-square test of independence was performed to examine the relationship between individual preparation to redeliver professional development and likelihood to redeliver professional development. The relationship between these variables was significant, X_2 (2, n=828) = 50.10, p=<.01. Teachers indicating they were better prepared to redeliver standards-implementation professional development were more likely to report that they intended to redeliver that professional development (Table 31).

Objective Indicators of Revised-Math-Standards Professional Development Efficacy

Characteristics of Effective Professional Development (CEPD)

K-8 Math Teacher Survey respondents reported whether they participated in state-, district-, or school-led revised Math standards professional development. They indicated participating in from zero to three of these forms of revised Math standards professional development. For each form of professional development a survey respondent reported attending, he or she was asked to rate the degree to which that professional development included each of the seven characteristics of effective professional development (CEPD) as identified by Darling-Hammond, Hyler, and Gardner (2017). ***Effective professional development: is content focused; incorporates active learning; supports collaboration; uses models of effective practice; provides expert coaching and feedback; offers opportunities for feedback and reflection; and is sustained in duration (Darling-Hammond et al., 2017).***

As set out in Figures 21, 22, and 23, attendees of all forms of revised-Math-standards professional development most frequently identified specific content focus, engagement in collaboration, and opportunities for reflection as CEPD that were

evident in professional development they attended. State-, district-, and school-led professional development attendees strongly or somewhat agreed that the professional development they attended included: specific content focus (77.6%, 78.8%, 81.5%, respectively); engagement in collaboration (77.5%, 73.5, 79.6%, respectively); and opportunities for reflection (64.1%, 67.5%, 72.2%, respectively).

Figure 21. Teacher assessment of 7 characteristics of effective PD in state-led revised Math standards professional development.

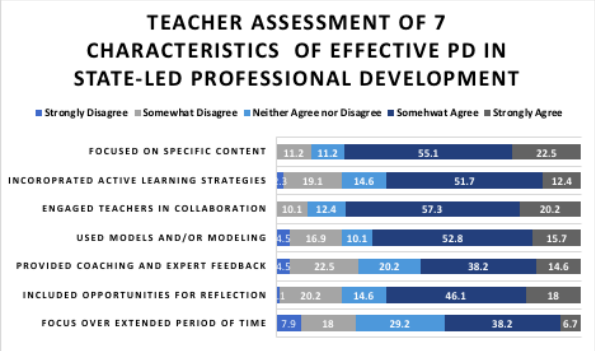


Figure 22. Teacher assessment of 7 characteristics of effective PD in district-led revised Math standards professional development.

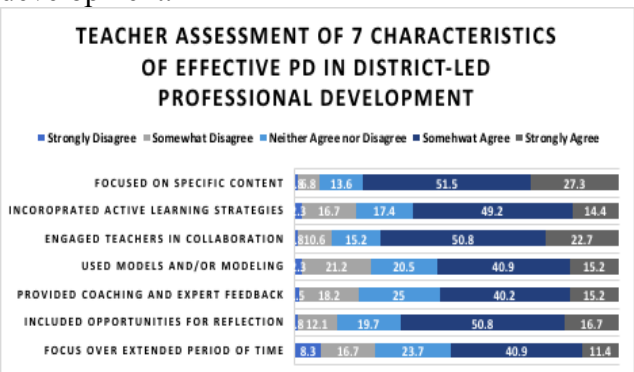
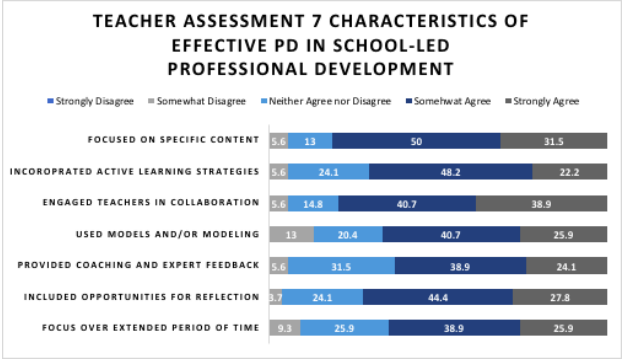


Figure 23. Teacher assessment of 7 characteristics of effective PD in school-led revised Math standards professional development.



District-level administrator interviews also indicated strong evidence of specific content focus in this professional development. For example, "We as a district created notebooks for our teachers… (E)very teacher left with their content notebook for their grade and it had the standards, the crosswalk, and then we also created our own template to use as a resource for collecting good assessment questions. We did some additional things with our training. We did a deep dive by table into the verbs within the standards – what is the standard actually asking students to do and what does that look like in your classroom?" (District Interview 2). Emphasis on materials, resources, and instructional shifts were themes that emerged in all district-level administrator interviews as interviewees discussed the specific content focus of the revised-Math-standards professional development they planned and facilitated (District Interview 1, 2, 3, 4, 5, 6).

While specific content focus was a frequently-identified CEPD of revised-Math-standards professional development that should be celebrated, the research establishes that content-focused professional development is most effective when job-embedded, because teachers are able to use their students and setting to develop their knowledge or skills within a new curricular or pedagogical area (Darling-Hammond et al., 2017). Offering

additional revised-Math- standards professional development that is closely tied to increased use of high-quality Math instructional materials is a strategy recommended to increase the job-embeddedness of professional development that will be explored in more detail in the Recommendations sections of this paper.

Interestingly, the importance of content-focused professional development also emerged in the 2017 Tennessee Educator Survey, in which teachers were asked to identify the aspect of their most effective 2016-17 professional learning activity that was most beneficial to their development as teachers. 16% of teachers reported the most beneficial aspect was that it "provided high-quality materials and strategies that were easy to implement in the classroom" (Tennessee Department of Education, 2017a).

K-8 Math Teacher Survey respondents' widespread reporting of opportunities for reflection in the revised-Math-standards professional development they attended is another positive survey finding, because providing intentional time for reflection during professional development can help teachers thoughtfully implement the strategies they are learning (Darling-Hammond et al., 2017).

The research establishes that effective collaboration in professional development can take many forms—such as paired work, small group work, school-wide initiatives, and collaboration with other professionals beyond one's school building or district (Darling-Hammond et al., 2017)—that are highlighted in teacher responses to other K-8 Math Teacher Survey questions in addition to responses to this survey question. Taken together, all of the foregoing findings represent an area of revised-Math-standards professional development strength.

In contrast, the largest percentages of attendees of all three forms of revised-Math-standards professional development disagreed that the professional development they attended was characterized by the CEPD of duration over an extended period of time. More specifically, state-led, district-led, and school-led professional development attendees strongly or somewhat disagreed that the professional development they attended was characterized by duration over an extended period of time (25.9%, 25.3% and 35.2%, respectively). With respect to duration, the research does not indicate a specific length of time that is required for professional development to be effective, but it is clear that effective professional development is not accomplished in short "one-shot" workshops (Darling-Hammond et al., 2017).

State-led and school-led professional development attendees also frequently disagreed that the CEPD of coaching and expert feedback (27.0% and 37.1%, respectively) was evident in professional development they attended. The largest percentage of district-led professional development attendees also disagreed that professional development they attended included use of models and/or modeling (23.5%). ***These are areas for possible professional development improvement, because teachers who receive coaching and expert support are more likely than those who attend only traditional professional development to try to implement new teaching practices.*** Increased use of models and modeling in professional development would also be beneficial, because it gives teachers a vision of best practice and an exemplar to guide their own learning and continued development (Darling-Hammond et al., 2017).

A relatively large percentage of school-led professional development attendees also disagreed that the professional development they attended included the CEPD of active learning strategies (29.7%). While active learning strategies did not emerge among the most prominent characteristics identified by survey respondents, evidence of that CEPD was prevalent in interviews of district-level

administrators. For example, one administrator stated, "It's not a sit-and-get with one person up in the front of the room. Rather, it's our teachers sitting around the table together and digging into this work" (District Interview 1). Another interviewee shared, "We did gallery walks, learning strategies, table talks. Not only did they grade-level plan, they did vertical planning and looked at the changes above and below each grade. We didn't do a whole lot of talking. I don't like to go to meetings and have it be a 'sit and get'" (District Interview 2).

Active learning in effective professional development shifts away from more traditional, "lecture-based" experiences in favor of models that engage teachers directly with the practices they are learning (Darling-Hammond, et al., 2017). Some of the described professional development elements may have been perceived by attendees as teacher collaboration opportunities more than active learning strategies. These elements likely supported both collaboration and active learning, but administrators' anecdotal accounts clearly conveyed that district-led revised-Math-standards professional development was deliberately designed using active learning strategies that sought to keep attendees engaged (District Interview 1, 2).

Characteristics of Effective Professional Development (CEPD) Composite Variable

K-8 Math Teacher Survey respondents were asked to rate the degree to which each of the seven characteristics of effective professional development (CEPD) identified by Darling-Hammond et al., (2017) was present in state-, district-, and school-led revised-Math-standards professional development they attended from Summer 2017 through March 2018. For each of the seven CEPD, respondents selected from five choices to indicate the extent to which the characteristic was present in professional development they attended (strongly disagree, somewhat disagree, neither agree nor disagree, somewhat agree, and strongly agree). Responses to these seven individual survey questions were analyzed descriptively by form of revised-Math-standards professional development in the preceding section of this paper. To capture a more holistic indicator of the efficacy of the three forms of revised-Math-standards professional development that have taken place from Summer 2017 through March 2018 and to be able to more robustly analyze survey results, we created a composite variable representing "characteristics of effective professional development."

To create this CEPD composite variable, the rating a survey respondent reported for each individual professional development characteristic was coded with a value of one through five (strongly disagree=1, strongly agree=5), and mean values out of 5.0 were calculated for each individual professional development characteristic. Next, mean values for responses to questions about all seven CEPD were grouped into one composite variable that reflected overall CEPD for each form of professional development survey respondents attended. Reliability analyses were run for composite CEPD for each of the three professional development forms, and each analysis resulted in a Cronbach's Alpha greater than 0.8 indicating a high degree of reliability. Finally, mean values for this composite CEPD variable were calculated out of 5.0 for each of the three forms of professional development.

School-led professional development had the highest composite CEPD mean of 3.9, and both district-led and state-led professional development had a composite CEPD mean of 3.6. This difference in CEPD means between forms of professional development was not statistically significant and may have been influenced by the different number of survey respondents participating in each of the three forms of professional development.

Figure 24. Individual characteristic means for revised Math standard professional development.

CEPD Findings - Individual Characteristic Means for Revised Math Standard PD			
Characteristics of Effective PD	**State-led PD**	**District-led PD**	**School-led PD**
Content Focused	3.9	4.0	4.1
Active Learning	3.5	3.6	3.9
Collaboration	3.9	3.8	4.2
Models/Modeling of Effective Practice	3.6	3.5	3.8
Expert Coaching/Feedback	3.4	3.5	3.8
Opportunities for Feedback and Reflection	3.6	3.7	4.0
Sustained Duration	3.2	3.3	3.8
Range of Individual Characteristics Means	3.2-3.9	3.3-4.0	3.8-4.2

Highest mean for PD form
2nd highest mean for PD form
2nd lowest mean for PD form
Lowest mean for PD form

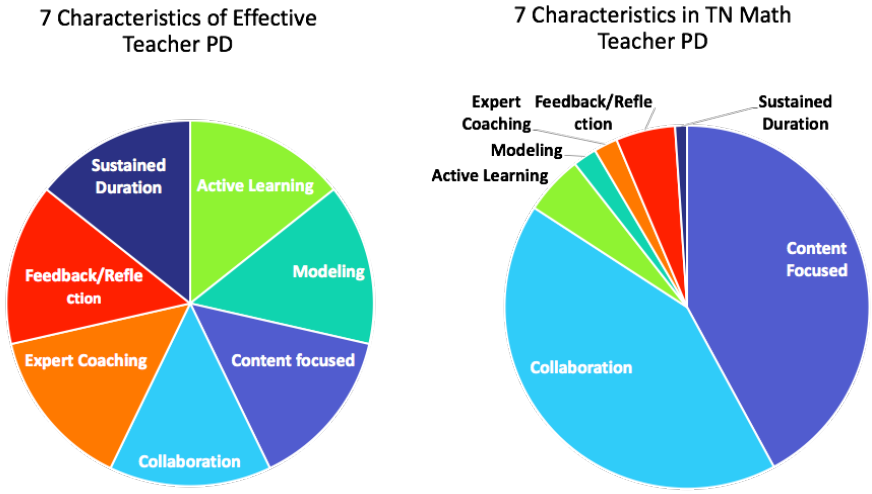
Individual CEPD characteristic means ranged from 3.2 to 3.9 for state-led professional development; 3.3 to 4.0 for district-led professional development; and 3.8 to 4.2 for school-led professional development (Figure 24).

For state-led professional development, the highest individual CEPD mean (3.9) existed for "was focused on specific content" and "engaged teachers in collaboration", and the lowest individual CEPD mean (3.2) existed for "has been the focus of teachers' Math related work over an extended period of time rather than an isolated learning event." The relatively low individual CEPD mean for sustained nature of professional development was not surprising, because the state-led professional development was not designed to be a continuous or recurring event. Similarly, the relatively high individual CEPD mean for "content-focused" was not surprising, as the state-led professional development sessions were focused on relaying specific changes to the Math standards. It was also encouraging that survey respondents indicated a high degree of collaboration during the state-led professional development (3.9). Conversely, the availability of expert coaching and feedback, which presented a lower individual CEPD mean value (3.4), offers an opportunity for improvement.

Individual CEPD characteristic means for district-led professional development revealed emphases that were similar to those found in state-led professional development. Like in the state-led setting, the lowest individual CEPD mean value existed for "extended period of time" (3.3) and the highest mean value was found for "content-focused" (4.0). For district-led professional development, an individual CEPD mean value of 3.5 for both presence of modeling and availability of expert coaching ranked second lowest among individual CEPD means.

Like in state- and district-led professional development, the lowest individual CEPD characteristic mean for school-level professional development existed for "extended period of time" (3.8); however, this mean value of 3.8 was higher than that found in the state-led (3.2) and district-led (3.3) professional development settings. This higher mean value may reflect schools' greater

Figure 25. Ideal and Tennessee distributions of characteristics of effective professional development in school year 2017-18 revised-Math-standards professional development.



capacity to continually revisit professional development topics through PLCs, faculty meetings, grade-level meetings, and other building-level meeting structures. The individual CEPD of "availability of expert feedback," "use of modeling," and "extended period of time" all shared the lowest mean value (3.8) for school-led professional development. The highest individual CEPD mean for school-led professional development existed for "collaboration" (4.2), and the second highest mean existed for "content focused" (4.1). The ranking of these high-scoring characteristics mirrored those found in state- and district-led professional development, but their values were slightly higher than in the state and district settings.

The familiarity of attendees at school-led professional development sessions, as well as the collaboration often found among grade-level/team teachers, are likely reflected in these higher individual CEPD mean values. Interviews with district-level administrators substantiated the existence of this school-level capacity. One administrator shared how common planning time facilitated ongoing collaboration among Math teachers in her schools: "They plan collaboratively on a daily basis. They sit down around the table and look at the standards as they plan their lessons. They look for where the changes are. And they collaborate vertically" (District Interview 1).

In sum, highly-effective professional development would incorporate all seven CEPD identified by Darling-Hammond et al. (2017) and not overemphasize any one characteristic over time. Project findings reveal that the distribution of CEPD in revised-Math-standards professional development that Tennessee teachers have been offered to date is skewed, rather than equally distributed. Figure 25 offers a visual representation of ideal CEPD distribution and CEPD distribution found in Tennessee.

Closer Look: Metro Nashville Public Schools Revised-Math-Standards Professional Development Efficacy

Metro Nashville Public Schools Focus Group

In an effort to further explore Tennessee's revised K-8 Math standards implementation, two focus groups were convened in the Metro Nashville Public School District (MNPS), the second-largest school district in Tennessee.

MNPS presented an important lens through which to view revised-Math-standards professional development and implementation due to its size and professional development model choice.

MNPS was one of 24 districts in the state that chose the "district only" professional development model, and focus group participants discussed the implementation process through this somewhat unique perspective. Participants in both MNPS focus groups included numeracy coaches, Math coaches, and lead Math coaches, all of whom had direct responsibility for revised K-8 Math standards professional development and implementation within the district.

The policy implementation literature focuses extensively on the critical role played by local actors, like the district leaders who participated in the MNPS focus groups. The extant literature highlights the importance of local-level capacity and willingness to implement policies, and the important role that local-level actors play in implementation. McLaughlin (1987) notes, "We have learned that policy success depends critically on two broad factors: local capacity and will" (p. 172). McLaughlin (1987) also asserts that motivation and will of influential actors is frequently beyond the reach of any policy; "(e)nvironmental stability, competing centers of authority, contending priorities or pressures and other aspects of the social-political milieu can influence implementation capacity or willingness profoundly" (p. 173).

Findings from the MNPS focus groups can be categorized into two groups: (1) professional development structure, which relates to the process, logistics, and materials of revised-Math-standards professional development; and (2) professional development substance, which relates to the presence or absence of the seven characteristics of effective professional development.

MNPS Revised-Math-Standards Professional Development and Implementation - Structure

MNPS' district-only redelivery of revised-Math-standards-implementation professional development relied on a train-the-trainer model. MNPS began preparing for the revised Math standards rollout prior to any TDOE-led trainings, and MNPS representatives attended the earliest TDOE-led trainings. "Because of the size of our district and the number of people we knew we would have to train, we began planning far in advance. We did not attend any of the trainings they did for teachers in the Spring and Summer [2017]. We trained our teachers in March and May. We knew it was a much bigger process for us so we started in the Fall [of 2016]." (Focus Group Participant 3). This early approach appeared to be unique among districts. As one focus group participant shared, "We tried to have a conversation about this with other district leaders from surrounding districts in the Fall [of 2016] and they all looked at us like we were crazy because we had already started the work." (Focus Group Participant 3).

MNPS focus group participants indicated that the autonomy to choose a professional development model played a limited role in their revised-Math-standards professional development and implementation planning. With close to 4,000 Math teachers in 163 schools, the potential for a TDOE-led or even hybrid standards-implementation professional development model seemed more

of a gesture than an actual possibility. "The state doesn't have the capacity to train everyone. When they have trainings, we can only send a couple of teachers." (Focus Group Participant 3).

MNPS train-the-trainer sessions took place in Spring 2017. Each school in the district was required to send a minimum of one to a maximum of three people to these sessions and at least one of these attendees had to be an administrator. MNPS train-the-trainer sessions occurred over two days. The focus of the first day was the revised standards and how they have changed. The second day focused on the instructional shifts required by the revised Math standards.

In fact, the train-the-trainer process described by MNPS was not just a re-delivery of TDOE professional development or content. When asked about the materials used for the train-the-trainer sessions, a focus group participant stated, "We took some things, but made most of it on our own." (Focus Group Participant 4). MNPS took ownership of their obligation to deliver standards-implementation professional learning; this ownership was reflected in a district-level employee's comment that "This was a moment to say, 'Hey, these are our standards, the Tennessee State Standards and what we need to teach. No matter what's been done in the past.' There was a shift and you felt that shift." (Focus Group Participant 1).

For the 2017-18 school year, MNPS was simultaneously implementing a new instructional model and the revised K-8 Math standards. "We decided to do the standards and the rollout of the instructional model together. It was very nice because this is the kind of instruction that will support the rigor of the standards." (Focus Group Participant 1). MNPS focus group participants were clear that the district's objective in structuring the revised-Math-standards professional development was to examine the standards and best teaching practices side by side so that actual improvements in teacher practice were more likely.

MNPS Revised-Math-Standards Professional Development and Implementation - Substance

The seven characteristics of effective professional development (CEPD) described in the literature existed in the MNPS train-the-trainer sessions to varying degrees.

MNPS sessions definitely included a focus on specific content. The entire first day of its two-day professional development was dedicated to examining the content of the revised Math standards. MNPS created materials for this session and relied on a side-by-side standards comparison document, which they had created through the Mid-Cumberland Math collaborative.

The MNPS train-the-trainer sessions also incorporated active learning strategies. For example, participants completed a jigsaw of the standards comparison, engaged in readings with protocols, engaged in a Number Talk, examined structures and routines of a lesson, and completed task-based teaching strategies. When asked about the degree of active learning found in these MNPS sessions, an MNPS focus group participant stated the professional development was, "(n)ot just straight sit and get. No one wants to deliver that or sit through it." (Focus Group Participant 3). The MNPS standards-related sessions included time for school teams to collaborate and plan, although with only two days to address the revised Math standards and MNPS' new instructional model, it is unclear how much time for teacher collaboration was actually possible during these sessions.

The MNPS train-the-trainer sessions included substantial use of the CEPD of using models and modeling. "We did the PD we wanted them to deliver. We were specific - 'we are going into a chunk we want you to redeliver.'" (Focus Group Participant 5). In addition to engaging in live modeling during the sessions, the slides and documents used

during the train-the-trainer sessions were shared with the professional development attendees. Slides throughout the MNPS PowerPoint deck contained an icon and redelivery notes, making expectations regarding professional development redelivery clear to attendees.

MNPS professional development sessions also included opportunities for reflection at the conclusion of each module. Each module had a reflection and planning section built into the end of it. According to focus group participants, reflection was a key component of all professional development within the district. "Reflection is always part of the process. At the conclusion of a module we will step out and say, 'We just went through this, what do you take away from it?'" (Focus Group Participant 4). Specifically related to revised-Math-standards professional development, a focus group participant shared, "The PD was so well delivered that they had time for reflection and to say 'How are you going to take this back? This is the slide deck you need to take back but think about how you will take this back.'" (Focus Group Participant 2).

MNPS train-the-trainer sessions offered attendees the CEPD of coaching and expert feedback, but only through the reflection elements built into the professional development. "After each module, there was time for reflection. During that time—reflection, processing, planning—at that moment we were available to answer questions." (Focus Group Participant 1). Beyond the actual professional development sessions, the facilitators had minimal contact with or feedback for the participants. More critically, beyond the train-the-trainer sessions, professional development facilitators did not have much awareness of the professional development sessions that occurred at the school level. "We needed the principals and the teachers leading the training, especially those without coaches. We were not there to go back and lead all of the training. I don't think we have any feedback loop on when the training happened, and who did what and when in the building, and how did it go." (Focus Group Participant 2).

As in other districts surveyed and interviewed, sustained duration was the CEPD that was least prevalent in MNPS. Although the focus group participants referenced the fact that all MNPS professional development includes the revised Math standards in some way, the professional development dedicated exclusively to the topic of revised Math standards implementation very clearly lasted only two days.

Section IV - Recommendations

Recommendation #1: Increase Use of High-Quality Math Instructional Materials in Classrooms and in Math Professional Development to Accelerate Achievement of Revised-Math-Standards Implementation Outcomes

It is recommended that TSBE and TDOE work to increase the use of high-quality, standards-aligned Math instructional materials in classrooms and in Math-related professional development throughout Tennessee to accelerate achievement of TSBE's articulated standards-implementation outcomes. This project documented varying degrees of teacher access to, use of, and knowledge of such instructional materials in participating districts. It also documented that any impact that Tennessee's process for selecting and approving standards-aligned instructional materials could have on full implementation of revised Math standards is blunted by low levels of reported teacher use of state-approved and district-adopted Math materials found in this project's survey. Teacher knowledge and use of standards-aligned, high-quality Math

instructional materials are crucial to achieving full Math standards implementation in the classroom, because high-quality instructional materials provide the missing link between rigorous academic standards and rigorous instruction that allows strong student outcomes to be achieved.

Providing teachers with access to high-quality, standards-aligned instructional materials can prompt substantial improvements in student outcomes (Chingos & Whitehurst, 2012; Kane, Owens, Marinell, Thal, and Staiger, 2016; Kane, 2016). ***Research also has demonstrated that the effects of high-quality instructional materials use may be greatest for the least effective teachers, who unfortunately continue to be inequitably distributed and disproportionately present in high-needs classrooms in the United States (Goldhaber, Cowan, & Theobald, 2017; Chiefs for Change, 2017).*** In one study, providing middle school Math teachers with access to quality instructional materials (i.e., standards-aligned anchor lessons) and supports to promote their use increased students' Math achievement by roughly 0.08 of a standard deviation. For students with teachers at the 20th value-added percentile, achievement increases were 1.5 times larger than for students with teachers at the 80th percentile. As importantly, the effects of these materials on the strongest teachers also were positive or non-existent (Jackson & Makarin, 2016).

In addition, providing teachers with access to high-quality instructional materials is one of few interventions in education that is effective, practical, and scalable enough to warrant attention from large systems like states and school districts. Improving instructional materials has, on average, 40 times the impact per dollar that reducing class sizes does (Boser, Chingos, & Straus, 2015). Purchasing or using high-quality instructional materials also does not tend to cost more than buying or using low-quality options (Koedel & Polikoff, 2017; Chiefs for Change, 2017). Use of existing and sure-to-be-developed quality open educational resources could compound savings associated with this intervention even further.

To increase K-8 teachers' access to and use of high-quality Math instructional materials throughout Tennessee the state should consider: (1) improving the state's textbook approval process; and (2) incentivizing districts to adopt and use high-quality Math instructional materials. It is recommended that districts increase K-8 teachers' access to and use of high-quality Math instructional materials by considering: (1) adopting high-quality Math instructional materials; and (2) mandating the use of district-adopted Math instructional materials.

When access to high-quality instructional materials is coupled with access to professional learning that is directly linked to those materials, substantial positive effects have been established. For example, in one study of an intervention that included both high-quality high school science instructional materials and professional development tightly linked to those materials, researchers found significant positive effects on student achievement and were able to attribute about 40% of the intervention's impact to the materials themselves and the other 60% to the accompanying professional development (Taylor, Getty, Kowalski, Wilson, Carlson, & Van Scotter, 2015). Indicators of these positive effects can be documented in both the research base and in the field (Weiner & Pimentel, 2017; Taylor et al., 2015, Pondiscio, 2017).

To increase the use of Math professional learning that is directly linked to high-quality, standards-aligned Math instructional materials throughout Tennessee the state should consider: (1) embedding high-quality instructional materials into K-8 Math-standards-implementation professional

development and all Math professional development the state offers; and (2) incentivizing districts to adopt and use such professional development.

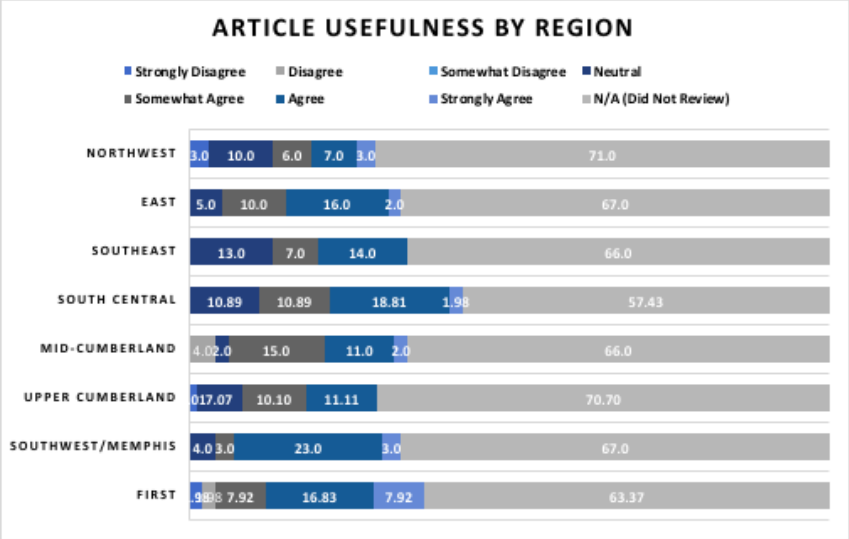
Any effort that the state or Tennessee school districts decide to take in furtherance of this recommendation will be buoyed and guided by an emerging and growing research base that supports specific dimensions of instructional materials quality and alignment (Agodini, Harris, Thomas, Murphy, Gallagher, and Pendleton, 2010; Bhatt & Koedel, 2012; Bhatt, Koedel, & Lehman, 2013; Card & Giuliano, 2016; Kane & Owens, 2016).

Recommendation #2: Revisit and Leverage TERA's "Reimagining State Support for Professional Learning" Practice Brief When Planning and Delivering Future Professional Development

It is recommended that TDOE revisit and leverage the "Reimagining State Support for Professional Learning: A Practice Brief to Inform a Research Agenda" brief that was part of its March 2017 Revised State Standards Implementation training. TDOE asked participants attending its March 2017 training session to rate the usefulness of this practice brief that was included in training materials. This brief, created as part of Tennessee Education Research Alliance's (TERA) efforts to support high-quality professional learning in Tennessee, highlights current research on the topic of effective professional development, speaks to the roles the state and districts can and should play in providing professional development, and offers options for building systems of effective professional learning that could scale across Tennessee and simultaneously meet the demands posed by local context (Reimagining State Support, 2017).

Of the 801 training attendees who responded to TDOE's survey question about the usefulness of the TERA practice brief, 66% reported that they had not read the brief, and 34% reported that they had read it. Interestingly, roughly the same number of attendees from each CORE Region (60-70) reported that they had not read the brief. Of the 272 who read the practice brief, 76.5% reported that they agreed the brief was useful, 19.1% were neutral, and 4.4% disagreed that the brief was useful. Figure 26 disaggregates these training attendee responses by CORE region.

Figure 26. Usefulness of "Reimagining State Support for Professional Learning: A Practice Brief to Inform a Research Agenda" by CORE region.



Because only about one-third of district teams attending TDOE's March 2017 Revised State Standards Implementation training session reported reading the "Reimagining State Support for Professional Learning" practice brief, TDOE would benefit from revisiting the brief's content with district teams involved in providing standards-implementation-related professional development to educators. The brief provides a theoretical framework and discussion points related to what is working and opportunities to improve professional learning in the State of Tennessee. Seeking district-level engagement with the brief's important content seems crucial to achieving the ambitious goals TSBE has set out in its "Tennessee Succeeds" strategic plan. Because roughly the same number of attendees from each CORE Region failed to read the practice brief, TDOE may want to explore causes for that decision that may be universal across the regions it serves.

TDOE, itself, also may benefit from engaging deeply with the contents of "Reimagining State Support for Professional Learning" and in better articulating how its work supporting professional learning will contribute to its being effective and scalable across Tennessee. TERA's brief describes a "tight-loose" approach in which accountability and support are established as guardrails within which school districts can make local decisions best suited for the organization (Reimagining State Support, 2017). It is recommended that TDOE deepen its knowledge of this approach and consider how it could be more effectively utilized in upcoming standards-implementation efforts.

Offering districts a choice about the type of professional development model they could use to deliver revised Math and ELA standards-implementation professional development at the district level amounted to a good first step in attempting to implement the tight-loose approach, but on its own, that opportunity amounted to a largely structural change that is unlikely to affect large improvements in the quality and efficacy of the professional learning that districts provide related to revised-Math-standards implementation.

TDOE's 2017-2018 revised-standards-implementation professional development also seemed to focus on describing the requirements and elements of the implementation process, rather than on supporting districts and schools in the ongoing work that is needed to implement said standards in the classroom once the requirements are made known. The literature underscores the simultaneous need for pressure and support for policy implementation to be successful (McLaughlin, 1987; Elmore & McLaughlin, 1982). In select circumstances, pressure or support by themselves may be sufficient for policy implementation, but the vast majority of policy initiatives will need both. "Pressure is required in most settings to focus attention on a reform objective; support is needed to enable implementation" (McLaughlin, 1987, p. 173).

By better leveraging content and undergirding theory found in the TERA practice brief, TDOE has an opportunity to craft more effective professional learning systems for educators in upcoming revised-standards implementations. Engaging more robustly with the tight-loose approach, TDOE could establish structures that better support professional learning and create better alignment at multiple agent-actor levels (state-district, region-district, district-school, school-teacher) at which professional learning takes place. This concerted alignment effort would maximize utilization of resources of TDOE, CORE offices, districts, and schools, thereby decreasing existing frictions that impede professional learning, and ultimately standards implementation. Through such efforts, TDOE would recognize the deep research base that establishes that policy implementation at scale simultaneously creates new issues and impacts

resources (Majone & Wildavsky, 1977) and that teachers who work in policy environments where they have few opportunities and incentives to learn about revising their practice are less likely to enact reforms (Spillane, 2000).

TERA calls out that "(s)tatewide improvements require a state-level strategy, but any such strategy must align with and work through locally directed efforts" (Reimagining State Support, 2017, p.3). Knowing this reality and how significantly financial and human capital resources at the local level influence the implementation of any policy, TDOE took a solid first step in recognizing district realities by offering districts the opportunity to choose from one of three standards-implementation professional development models in 2017-18. TDOE now has an opportunity to truly embrace district-level realities in upcoming implementation rollouts and to recognize standards implementation as part of a statewide professional learning strategy, rather than a short-term, one-time professional development opportunity.

Recommendation #3: Attend to Characteristics of Effective Professional Development When Planning Future Revised-Standards-Implementation Professional Development

It is recommended that the state and districts attend to characteristics of effective professional development when facilitating professional development for future revised standards implementation. According to Darling-Hammond et al. (2017), effective professional development is: content focused; incorporates active learning; supports collaboration; uses models of effective practice; provides coaching and expert support; offers feedback and reflection; and is of sustained duration. The authors assert that effective professional learning incorporates most or all of these seven characteristics (Darling-Hammond et al., 2017).

With regard to these seven characteristics, it is recommended that duration is carefully considered when planning future professional learning. Professional development research suggests that "if adults are to change their beliefs and practices they need opportunities to learn over time where they can test ideas out in practice with the support of more knowledgeable others" (Aikens, Akers and Atkins-Burnett, 2016). And yet, according to Fullan (2007), professional development is rarely sustained enough to affect necessary changes classroom and school culture. ***The fact that K-8 Math Teacher Survey responses established "sustained duration" as the characteristic with the lowest mean score for revised-Math-standards professional development led by the state, districts, and schools in school year 2017-18 should give all Tennessee professional development providers pause.***

Although there is no "magic number" of professional development hours required to be effective, the research indicates that short, episodic professional development sessions, which are common, are not sufficient to allow for rigorous and cumulative learning and reflection. The distinction between professional development and professional learning is important in examining this recommendation. Professional development is a training, a "one-off" experience, while professional learning requires the presence of many of the characteristics of effective professional development as identified by Darling-Hammond et al. (2017).

The policy implementation research shares a common thread of emphasis on the importance of local actors in effective implementation. Research on the implementation of educational reform initiatives highlights how local conditions shape the success of any net set of practices being taken up. These local conditions include the leadership of a site or program, the resources made available for individuals to

make desired changes, and the processes or patterns of interaction that make up an organizational culture (Century & Cassata, 2016; Coburn, 2003).

As local actors develop future revised-standards professional development, it is recommended that professional development duration be conceptualized in terms of the amount of time required for quality standards implementation to be actualized in the classroom, rather than just the amount of time required to build awareness and surface-level understanding of the revised standards and their requirements. For example, professional development should be planned as quarter-, half-year-, full-year-, or multi-year-experiences that reflect the length of time needed to accomplish required professional learning. It is also recommended that the state and districts examine mixed-modality professional development models, which utilize in-person and online professional development in concert. These models would facilitate increased duration, as well as offer an opportunity for sustained collaboration and reflection among professional development participants.

Recommendation #4: Deliberately, explicitly, and realistically assess the state's ongoing and multiple standards implementation efforts

As they begin additional revised standards implementations and continue to oversee ongoing Math and ELA standards implementation processes, it is recommended that TSBE and TDOE exercise deliberate and explicit assessment of their standards implementation approaches and processes. For example, the state should work to create more realistic, specific revised-standards-implementation plans for all subjects with consideration given to that fact that standards revisions in multiple academic areas are being rolled out simultaneously.

Interview findings from this project that has examined only the early stages of the revised K-8 Math standards implementation process, which has taken place simultaneously with the revised ELA implementation, already offer evidence of tangible concerns and stressors at the district and school levels. One district-level administrator summed up existing sentiment in saying: "Implementing new standards in both content areas is a nightmare—overwhelming. We had to change everything. I had people say, 'I feel like a first-year teacher.' Good, seasoned teachers were just so overwhelmed" (District Interview 3). In addition, this project surfaced district-level concerns regarding the timeliness of state-led training schedules. This same interviewee summed up concerns well when stating: "Earlier is better than later. We were pushed with time with this roll-out. By the time we really got the materials it was May. By then I had already had to develop some materials because of the dates embedded in our calendar. Mid-April versus mid-May would allow for PD in early May after testing and before school ends. It would allow us more time to start planning" (District Interview 3). Both of these examples illustrate that the state could be well served to remember to analyze its implementation efforts using the "eyes" of a district- or school-level educator in Tennessee, who shoulders the burden of actually effectuating all of the state's standards-implementation mandates in schools and classrooms.

> *"Implementing new standards in both content areas is a nightmare-overwhelming. We had to change everything. I had people say, 'I feel like a first-year teacher.' Good, seasoned teachers were just so overwhelmed."*
> *(District Interview 3)*

In the literature, the need for effective professional development is not in question; the degree to which such professional development exists is. "Policy makers and educators are coming to see that what students

learn is directly related to what teachers teach; and what and how teachers teach depends on the knowledge, skills, and commitments they bring to their teaching and the opportunities they have to continue learning in and from their practice" (Feiman-Nemser, 2001, p. 1013). Moving forward we recommend that TSBE and TDOE hone in on the characteristics of effective professional development as organizing principles for their revised-standards-implementation professional development and its assessment.

As the state increases its focus on specific revised-standards implementation details, it is also recommended that the state maximize collaboration between state-, region-, and local-level actors. Cooperation across districts could lead to increased efficiency and quality in professional development planning and creation of professional development materials. Focus groups and district-level interviews revealed duplication of work across districts related to revised-standards-implementation professional development, underscoring the need for increased efficiency and collaboration. For example, one district-level interviewee shared that the district created a crosswalk of the old and revised standards and created notebooks for their teachers (District Interview 2). An interviewee from another district stated that the district laid the standards out to create a document illustrating the differences and shifts (District Interview 1). The two documents referenced by each interviewee sound similar, but were created independently, illustrating the kind of work duplication that remains common in the absence of state facilitation of collaboration opportunities between districts.

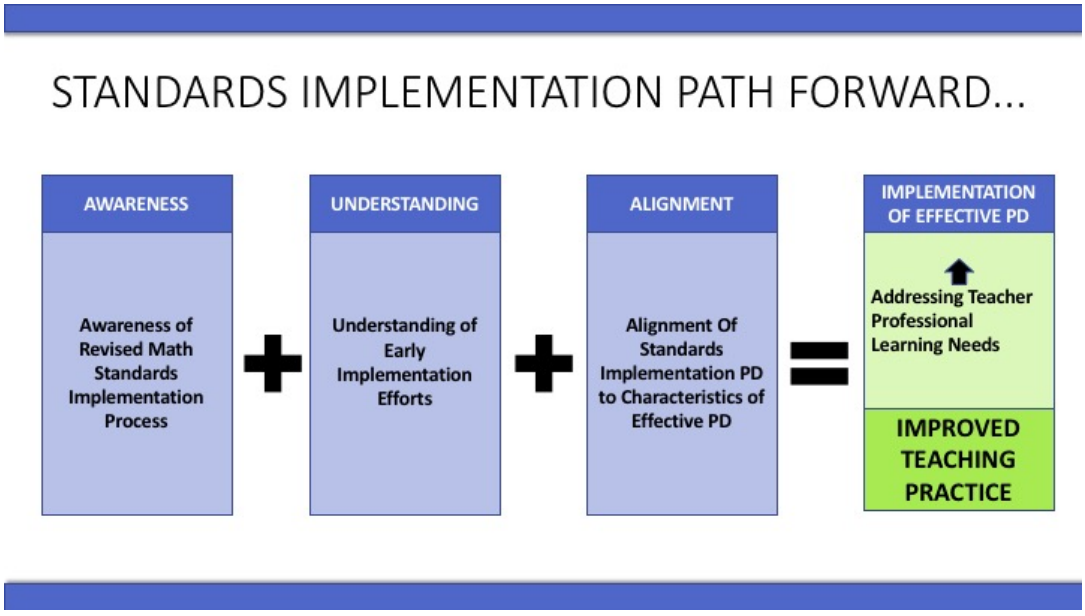
To date, many of TDOE's assessment efforts related to standards-implementation professional development and outcomes have relied on attendees' self-reporting of perceived understanding of the standards and the standards' requirements. Consequently, it is also recommended that this project's K-8 Math Teacher Survey and several other more powerful survey instruments that exist in the field be used by TSBE and TDOE to more validly and robustly evaluate the effects of their professional development efforts and implementation outcomes. These assessment instruments also offer opportunities for the state to gather valuable insights about whether the tools and supports necessary for successful implementation exist at the teacher, school leader, district leader, and regional levels.

Conclusion

Approximately 16 months ago, TSBE and TDOE began supporting Tennessee school districts in their implementation of revised Math and ELA state standards. TDOE has provided professional development to all school districts regarding specific standards revisions and implementation expectations. In addition, the state offered districts new flexibilities in how they could redeliver revised-standards-implementation professional development within their respective districts. Teachers were expected to begin implementing these revised state standards in their classrooms at the start of school year 2017-18. This project examined all aspects of the early stages of the implementation process for revised K-8 Math standards seeking to learn what progress teachers and districts have made in achieving five key implementation outcomes identified by TSBE and to examine the efficacy of professional development related to that implementation effort.

By identifying five key outcomes that together equate to implementation of the revised state academic standards, the state created a pathway for increasing student Math achievement in Tennessee. More specifically, TSBE articulated an implementation pathway for its districts and teachers that first sought to increase their awareness of the standards, next to increase their understanding of the standards, and finally to align their instructional materials, assessments, and instruction to the standards. Drawing on this same pathway, our project sought to increase TSBE and TDOE's awareness of its revised-Math–standards implementation process and its understanding of various aspects of its early implementation efforts, including professional development (Figure 27). We believe these project findings can inform TSBE and TDOE's future standards implementation efforts and better position them to undertake the work ahead of increasing the alignment of their standards-implementation professional development efforts to the characteristics of effective professional development and to teacher and district Math needs. Both teaching practice and student outcomes in Tennessee stand to benefit greatly from these efforts.

Figure 27. *Standards implementation path forward.*



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Appendices

Appendix A: Data Analysis Construct Map

Appendix B: K-8 Math Teacher Survey Concept Map and Teacher Survey Instrument
- B.1 K-8 Math Teacher Survey Concept Map
- B.2 K-8 Math Teacher Survey Instrument

Appendix C: K-8 Math Teacher Survey Recruitment Emails
- C.1 K-8 Math Teacher Survey Recruitment Email to District Contacts
- C.2 K-8 Math Teacher Survey Recruitment Email Text from District Contact to Teachers
- C.3 K-8 Math Teacher Survey Reminder Email Text from District Contact to Teachers
- C.4 Updated K-8 Math Teacher Survey Reminder Email Text from District Contact to Teachers with Incentive

Appendix D: K-8 Math Teacher Survey Item Analysis and Variable Construction
- **D.1** Reliability Statistics for Composite Variables
- **D.2** Teacher Objective Standards Knowledge (TOSK) Composite Variable Methodology

Appendix E: Interview and Focus Group Protocol for District- and Region-Level Math Professional Development Facilitators

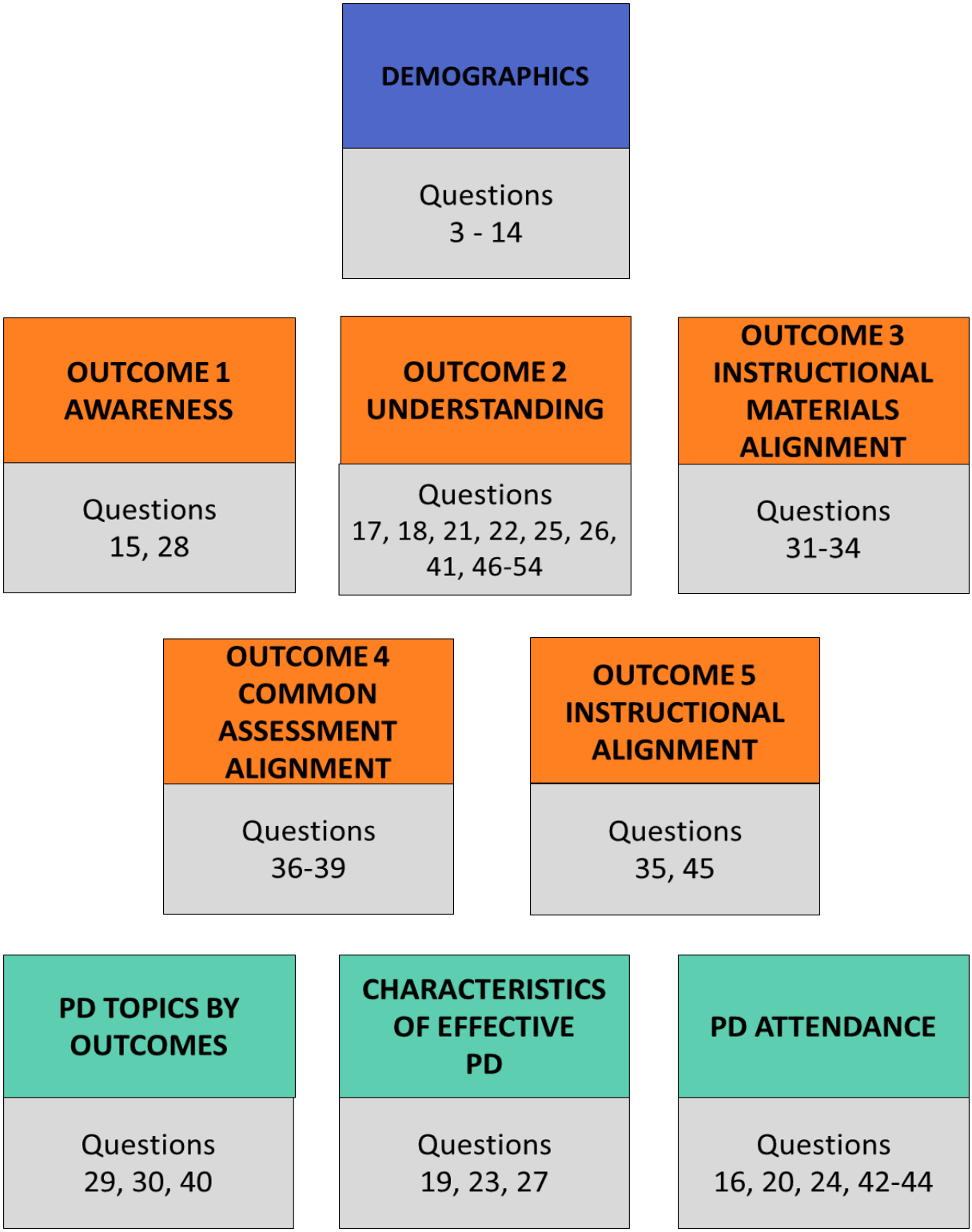
Appendix F: K-8 Math Teacher Survey Data Tables

Appendix A: Data Analysis Construct Map

Project Questions (for early standards implementation Summer 2017 through March 2018)		Research Question Category	Existing TDOE State-led Training Surveys	Project's K-8 Math Teacher Survey	Interviews and/or Focus Groups	Document and/or Data Review
1a	How aware of revised Math standards are K-8 Math teachers?	Implementation outcomes		x	x	x
1b	How much do K-8 Math teachers understand the revised Math standards?	Implementation outcomes	x	x	x	x
1c	How aligned are instructional materials used by K-8 Math teachers to revised Math standards?	Implementation outcomes	x	x		x
1d	How aligned are common assessments used by K-8 Math teachers to revised Math standards?	Implementation outcomes	x	x		
1e	How aligned is instruction by K-8 Math teachers to revised Math standards?	Implementation outcomes	x	x	x	x
2a	How effective has state-level professional development related to revised Math standards implementation been to date?	Professional learning	x	x	x	x
2b	How effective has district-level professional development related to revised Math standards implementation been to date?	Professional learning		x	x	x
2c	How effective has school-level professional development related to revised Math standards implementation been to date?	Professional learning		x		x

Appendix B: K-8 Math Teacher Survey Concept Map and Teacher Survey Instrument

B.1 K-8 Math Teacher Survey Concept Map



B.2 K-8 Math Teacher Survey Instrument

SURVEY ON K-8 REVISED MATH STANDARDS IMPLEMENTATION

Q1 SURVEY ON K-8 REVISED MATH STANDARDS IMPLEMENTATION
As you may know, the Tennessee State Board of Education (SBE) approved revised Mathematics Standards in 2016. The Tennessee Department of Education (TDOE) was charged with offering initial professional development about the revised standards and ongoing support to districts and schools as necessary for full implementation. SBE has joined with Vanderbilt University's Peabody College to conduct an initial review of the professional development models districts utilized to implement the revised standards. This survey is an opportunity for you to provide insight into what works and what doesn't when providing professional development about revised Math standards. We thank you in advance for your participation in this survey.

- Continue to Survey Informed Consent

Q2 SURVEY ON K-8 REVISED MATH STANDARDS IMPLEMENTATION
SURVEY INFORMED CONSENT
Project Title: Tennessee State Board of Education Capstone Project
Principal Investigator: Kenneth Roumpos
Co-Investigators: Renee Blahuta, Carolyn Probst
Faculty Advisor: Dr. Claire Smrekar, Vanderbilt University

Sponsor: Tennessee State Board of Education, Vanderbilt University
This consent form will give you the information you will need to understand why this project is being done and why you are being invited to participate. It will also describe what you will need to do to participate as well as any known risks, inconveniences or discomforts that you may have while participating. We encourage you to ask questions at any time. If you decide to participate, you will be asked to sign this form and it will be a record of your agreement to participate. You may print a copy of this form to keep.

Purpose and Background
You are invited to participate in a project exploring professional development related to the Tennessee Revised Mathematics Standards and their implementation. The information gathered will be used to better understand the professional development models utilized for implementation of the revised standards. You are being asked to participate because you are a teacher of mathematics in Tennessee.

Procedures
If you click that you would like to participate in this survey at the end of this consent form, you will be taken to the electronic survey that will take approximately 20 minutes to complete. In the survey, you will be asked about your knowledge of professional development related to the Tennessee Revised Mathematics Standards, and how the revised Math standards have impacted instruction and assessment in your classroom.

Q3 Do you teach Math this school year?

- Yes
- No

Q4 In which grades do you teach Math this school year? (Check all grades that you teach Math.)

- PreK Math
- Kindergarten Math
- 1st Math
- 2nd Math
- 3rd Math
- 4th Math
- 5th Math
- 6th Math
- 7th Math
- 8th Math
- High School Math

Q5 This school year, how many total periods are you scheduled to teach Math in a typical week? If you teach on a block or non-traditional schedule, consider one period to be approximately 45 minutes.

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10
- 11-15
- 16-20
- 21-25

Q6 Which subjects other than Math do you teach this school year? (Check all subjects that you teach.)

- Reading/English/Language Arts
- Science
- Social Studies/History
- Other

Q7 How many years have you taught Math (including this school year)?

- 1-2 years
- 3-5 years
- 6-9 years
- 10-14 years
- 15-19 years
- 20+ years

Q8 How many years have you been a teacher (including this school year)?

- 1-2 years
- 3-5 years
- 6-9 years
- 10-14 years
- 15-19 years
- 20+ years

Q9 What grade span best describes your school?

- Elementary (PreK-5th or 6th OR K-5th or 6th)
- Middle School (5th or 6th-8th)
- Junior High (7th-8th)
- Combined (PreK or K-8th)
- Other

Q10 In what school district do you currently work?

_____

Q11 Please select your age.

- ○ Under 25
- ○ 25-29
- ○ 30-39
- ○ 40-49
- ○ 50-59
- ○ 60+

Q12 Please select your gender.

- ○ Female
- ○ Male
- ○ Prefer not to respond

Q13 This school year, does your teaching schedule contain any teacher preparation periods? A preparation period is a class period during which you do not teach students and are free to engage in activities related to teaching and preparing for the classes you teach this year.

- ○ Yes
- ○ No

Q14 In a typical week this school year, how many of your preparation periods are designated specifically for Math preparation?

- ○ 0
- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6-10
- ○ 11 or more

Q15 Which academic standards does Tennessee currently use for Mathematics?

- o Common Core State Standards (CCSS)
- o Tennessee-specific standards focused on post-secondary and workforce readiness
- o I'm not sure.

Q16 In School Year 2017-2018 (including Summer 2017), did you attend **state-led** professional development on the topic of revised state Math standards, conducted by the Tennessee Department of Education (TDOE) and the CORE offices?

- o Yes
- o No

Q17 Prior to attending this **state-led** professional development, were you aware that Tennessee had revised its Math standards?

- o Yes, and I had a clear understanding of the revisions.
- o Yes, but I was not familiar with the specifics of the revisions.
- o No, I was not aware of the revised standards.

Q18 Please rate your understanding of the revised state Math standards:

	Poor	Fair	Good	Very Good	Excellent
PRIOR to attending this **state-led** revised Math standards professional development.	o	o	o	o	o
AFTER to attending this **state-led** revised Math standards professional development.	o	o	o	o	o

Q19 Please indicate the extent to which you agree or disagree with each of the following statements related to the **state-led** School Year 2017-2018 (including Summer 2017) revised state Math standards professional development, conducted by TDOE and the CORE offices.

This **state-led** professional development:

	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree
was focused on specific content.	○	○	○	○	○
incorporated active learning strategies for attendees.	○	○	○	○	○
engaged teachers in collaboration.	○	○	○	○	○
used models and/or modeling.	○	○	○	○	○
provided coaching and expert feedback.	○	○	○	○	○
included opportunities for feedback and reflection.	○	○	○	○	○
has been the focus of teachers' Math-related work over an extended period of time rather than an isolated learning event.	○	○	○	○	○

Q20 In School Year 2017-2018 (including Summer 2017), did you attend professional development on the topic of revised state Math standards led by your **school district**?

- ○ Yes
- ○ No

Q21 Prior to attending this **district-led** professional development, were you aware that Tennessee had revised its Math standards?

- ○ Yes, and I had a clear understanding of the revisions.
- ○ Yes, but I was not familiar with the specifics of the revisions.
- ○ No, I was not aware of the revised standards.

Q22 Please rate your understanding of the revised state Math standards:

	Poor	Fair	Good	Very Good	Excellent
PRIOR to attending this **district-led** revised Math standards professional development.	○	○	○	○	○
AFTER to attending this **district-led** revised Math standards professional development.	○	○	○	○	○

Q23 Please indicate the extent to which you agree or disagree with each of the following statements related to the **district-led** School Year 2017-2018 (including Summer 2017) revised state Math standards professional development, conducted by TDOE and the CORE offices.

This **district-led** professional development:

	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree
was focused on specific content.	○	○	○	○	○
incorporated active learning strategies for attendees.	○	○	○	○	○
engaged teachers in collaboration.	○	○	○	○	○
used models and/or modeling.	○	○	○	○	○
provided coaching and expert feedback.	○	○	○	○	○
included opportunities for feedback and reflection.	○	○	○	○	○
has been the focus of teachers' Math-related work over an extended period of time rather than an isolated learning event.	○	○	○	○	○

Q24 In School Year 2017-2018 (including Summer 2017), did you attend professional development on the topic of revised state Math standards led by your **school**?

- ○ Yes
- ○ No

Q25 Prior to attending this **school-led** professional development, were you aware that Tennessee had revised its Math standards?

- ○ Yes, and I had a clear understanding of the revisions.
- ○ Yes, but I was not familiar with the specifics of the revisions.
- ○ No, I was not aware of the revised standards.

Q26 Please rate your understanding of the revised state Math standards:

	Poor	Fair	Good	Very Good	Excellent
PRIOR to attending this **school-led** revised Math standards professional development.	○	○	○	○	○
AFTER to attending this **school-led** revised Math standards professional development.	○	○	○	○	○

Q27 Please indicate the extent to which you agree or disagree with each of the following statements related to the **school-led** School Year 2017-2018 (including Summer 2017) revised state Math standards professional development.
This **school-led** professional development:

	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree
was focused on specific content.	○	○	○	○	○
incorporated active learning strategies for attendees.	○	○	○	○	○
engaged teachers in collaboration.	○	○	○	○	○
used models and/or modeling.	○	○	○	○	○
provided coaching and expert feedback.	○	○	○	○	○
included opportunities for feedback and reflection.	○	○	○	○	○
has been the focus of teachers' Math-related work over an extended period of time rather than an isolated learning event.	○	○	○	○	○

Q28 When does your district expect teachers to start addressing the revised state Math standards (adopted in 2016) in their instruction?

- ○ This school year (2017-2018)
- ○ Next school year (2018-2019)
- ○ School year 2019-2020 or later
- ○ I don't know.

Q29 During this school year, which of the following have been topics of professional development in your district? (Check all topics that apply.)

- ○ increasing understanding of revised Math standards content
- ○ evaluating instructional materials for alignment to the revised Math standards
- ○ aligning assessments to the revised Math standards
- ○ identifying instructional shifts required by the revised Math standards
- ○ Other (please identify)
- ○ I don't know.

Q30 During this school year, which one topic below has been the **primary** focus of Math-standards professional development in your district?

- ○ increasing understanding of revised Math standards content
- ○ evaluating instructional materials for alignment to the revised Math standards
- ○ aligning assessments to the revised Math standards
- ○ identifying instructional shifts required by the revised Math standards
- ○ Other (please identify)

Q31 Please indicate how often you have drawn upon the following instructional materials for your Math classroom this year.

	Never	Rarely (1x per month or less)	Occasionally (2-3x per month)	Often (1-2x per week)	Daily or almost daily (3-5x per week)
District- or state-wide adopted materials	○	○	○	○	○
Materials developed and/or selected by my district	○	○	○	○	○
Materials I developed and/or selected myself	○	○	○	○	○
Materials developed in collaboration with other teachers but not formally circulated by the district for use in classroom lessons	○	○	○	○	○
Other instructional materials	○	○	○	○	○

Q32 What directions has your school received from your district regarding use of the following types of Math instructional materials for your Math classroom lessons this school year?

	My district requires use.	My district recommends but does not require use.	My district does not recommend or require use.
District- or state-wide adopted materials	○	○	○
Materials developed and/or selected by my district	○	○	○

Q33 Please indicate which of the following types of Math instructional materials you have developed or selected yourself during the current school year. (Check all that apply.)

- ○ Unit plans
- ○ Less plans
- ○ Assessments
- ○ Adaptations for students below/above grade level
- ○ Unit objectives
- ○ Lesson tasks or activities
- ○ Projects
- ○ Other (please describe)
- ○ Lesson objectives
- ○ Problems or questions
- ○ Adaptations for students with special needs
- ○ None of the above

Q34 During the current school year, who do you collaborate with or consult when developing or selecting the Math instructional materials you use in your classroom? (Check all that apply.)

- ○ District and/or curriculum specialists
- ○ Special education teachers or specialists
- ○ Teachers in my professional network outside my district or school
- ○ Math instructional coach
- ○ Subject or grade level teachers from my district (not my school)
- ○ Other (please describe)
- ○ ELL teachers or specialists
- ○ Subject or grade level teachers from my school
- ○ No one

Q35 During the current school year, how does your school monitor alignment of Math instruction to the state Math standards? (Check all that apply.)

- ○ Collection of unit plans
- ○ Formal observations
- ○ Grade-level team meetings
- ○ There is no school-wide system for monitoring alignment
- ○ Collection of lesson plans
- ○ Review of student Math assessment outcome data
- ○ Math-teacher team meetings
- ○ I don’t know.
- ○ Walkthroughs
- ○ Professional development sessions
- ○ A designated team of teachers on a “Math Standards Alignment” team
- ○ Other

Q36 To what extent are the assessments you use in your Math instruction this school year aligned to the revised state Math standards?

- ○ Not at all
- ○ Minimally
- ○ Somewhat
- ○ Moderately
- ○ Extensively
- ○ I don't know.

Q37 Do common Math assessments exist in your school for the current school year?

- ○ Yes, at all grade levels.
- ○ Yes, at certain grade levels.
- ○ No, we do not use any common Math assessments.

Q38 Please indicate which **types of common Math** assessments exist in your school for the current school year. (Check all that apply.)

- ○ District-mandated assessments
- ○ School-mandated assessments
- ○ Benchmark assessments
- ○ Formative assessments
- ○ Unit assessments
- ○ Lesson assessments

Q39 Are these common assessments that exist in your school this school year aligned to the revised state Math standards?

	Yes	No	I don't know.
District-mandated assessments	○	○	○
School-mandated assessments	○	○	○
Benchmark assessments	○	○	○
Unit assessments	○	○	○
Lesson assessments	○	○	○
Formative assessments	○	○	○

Q40 This school year, which of the following have been topics of professional development in your school? (Check all topics that apply.)

- ○ increasing understanding of revised Math standards content
- ○ evaluating instructional materials for alignment to the revised Math standards
- ○ aligning assessments to the revised Math standards
- ○ creating common assessments aligned to the revised Math standards
- ○ identifying instructional shifts required by the revised Math standards
- ○ Other (please identify)

Q41 How do the revised Math standards differ from the previous version of the state Math standards? (Check all that apply.)

- o Standards changed in the same way for all grade levels K-8
- o More common terms, often used in instructional materials, were included
- o More topics with decreased depth for each topic
- o Grade-level major work changed
- o Middle grade statistics and probability standards were the most affected
- o Mathematical practice can now be taught separately from mathematics content
- o Increased emphasis on fluency
- o Fewer topics with increased depth for each topic

Q42 How much professional development have you received this school year to support your implementation of the revised state Math standards?

- o 0 hours
- o 1 to 4 hours
- o 5 to 8 hours
- o 9 to 16 hours
- o More than 16 hours

Q43 This school year, how frequently do you engage in professional development to support your implementation of the revised state Math standards?

- o Quarterly
- o Monthly
- o Weekly
- o Several times each week
- o Daily
- o Never

Q44 This school year, which of the following types of professional development have you engaged in related to implementation of the revised state Math standards? (Check all that apply.)

- o School-wide professional development
- o Meetings with school principal
- o 1-on-1 meetings with a Math instructional coach
- o Grade-level team meetings
- o Meetings with Math teacher colleagues from my school
- o Other
- o Math-teacher team meetings
- o Meetings with Math teacher colleagues from other schools

Q45 How frequently have the revised state Math standards caused you to alter your Math instruction this school year?

- o Never
- o Rarely (1x per month)
- o Occasionally (2-3x per month)
- o Often (1-4x per week)
- o Daily

Q46 Math content standards emphasize particular topics or work (called "major work") in each grade. Which of the following is major work found in Tennessee's revised Math standards for Kindergarten? (Check all that apply.)

- o Fluently add and subtract within 5
- o I don’t know.
- o Fluently add and subtract within 10
- o Identify the penny, nickel, dime, and quarter and recognize the value of each

Q47 Math content standards emphasize particular topics or work (called "major work") in each grade. Which of the following is major work found in Tennessee's revised Math standards for 1st Grade? (Check all that apply.)

- Add and subtract within 20, demonstrating fluency for addition and subtraction within 10
- Fluently add and subtract within 20 using mental strategies
- Know from memory all sums up to 10
- Count the value of a set of like coins less than one dollar using the cent symbol only
- I don't know.

Q48 Math content standards emphasize particular topics or work (called "major work") in each grade. Which of the following is major work found in Tennessee's revised Math standards for 2nd Grade? (Check all that apply.)

- Fluently add and subtract within 20 using mental strategies
- Fluently add and subtract within 30 using mental strategies
- Know from memory all sums of two one-digit numbers and related subtraction facts
- I don't know.

Q49 Math content standards emphasize particular topics or work (called "major work") in each grade. Which of the following is major work found in Tennessee's revised Math standards for 3rd Grade? (Check all that apply.)

- Use multiplication and division within 100 to solve word problems in situations involving equal groups, arrays, and measurement quantities, e.g., by using drawings and equations with a symbol for the unknown number to represent the problem
- Multiply and divide within 100 to solve contextual problems, with unknowns in all positions, in situations involving equal groups, arrays, and measurement quantities using strategies based on place value, the properties of operations, and the relationships between multiplication and division
- I don't know.

Q50 Math content standards emphasize particular topics or work (called "major work") in each grade. Which of the following is major work found in Tennessee's revised Math standards for 4th Grade? (Check all that apply.)

- Fluently add and subtract multi-digit
- Fluently add and subtract within
- I don't know.

whole numbers using the standard algorithm

1,000,000 using appropriate strategies and algorithms

Q51 Math content standards emphasize particular topics or work (called "major work") in each grade. Which of the following is major work found in Tennessee's revised Math standards for 5th Grade? (Check all that apply.)

- Fluently multiply multi-digit whole numbers using the standard algorithm
- Fluently multiply multi-digit whole numbers (up to three-digit by four-digit factors) using appropriate strategies and algorithms
- I don't know.

Q52 Math content standards emphasize particular topics or work (called "major work") in each grade. Which of the following is major work found in Tennessee's revised Math standards for 6th Grade? (Check all that apply.)

- Measure volume by counting unit cubes, using cubic centimeters, cubic inches, cubic feet, and improvised units
- Understand that a set of data collected to answer a statistical question has a distribution which can be described by its center (mean, median, mode), spread (range), and overall shape
- I don't know.

Q53 Math content standards emphasize particular topics or work (called "major work") in each grade. Which of the following is major work found in Tennessee's revised Math standards for 7th Grade? (Check all that apply.)

- Describe the two-dimensional figures that result from slicing three-dimensional figures, as in plane sections of right rectangular prisms
- Use proportional relationships to solve multistep ratio and percent
- Convert a rational number to a decimal using long division; know that the decimal form of a rational number terminates in 0s or eventually repeats
- I don't know.

Q54 Math content standards emphasize particular topics or work (called "major work") in each grade. Which of the following is major work found in Tennessee's revised Math standards for 8th Grade? (Check all that apply.)

- Understand that a two-dimensional figure is congruent to another if the second can be
- Graph proportional relationships, interpreting the unit rate as the slope of the graph
- Solve linear equations in one variable

obtained from the first by a sequence of rotations, reflections, and translations; given two congruent figures, describe a sequence that exhibits the congruence between them

- I don't know.

Q55 Do you wish to be entered into the drawing for a $25 Amazon Gift Card for completing this survey? If you select yes, you will be redirected to a separate survey where you will be asked for your email address.

- Yes
- No

Appendix C: K-8 Math Teacher Survey Recruitment Emails

C.1 K-8 Math Teacher Survey Recruitment Email to District Contacts

Hello and Happy New Year, Dr. XXXX!

We are emailing in follow up to your CORE Director's outreach to you this Fall regarding participating in our Vanderbilt Ed.D. Capstone Project that seeks to learn more about the implementation of revised K-8 Math standards in Tennessee. **Thank you for agreeing to be a district that we can learn from!**

The survey that we will use to gather vital information for our project is now complete and ready for distribution to your district's K-8 teachers. **We are reaching out to ask you to distribute the survey** according to this proposed survey plan:

> -Email #1 Invitation: **As early as JANUARY 30, 2018 and no later than this Thursday, FEBRUARY 1st**, please email all K-8 teachers in the district an invitation to complete the survey. (The invitation text that describes our survey and contains the survey link is set out below.)
>
> -Initial Survey Window: Open JANUARY 30, 2018 through FEBRUARY 11, 2018 (2 weeks).
>
> -Email #2 Reminder: On FEBRUARY 12, 2018 please email all K-8 teachers in the district a reminder (text found below) to complete the survey within the week.
>
> -Follow-up Survey Window: FEBRUARY 12, 2018 through FEBRUARY 19, 2018 (1 week).

Could you please reply to this email and:

(1) confirm that this proposed survey plan works on your end; and
(2) advise when in the Jan. 30-Feb. 1 window you plan to send Email#1 to the district's K-8 teachers?

Thank you VERY much for your assistance with this project that will allow us to gain a deeper statewide view of K-8 Math standards implementation in Tennessee!

Renee Blahuta, Carolyn Probst, and Ken Roumpos
Ed.D. Candidates, Peabody College at Vanderbilt University

C.2 K-8 Math Teacher Survey Recruitment Email Text from District Contact to Teachers

Dear K-8 Math Teacher,

My name is Kenneth Roumpos, and I am a graduate student at Vanderbilt University's Peabody College. My colleagues Renee Blahuta and Carolyn Probst, and I, along with our faculty advisor, Dr. Claire Smrekar, are seeking volunteers to participate in a project studying professional development related to recently revised Math standards in Tennessee. **We are reaching out to ask you to complete a short survey on this topic by February 11, 2018.**

As you may know, the Tennessee State Board of Education (SBE) approved revised Mathematics Standards in 2016. The Tennessee Department of Education (TDOE) was charged with offering initial professional development about the revised standards and ongoing support to districts and schools as necessary for their full implementation. SBE has joined with Vanderbilt University's Peabody College to conduct a review of the professional development models districts have utilized to implement the revised Math standards. **This survey is an opportunity for you to offer insights into what works and what doesn't when providing professional development about revised Math standards.**

The survey should take approximately 20 minutes to complete. Participation in this survey is *voluntary* and your responses will remain *confidential*, but your feedback will be helpful as the TDOE considers how to best support future revised standards implementation. No identifying information will be included in any reports on this project. All responses will be reported in the aggregate.

If you have any questions or concerns, please free to contact any of the project co-investigators-or their faculty advisor listed below.

Renee Blahuta, graduate student
Vanderbilt University
773.531.9541
renee.blahuta@vanderbilt.edu

Carolyn Probst, graduate student
Vanderbilt University
631-664-1498
carolyn.probst@vanderbilt.edu

Kenneth Roumpos, graduate student
Vanderbilt University
314.814.3664
kenneth.d.roumpos@vanderbilt.edu

Dr. Claire Smrekar, faculty advisor
Vanderbilt University
615.322.8001
claire.smrekar@vanderbilt.edu

If you would like to participate, please complete the survey at this link: https://peabody.az1.qualtrics.com/jfe/form/SV_2bLZtBIIpgYRlVH.

Thank you for your time and consideration!

C.3 K-8 Math Teacher Survey Reminder Email Text from District Contact to Teachers

Please forward Email #1 above to all K-8 teachers again with this text:

REMINDER TO COMPLETE
REVISED MATH STANDARDS PROFESSIONAL DEVELOPMENT SURVEY

Dear K-8 Math Teacher,

We are reaching out again to ask you to complete a short survey on the topic of professional development related to revised state Math standards. Your confidential survey responses will help TDOE support teachers in ongoing and future revised standards implementations.

If you have already completed the survey, thank you very much for your insights! If you haven't yet completed the survey, please consider **completing the survey (that takes approximately 20 minutes to complete) at this link by February 19, 2018**:
https://peabody.az1.qualtrics.com/jfe/form/SV_2bLZtBIIpgYRlVH.

Thank you for your time and contribution to our project that will allow us to gain a deeper statewide view of K-8 Math standards implementation in Tennessee!

Renee Blahuta, Carolyn Probst, and Ken Roumpos
Ed.D. Candidates, Peabody College at Vanderbilt University

C.4 Updated K-8 Math Teacher Survey Reminder Email Text from District Contact to Teachers with Incentive

Subject: Incentive for Revised Math Standards Professional Development Survey!

REMINDER TO COMPLETE
REVISED MATH STANDARDS PROFESSIONAL DEVELOPMENT SURVEY

Dear K-8 Math Teacher,

We are reaching out with a final request to ask you to complete a short survey on the topic of professional development related to revised state Math standards. Your confidential survey responses will help TDOE support teachers in ongoing and future revised standards implementations. Please consider **completing the survey (that takes approximately 20 minutes) at this link by March 9, 2018**.

https://peabody.az1.qualtrics.com/jfe/form/SV_2bLZtBIIpgYRlVH.

To thank you for your time completing the survey, we will be doing a random drawing for four $25 Amazon Gift Cards. Upon completion of the survey, you will have the option of being taken to a **separate** survey that will collect your email address for the drawing. This will protect the anonymity of the first survey. If you have previously completed the survey, please email Ken Roumpos directly at kenneth.d.roumpos@vanderbilt.edu to be entered into the drawing.

Thank you for your time and contribution to our project that will allow us to gain a deeper statewide view of K-8 Math standards implementation in Tennessee!

Renee Blahuta, Carolyn Probst, and Ken Roumpos

Ed.D. Candidates, Peabody College at Vanderbilt University

Appendix D: K-8 Math Teacher Survey Item Analysis and Variable Construction

D.1

Reliability Statistics for Composite Variables

	Cronbach's α	*N of items*
Teacher Objective Standard Knowledge	*.845*	*4*
Which academic standards does Tennessee currently use for Mathematics?		
When does your district expect teachers to start addressing the revised state Math standards in their instruction?		
How do the revised state Math standards differ from the previous version of the state Math standards?		
Math content standards emphasize particular topics or work (called "major work") in each grade. Which of the following is major work found in Tennessee's revised math standards for Kindergarten (and each grade level taught K-8)?		
State-Led Characteristics of Effective Professional Development	*.890*	*7*
Professional development was focused on specific content.		
Professional development incorporated active learning strategies for attendees.		
Professional development engaged teachers in collaboration.		
Professional development used models and/or modeling.		
Professional development provided coaching and expert feedback.		
Professional development included opportunities for feedback and reflection.		
Professional development has been the focus of teachers' Math-related work over an extended period of time rather than an isolated learning event.		
District-Led Characteristics of Effective Professional Development	*.909*	*7*
Professional development was focused on specific content.		
Professional development incorporated active learning strategies for attendees.		
Professional development engaged teachers in collaboration.		
Professional development used models and/or modeling.		
Professional development provided coaching and expert feedback.		
Professional development included opportunities for feedback and reflection.		
Professional development has been the focus of teachers' Math-related work over an extended period of time rather than an isolated learning event.		
School-Led Characteristics of Effective Professional Development	*.928*	*7*
Professional development was focused on specific content.		
Professional development incorporated active learning strategies for attendees.		
Professional development engaged teachers in collaboration.		
Professional development used models and/or modeling.		
Professional development provided coaching and expert feedback.		
Professional development included opportunities for feedback and reflection.		
Professional development has been the focus of teachers' Math-related work over an extended period of time rather than an isolated learning event.		

D.2 Teacher Objective Standards Knowledge (TOSK) Composite Variable Methodology

The composite teacher objective Math standards knowledge (TOSK) variable was created by grouping responses to K-8 Math Teacher Survey questions 15, 28, 41, and 46-54. In creating the composite TOSK variable from these four individual survey questions that revealed objective teacher knowledge of the revised Math standards, each of these four component variables was weighted equally and scored out of eight points.

Respondents received eight points for correctly identifying the Tennessee-specific Math standards (question 15) and eight points for correctly identifying the 2017-18 school year as the year of expected implementation of the revised Math standards (question 28).

For question 41 regarding how revised Math standards content differs from the previous standards, survey respondents received one point for each correct statement selected and one point for each incorrect statement not selected for a total of eight possible points.

For the grade-level major work questions (46-54), survey respondents received one point for each correct statement selected and one point for each incorrect statement not selected for each question they answered about major work. Survey respondents answered one major work question for each grade they indicated teaching Math in during the 2017-18 school year. For respondents who answered multiple grade-level major work questions, responses were coded into one value out of eight points, maintaining equal weight for each of the four survey questions that constitutes the TOSK composite variable.

Respondents then received a score based on total points earned out of total possible points, which was ultimately converted to a score out of eight points representing their composite TOSK score.

Appendix E: Interview and Focus Group Protocol for District- and Region-Level Math Professional Development Facilitators

INTRODUCTION TO THE INTERVIEW:
It's our understanding that TN is engaged in the early stages of implementing the state's revised K-12 Literacy and Math standards and that the State (TDOE) held initial mandatory trainings for districts teams about these revised standards last Spring and Summer.

It's also our understanding that during these state trainings, districts made some decisions about how they would convey information about these revised standards to their district leaders, school leaders, and teachers.

Our project is pulling together a state-wide view of how the K-8 revised Math standards implementation has unfolded so far. We're collecting information via an online survey for K-8 Math teachers and via interviews with district and regional Math personnel in a variety of districts. We realize that this implementation is in its early stages and are really seeking to just pull together some baseline information about how it has gone so far.

DISTRICT REDELIVERY INTERVIEW Qs:

Q: After attending the State's Spring and Summer 2017 Revised State Standards PD, which PD Redelivery Model did your district chose (state, district, hybrid)?

-The person in what district role made that decision?
-Why did the district chose that PD Redelivery Model?
-Did the ability to make that explicit choice of redelivery model (state, district, hybrid) impact/influence/change the district's approach to Revised Standards PD in any way?

Q: Did your district use the same Redelivery Model for Literacy and Math Standards?

-Why or why not?
-If used different model can you describe how the Math PD differed from the Literacy PD?

Q: Did the district view this Revised Math Standards Redelivery PD that occurred after the district team attended the State's Summer Training more as a single event or an ongoing process?

-More of a one-off obligation to convey the State's Math-standards-related information in a single district PD session?
-More of a continuous PD process aimed at having teachers gain proficiency in all of the elements that the revised Math standards contain?

Q: What did the Revised Math Standards Redelivery PD consist of?

-When did it occur?
-What was the content of that PD?
-Which roles were responsible for facilitating that PD? (we want roles not people identified here)

-Who was the audience in the district for that PD? (we want roles not people identified here)

*Who actually attended that PD?

attendees, #districts, roles of attendees

*Is that PD complete or does it continue?

*If it continues, what PD is continuing, for whom, and why?

-Could you describe the process for or some of the elements of that Revised Math Standards Redelivery PD?

-Follow-up Qs that get at the 7 elements/characteristics of effective PD

1. Content focused-n/a??
2. Incorporate active learning strategies
   -Q: Was the PD more of a sit-and-get or an active session(s)?
3. Engage teachers in collaboration
   -Q: Were attendees/teachers working in groups during the session(s)?
4. Use models and/or modeling
   -Q: Did facilitators model how to do Math-standards-related things, like planning of implementation in the PD? What is an example or two of things they modeled?
5. Provide coaching and expert support
   -Q: How many facilitators were at this session? How many attendees?
   -Q: Were there any district roles that coached or supported PD attendees or was that not necessary?
6. Include opportunities for feedback and reflection
   -Q: Were attendees/teachers given time to reflect on Math-standards-related things during the PD or was the expectation that they should do that after the session was over?
   -Q: Did attendees/teachers receive any feedback about their ideas or plans during this session or was that saved for another time?
7. Sustained duration
   -Q: Was this PD a single session or a series of sessions? How long did the series last?

-How would you sum up the goals of that Revised Math Standards Redelivery PD?

-What was the impact of that PD?

*on attendees'/teachers' knowledge related to the revised K-8 Math standards?

*on attendees'/teachers' skills related to the revised K-8 Math standards?

*How do you know? (how did you assess that?)

Q: What PD has your district facilitated related to revised K-8 Math Standards since the district team attended the Summer State Training?

-When did it occur?

-What was the content of that PD?

-Which roles were responsible for facilitating that PD? (we want roles not people identified here)

-Who was the audience in the district for that PD? (we want roles not people identified here)

*Who actually attended that PD?

attendees, #districts, roles of attendees

-Is that PD complete or does it continue?

*If it continues, what PD is continuing, for whom, and why?

-Could you describe the process for or some of the elements of that revised K-8 Math Standards PD?

-Follow-up Qs that get at the 7 elements/characteristics of effective PD

1. Content focused-n/a??
2. Incorporate active learning strategies
   -Q: Was the PD more of a sit-and-get or an active session(s)?
3. Engage teachers in collaboration
   -Q: Were attendees/teachers working in groups during the session(s)?
4. Use models and/or modeling
   -Q: Did facilitators model how to do Math-standards-related things, like planning of implementation in the PD? What is an example or two of things they modeled?
5. Provide coaching and expert support
   -Q: How many facilitators were at this session? How many attendees?
   -Q: Were there any district roles that coached or supported PD attendees or was that not necessary?
6. Include opportunities for feedback and reflection
   -Q: Were attendees/teachers given time to reflect on Math-standards-related things during the PD or was the expectation that they should do that after the session was over?
   -Q: Did attendees/teachers receive any feedback about their ideas or plans during this session or was that saved for another time?
7. Sustained duration
   -Q: Was this PD a single session or a series of sessions? How long did the series last?

-How would you sum up the goals of that Revised Math Standards Redelivery PD?

-What was the impact of that PD?

*on attendees'/teachers' knowledge related to the revised K-8 Math standards?

*on attendees'/teachers' skills related to the revised K-8 Math standards?

*How do you know? (how did you assess that?)

Q: As you think about the district PD related to the revised K-8 Math standards that you've undertaken so far, what's a bright spot or strength of the district that you see?

Q: As you think about the district's PD related to the revised K-8 Math standards that you've done so far, what's an area of need that you see?

Q: As you think about the revised standards implementation process for Literacy and Math that rolled out this year, what's a bright spot or strength of the district that you see?
-What's an area of need that you see?

*Is that an area that needs to be addressed at the district, regional or state level? Some combination?

Appendix F: K-8 Math Teacher Survey Data Tables

Table 1

Descriptive student statistics for school districts surveyed

Variable	Coffee County	Fayetteville City	Giles County	Hamblen County	Johnson City	Knox County	Meigs County
Enrollment (PreK-12)	4,473	1,502	3,949	10,423	7,981	60,356	1,754
% Econ. Disadvantage	35.9	45.3	37.1	43.3	33.9	28.3	34.0
Special Education	657	219	482	1,468	1,121	8,686	354
% Special Education	14.7	14.6	12.2	14.1	14.0	14.4	20.2
EL/LEP	60	23	53	1,364	434	3,094	
% EL/LEP	1.3	1.5	1.3	13.1	5.4	5.1	
Per-pupil Expenditure	9,506.50	9,022.10	9,473.00	8,818.40	10,282	9,238.60	9,544.4
% Asian	0.9	0.7	0.9	1.1	3.5	2.7	0.0
% African American	3.2	33.9	17.7	7.0	15.1	17.0	1.8
% Hispanic	6.3	5.1	3.2	25.1	9.8	8.7	1.7
% American Indian	0.0	0.0	0.4	0.4	0.3	0.4	0.0
% White	89.1	59.9	77.7	66.0	71.1	70.9	95.9

Table 2

K-8 Math Teacher Survey respondents' personal characteristics

	All Districts	Coffee County	Fayette. City	Giles County	Hamblen County	Johnson City	Knox County	Meigs County
Gender								
Male	16 (8.7)				2 (14.3)		13 (11.0)	1 (20.0)
Female	166 (89.7)	7 (100.0)	7 (100.0)	17 (100.0)	12 (85.7)	17 (100.0)	102 (86.4)	4 (80.0)
Prefer not to respond	3 (1.6)						3 (2.5)	
Total	185	7	7	17	14	17	118	5
Age								
Under 25 years	5 (2.7)	1 (14.3)		1 (5.9)			2 (1.7)	1 (20.0)
25-29 years	20 (10.8)	1 (14.3)	1 (14.3)	1 (5.9)	3 (21.4)	2 (11.8)	12 (10.2)	
30-39 years	48 (26.0)	3 (42.9)	2 (28.6)	5 (29.4)	6 (42.9)	2 (11.8)	27 (22.9)	3 (60.0)
40-49 years	58 (31.3)		3 (42.9)	6 (35.3)	4 (28.6)	8 (47.1)	37 (31.4)	
50-59 years	47 (25.4)	2 (28.6)	1 (14.3)	4 (23.5)		4 (23.5)	35 (29.7)	1 (20.0)
60+ years	7 (3.8)				1 (7.1)	1 (5.9)	5 (4.2)	
Total	185	7	7	17	14	17	118	5
Teaching experience								
1-2 years	12 (6.5)	1 (14.3)	1 (14.3)	2 (11.8)	4 (28.6)		3 (2.5)	1 (20.0)
3-5 years	24 (13.0)	1 (14.3)		3 (17.6)	1 (7.1)	1 (5.9)	17 (14.4)	1 (20.0)
6-9 years	32 (17.3)	2 (28.6)	2 (28.6)		2 (14.3)	2 (11.8)	23 (19.5)	1 (20.0)
10-14 years	41 (22.2)	1 (14.3)	1 (14.3)	4 (23.5)	3 (21.4)	1 (5.9)	30 (25.4)	1 (20.0)
15-19 years	25 (13.5)		2 (28.6)	3 (17.6)	1 (7.1)	3 (17.6)	15 (12.7)	1 (20.0)
20+ years	51 (27.6)	2 (28.6)	1 (14.3)	5 (29.4)	3 (21.4)	10 (58.8)	30 (25.4)	
Total	185	7	7	17	14	17	118	5
Math teaching experience								
1-2 years	17 (9.2)	2 (28.6)	3 (42.9)	3 (17.6)	3 (21.4)	1 (5.9)	4 (3.4)	1 (20.0)
3-5 years	28 (15.1)			2 (11.8)	1 (7.1)		24 (20.3)	1 (20.0)
6-9 years	31 (16.8)	2 (28.6)			2 (14.3)	3 (17.6)	22 (18.6)	2 (40.0)
10-14 years	37 (20.0)	1 (14.3)	1 (14.3)	4 (23.5)	4 (28.6)	1 (5.9)	25 (21.2)	1 (20.0)
15-19 years	26 (14.1)		2 (28.6)	3 (17.6)	1 (7.1)	7 (41.2)	13 (11.0)	
20+ years	46 (24.9)	2 (28.6)	1 (14.3)	5 (29.4)	3 (21.4)	5 (29.4)	30 (25.4)	
Total	185	7	7	17	14	17	118	5
Amount of revised Math standards PD								
0 hours	21 (12.6)	2 (28.6)	1 (14.3)		4 (28.6)	1 (6.7)	13 (12.4)	
1-4 hours	74 (44.3)	3 (42.9)	2 (28.6)	9 (56.3)	5 (35.7)	11 (73.3)	44 (41.9)	
5-8 hours	40 (24.0)	1 (14.3)	2 (28.6)	5 (31.3)	3 (21.4)	2 (13.3)	26 (24.8)	1 (33.3)
9-16 hours	23 (13.8)		2 (28.6)	1 (6.3)			18 (17.1)	2 (66.7)
17+ hours	9 (5.4)	1 (14.3)		1 (6.3)	2 (14.3)	1 (6.7)	4 (3.8)	
Total	167	7	7	16	14	15	105	3
Frequency of revised Math standards PD								
Never	37 (22.2)	4 (57.1)	2 (28.6)	6 (37.5)	4 (28.6)	3 (20.0)	18 (17.1)	
Quarterly	68 (40.7)	1 (14.3)		8 (50.0)	5 (35.7)	4 (26.7)	47 (44.8)	3 (100.0)
Monthly	39 (23.4)	2 (28.6)	4 (57.1)	2 (12.5)	3 (21.4)	6 (40.0)	22 (21.0)	
Weekly	20 (12.0)		1 (14.3)		2 (14.3)		17 (16.2)	
Several times/week	3 (1.8)					2 (13.3)	1 (1.0)	
Daily								
Total	167	7	7	16	14	15	105	3
Form of revised Math standards PD attended								
State-led PD	92 (49.7)	2 (28.6)	4 (57.1)	10 (58.9)	3 (21.4)	5 (29.4)	67 (57.8)	1 (20.0)
District-led PD	136 (73.5)	4 (57.1)	3 (42.9)	13 (76.5)	7 (50.0)	13 (76.5)	92 (78.0)	4 (80.0)
School-led PD	58 (31.4)	2 (28.6)	3 (42.9)	5 (29.4)	6 (42.9)	2 (11.8)	37 (31.4)	3 (60.0)
Total (*N*)	185	7	7	17	14	17	118	5

Table 2.1

Amount and frequency of revised-Math-standards professional development by participating district

	Coffee County	Fayetteville City	Giles County	Hamblen County	Johnson City	Knox County	Meigs County
Amount of PD							
0 hours	2 (28.6)	1 (14.3)		4 (28.57)	1 (6.67)	13 (12.4)	
1-4 hours	3 (42.9)	2 (28.6)	9 (56.3)	5 (35.71)	11 (73.33)	44 (41.9)	
5-8 hours	1 (14.3)	2 (28.6)	5 (31.3)	3 (21.43)	2 (13.33)	26 (24.8)	1 (33.33)
9-16 hours		2 (28.6)	1 (6.3)			18 (17.1)	2 (66.67)
More than 16 hours	1 (14.3)		1 (6.3)	2 (14.29)	1 (6.67)	4 (3.8)	
Frequency of PD							
Quarterly	1 (14.3)		8 (50.0)	5 (35.71)	4 (26.67)	47 (44.8)	3 (100.00)
Monthly	2 (28.6)	4 (57.1)	2 (12.5)	3 (21.43)	6 (40.0)	22 (21.0)	
Weekly		1 (14.3)		2 (14.29)		17 (16.2)	
Several times/week					2 (13.33)	1 (1.0)	
Daily							
Never	4 (57.1)	2 (28.6)	6 (37.5)	4 (28.57)	3 (20.0)	18 (17.1)	

Table 2.2

K-8 Math Teacher Survey respondents' revised-Math-standards professional development attendance by form and combination of forms

	n	% of Total
State-led PD only	13	7.0
District-led PD only	39	21.1
School-led PD only	8	4.3
State- and District-led PD	51	27.6
State- and School-led PD	4	2.2
District- and School-led PD	22	11.9
District-, State-, and School-led PD	24	13.0
Did not attend	24	13.0
Total (*N*)	185	

Table 3

Survey respondents by grade level

			Math Periods Taught Per Week		
Grade-level	*n*	%	M	Min.	Max.
Pre-Kindergarten	6	3.2	4.5	2	5
Kindergarten	10	5.4	4.1	1	6
1st grade	12	6.5	4.75	1	10
2nd grade	23	12.4	9.6	2	25
3rd grade	37	20.0	10.4	2	25
4th grade	24	13.0	10.7	2	25
5th grade	19	10.3	10.6	4	25
6th grade	16	8.6	13.4	4	25
7th grade	13	7.0	13.5	4	25
8th grade	1	0.5	4.0	4	4
Elementary multi-grade	11	5.9	7.8	2	25
Middle School multi-grade	13	7.0	12.5	3	25
Total (*N*)	185				

Table 3.1

Survey respondents by grade level by participating district

	All Districts	Coffee County	Fayette. City	Giles County	Hamblen County	Johnson City	Knox County	Meigs County
Pre-Kindergarten	6 (3.2)			3 (17.6)	2 (14.3)	1 (5.9)		
Kindergarten	10 (5.4)		1 (14.3)	5 (29.4)	1 (7.1)	3 (17.6)		
1st grade	12 (6.5)		1 (14.3)	3 (17.6)	5 (35.7)	3 (17.6)		
2nd grade	23 (12.4)	1 (14.3)		2 (11.8)		5 (29.4)	15 (12.7)	
3rd grade	37 (20.0)	3 (42.9)	1 (14.3)	3 (17.6)	2 (14.3)	2 (11.8)	25 (21.2)	1 (20.0)
4th grade	24 (13.0)	2 (28.6)	3 (42.9)	1 (5.9)	2 (14.3)		15 (12.7)	1 (20.0)
5th grade	19 (10.3)		1 (14.3)			1 (5.9)	16 (13.6)	1 (20.0)
6th grade	16 (8.6)					1 (5.9)	15 (12.7)	
7th grade	13 (7.0)						13 (11.0)	
8th grade	1 (0.5)						1 (0.8)	
Elementary multi-grade	11 (5.9)	1 (14.3)			1 (7.1)	1 (5.9)	7 (5.9)	1 (20.0)
Middle School multi-grade	13 (7.0)				1 (7.1)		11 (9.3)	1 (20.0)
Total (*N*)	185	7	7	17	14	17	118	5

Table 3.2

Survey respondents by number of Math periods taught per week by participating district

	All Districts	Coffee County	Fayetteville City	Giles County	Hamblen County	Johnson City	Knox County	Meigs County
1 period	4 (2.2)		1 (14.3)	1 (5.9)			2 (1.7)	
2 periods	15 (8.1)		1 (14.3)	2 (11.8)	1 (7.1)	3 (17.6)	8 (6.8)	
3 periods	10 (5.4)	3 (42.9)	1 (14.3)				5 (4.2)	1 (20.0)
4 periods	22 (11.9)		2 (28.6)				20 (16.9)	
5 periods	35 (18.9)			8 (47.1)	7 (50.0)	7 (41.2)	13 (11.0)	
6 periods	6 (3.2)		1 (14.3)	1 (5.9)			4 (3.4)	
7 periods	2 (1.1)						2 (1.7)	
8 periods	3 (1.6)			1 (5.9)	1 (7.1)		1 (0.8)	
9 periods								
10 periods	20 (10.8)			4 (23.5)	3 (21.4)	3 (17.6)	9 (7.6)	1 (20.0)
11-15 periods	15 (8.1)	2 (28.6)			1 (7.1)	1 (5.9)	11 (9.3)	
16-20 periods	37 (20.0)	1 (14.3)			1 (7.1)	3 (17.6)	29 (24.6)	3 (60.0)
21-25 periods	16 (8.6)	1 (14.3)	1 (14.3)				14 (11.9)	
Total (*N*)	185	7	7	17	14	17	118	5

Table 4

Survey respondents by Math specialization

	n	% of Total
Math Specialist	86	46.5
Semi-Math Specialist	46	24.9
Generalist	53	28.6
Total (*N*)	185	

Table 4.1

Survey respondents by Math specialization by participating district

	All Districts	Coffee County	Fayette. City	Giles County	Hamblen County	Johnson City	Knox County	Meigs County
Math Specialist	46 (24.9)	3 (42.9)		4 (23.5)	5 (35.7)	3 (17.6)	30 (25.4)	1 (20.0)
Semi-Math Specialist	86 (46.5)	3 (42.9)	5 (71.4)		3 (21.4)	2 (11.8)	70 (59.3)	3 (60.0)
Generalist	53 (28.6)	1 (14.3)	2 (28.6)	13 (76.5)	6 (42.9)	12 (70.6)	18 (15.3)	1 (20.0)
Total (*N*)	185	7	7	17	14	17	118	5

Table 5

Survey respondents' number of Math-designated preparation periods among respondents who have preparation period(s)

Math Prep Period(s)	*n*	% of Total
0	20	11.3
1	28	15.8
2	33	18.6
3	35	19.8
4	23	13.0
5	31	177.5
6-10	5	2.8
11 or more	2	1.1
Total (*N*)	177	

Table 5.1

Survey respondents' number of Math-designated preparation periods by participating district

	All Districts	Coffee County	Fayetteville City	Giles County	Hamblen County	Johnson City	Knox County	Meigs County
0 periods	20 (11.4)			3 (17.6)	1 (7.7)	4 (23.5)	11 (9.9)	1 (20.0)
1 period	28 (15.9)		1 (14.3)	1 (5.9)		5 (29.4)	21 (18.9)	
2 periods	33 (18.8)		1 (14.3)	3 (17.6)	5 (38.5)	3 (17.6)	19 (17.1)	2 (40.0)
3 periods	35 (19.9)	1 (14.3)	1 (14.3)	6 (35.3)	1 (7.7)	1 (5.9)	25 (22.5)	
4 periods	23 (13.1)	3 (42.9)	2 (28.6)	2 (11.8)	1 (7.7)	2 (11.8)	13 (11.7)	
5 periods	31 (17.6)	3 (42.9)	2 (28.6)	1 (5.9)	5 (38.5)	2 (11.8)	16 (14.4)	2 (40.0)
6-10 periods	4 (2.3)			1 (5.9)			4 (3.6)	
11+ periods	2 (1.1)						2 (1.8)	
Total (*N*)	176	7	7	17	13	17	111	5

Table 6

Survey respondent report of how schools monitor alignment of Math instruction to Math standards

	Coffee County		Fayetteville City		Giles County		Hamblen County		Johnson City		Knox County		Meigs County	
	n	% of Total	*n*	% of Total	*n*	% of Total	*n*	% of Total	*n*	% of Total	*n*	% of Total	*n*	% of Total
Collection of unit plans					1 (15.4)	10.0			2 (3.4)	20.0	6 (1.5)	60.0	1 (7.7)	10.0
Collection of lesson plans	6 (17.6)	10.0	5 (23.8)	8.3	9 (13.8)	15.0	7 (13.2)	11.7	6 (10.3)	10.0	27 (8.4)	45.0		
Walk throughs	7 (20.6)	5.7	6 (28.6)	4.9	12 (18.5)	9.8	10 (18.9)	8.1	10 (17.2)	8.1	77 (19.6)	62.6	1 (7.7)	0.8
Formal Observations	7 (20.6)	5.4	5 (23.8)	3.9	14 (21.5)	10.9	11 (20.8)	8.5	10 (17.2)	7.8	80 (20.4)	62.0	2 (15.4)	1.6
Review of student math assessment outcome data	4 (11.8)	5.1	1 (4.8)	1.3	7 (10.8)	9.0	6 (11.3)	7.7	12 (20.7)	15.4	48 (12.2)	61.5		
Professional development sessions	1 (2.9)	2.4			4 (6.2)	9.8	5 (20.8)	12.2	4 (6.9)	9.8	24 (6.1)	58.5	3 (23.1)	7.3
Grade-level team meetings	5 (14.7)	5.1	2 (9.5)	2.0	13 (20.0)	13.1	7 (13.2)	7.0	10 (17.2)	10.1	59 (15.0)	59.6	3 (23.1)	3.0
Math-teacher team meetings	2 (5.9)	2.5	2 (9.5)	2.5	3 (4.6)	3.8	4 (7.5)	5.0	4 (6.9)	5.0	62 (15.8)	77.5	3 (23.1)	3.8
A designated "Math Standards Alignment" team	1 (2.9)	50.0					1 (1.9)	50.0						
There is no school-wide system for monitoring alignment					2 (3.1)		2 (3.8)				9 (2.3)			
Other	1 (2.9)	100.0									1 (0.3)			
Total *(N)*	34		21		65		53		58		393		13	

Table 7

Survey respondents by district

	n	% of Total
Coffee County	7	3.9
Fayetteville City	7	3.9
Giles County	17	9.2
Hamblen County	14	7.6
Johnson City	17	9.2
Knox County	118	63.8
Meigs County	5	2.7
Total *(N)*	185	

Table 8

Survey respondent self-reported revised-Math-standards awareness level prior to attending revised-Math-standards professional development by form attended

	No Awareness		Awareness (aware, but not familiar with revision specifics)		Understanding (aware and had clear understanding of revisions)	
	n	Percent of Total	*n*	Percent of Total	*n*	Percent of Total
State-led PD	4 (40.0)	4.4	51 (37.0)	56.0	36 (26.7)	39.6
District-led PD	5 (50.0)	3.7	65 (47.1)	48.1	65 (48.1)	48.1
School-led PD	1 (10.0)	1.8	22 (15.9)	38.6	34 (25.2)	59.6
Total *(N)*	10		138		135	

Table 9

Survey respondent awareness of revised-Math-standards implementation timeline

	n	Percent of Total
This school year (2017-18)	159	98.1
Next school year (2018-19)	3	1.9
School year 2019-20 or later		
Total *(N)*	162	

Table 10

Survey respondent classification of revised Math standards

	n	%
Common Core State Standards	84	46.7
Tennessee-specific standards	96	53.3
Total (*N*)	180	

Table 10.1

Survey respondent classification of revised Math standards by district

	CCSS	TN-specific
	n	*n*
Coffee County	2	4
Fayetteville City	6	1
Giles County	6	11
Hamblen County	6	8
Johnson City	5	12
Knox County	57	58
Meigs County	2	2
Total (*N*)	84	96

Table 10.2

Survey respondent classification of revised Math standards by years of teaching experience

	CCSS		TN-specific	
	n	% of Total	*n*	% of Total
1-2 years	9 (75.0)	5.0	3 (25.0)	1.7
3-5 years	14 (56.0)	7.8	9 (36.0)	5.0
6-9 years	20 (62.5)	11.1	12 (37.5)	5.6
10-14 years	16 (40.0)	8.9	24 (60.0)	13.3
15-19 years	6 (25.0)	3.3	18 (75.0)	10.0
20+ years	19 (38.8)	10.6	30 (61.2)	16.7
Total (*N*)	84		96	

Note. Count is in parentheses. N=180. Pearson $\chi^2 = 6.33$, df = 1 at $p = .024$

Table 11

Survey respondent self-reported revised Math standards depth of understanding before and after attending revised Math standards professional development by form

	Before			After		
	No Awareness	Awareness	Understanding	No Awareness	Awareness	Understanding
	n	*n*	*n*	*n*	*n*	*n*
State-led PD	15 (16.5)	51 (56.0)	25 (27.5)		36 (39.6)	55 (60.4)
District-led PD	13 (9.6)	77 (57.0)	45 (33.3)		50 (37.0)	85 (63.0)
School-led PD	3 (5.3)	31 (54.4)	23 (40.3)	1 (1.8)	21 (36.8)	35 (61.4)
Total (*N*)	31	159	93	1	107	175

Table 12

June 2017 TDOE Math session teacher training knowledge of revised Math standards expectations before and after training

	Before Training		After Training	
	n	% of Total	*n*	% of Total
Mastery	13	1.2	176	15.8
Extensive	128	11.5	513	46.1
A lot	266	23.9	345	31.0
Some	430	36.8	52	4.7
Limited	130	11.7	6	0.5
Minimal	97	8.7	2	0.2
None	30	2.7		
Invalid Response	20	1.8	20	1.8
Total *(N)*	1114		1114	

Table 13

Descriptive statistics of survey respondents by K-8 Math standards content knowledge level

	Low Content Knowledge		Medium Content Knowledge		High Content Knowledge	
	n	Percent of Total	*n*	Percent of Total	*n*	Percent of Total
School District						
Coffee County	2 (3.6)	28.6	4 (3.9)	57.1	1 (11.1)	14.3
Fayetteville City	1 (1.8)	14.3	6 (5.9)	85.7		
Giles County	7 (12.5)	43.8	9 (8.8)	56.2		
Hamblen County	7 (12.5)	50.0	6 (5.9)	42.9	1 (11.1)	7.1
Johnson City	3 (5.4)	20.0	12 (11.8)	80.0		
Knox County	36 (64.3)	34.3	62 (60.8)	59.0	7 (77.8)	6.7
Meigs County			3 (2.9)	100.0		
School Type						
Elementary	38 (67.9)	39.6	52 (51.0)	54.2	6 (66.7)	6.2
Middle School/Jr. High	13 (23.2)	22.8	41 (40.2)	71.9	3 (33.3)	5.7
Combined (K-8)	3 (5.4)	42.9	4 (3.9)	57.1		
Other	2 (3.6)	40.0	5 (4.9)	60.0		
Teacher Specialization						
Generalist	17 (30.4)	35.4	29 (28.4)	60.4	2 (22.2)	4.2
Semi-Math Specialist	17 (30.4)	41.5	23 (22.5)	56.1	1 (11.1)	2.4
Math Specialist	22 (39.3)	28.2	50 (49.0)	64.1	6 (66.7)	7.7
Years teaching						
1-2 years	5 (8.9)	50.0	5 (4.9)	50.0		
3-5 years	5 (8.9)	23.8	15 (14.7)	71.4	1 (11.1)	4.8
6-9 years	11 (19.6)	36.7	18 (17.6)	60.0	1 (11.1)	3.3
10-14 years	11 (19.6)	32.4	21 (20.6)	61.8	2 (22.2)	5.8
15-19 years	10 (17.9)	40.0	14 (13.7)	56.0	1 (11.1)	4.0
20+ years	14 (25.0)	29.8	29 (28.4)	61.7	4 (44.4)	8.5
Years teaching Math						
1-2 years	7 (12.5)	46.7	7 (6.9)	46.7	1 (11.1)	6.7
3-5 years	7 (12.5)	29.2	17 (16.7)	70.8		
6-9 years	10 (17.9)	35.7	17 (16.7)	60.7	1 (11.1)	3.6
10-14 years	10 (17.9)	31.3	20 (19.6)	62.5	2 (22.2)	6.2
15-19 years	9 (16.1)	36.0	13 (12.7)	52.0	3 (33.3)	12.0
20+ years	13 (23.2)	30.2	28 (27.5)	65.1	2 (22.2)	4.7
Form of revised Math Standards PD attended						
State-led PD Only	2 (3.6)	20.0	7 (6.9)	70.0	1 (11.1)	10.0
District-led PD Only	11 (19.6)	31.4	23 (22.5)	67.6	1 (11.1)	2.9
School-led PD Only	3 (5.4)	37.5	5 (4.9)	62.5		
District- AND State-led PD	20 (58.9)	41.7	25 (24.5)	52.1	3 (33.3)	6.2
District- AND School-led PD	4 (7.1)	20.0	15 (14.7)	75.0	1 (11.1)	5.0
State- AND School-led PD	1 (1.8)	25.0	3 (2.9)	75.0		
District- State- AND School-led PD	7 (12.5)	35.0	11 (19.6)	55.0	2 (22.2)	20.0
Did not attend PD	8 (14.3)	36.4	13 (12.7)	59.1	1 (11.1)	4.5
Total *(N)*	56		102		9	

Table 14

Survey respondents' level of revised Math standards major-work knowledge for grade level(s) taught in school year 2017-18

	Low Major Work Knowledge		Medium Major Work Knowledge		High Major Work Knowledge	
	n	Percent of Total	*n*	Percent of Total	*n*	Percent of Total
School District						
Coffee County	3 (5.4)	42.9			4 (6.5)	57.1
Fayetteville City	1 (1.8)	16.7			5 (8.1)	83.3
Giles County	3 (5.4)	20.0	7 (15.2)	46.7	5 (8.1)	33.3
Hamblen County	5 (8.9)	35.7	5 (10.9)	35.7	4 (6.5)	28.6
Johnson City	2 (3.6)	13.3	6 (13.0)	40.0	7 (11.3)	46.7
Knox County	40 (71.4)	38.5	28 (60.9)	26.9	36 (58.1)	34.6
Meigs County	2 (3.6)	66.7			1 (1.6)	33.3
School Type						
Elementary	21 (37.5)	22.1	27 (58.7)	28.4	47 (75.8)	49.5
Middle School/ Jr. High	34 (60.7)	59.6	14 (30.4)		9 (14.5)	16.9
Combined (K-8)			4 (8.7)	57.1	3 (4.8)	42.9
Other	1 (1.8)	20.0	1 (2.2)	20.0	3 (4.8)	60.0
Teacher Specialization						
Generalist	13 (23.2)	28.3	18 (39.1)	39.1	15 (24.2)	32.6
Semi-Math Specialist	9 (16.1)	22.0	6 (13.0)	14.6	26 (41.9)	63.4
Math Specialist	34 (60.7)	44.2	22 (47.8)	28.6	21 (33.9)	27.2
Years teaching						
1-2 years	5 (8.9)	50.0	2 (4.3)	20.0	3 (4.8)	30.0
3-5 years	8 (14.3)	38.1	4 (8.7)	19.0	9 (14.5)	42.9
6-9 years	9 (16.1)	30.0	7 (15.2)	23.3	14 (22.6)	46.7
10-14 years	10 (17.9)	29.4	13 (28.3)	38.2	11 (17.7)	32.4
15-19 years	8 (14.3)	34.8	7 (15.2)	30.4	8 (12.9)	34.8
20+ years	16 (28.6)	34.8	13 (28.3)	28.3	17 (27.4)	36.9
Years teaching Math						
1-2 years	3 (5.4)	20.0	3 (6.5)	20.0	9 (14.5)	60.0
3-5 years	14 (25.0)	58.4	5 (10.9)	20.8	5 (8.1)	20.8
6-9 years	6 (10.7)	21.4	8 (17.4)	30.8	14 (22.6)	53.8
10-14 years	9 (16.1)	28.1	12 (26.1)	37.5	11 (17.7)	34.4
15-19 years	7 (12.5)	30.4	7 (15.2)	30.4	9 (14.5)	39.2
20+ years	17 (30.4)	40.5	11 (23.9)	26.2	14 (22.6)	33.3
Form of revised Math Standards PD attended						
State-led PD Only	4 (7.1)	40.0	3 (6.5)	30.0	3 (4.8)	30.0
District-led PD Only	14 (25.0)	41.2	9 (19.6)	26.5	11 (17.7)	32.3
School-led PD Only	2 (3.6)	25.0	5 (10.9)	87.5	1 (1.6)	12.5
District- AND State-led PD	15 (30.4)	31.9	10 (21.7)	21.3	22 (35.5)	46.8
District- AND School-led PD	7 (12.5)	35.0	4 (8.7)	20.0	9 (14.5)	45.0
State- AND School-led PD					4 (6.5)	100.0
District- State- AND School-led PD	4 (7.1)	20.0	10 (21.7)	50.0	6 (9.7)	30.0
Did not attend PD	10 (17.9)	47.6	5 (10.9)	23.8	6 (9.7)	28.6
Total *(N)*	56		46		62	

Table 15
K-8 Math Teacher Survey respondents' composite teacher objective skill knowledge (TOSK) level by respondent characteristics

Group	Mean	*n*	Standard Deviation
Overall	5.07	183	1.971
Age			
Under 25	3.15	5	3.100
25-29	4.57	19	2.136
30-39	5.46	47	1.874
40-49	4.76	58	2.013
50-59	5.25	47	1.874
60 plus	6.67	7	0.890
Years teaching			
1-2	3.80	12	2.492
3-5	5.00	23	1.949
6-9	5.07	32	1.804
10-14	4.85	40	2.117
15-19	5.65	25	1.631
20 plus	5.31	51	1.915
Years teaching Math			
1-2	4.52	17	2.353
3-5	4.41	27	1.941
6-9	5.18	31	1.912
10-14	5.19	36	1.999
15-19	5.43	26	2.208
20 plus	5.30	46	1.793
Hours PD attended			
0 hours	4.22	21	2.061
1-4 hours	5.78	74	1.419
5-8 hours	5.37	40	1.430
9-16 hours	5.58	23	1.242
17 or more	5.64	9	1.388
PD frequency			
Quarterly	5.70	68	1.455
Monthly	5.24	39	1.297
Weekly	5.57	20	1.261
Several per week	6.86	3	0.347
Never	5.05	37	2.027
Form of PD attended			
State-led	5.00	13	2.640
District-led	5.20	39	1.884
School-led	4.65	8	0.710
State and district	5.49	50	1.552
District and school	5.50	22	2.298
State and school	5.25	4	1.671
All three	4.75	24	2.060
None	4.05	23	2.226

Table 15.1
K-8 Math Teacher Survey respondents' composite teacher objective skill knowledge (TOSK) level by participating district

District	Mean	*n*	Standard Deviation
Coffee County	5.46	7	1.799
Fayetteville City	4.39	7	2.091
Giles County	5.41	17	1.339
Hamblen County	4.99	14	2.182
Johnson City	5.51	17	2.086
Knox County	5.02	117	1.990
Meigs County	4.06	4	3.064

Table 15.2
K-8 Math Teacher Survey respondent composite teacher objective skill knowledge (TOSK) level by forms of revised Math Standards PD attended

PD attended	*n*	Mean	Standard Deviation
Knox County Schools			
State- and district-led PD	38	5.5	1.650
District- and school-led PD	13	5.8	2.198
State- and school-led PD	2	6.1	1.945
Other districts			
State- and district-led PD	12	5.6	1.248
District- and school-led PD	9	5.1	2.501
State- and school-led PD	2	4.4	1.237

Table 16

Survey respondents' self-reported knowledge and understanding of how to align Math instructional materials to the revised Math standards before and after March 2017 TDOE training by participating district

Before

Region	None	Minimal	Limited	Some	A lot	Extensive	Mastery
Mid-Cumberland		2 (10.0)	8 (10.7)	34 (9.2)	32 (15.5)	19 (16.0)	6 (42.9)
First		2 (10.0)	2 (2.7)	50 (13.6)	34 (16.5)	11 (9.2)	2 (14.3)
East	1 (100.0)	1 (5.0)	7 (9.3)	44 (11.9)	22 (10.7)	22 (18.5)	3 (21.4)
Southeast		4 (20.0)	9 (12.0)	45 (12.2)	25 (12.1)	16 (13.4)	2 (14.3)
South Central		5 (25.0)	8 (10.7)	48 (13.0)	27 (13.1)	13 (10.9)	
Southwest/Memphis		3 (15.0)	13 (17.3)	41 (11.1)	27 (13.1)	14 (11.8)	1 (7.1)
Northwest		3 (15.0)	9 (12.0)	56 (15.2)	18 (8.7)	15 (12.6)	
Upper Cumberland			19 (25.3)	51 (13.8)	21 (10.2)	9 (7.6)	
Total *(N)*	1	20	75	369	206	119	14

After

Region	None	Minimal	Limited	Some	A lot	Extensive	Mastery
Mid-Cumberland				8 (7.5)	36 (10.6)	47 (15.1)	9 (23.1)
First				6 (5.6)	50 (14.7)	39 (12.5)	5 (12.8)
East				10 (9.3)	44 (13.0)	41 (13.1)	5 (12.8)
Southeast				11 (10.3)	45 (13.3)	38 (12.1)	7 (17.9)
South Central				8 (7.5)	55 (16.2)	34 (10.9)	3 (7.7)
Southwest/Memphis		1 (50.0))		14 (13.1)	43 (12.7)	39 (12.5)	3 (7.7)
Northwest		1 (50.0)	1 (100.0)	31 (29.0)	26 (7.7)	34 (10.9)	6 (15.4)
Upper Cumberland				19 (17.8)	40 (11.8)	40 (12.8)	1 (2.6)
Total *(N)*	0	2	1	107	339	312	39

Table 17

Extent to which districts mandate state- or district-adopted Math instructional material use by participating district

	No requirements (silent)		Recommends, but does not require		Requires	
	n	% of Total	*n*	% of Total	*n*	% of Total
Coffee	1 (4.3)	14.3	6 (5.7)	85.7		
Fayetteville			6 (5.7)	85.7	1 (2.4)	14.3
Giles	4 (17.4)	23.5	7 (6.6)	41.2	6 (14.6)	35.3
Hamblen	8 (34.8)	57.1	6 (5.7)	42.9		
Johnson	3 (13.0)	20.0	9 (8.5)	60.0	3 (7.3)	20.0
Knox	6 (26.1)	56.6	69 (65.1)	65.1	31 (75.6)	29.2
Meigs	1 (4.3)	25.0	3 (2.8)	75.0		
Total *(N)*	23		106		41	

Table 18

Frequency with which survey respondents use state- or district-adopted Math instructional materials by participating district

	Never	Rarely	Occasionally	Often	Daily
Coffee	1 (14.3)		4 (57.1)	2 (28.6)	
Fayetteville		2 (28.6)	3 (42.9)	1 (14.3)	1 (14.3)
Giles	1 (5.9)	1 (5.9)	4 (29.4)	2 (11.8)	9 (52.9)
Hamblen	6 (42.9)	2 (14.3)	2 (14.3)	4 (28.6)	
Johnson	3 (20.0)	4 (26.7)	2 (13.3)	3 (20.0	3 (20.0)
Knox	11 (10.4)	21 (19.8)	16 (15.1)	23 (21.7)	35 (33.0)
Meigs	1 (25.)	1 (25.0)		2 (50.0)	
Total *(N)*	23	31	31	37	48

Table 19

Frequency with which survey respondents use district-developed Math instructional materials by participating district

	Never	Rarely	Occasionally	Often	Daily
Coffee	2 (28.6)		3 (42.9)	2 (28.6)	
Fayetteville	1 (14.3)	2 (28.6)	3 (42.9)	1 (14.3)	
Giles	2 (11.8)	2 (11.8)	2 (11.8)	2 (11.8)	9 (52.9)
Hamblen	6 (42.9)	3 (21.4)	1 (7.1)	2 (14.3)	2 (14.3)
Johnson		3 (20.0)	5 (33.3)	6 (40.0)	1 (6.7)
Knox	10 (9.4)	22 (20.8)	22 (20.8)	18 (17.0)	34 (32.1)
Meigs	1 (25.0)		1 (25.0)	1 (25.0)	1 (25.0)
Total *(N)*	22	32	37	32	47

Table 20
Frequency with which survey respondents use self-developed Math instructional materials by participating district

	Never	Rarely	Occasionally	Often	Daily
Coffee				3 (42.9)	4 (57.1)
Fayettevill e				1 (14.3)	6 (85.7)
Giles		1 (5.9)	2 (11.8)	7 (41.2)	7 (41.2)
Hamblen			4 (28.6)	2 (14.3)	8 (57.1)
Johnson			1 (6.7)	5 (33.3)	9 (60.0)
Knox	1 (0.9)	6 (5.7)	8 (7.5)	23 (21.7)	68 (64.2)
Meigs				1 (25.0)	3 (75.)
Total *(N)*	1	7	15	42	105

Table 21
Frequency with which survey respondents use Math instructional materials developed in collaboration with colleagues by participating district

	Never	Rarely	Occasionally	Often	Daily
Coffee		1 (14.3)	2 (28.6)	2 (28.6)	2 (28.6)
Fayetteville	1 (14.3)	1 (14.3)	2 (28.6)		3 (42.9)
Giles	1 (5.9)	2 (11.8)	5 (29.4)	4 (23.5)	5 (29.4)
Hamblen		5 (35.7)	3 (21.4)	1 (7.1)	5 (35.7)
Johnson		1 (6.7)	1 (6.7)	4 (26.7)	9 (60.0)
Knox	6 (5.7)	10 (9.4)	18 (17.0)	28 (26.4)	44 (41.5)
Meigs			1 (25.0)	3 (75.0)	
Total *(N)*	8	20	32	42	68

Table 22
Frequency with which survey respondents use "other" Math instructional materials by participating district

	Never	Rarely	Occasionally	Often	Daily
Coffee				5 (71.4)	2 (28.6)
Fayetteville		1 (14.3)		4 (57.1)	2 (28.6)
Giles	2 (11.8)	4 (23.5)	6 (35.3)	2 (11.8)	3 (17.6)
Hamblen		1 (7.1)	2 (14.3)	5 (35.7)	6 (42.9)
Johnson			4 (26.7)	4 (26.7)	7 (46.7)
Knox	8 (7.5)	8 (7.5)	21 (19.8)	32 (30.2)	37 (34.9)
Meigs		1 (25.0)	2 (50.0)		1 (25.0)
Total *(N)*	10	15	35	52	58

Table 23
Survey respondents' trusted sources for teacher-developed Math instructional materials

	n	Percent of Total
District and/or school curriculum specialists	40	10
Math instructional coach	71	17.8
ELL teachers or specialists	8	2.0
Special education teachers or specialists	42	10.5
Subject or grade level teachers from my district (not my school)	49	12.23
Subject or grade level teachers from my school	141	35.3
Teachers in my professional network outside my district or school	39	9.8
Other	6	1.5
No one	4	1.0
Total *(N)*	400	

Table 24
Extent to which survey respondents' own Math assessments are aligned to revised state Math standards

	Minimally		Somewhat		Moderately		Extensively	
	n	% of Total	*n*	% of Total	*n*	% of Total	*n*	% of Total
Coffee			1 (11.1)	14.3	1 (3.7)	14.3	5 (4.5)	71.4
Fayetteville			1 (11.1)	14.3	4 (14.8)	57.1	2 (1.8)	28.6
Giles			2 (22.2)	11.8	5 (18.5)	29.4	10 (8.9)	58.8
Hamblen	1 (16.7)	8.3	1 (11.1)	8.3	4 (14.8)	33.3	6 (5.4)	50.0
Johnson					4 (14.8)	26.67	11 (9.8)	73.33
Knox	5 (83.3)	4.9	4 (44.4)	3.9	18 (66.7)	17.5	76 (67.9)	73.8
Meigs					1 (3.7)	33.33	2 (1.8)	66.67
Total *(N)*	6		9		27		112	

Table 25

Extent to which common Math assessments exist in respondents' schools by participating district

	No common assessments		Yes, at certain grade levels		Yes, at all grade levels	
	n	% of Total	*n*	% of Total	*n*	% of Total
Coffee	3 (8.1)	42.86			4 (5.1)	57.14
Fayetteville	5 (13.5)	71.4	1 (1.9)	14.3	1 (1.3)	14.3
Giles	2 (5.4)	11.8	8 (14.8)	47.1	7 (9.0)	41.2
Hamblen	6 (16.2)	42.9	5 (9.3)	35.7	3 (3.8)	21.4
Johnson			7 (13.0)	46.67	8 (14.1)	53.33
Knox	20 (54.1)	19.0	32 (59.3)	30.5	53 (67.9)	50.1
Meigs	1 (2.7)	25.0	1 (1.9)	25.0	2 (2.6)	50.0
Total *(N)*	37		54		78	

Table 26

Types of common Math assessments in use in respondents' schools

	n	% of Total
District-mandated assessments	50	12.3
School-mandated assessments	36	8.8
Benchmark assessments	103	25.3
Unit assessments	78	19.1
Lesson assessments	66	16.2
Formative assessments	75	18.4
Total *(N)*	408	

Table 27

Extent to which survey respondents report common Math assessments are aligned to the revised state Math standards

	Yes		No		I don't know	
	n	% of Total	*n*	% of Total	*n*	% of Total
District-mandated assessments	41	82.0	4	8.0	5	10.0
School-mandated assessments	32	88.9	2	5.6	2	5.6
Benchmark assessments	74	72.6	14	13.7	14	13.7
Unit assessments	72	92.3	2	2.6	4	5.1
Lesson assessments	60	92.3	1	1.5	4	6.2
Formative assessments	66	89.2	1	1.4	7	9.5
Total *(N)*	345		24		36	

Table 28

Topics of 2017-18 district and school revised-Math-standards professional development by district

	TSBE Outcome 2: Increasing understanding of revised Math standards content		TSBE Outcome 3: Evaluating instructional materials for alignment to the revised Math standards		TSBE Outcome 4: Aligning assessments to the revised Math standards		TSBE Outcome 5: Identifying instructional shifts required by the revised Math standards		Other	
	District	School	District	School	District	School	District	School	District	School
Coffee County	4 (4.1)	1 (1.5)	3 (4.5)	1 (1.7)	4 (5.0)	2 (2.4)	3 (3.9)	2 (3.9)	2 (18.2)	3 (15.8)
Fayetteville City	2 (2.1)	2 (3.0)	1 (1.5)	3 (5.0)	1 (1.3)	2 (2.4)	1 (1.3)	1 (1.9)	2 (18.2)	2 (10.5)
Giles County	11 (11.3)	9 (13.4)	8 (11.9)	4 (6.7)	9 (11.3)	5 (8.5)	9 (11.7)	3 (5.9)		
Hamblen County	9 (9.3)	6 (9.0)	4 (6.0)	5 (8.3)	7 (8.8)	9 (11.0)	6 (7.8)	3 (5.9)	1 (9.1)	1 (5.2)
Johnson City	8 (8.2)	7 (10.4)	4 (6.0)	4 (6.7)	6 (7.5)	7 (8.5)	7 (9.1)	6 (11.8)		3 (15.8)
Knox County	60 (61.9)	39 (58.2)	46 (68.7)	41 (68.3)	52 (65.0)	54 (65.9)	51 (66.2)	36 (70.6)	6 (54.5)	10 (52.6)
Meigs County	3 (3.1)	3 (4.5)	1 (1.5)	2 (3.3)	1 (1.3)	3 (3.7)				
Total *(n)*	97	67	67	60	80	82	77	51	11	19

Table 29

Primary focus of revised-Math-standards professional development by district

	TSBE Outcome 2: Increasing understanding of revised Math standards content		TSBE Outcome 3: Evaluating instructional materials for alignment to the revised Math standards		TSBE Outcome 4: Aligning assessments to the revised Math standards		TSBE Outcome 5: Identifying instructional shifts required by the revised Math standards		Other	
	n	% of Total	*n*	% of Total	*n*	% of Total	*n*	% of Total	*n*	% of Total
Coffee County	2 (3.5)	28.6			4 (10.8)	57.1			1 (5.3)	
Fayetteville City	1 (1.8)	14.3	1 (3.7)	14.3	2 (5.4)	28.6			2 (10.5)	28.6
Giles County	6 (10.5)	37.5	2 (7.4)	12.5	5 (13.5)	31.3	2 (7.4)	12.5	1 (5.3)	6.2
Hamblen County	4 (7.0)	30.8	1 (3.7)	7.7	4 (10.8)	30.8	1 (3.7)	7.3	3 (15.8)	23.1
Johnson City	6 (10.5)	40.0	3 (11.1)	20.0	3 (8.1)	20.0	3 (11.1)	20.0		
Knox County	36 (63.2)	34.0	20 (74.1)	18.9	18 (48.6)	17.0	21 (77.8)	19.8	11 (57.9)	10.4
Meigs County	2 (5.13)	50.0			1 (4.0)	25.0			1 (9.09)	25.0
Total *(N)*	57		27		37		27		19	

Table 30

June 2017 TDOE Math teacher training attendees' likelihood of redelivering revised-Math-standards-implementation professional development

	n	% of Total
Very likely	389	38.1
Likely	276	27.0
Somewhat likely	164	16.0
A little likely	116	11.4
Not at all likely	77	7.5
Total *(N)*	1022	

Table 31

June 2017 TDOE Math teacher training attendees' self-reported level of preparedness to redeliver revised-Math-standards-implementation professional development

	n	% of Total
Very well	208	25.1
Quite well	444	53.6
Somewhat	156	18.8
A little	16	1.9
Not at all	5	0.6
Total *(N)*	829	