

Elementary Mathematics Specialists in Illinois

A Landscape Study of Statewide Interest and Need



Acknowledgements

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Steering Committee members of the Elementary Mathematics Specialist Working Group from the Department of STEM at Chicago Public Schools, the University of Chicago, DePaul University, and the University of Illinois at Chicago (UIC) reviewed the study results and offered feedback for this report. Specifically, we appreciate the contributions of Kathleen Pitvorec, Research Assistant Professor at UIC; Mary Jo Tavormina, Project Director of the Metro Chicago Math Initiative at UIC; Alison Whittington, Associate Director of School Support Services at UChicago STEM Education; and Carolyn Narasimhan, Professor Emeritus, Department of Mathematics at DePaul University, in developing and administering the EMS Pilot Program teacher cohort survey. The EMS district and school surveys were strengthened by feedback provided by Mark Klaisner; Lori Connolly, Director of Teaching and Learning at Alsip School District 126; and Steering Committee members. Finally, we extend special thanks to Mary Jo Tavormina and Alison Whittington, who provided significant written feedback on the report.

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Elementary
Mathematics
Specialists
IN ILLINOIS

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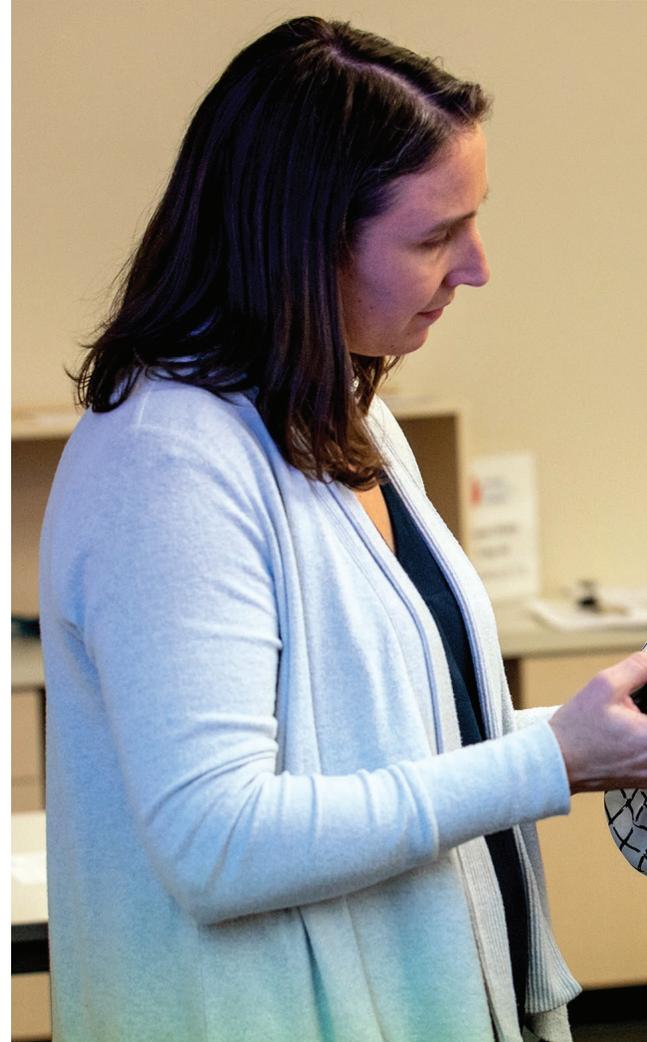
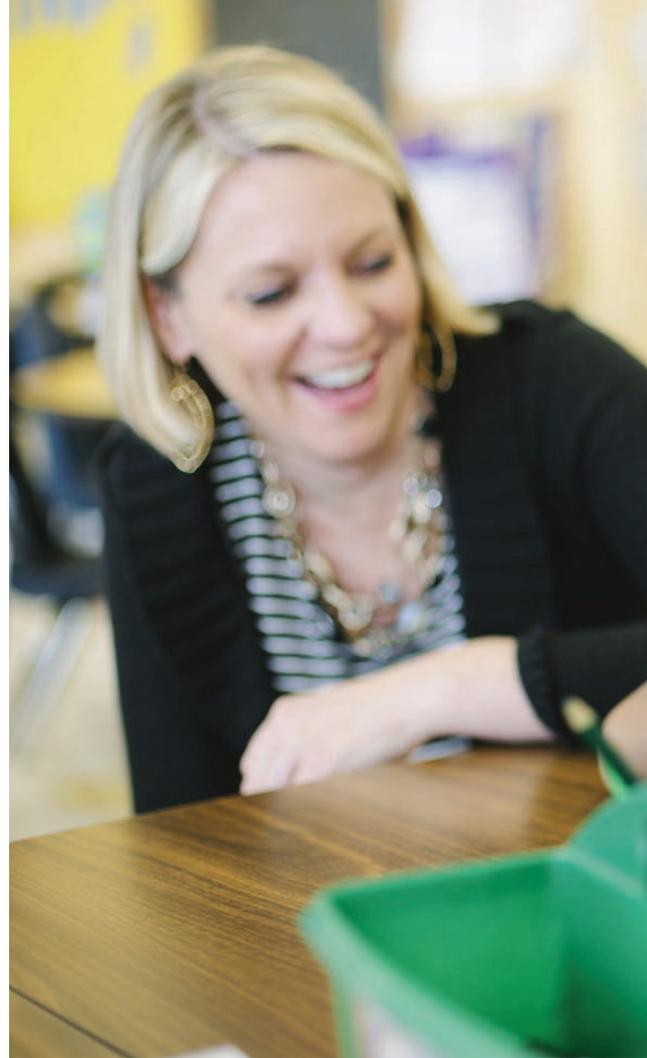
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Executive Summary

Districts and Educator Leaders Support the Elementary Mathematics Teacher (EMT) and Elementary Mathematics Specialist (EMS) Endorsements in Illinois

In November 2018, a broad group of stakeholders submitted proposals to the Illinois State Board of Education (ISBE) to establish two new teaching credentials for elementary school teachers who specialize in the teaching of mathematics. These new credentials are intended for teachers who already hold a Professional Educator License and are not intended to add new requirements for hiring. Rather, they are intended to provide pathways to help elementary teachers deepen their knowledge of mathematics teaching and learning, and for districts and schools to strengthen their mathematics leadership.

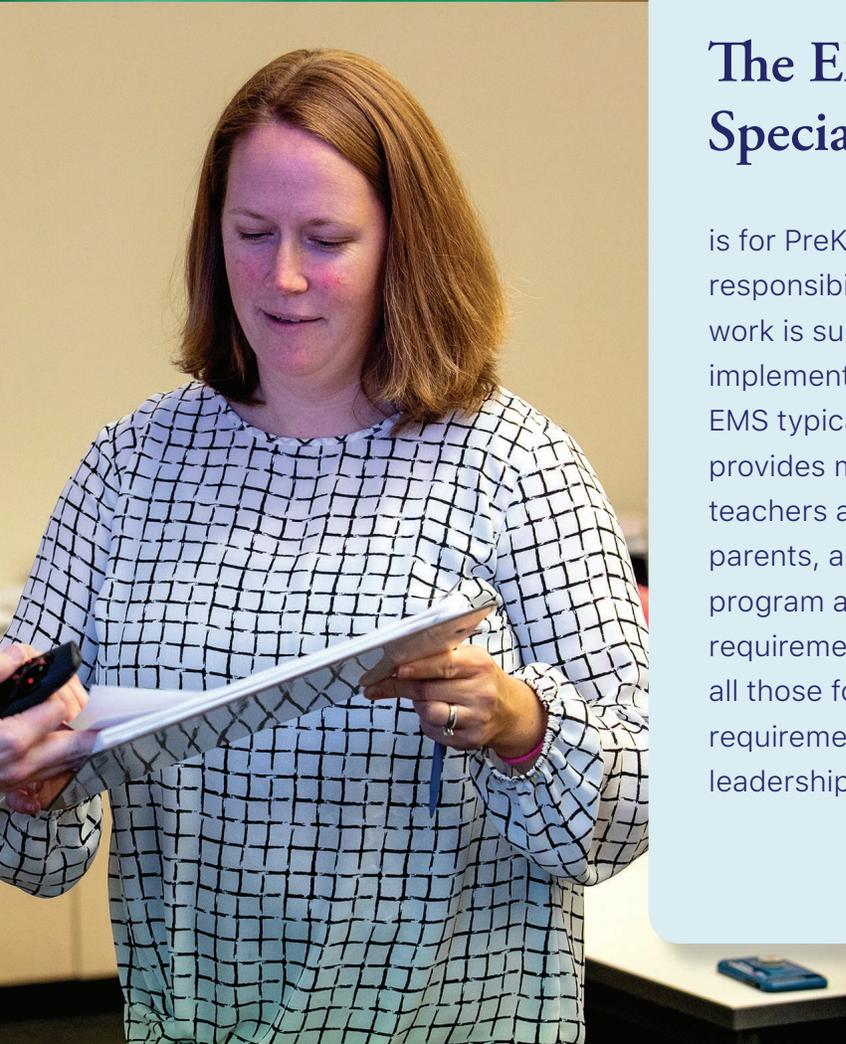
The two proposed teaching endorsements would create teacher development pathways similar to those that already exist for reading teachers and reading specialists, and they are modeled on the existing Reading Teacher and Reading Specialist endorsements (EMS Steering Committee, 2018).





The Elementary Mathematics Teacher (EMT) Endorsement

is for PreK–6 teachers whose primary responsibility is to work directly with students, either in a regular classroom setting, where the EMT is the principal mathematics teacher for groups of students, or in an intervention or support setting, where the EMT provides instruction for designated students. The EMT can also support school and district leadership with mathematics program development and home connections.



The Elementary Mathematics Specialist (EMS) Endorsement

is for PreK–6 teachers who may have some responsibilities working with students but whose major work is supporting teachers and administrators as they implement their school's mathematics program. The EMS typically coaches other teachers, designs and provides mathematics professional development for teachers and administrators, develops programs for parents, and provides leadership for the mathematics program at the school or district level. Proposed requirements for the EMS endorsement include all those for the EMT endorsement and additional requirements related to mathematics content, leadership, and working with adults.

Teacher educators from 14 Illinois universities and colleges, personnel from two ISBE Intermediate Service Centers, leaders from school districts across the state, and mathematics education leaders provided input into the development of these two proposals.



Following their review of the proposals, ISBE staff requested additional information, including a request for a "landscape scan" of Illinois school districts and higher education institutions, to further document the need for and interest in the proposed credentials.

The landscape scan was conducted during Spring and Summer 2019. The study utilized a mixed-methods approach:

153
DISTRICTS

153 districts in 44 counties completed the district survey, including small, medium, and large districts from all areas of the state. These districts educate 40% of Illinois' students.

51%
of the respondents
were superintendents.

110
SCHOOLS

A total of 110 schools across the state (5% of Illinois schools) responded to the school survey. Eighty-six percent of the respondents were principals. Thus, the school survey provides insights into the beliefs of principals.

86%
of the respondents
were principals.

A survey of teacher participants in a pilot EMS program at three universities, DePaul University, University of Illinois at Chicago, and the University of Chicago was conducted. Seventy-four percent of the first cohort completed the survey.

Semi-structured interviews were conducted with EMS leaders in California, Maryland, Oregon, and Pennsylvania, states that have existing credentials similar to those proposed in Illinois.

Semi-structured interviews with key Illinois stakeholders included Illinois educator organizations (the Illinois Federation of Teachers, the Illinois Principals Association, the Illinois Education Association, and the Illinois Council of Teachers of Mathematics); Regional Offices of Education (five offices); and Illinois universities (four universities).

Considerable support exists for the creation of the EMS and EMT endorsements from districts, schools, education leaders, Regional Offices of Education leaders, and university faculty.



DISTRICT SURVEY

- School districts overwhelmingly indicated that Illinois should offer both the EMS and EMT endorsements. Eighty-six percent of respondents indicated that Illinois should offer the EMS endorsement; 85% indicated support for the EMT endorsement. The positive response was prevalent across all regions of the state and in districts of all sizes.
- Over 80% of districts agreed or strongly agreed that they would encourage educators to take courses toward the elementary mathematics endorsements; 90% would encourage math/instructional coaches to take courses toward the EMS endorsement.
- Over 95% of individuals responsible for curriculum and instruction in general, and mathematics in particular, want Illinois to offer the EMS and EMT endorsements.
- Over 70% of districts offer tuition support for teachers to enroll in university courses.
- While support for the new endorsements was strong, some stakeholders who were interviewed and some district leaders who responded to an open-ended question in the survey expressed concerns and indicated that their support was contingent on the endorsements not being a requirement for hiring and placement.



SCHOOL SURVEY

- In response to the school survey, 90% of school survey respondents indicated the state should offer the EMT and EMS endorsements.
- Ninety percent agreed or strongly agreed that they would encourage teachers to take courses toward the EMT endorsement; over 80% would encourage teachers to take courses toward the EMS endorsement.



INTERVIEWS WITH KEY ILLINOIS STAKEHOLDERS

To understand Illinois stakeholders' thoughts about the proposed elementary mathematics endorsements, interviews were conducted with representatives from three groups: Illinois educator organizations, Region Offices of Education, and Illinois universities.

- There was broad support for the proposed endorsements across all groups.
- Nearly all felt that the proposed endorsements address a need in Illinois districts and schools, and that the endorsements have the potential to improve mathematics teaching and learning.
- All recognized the value and importance of teachers deepening their knowledge base in mathematics and teaching mathematics.
- The Illinois stakeholders also acknowledged the value of coaching.
- About half of the leaders from Illinois educator organizations and Regional Offices of Education cautioned that these must not be required for hiring.
- Some stakeholders expressed concerns about the cost of coursework for teachers and mathematics coaches for districts.
- Leaders from Regional Offices of Education felt that districts in their respective areas would value the proposed endorsements and they would encourage and support teachers to complete them.
- There was interest among universities to establish programs that align with the proposed endorsements.



EMS COHORT SURVEY

Teams from DePaul University, the University of Chicago, and the University of Illinois at Chicago (UIC) worked together to develop a pilot two-year course sequence focused on strengthening the mathematics, pedagogical content knowledge, and leadership skills of teachers in elementary schools. The teachers in the first cohort were Chicago Public School (CPS) teachers and the majority, 62% of them, had been teaching for less than 15 years.

- Many teachers who participated in the prototype programs saw a shift in their teaching assignments from self-contained classrooms to more departmentalized settings, where they taught more than one class of mathematics.
- Teachers who participated in the prototype programs expressed more confidence about their knowledge and ability to teach mathematics effectively.
- Teachers who participated in the prototype programs were far more likely than before to engage in mathematics leadership activities within their buildings and more likely to engage in collaborative mathematics activities with colleagues, such as jointly examining and analyzing student work or participating in peer observations of mathematics classes.



INTERVIEWS WITH LEADERS IN OTHER STATES

Twenty states have already established certification endorsements or similar credentials for specialized elementary mathematics teachers, with eight additional states, including Illinois, considering adding such credentials. The landscape study included interviews with leaders from four of the states (California, Maryland, Oregon, and Pennsylvania) that have current elementary mathematics certification credentials. The leaders were higher education faculty and state leaders who were involved in the establishment of elementary mathematics specialist credentials in their respective states.

- While each of the states adopted slightly different approaches, each state developed their certification credentials with the goal of improving mathematics teaching and strengthening mathematics leadership.
- A limited number of universities in each of the states has developed programs that fulfill the requirements of the credentials.
- Grant subsidies, including grant-supported cohort programs, have been helpful in increasing the number of teachers who earn the credentials.
- Teachers who earned the credentials often assumed mathematics leadership roles in their schools and districts.



COACHING AND CONTENT SPECIALIZATION

The district survey included questions on coaching and specialization or departmentalization of mathematics teaching in Grades 1—5. Coaching is provided in districts across the state.

- District leaders believe that coaching support and increasing knowledge about teaching mathematics would contribute significantly to improving mathematics instruction. School leaders concur.
- Almost 40% of the responding districts offer coaching to teachers in mathematics, though coaching differences exist across regions, with the Northeast and East Central regions of the state offering the most coaching.
- Forty percent of districts are organized so that Grade 5 is specialized or departmentalized, with another 17% indicating interest in doing so. Specialization and departmentalization are less common in lower grades, with 21% of districts having specialized or departmentalized mathematics instruction in Grade 4 and 7% of districts in Grade 3. An additional 13–17% of districts expressed interest in specialization or departmentalization in those grades.



Introduction

In November 2018, in conjunction with stakeholders, personnel from the University of Chicago, DePaul University, the University of Illinois at Chicago (UIC), and the Chicago Public Schools submitted proposals to the Illinois State Board of Education (ISBE) to establish two new elementary mathematics teaching endorsements: an Elementary Mathematics Teacher (EMT) endorsement and an Elementary Mathematics Specialist (EMS) endorsement.

Following their review of the proposals, ISBE staff requested additional information related to the proposed new teaching credentials. This included a request for a “landscape scan” of Illinois school districts and higher education institutions to further document the need for and interest in the proposed credentials.

The landscape study included surveys of Illinois school districts and schools and interviews with key Illinois stakeholders and education leaders in other states with elementary mathematics specialist credentials. The online surveys to districts and schools captured information about mathematics teaching and learning in Illinois, whether districts and schools hire educators to serve in mathematics coach positions at a school and/or district level, and whether they are interested in and/or see the need for elementary mathematics specialist endorsements as a way to improve mathematics teaching and learning.

Interviews with key stakeholders included leaders from Illinois Regional Offices of Education, Illinois university faculty, and leaders of key education organizations in Illinois. Education leaders in other states that have implemented elementary mathematics specialist credentials were also interviewed.

This report summarizes the landscape study.





People are always asking me, like, “How do I become a math coach?” Or, “What do I need to do that?” [Coaching] looks so different in every district, it’s sort of hard to make sure that people are doing best practice if they’re sort of making it up or reinventing the wheel every place you go.

(Educator)

EMS Background and Research

EMS BACKGROUND

In elementary schools, mathematics is typically taught in self-contained classrooms by teachers who have limited mathematical content knowledge and mathematical knowledge for teaching (Hill et al., 2008; CBMS, 2012; Hill & Ball, 2004; Banilower et al., 2018). However, mathematics teaching at the elementary level requires specialized content knowledge (CBMS, 2012; Ball, Thames, & Phelps, 2008; Ball, Hill, & Bass, 2005).

In response to the need for specialized expertise for teaching elementary mathematics, major mathematics professional organizations encourage the use of elementary mathematics specialists. The call for specialists began in 1984 with the National Council of Teachers of Mathematics (NCTM) recommending state certification endorsements for elementary mathematics specialists (Fennell, 2017). In 2006, Fennell, then President of NCTM, stated,

A mathematics specialist is needed because the preservice background and general teaching responsibilities of elementary teachers do not typically furnish the continuous development of specialized knowledge required for teaching mathematics today. (Fennell, November 2006)

For the past 40 years, mathematics education leaders and professional organizations have recommended the use of mathematics specialists (Fennell, 2006; NMAP, 2008; Lott, 2003; NCTM, 2000; NRC, 1989; NRC, 2001). In 2008, the National Mathematics Advisory Panel called for the development of elementary mathematics specialists to help improve mathematics teaching and learning, noting the important role of EMS professionals in working with students:

The use of teachers who have specialized in elementary mathematics teaching could be a practical alternative to increasing all elementary teachers' content knowledge (a problem of huge scale) by focusing the need for expertise on fewer teachers. (NMAP, 2008, p. xxii)

In 2009, the Association of Mathematics Teacher Educators (AMTE) released Standards for Elementary Mathematics Specialists. In 2010, four professional organizations—AMTE, NCTM, the Association of State Supervisors of Mathematics (ASSM), and the National Council of Supervisors of Mathematics (NCSM)—developed a joint statement in support of the use of elementary mathematics specialists.



The AMTE, ASSM, NCSM, and NCTM recommend the use of Elementary Mathematics Specialists (EMS professionals) in pre-K–6 environments to enhance the teaching, learning, and assessing of mathematics to improve student achievement. We further advocate that every elementary school have access to an EMS. Districts, states or provinces, and institutions of higher education should work in collaboration to create (1) advanced certification for EMS professionals and (2) rigorous programs to prepare EMS professionals. EMS professionals need a deep and broad knowledge of mathematics content, expertise in using and helping others use effective instructional practices, and the ability to support efforts that help all pre-K–6 students learn important mathematics. Programs for EMS professionals should focus on mathematics content knowledge, pedagogical knowledge, and leadership knowledge and skills. (NCTM, 2010)

Since then, 20 states have developed these credentials to improve mathematics teaching and learning.

Across the country, elementary mathematics specialists play different roles in districts and schools, including the roles of specialized classroom teacher, elementary mathematics coach, elementary mathematics instructional leader, mathematics support teacher, mentor teacher, mathematics resource teacher, and lead teacher. In addition to classroom instruction, responsibilities of these individuals can include mentoring or coaching other teachers, developing and providing professional development, assisting with curriculum and instruction planning and decision making, coordinating and implementing intervention strategies, and supporting professional learning communities. Of the over 7,900 elementary schools responding to the 2016 biannual NAEP survey, 38% of them had a full- or part-time EMS (Fennell, 2017).

EMS RESEARCH

The research on elementary mathematics specialists serving as mathematics teachers is limited (McGatha, Davis, & Stokes-Levine, 2017; Markworth, 2017). Some researchers find that elementary mathematics specialists serving as mathematics teachers have more time to effectively plan their lessons and can focus their professional learning (Gerretson, Bosnick, & Schoefield, 2008; Markworth, 2017). Markworth (2017) found that teachers who taught in departmentalized settings believed they were better able to support student learning and felt their schedules were less flexible than those of self-contained classrooms. Mathematics teachers often felt isolated, as they were sometimes the only mathematics teacher in the building. In terms of student achievement, results are mixed. One study found no significant differences in student achievement gains between students in self-contained and departmentalized classes (McGrath & Rust, 2002), while another study revealed significant gains in student achievement for students taught by teachers who had completed elementary mathematics specialist coursework (Lewis et al., 2017).

In a recent program evaluation of the East Metro Mathematics Leadership Project (EaMML), teachers demonstrated increased pedagogical content knowledge and mathematical knowledge for teaching, with increases greater for K–5 teachers than for 6–12 teachers, as a result of taking credential coursework (Lewis et al., 2017). Moreover, this three-year evaluation of developing elementary mathematics specialists in Oregon revealed that “students whose teacher participated in the EaMML project demonstrated significantly **greater level of improvement in math achievement over time** than comparison students” (p. 15) on the Smarter Balanced Assessment Consortium (SBAC) test and this effect was consistent across student subgroups (gender, race, ethnicity, and socioeconomic status). Furthermore, in focus groups, teachers indicated that the courses were one of two most critical activities that allowed them to

improve their content knowledge and instructional practice and increase their students' understanding of math. Elementary teachers also showed growth in leadership skills.

More research has been conducted on elementary mathematics specialists serving as mathematics coaches. Studies have documented the positive impact of elementary mathematics specialists who serve in coaching positions on teacher practice (McGatha, 2008; Polly 2012; Balfanz, Maclver, & Byrnes, 2006; Krupa & Confrey, 2010; Rudd et al., 2009). Polly (2012) noted that coaching increased teachers' use of high-quality mathematics tasks and higher-order-thinking questioning. In a study of professional development on a new mathematics curriculum and nine specific instructional practices, 71% of teachers who were coached utilized five or more of the nine instructional practices, compared to 51% of teachers who were not coached (Balfanz, Maclver, & Byrnes, 2006). Another study of high school teachers implementing a new curriculum over a three-year period also saw coached teachers using classroom time more effectively, delivering content more accurately, and more frequently recognizing students' misunderstandings (Krupa & Confrey, 2010). While coaches can impact teachers' practice, Campbell and Griffin (2017) noted that "coaches need to engage teachers in fundamental dialogue about mathematical content, mathematical learning, and student understanding" (p. 163), not simply provide materials or fulfill administrative needs.

Research studies have also documented the impact of coaches on improved student outcomes, including student achievement (Campbell & Malkus, 2010; Conaim, 2010; Zollinger, Brosnan, Erchick, & Bao, 2010; Balfanz, Maclver, & Byrnes, 2006; Brosnan & Erchick, 2010). In Ohio, the Mathematics Coaching Program (MCP) placed coaches in low-performing schools. A study comparing a large sample of MCP schools and non-MCP schools found coaching to have a sizeable and statistically significant impact

on student performance on the Ohio Achievement Test (Brosnan & Erchick, 2010). A randomized control study of mathematics coaches found that schools with a mathematics coach had, on average, statistically significant higher student achievement scores than control schools. However, improvements in student achievement took time. No difference was seen in students' mathematics achievement between the treatment and control schools in the first year of coaching (Campbell & Malkus, 2010). "Campbell and Malkus reiterated the importance of adequate preparation for coaches so they possess the knowledge necessary to be effective coaches" (McGatha et al., 2017).



Existing Endorsements in Illinois

Except for reading teachers, reading specialists, library information specialists, and teachers in ESL, bilingual education, and special education, teachers teaching in a specialized or departmentalized role in Grades K–5 only need to hold the general Professional Educator License (PEL) with an endorsement in the grade they will teach and have completed one course in the subject they will teach. Teachers licensed before September 1, 1978 only need the PEL endorsed for elementary education (ISBE, 2019).

The state of Illinois does not currently have specific requirements for individuals who are responsible for coaching teachers. A teacher leader endorsement exists. The possible roles individuals with a teacher leader endorsement might fill include curriculum specialist, coach, department chair, mentor teacher, or content specialist. The requirements for the endorsement contain topics such as knowledge of leadership frameworks and assessments; ability to lead teams in setting and accomplishing goals; ability to coach teachers, including observing instruction; providing coaching or offering professional development feedback to teachers; and understanding diverse learners (ISBE, 2015). However, many of these topics require depth of content knowledge and pedagogical content knowledge specific to the subject matter at hand in order to provide effective coaching support, and additional content knowledge is not required for the leadership endorsement.





The Reading Specialist K–12 endorsement requires additional knowledge of literacy and provides a path to supporting teachers (ISBE, 2018b). It should be noted that all 50 states have reading specialist endorsements.

Illinois also has a Reading Teacher Pre-K–12 (24 credit hours) endorsement. In mathematics, only a middle school mathematics endorsement (requiring passing the applicable content area test after completion of 21 semester hours of content-specific coursework and three semester hours of content-specific methodology coursework focused on the middle grades) is available (ISBE, 2018b).

Illinois does not have endorsements in elementary mathematics. Twenty states have established certification endorsements or similar credentials for specialized elementary mathematics teachers, with eight additional states, including Illinois, currently considering adding such certification endorsements (Elementary Mathematics Specialists & Teacher Leaders Project, 2019).

Increasingly, schools and districts are using mathematics coaches and other math-specialist models to improve mathematics teaching and learning.

Proposed Endorsements

Teams from DePaul University, the University of Chicago, and the University of Illinois at Chicago (UIC), in collaboration with numerous public school districts (including CPS) and parochial schools, have extensive experience with mathematics professional development for Pre-K–12 teachers. They have an understanding of the needed supports in elementary mathematics teaching and the current lack of credentials for elementary teachers interested in specializing in mathematics or coaching teachers in mathematics in Illinois. This understanding, as well as the long-standing national call for elementary mathematics specialists, led them to collaboratively develop a prototype elementary mathematics specialist

preparation program, a two-year course sequence focused on strengthening the mathematics content, pedagogical content, and leadership knowledge and skills of current elementary teachers. This prototype course sequence has been offered at all three institutions since 2017.

In 2018, personnel from this group engaged educators throughout Illinois in the development of proposals to the Illinois State Board of Education (ISBE) to establish two new teaching credentials for elementary school teachers who specialize in the teaching of mathematics (EMS Steering Committee, 2018).



The Elementary Mathematics Teacher (EMT) endorsement

is for Pre-K–6 teachers whose primary responsibility is to work directly with students, either in a regular classroom setting, where the EMT is the principal mathematics teacher for groups of students, or in an intervention or support setting, where the EMT provides instruction for designated students. The EMT can also support school and district leadership with mathematics program development and home connections.

These two new endorsements are intended for teachers who already hold a Professional Educator License and are not intended to add new requirements for hiring. Rather, they are intended to provide pathways to help elementary teachers deepen their knowledge of mathematics teaching and learning, and for districts and schools to strengthen their mathematics leadership.

Teacher educators from 14 Illinois universities and colleges, personnel from two ISBE Intermediate Service Centers (ISCs), leaders from school districts across the state, and mathematics education leaders

provided input into the development of the two proposals, which were submitted to ISBE in November 2018.

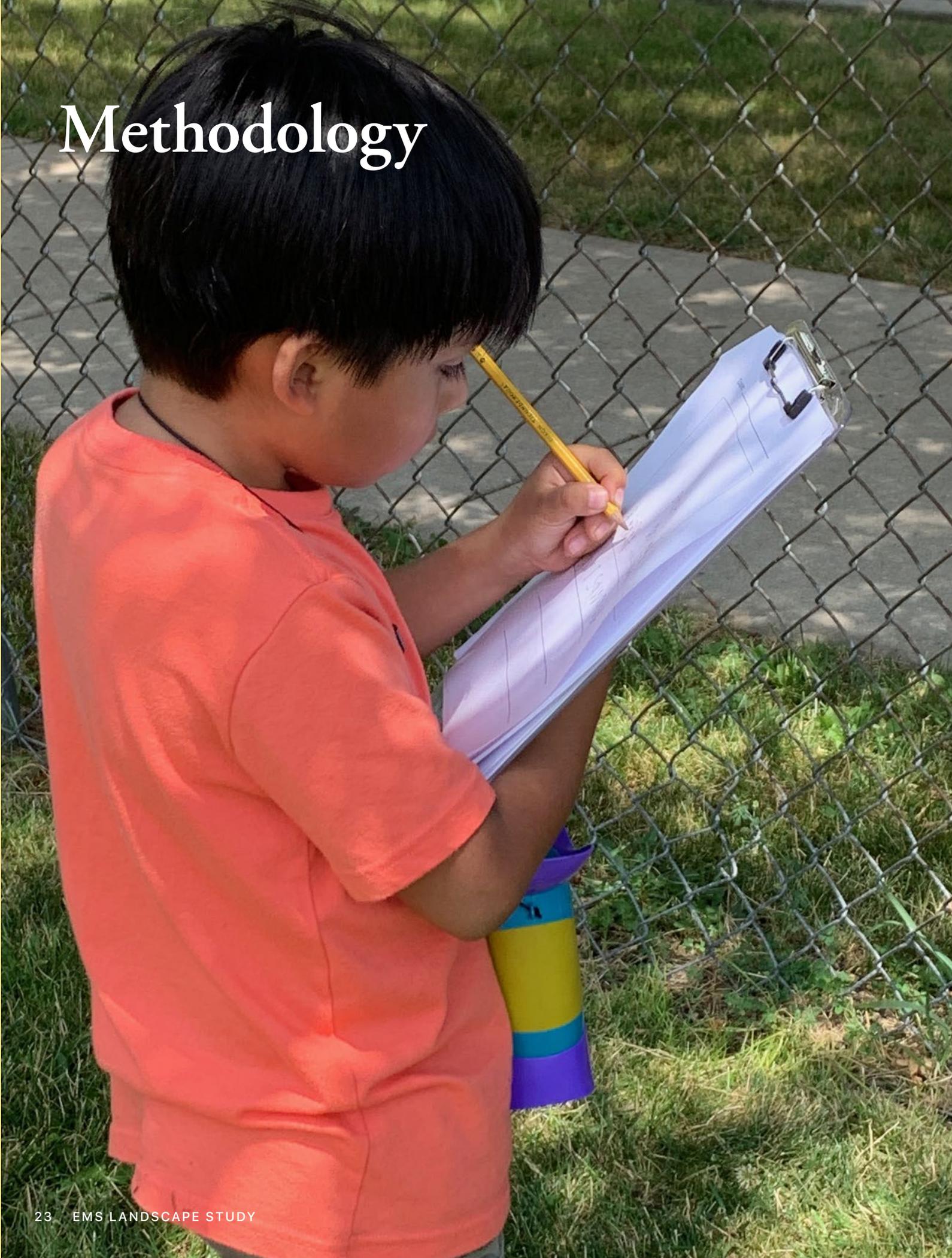
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The Elementary Mathematics Specialist (EMS) endorsement

is for Pre-K–6 teachers who may have some responsibilities working with students but whose major work is supporting teachers and administrators as they implement their school’s mathematics program. The EMS typically coaches other teachers, designs and provides mathematics professional development for teachers and administrators, develops programs for parents, and provides leadership for the mathematics program at the school or district level. Proposed requirements for the EMS endorsement include all those for the EMT endorsement along with additional requirements related to mathematics content, leadership, and working with adult learners.

Methodology



The purpose of the EMS landscape study was to understand the need for and interest in the Elementary Mathematics Teacher and Elementary Mathematics Specialists endorsements. The study utilized a mixed-methods approach, with the development of three surveys and interviews of key stakeholders and experts.

QUANTITATIVE DATA

Existing mathematics surveys, such as the National Survey of Science and Mathematics Education, were reviewed and some questions were adapted from these surveys to create the EMS district survey for elementary and unit districts. New items were created as well.

University and ISC partners reviewed draft versions of the surveys and provided feedback. Once the EMS district survey was developed, a draft online version was submitted to a district mathematics director to complete and provide feedback on the items and length of the survey. Questions that might have been problematic were removed or rephrased.

The school-level survey included a majority of the EMS district survey questions, with some additional or revised questions to better fit the school administration.

A short survey was also developed for teachers finishing the pilot, two-year EMS programs at DePaul, UIC, and the University of Chicago. The focus of this survey was to understand if and how teachers' roles had changed since beginning the program as well as their attitudes about different aspects related to mathematics teaching and leadership.

Mark Klaisner, Executive Director of the West 40 Intermediate Service Center, and Vanessa Kinder,

Executive Director of the South Cook Intermediate Service Center, provided crucial guidance and support for the administration of the EMS district and school surveys. Dr. Klaisner provided information about the landscape study and survey administration to his peers in all the Regional Offices of Education (ROEs) across Illinois. The ROEs were asked to distribute the Survey Monkey link to all districts and schools in each region.



EMS District Survey

This district survey was administered from May 12 through May 31, resulting in 173 responses. Only one response from each district was included in the data set. Only responses from elementary and unit districts were included in the final file. Thus, a total of 153 districts were included in the analyzed data set, representing 20% of elementary and unit



153 districts
were included in the data set

school districts in Illinois. Each district’s unique identifier, the RCTD code, was attached to each record, and additional data from the state report card file and other publicly available data was included in the final data set. All responses to the quantitative survey items were analyzed. Percentages were calculated based on the number of respondents. In some cases, these summed to more than 100%, as respondents could select more than one answer. Descriptive statistics are reported and chi-squared tests of independence were run to compare results of different groups. The relation between groups was significant when $p < 0.05$. Results are described in the report when noteworthy.

Analysis began in Summer 2019 and at that time only the 2018 Illinois report card data file was available. Thus, district level characteristics come from the 2018 data file. In 2018, Illinois was comprised of 759 elementary and unit districts. Twenty percent of these districts responded to the survey. Responses were received from all district types, sizes, and regions. Response rates for the EMS District Survey are noted in Table 2. The responding districts educate over 700,000, or 40%, of Illinois students in elementary and unit districts, though unit and small districts were somewhat underrepresented in the EMS District Survey data set when compared to the state, as seen in Table 3. Geographically, the respondents represented all regions of the state, with the Northwest and West Central regions somewhat underrepresented.



the responding districts educate
40% of students
in Illinois

Table 1: Response Rates for EMS District Survey

	<i>n</i>	<i>N</i>	Response Rate
OVERALL	153	759	20.2%
DISTRICT TYPE			
Elementary	84	371	22.6%
Unit	69	388	17.8%
DISTRICT SIZE			
Large	56	190	29.5%
Medium	77	380	20.3%
Small	20	189	10.6%
REGION			
Northeast	71	256	27.7%
Northwest	13	108	12.0%
East Central	18	102	17.6%
West Central	14	102	13.7%
Southeast	25	112	22.3%
Southwest	12	79	15.2%

Table 2: Distribution of Districts

	Percent of Districts Completing the EMS Survey	Percent of All Districts
DISTRICT TYPE		
Elementary	54.9%	48.9%
Unit	45.1%	51.1%
DISTRICT SIZE		
Large	36.6%	25.0%
Medium	50.3%	50.1%
Small	13.1%	24.9%
REGION		
Northeast	46.4%	33.7%
Northwest	8.5%	14.2%
East Central	11.8%	13.4%
West Central	9.2%	13.4%
Southeast	16.3%	14.8%
Southwest	7.8%	10.4%

Note: This table includes: *n* (the number of responses), *N* (the total number of districts), and the response rate (the percentage of districts responding). Only elementary and unit districts are included in these tables.

EMS School Survey

The school survey was administered from June 1 through June 21, resulting in 130 responses. Twenty records were deleted from the final data set, because either the school did not serve students in Grades 1—5 or multiple staff

86%

of the respondents were

**SCHOOL
PRINCIPALS**

members completed the survey (only one response was included per school). Thus, a total of 110 records were included in the analyzed data set, representing 5% of elementary schools in Illinois with Grades 1—5. While this is a smaller response rate than was received from the EMS District Survey, the intent of the school survey was to give principals a voice in the landscape study. Eighty-six percent of the respondents were school principals,

providing insight into the perspectives of Illinois principals about the proposed endorsements. The school survey responses turned out to be very similar to the district responses, thus only a few key items are discussed in the report.

Teachers in the EMS Pilot Program

In constructing the survey for teachers who completed the EMS Pilot Program at DePaul, UIC, and the University of Chicago, existing surveys developed by two of the three universities and the National Survey of Science and Mathematics Education survey were reviewed. Some questions were adapted from these surveys and new items were developed to create the EMS Teacher Cohort Survey. University partners provided feedback and the survey was revised twice with additional feedback. This survey was administered in class in Spring 2019 or provided electronically to teachers. Of the 35 teachers in the courses, the survey was completed by 26 teachers, resulting in a 74% response rate.

74%

RESPONSE RATE

from teachers in
EMS Pilot

QUALITATIVE DATA

To understand Illinois stakeholders' thoughts about the proposed elementary mathematics specialists endorsements, interviews were conducted with representatives from three groups: Illinois educator organizations (Illinois Federation of Teachers, the Illinois Principals Association, the Illinois Education Association, and the Illinois Council of Teachers of Mathematics); Regional Offices of Education (five offices); and Illinois universities (four universities). Again, Mark Klaisner provided substantial assistance by introducing the researcher and the landscape study to Illinois educator leaders and ROE leaders.

Five leaders in Regional Offices of Education (ROEs), serving districts in West Central, Southeast, and Northeast Illinois, were interviewed. The ROEs interviewed serve a diverse group of districts, including highly urban districts and rural districts, and districts serving less than 100 students as well as those serving 15,000 students or more. All leaders have over 15 years of experience as educators and have taught in and/or led elementary schools.

In addition, five leaders from four states with EMS credentials were interviewed to understand how these states enacted and use these credentials as well as what implications their experiences may hold for Illinois. In total, 18 leaders were interviewed using semi-structured interview protocols with some common questions and some questions specific to each group.

Thematic categories were developed after reading the interviews. Verbatim responses are noted in relevant parts of the report, although spelling and grammar errors were corrected to ensure clarity of content.

Illinois stakeholder results are included in relevant sections of the report and interview notes from the other states' leaders were used to create a short description of efforts in each of the four states.

For surveys and interview protocols as well as additional results for the EMS School Survey and all survey comments, please visit <http://emsforil.uchicago.edu/#report>



Landscape Study Results

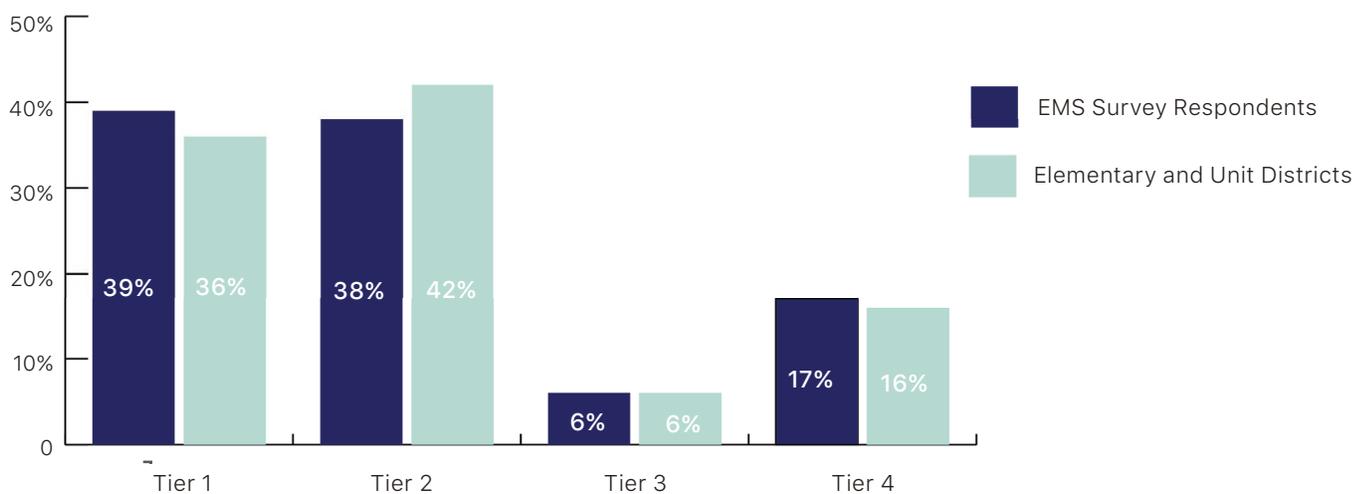
Districts in 44 counties completed the EMS District Survey, with the largest percentage, 46%, in Cook County. As mentioned earlier, these districts educate 40% of students in elementary and unit school districts.

In 2018, Illinois developed a new formula for funding schools, the Evidence-Based Funding (EBF) formula. EBF identifies how far away each district is from having the resources it needs to provide an effective education to the students it serves, known as adequacy targets. Resources include those needed for children who require special education services, are English language learners, or who come from low-income backgrounds. Districts that were furthest from their adequacy targets were identified as Tier 1 districts by the state and those that fell above their adequacy targets were identified as

Tier 4 districts. In 2018, the state has continued to provide the same amount of funding to each school district as in FY2017. However, it has committed to providing additional funding, about \$350 million dollars per year, and provides this additional funding to districts that are farthest from their adequacy targets. Thus, the tier indicator currently serves as an indicator of wealth and is used in examining key district decisions such as whether coaching is provided to teachers, as well as support for enacting elementary mathematics endorsements.

As seen in Figure 1, 77% of districts that responded to the EMS District Survey are Tier 1 and Tier 2 districts. This is comparable to the distribution of all elementary and unit districts in the state.

FIGURE 1 | Tiers of Districts

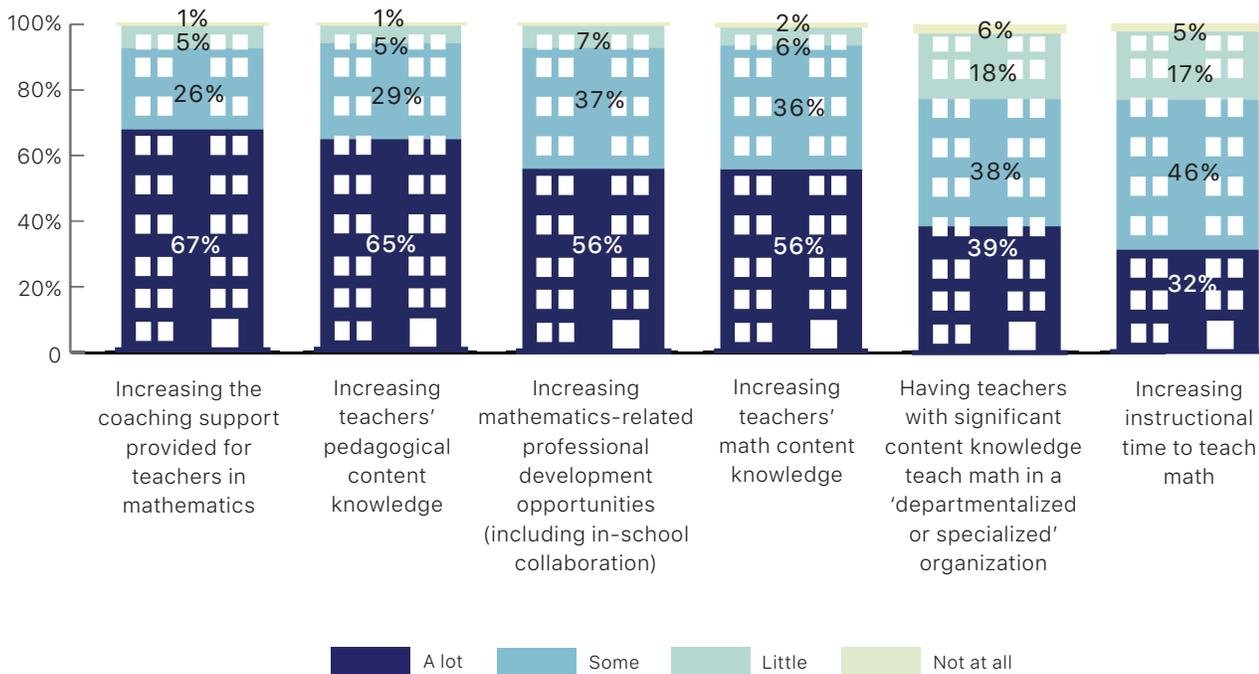


Note: The tier designation is missing for six elementary and unit districts.

The EMS District Survey was most often completed by superintendents (51%), followed by directors of curriculum and instruction (17%) and assistant superintendents of curriculum and instruction (14%). Forty-four percent of EMS District Survey respondents have worked in their district for more than 10 years. The EMS School Survey was most often completed by principals (44%). Fifty-five percent of respondents to the EMS School Survey have worked in their district for more than 10 years. Throughout this section of this report, all references are to districts or schools that responded to the survey.

District leaders were asked to what extent a series of strategies would contribute to improving mathematics instruction in their districts. About 65% responded that increasing coaching support for teachers in mathematics and increasing teachers' pedagogical content knowledge would contribute significantly to improving mathematics instruction.

FIGURE 2 | How Districts Envision Improving Mathematics Instruction



n = 153, missing = 0; n = 152, missing = 1 for increasing coaching support and instructional time

Question stem: To what extent would each of the following contribute to improving mathematics instruction in your district?

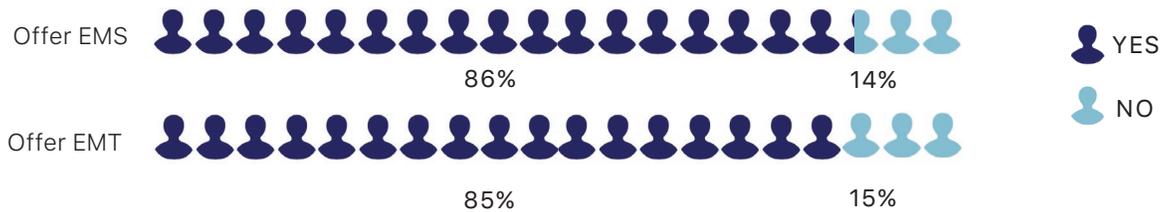
Elementary Mathematics Endorsements



EMS DISTRICT SURVEY

Given how district leaders envision effective strategies for improving mathematics instruction, it is not surprising that district leaders support the creation of the two elementary mathematics endorsements. Eighty-six percent and 85% percent of district respondents indicated that Illinois should offer the EMS and the EMT endorsements, respectively (Figure 3).

FIGURE 3 | Overwhelming Majority of District Leaders Indicated Illinois Should Offer Both Endorsements



n = 150, missing = 3, on each question

Analyses were run to understand if there are differences in agreement with the creation of the EMS endorsement by key indicators. Similar analyses were run for both the EMT and EMS endorsements. Results related to the proposed EMS endorsement are shown first, followed by results related to the proposed EMT endorsement.

As the following figures reveal, though support for the proposed endorsements was widespread across all indicators, there were some differences in responses depending upon the district’s location, the size of the district, and the staff member’s role. Districts across Illinois support the creation of the specialist endorsement,

with a greater percent in Northeast and East Central Illinois (Figure 4). Large and medium school districts were more likely to agree with the creation of the EMS endorsement than small districts and a $p < 0.05$ indicated a relationship between the size of the district and support for the EMS endorsement (Figure 5). Finally, respondents with district roles in curriculum and instruction were most likely to support the creation of the EMS endorsement, though support was high among all groups. Superintendents were the individuals who most often completed the district survey and almost 80% of them indicated support for the EMS endorsement (Figure 6).

Elementary Mathematics Specialist Endorsements

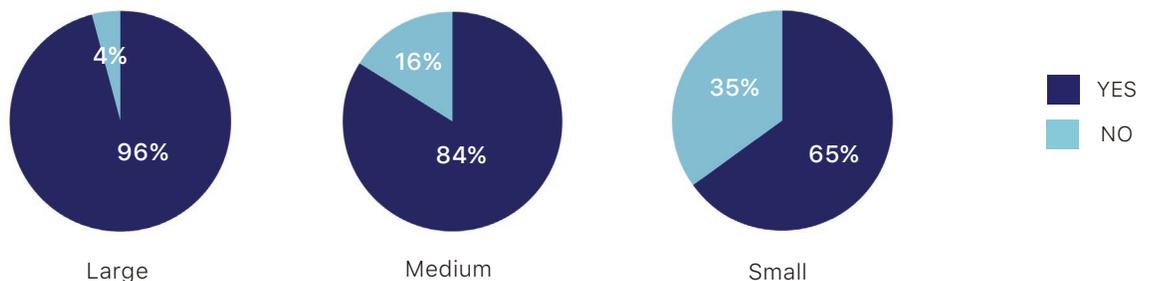
The following data is related to the proposed EMS endorsement.

FIGURE 4 | Strong Support Across All Regions for Elementary Mathematics Specialist Endorsement

	Yes	No
Northeast	96%	4%
Northwest	77%	23%
West Central	71%	29%
East Central	89%	11%
Southeast	76%	24%
Southwest	73%	27%

n = 150, missing = 3

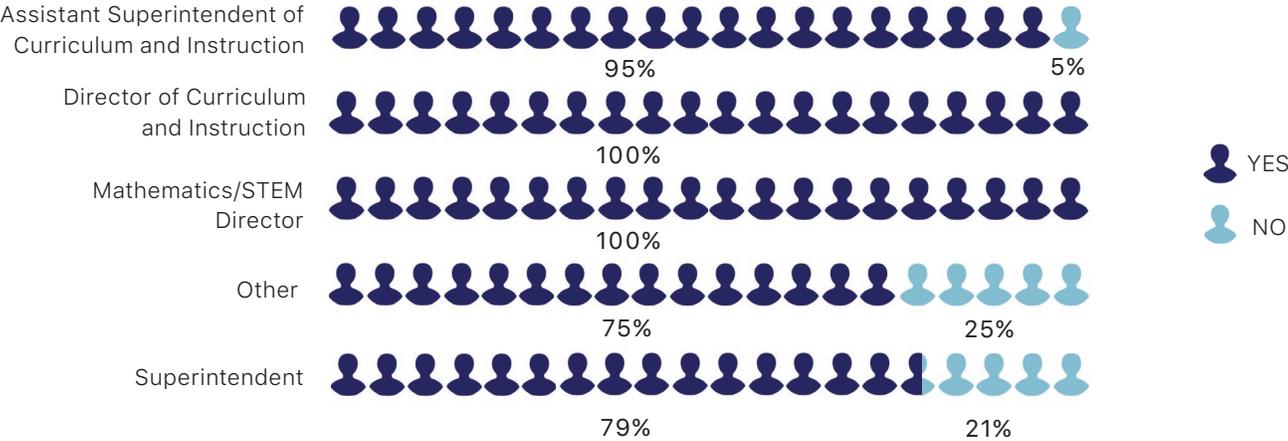
FIGURE 5 | Strong Support for Elementary Mathematics Specialist Endorsements Across All Districts of All Sizes



n = 150, missing = 3, $\chi^2(2) = 12.686, p = 0.002$, Cramer's V = 0.291, indicating a small relationship between support for the EMS endorsement and district size

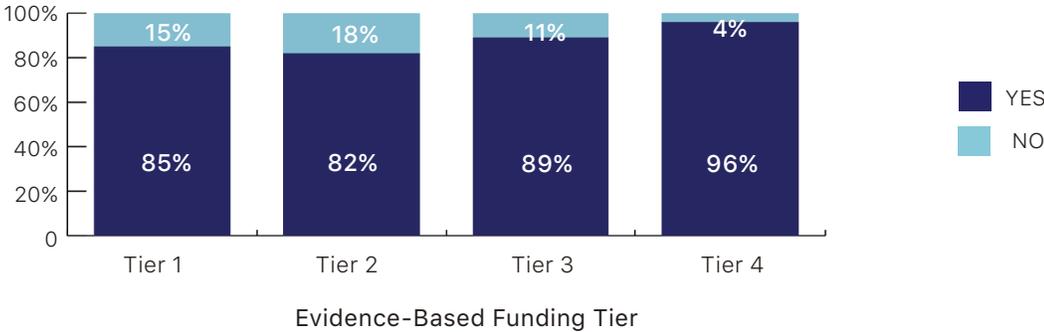
Although there were some differences by the evidence-based funding (EBF) tier of district (Figure 7) and whether the district provides reimbursements for courses (Figure 8), support was high across all groups.

FIGURE 6 | Across Roles Strong Support for the Elementary Mathematics Specialist Endorsement



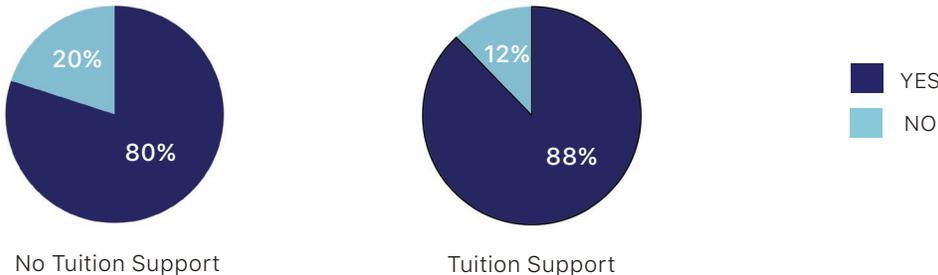
n = 150, missing = 3

FIGURE 7 | Strong Support for the Elementary Mathematics Specialist Endorsement Across Districts in All EBF Tiers



n = 150, missing = 3

FIGURE 8 | Regardless of Tuition Support, Districts Indicated Illinois Should Offer the Elementary Mathematics Specialist Endorsement



n = 150, missing = 3

Elementary Mathematics Teacher Endorsements

The following data is related to the proposed EMT endorsement.

As with the responses related to the proposed EMS endorsement, support for the EMT endorsement was widespread across all indicators, though there were some differences in responses depending upon the district’s location, the size of the district,

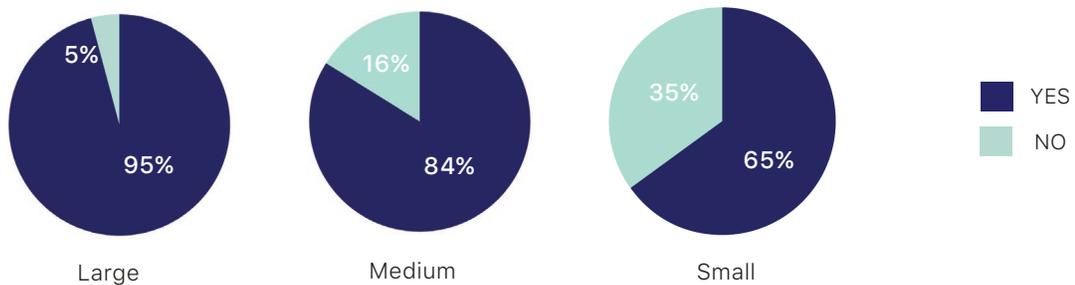
and the staff member’s role (Figures 9–12). Large and medium districts were more likely than small districts to support the creation of the EMT endorsement (Figure 9).

FIGURE 9 | Strong Support Across All Regions for the Elementary Mathematics Teacher Endorsement

	Yes	No
Northeast	96%	4%
Northwest	77%	23%
West Central	79%	21%
East Central	78%	22%
Southeast	80%	20%
Southwest	64%	36%

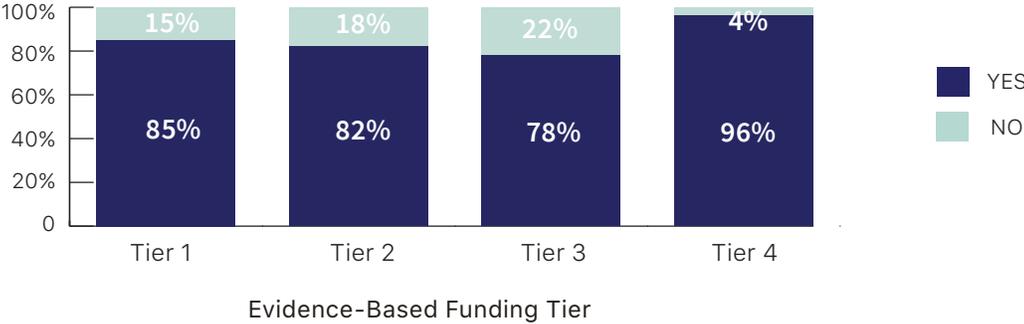
n = 150, missing = 3

FIGURE 10 | Strong Support for the Elementary Mathematics Teacher Endorsement Across Districts of All Sizes



n = 150, missing = 3, $\chi^2 (2) = 10.627, p = 0.005$, Cramer’s V = 0.266, indicating a small relationship between support for the EMT endorsement and district size

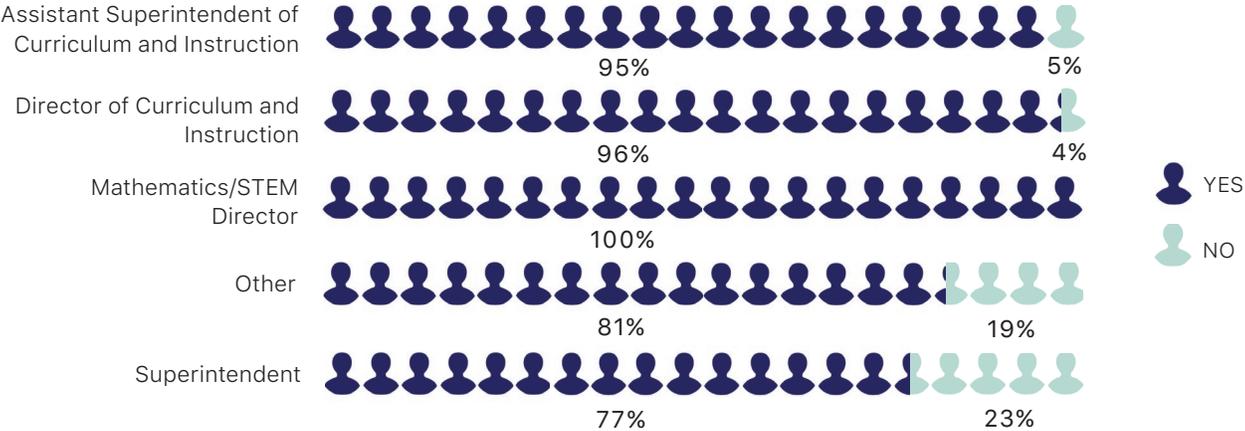
FIGURE 11 | Strong Support for the Elementary Mathematics Teacher Endorsement Across Districts in All EBF Tiers



n = 150, missing = 3

Although there were some differences in support of the EMT by EBF tier (Figure 12) and job title (Figure 13), support for the EMT endorsement was high.

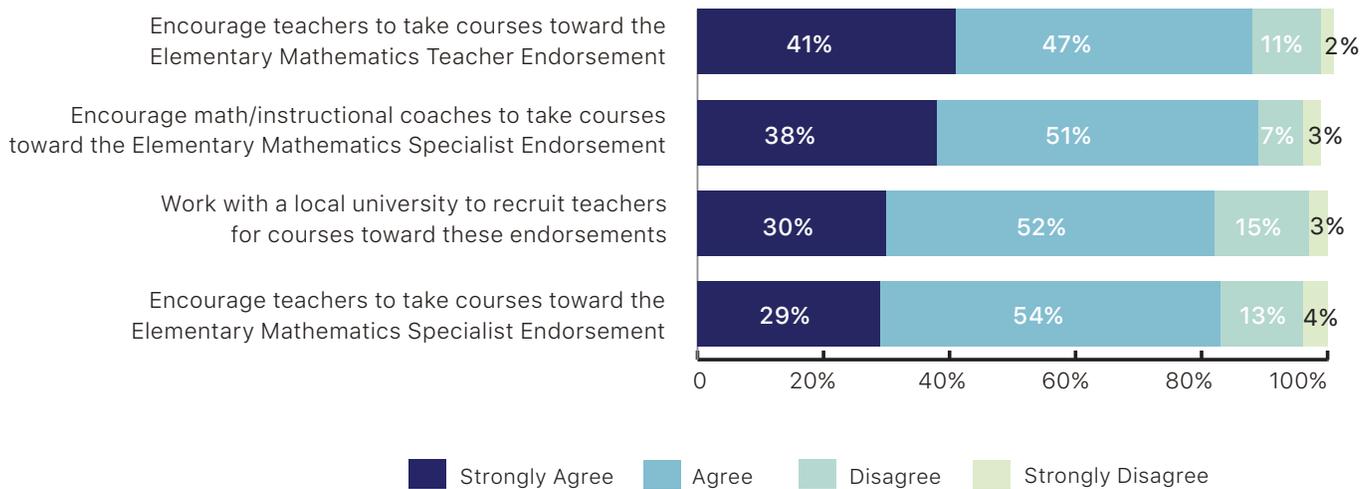
FIGURE 12 | Across District Roles, Strong Support for the Elementary Mathematics Teacher Endorsement



n = 150, missing = 3

Over 80% of district leaders agreed or strongly agreed that they would encourage teachers to take courses toward the EMT endorsement and EMS endorsement. Eighty-two percent of districts agreed or strongly agreed that they would work with a local university to recruit teachers for courses toward these endorsements.

FIGURE 13 | Strong Support for the Elementary Mathematics Teacher Endorsement Across Districts in All EBF Tiers



n = 150, missing = 3 for encouraging teachers to take courses toward EMT and EMS; *n* = 147, missing = 6 for encouraging math/instructional coaches and work with a local university

Question stem: If these endorsements were available, our district would...

Comments

At the end of the district survey, respondents were asked if they had any questions or comments they wished to share about the endorsements. Just over a quarter of district leaders wrote in comments, suggestions, or questions. Forty-seven percent of these comments provided explicit support for and 19% expressed a lack of support for the endorsements. Almost 20% of the comments indicated a concern about requiring the

endorsements and raised the teacher shortage issue. A few of the comments were questions about the proposed endorsements, clarifications of how district leaders responded to prior survey items, or recommendations for providing flexibility to meet the endorsement requirements or for improving preservice training in mathematics. On the following page is a sample of responses to this open-ended item.



Please provide/encourage flexible coursework credentialing. Many educators are looking for intensive/digital programs more than the traditional 16–18 weeks model.

(Assistant Superintendent of Curriculum and Instruction, Southeast)

Adding more endorsements only complicates licensure and is overkill. We are already pursuing professional development, instructional coaching, and opportunities for our math teachers to continue to improve. This is absolutely unnecessary.

(Superintendent, West Central)

I have indicated that the state should offer the endorsements. I admit that I was hesitant, because although it is stated that the endorsement would not be required to teach mathematics, I've seen the state change course many times, and if the endorsement were required, I would not support the creation of the endorsement.

(Superintendent, Northeast)

For self-contained elementary teachers, increasing pedagogical knowledge and understanding of how students best learn mathematics is essential. Too many of them are teaching the way they were taught, which provides a very limited scope of mathematics. “Traditional” math instruction is too procedural [and] lacks reasoning and flexibility. An endorsement would be very welcome.

(Assistant Superintendent of Curriculum and Instruction, Northeast)

This is a terrific idea.

(Superintendent, Northeast)

This has to remain as an option or we, once again, create an issue for ourselves. I love the idea, because it encourages getting better as an educator. Please never make it a requirement at any grade level K–6.

(Superintendent, East Central)

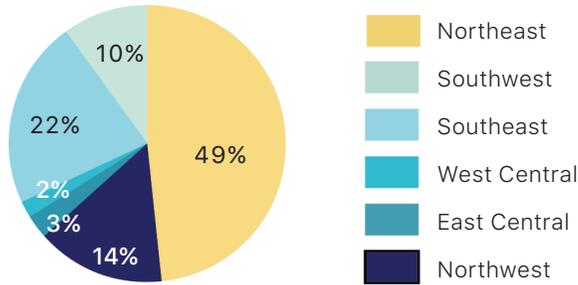


*I feel strongly that this would benefit our math program [similarly] to [how] the reading specialist endorsement [assisted] with our ELA teachers and instructional opportunities.
(Principal, Southeast)*

EMS SCHOOL SURVEY

As shown in Figure 14, almost half of the responses came from schools in northeastern Illinois.

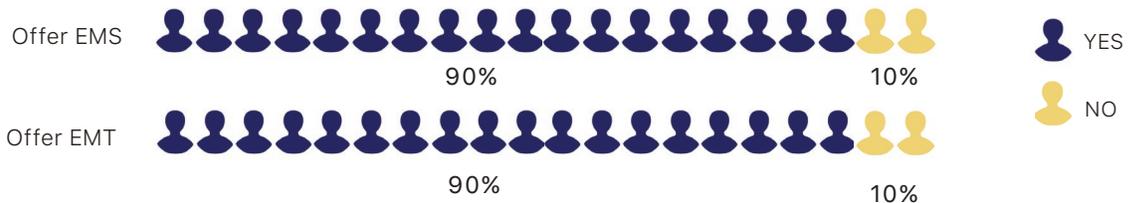
FIGURE 14 | Responses from Schools Throughout the State



n = 110, missing = 0

Fifty-five percent of respondents have worked in their districts for more than 10 years and 86% were principals. Thus, the school survey provides insights into the beliefs of principals. As Figure 15 reveals, 90% of school survey respondents support the creation of the EMT and EMS endorsements.

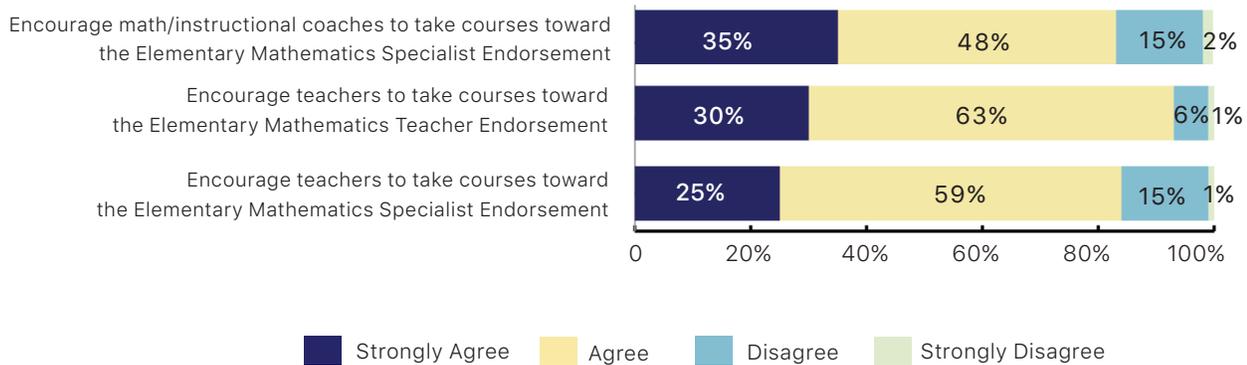
FIGURE 15 | Overwhelming Support Among School Leaders for Both Endorsements



n = 105, missing = 5

Ninety percent of respondents agreed or strongly agreed that they would encourage teachers to take courses toward the EMT endorsement; over 80% would encourage teachers to take courses toward the EMS endorsement. Some of the sample comments further illustrate this support.

FIGURE 16 | Majority of Schools Agreed or Strongly Agreed They Would Encourage Educators to Take Courses Toward the Elementary Mathematics Endorsements



n = 104, missing = 6 for encouraging teachers to take courses toward EMT; *n* = 105, missing = 5 for encouraging math/instructional coaches; *n* = 102, missing = 8 for encourage teachers to take courses toward the EMS

Question stem: If these endorsements were available, our school would...

School survey respondents also noted that increasing mathematics-related professional development opportunities, coaching support, and teachers’ pedagogical content knowledge would contribute the most to improving mathematics instruction.

Comments

About a quarter of school leaders wrote in comments or questions in an open-ended item at the end of the survey. Almost half of the comments from school leaders indicated support for the endorsements and about a third of these leaders raised the issue of teachers paying for the endorsements. On the following page are a few sample comments.



I believe one of the strongest barriers to successful math instruction at the intermediate grades is a lack of content knowledge in general ed teachers. This lack of content knowledge results in less confidence and less differentiated instruction. Any effort to build the content knowledge of elementary teachers is welcomed. Furthermore, I believe this graduate school coursework/path is a much better use of teachers' time than some of the online coursework taken to advance teacher "lane change" (e.g., MA + 15 + 30).

(Principal, Northeast)

This allows yet another opportunity for teachers to become leaders in their particular field of interest. If we have a reading specialist, why not math?

(Principal, Southwest)

We have no extra revenue and resources to accomplish sending teachers back to get endorsed. If funding were available, I would strongly encourage my staff to get the endorsement.

(Principal, Southeast)

I feel strongly that this would benefit our math program [similarly] to [how] the reading specialist endorsement [assisted] with our ELA teachers and instructional opportunities.

(Principal, Southeast)

If this is something that [is to continue] with momentum, the state [will need] to find a way to offer stipends to pay for the coursework for teachers and specialists. The state of our state and taxes is making it increasingly difficult to have teachers continuously expected to pay out of pocket.

(Principal, Northwest)

Financial restraints would dissuade teachers from applying for this endorsement.

(Classroom teacher, Northeast)

A photograph of a woman with dark hair pulled back, wearing a light blue patterned button-down shirt. She is looking towards the left and appears to be in conversation. In the foreground, there is a blurred tray with a bottle and a glass. The background is out of focus, showing other people and what looks like an indoor event space.

All university stakeholders endorsed the establishment of the elementary mathematics endorsements, EMT and EMS.

STAKEHOLDER PERSPECTIVES

Similar to the results in the district and school surveys, there is overwhelming support for the endorsements among the stakeholders interviewed. Some of the individuals interviewed worry that these endorsements would be required to teach or coach in the future, causing issues in hiring staff. Other concerns include cost to the teachers in taking the coursework and to districts in hiring mathematics coaches.

Illinois Universities

Individuals from 14 higher education institutions participated in developing the draft proposed EMS and EMS endorsements. As part of the landscape study, individuals from four universities were interviewed. They represented large and small universities in different areas of the state. The goal of the interview was to get more in-depth information about the support of each institution for the endorsements. The interview protocol was emailed in advance with the request that the interviewees prepare to provide their institution's stance on the questions. One of the individuals interviewed was a dean.

All university stakeholders endorsed the establishment of the elementary mathematics endorsements, EMT and EMS.

Overall, we feel like these seem like good endorsements. They seem like they have the potential to be useful to help support students in the schools, who are either having difficulties with math or to learn mathematics better, high quality mathematics.
(Faculty, public university)

The field of teacher education and the field of education, in general, needs this kind of expertise to help our children better understand what [are] the big ideas, what are the key concepts in mathematics.
(Administrator, private university)

I think we can always benefit from people with additional expertise and thoughtfulness when it comes to teaching and coaching math instruction, especially at the elementary level.
(Faculty, public university)

Three of the institutions would be willing to consider developing courses toward the endorsements if ISBE approves the endorsements, although one of the three indicated that they are concerned about demand for the credentials from teachers and districts. One institution would embed the mathematics courses into a master's program to make it more attractive for teachers. One institution indicated it is not able to consider developing courses toward the endorsements because at this point it only offers master's degrees.

Regional Offices of Education

Five leaders in ROEs, serving districts in West Central, Southeast, and Northeast Illinois, were interviewed. The ROEs interviewed serve a diverse group of districts, including highly urban districts and rural districts, and districts serving less than 100 students as well as those serving 15,000 students or more. All leaders have over 15 years of experience as educators and have taught in and/or led elementary schools.

All five ROE leaders expressed support for the two elementary mathematics endorsements. Below are three statements of support.

I think what [the universities are] proposing in terms of [math] ... I think the teachers would be excited by that, because I think we have teachers out there

They don't want to go back to get a master's degree in administration. They don't want to get a degree in counseling. They are very, very happy and love what they're doing, and they want to be a math teacher all their life. So the opportunity to take classes that will strengthen [their teaching] I think is really going to be a positive for them. (ROE leader)

If I knew that I wanted to systemically change some things, if I wanted to make a big difference across a district or across a couple buildings or even throughout a large building To have a specialist do that alongside coaching [to] help a number of teachers improve, I love that idea, and I think it would mean a lot to me if I [were] looking for a coach. Even if I [were] looking for one of those generic instructional coaches, and I knew that they were a math specialist and had that expertise, I just think that's value added. (ROE leader)

I think if we could get people that have that high level of expertise, it would really benefit the kids. We do it for reading, we do it for fine arts, we do it for a lot of the content areas, but we don't necessarily have it for math,

and that's one of the foundational content areas that a kid needs. I would be absolutely in favor of it. I think if we do nothing but help, and if it's not a requirement, I think it just, it could incentivize somebody, to move on the salary scale to be a better teacher, I think it would be a great thing. (ROE leader)

One ROE leader voiced a caution about not tying this to a title, such as has been done in reading, noting that it could lead to difficulties finding teachers to fill those roles.

So why don't we encourage our people who are good at it to become coaches and give them a stipend and help with professional development and things like that? I can only see a win-win from this at this point, as long as it's not tied [to a] title. (ROE leader)

Another leader loved the concept but was concerned about how much time it would take teachers to earn the endorsements:

I wouldn't want to make it so challenging and so time consuming that they don't value it or want to commit to it. I guess, [that] would be my concern. But in terms of building and growing [the] knowledge our elementary teachers [have] in math, I think it's a fantastic idea. (ROE leader)



In addition to asking the ROE leaders to share their thoughts on the two endorsements, they were asked whether districts in their regions would utilize these endorsements and whether they would subsidize teachers to earn them. ROE leaders shared that their districts would use these teachers to provide professional development to their teachers, with one indicating she would seek them out to lead workshops in institutes offered at the ROE. All five ROE leaders concurred that their districts would utilize individuals with these endorsements in coaching positions; however, two identified funding as a potential issue—first in enabling teachers to become endorsed and second in paying additional staff to serve in coaching roles. One ROE leader indicated that districts might also strategically place teachers with these endorsements in grade levels that might be struggling in mathematics or use them to lead STEM initiatives. Another ROE leader asserted that having the endorsements would give teachers who earned them a competitive advantage.

Across the five regions, the ROE leaders noted that some districts reimburse teachers for courses, though it often depends on what is built into the

teacher contracts and how much funding districts have available. One ROE leader discussed using Title II funds to support teachers seeking these endorsements.

If I were a superintendent, I think this is a unique enough position that I would look for ways to fund it, whether that's [with] Title II money or I would find somebody who is excited about math and say, "Hey, do you want to go back to school and get this endorsement? I'll pay for it." That's how strongly I feel about it. I probably have a couple of my superintendents who would feel that way. But by and large they would refer back to [their collective bargaining agreements] and their tuition reimbursement systems. (ROE leader)

I think they would utilize the endorsements. Many of our districts do offer tuition reimbursement for their teachers, as long as it's based on their content. Actually, I think that will be a benefit, because we have teachers that go and get administrative [endorsements], and the district [does] not [reimburse those], because [they're] not related to the content [areas] that they're teaching. (ROE leader)

Educator Organizations

Individuals representing the Illinois Council of Teachers of Mathematics, the Illinois Federation of Teachers, the Illinois Principals Association, and the Illinois Education Association were interviewed to understand their perspectives on the two proposed endorsements as well as how to improve mathematics teaching and learning. All stakeholders had been classroom teachers in elementary, middle, or high school with classroom experience ranging from 12 to 19 years, with two out of the four having taught middle school mathematics for 12 of those years and a third for two years. Two of the stakeholders served as mathematics coaches for their districts.



I think all schools need ... [coaches]. I think this speaks to the second endorsement, right? I think it's a great idea. Yes. (Educator)

I love the idea of anybody who's kind of working in intervention, working with students, or working to be a math coach, getting more content, getting more training, getting more information. (Educator)

The stakeholders agree that these endorsements can help teachers improve their mathematics teaching directly with the EMT, or indirectly with the EMS by having access to well-prepared mathematics coaches.

You need a lot of people right now with the second endorsement as a specialist. People that can go into a school and work with adults or work with kids to be able to identify ... the needs. (Educator)

People are always asking me, like, "How do I become a math coach?" Or, "What do I need to do that?" [Coaching] looks so different in every district, it's sort of hard to make sure that people are doing best practice if they're sort of making it up or reinventing the wheel every place you go. (Educator)

Stakeholders offered various recommendations for how to enact the endorsements. Two stakeholders stated that it would be attractive to include the elementary mathematics endorsement courses as part of a master's degree, as some school districts will only reimburse teachers for courses that are part of a degree program, and the degree would be attractive to many teachers. One of them also suggested allowing preservice teachers to add these courses to their programs of study. Another stakeholder asked that the state figure out how to count some of the course work from a middle school math endorsement toward the proposed elementary mathematics teacher endorsement so that teachers who already have the middle school math endorsement can obtain the EMT if they wish. This person also suggested the state consider providing some financial support for teachers to take these courses, as "it's a good investment."

When asked how districts might respond to individuals having these endorsements, stakeholders indicated that districts would opt to hire teachers with an EMT endorsement over teachers without one, and that districts would utilize these individuals as coaches, as interventionists, or as professional development leaders. Most indicated that districts would reimburse teachers for the courses.

However, there were a few concerns about offering the endorsements. Two stakeholders remarked that the individuals with endorsements might not necessarily be better teachers or coaches than those without them. One worried about access with regard to cost and getting into programs, and how this might act a barrier for underrepresented groups. She also expressed a concern about what might happen to individuals already serving as coaches but who opt not to obtain the endorsements. A stakeholder remarked that it would be difficult for universities to attract individuals into credentialing programs until districts value hiring people with



these endorsements, a concern shared by university faculty who were interviewed.

Concerns were raised about the possibility of ISBE eventually requiring the endorsements for mathematics specialist positions. One noted that if the endorsements were later required, it could lead to difficulty hiring teachers. This sentiment was raised by another stakeholder, who discussed the teacher shortage in Illinois, acknowledging that it is more prevalent in some areas of the state and noting that hiring mathematics teachers is particularly challenging. However, this individual recognized the value of having teachers increase their content knowledge and having coaches in schools. This educator was also concerned about the state making these endorsements mandatory in the future, but stated, "I don't know that that's a great reason not to make them available."



*I am more reflective
and intentional in my
instructional practices and
planning of instruction.
(CPS teacher)*

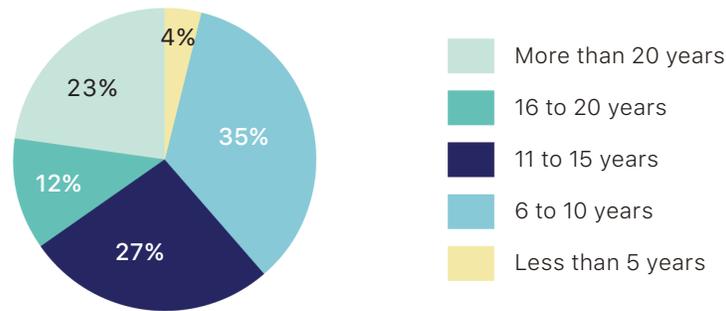
PILOT EMS PROGRAM COHORT SURVEY

With initial funding from The Chicago Community Trust, three universities—DePaul University, the University of Illinois at Chicago, and the University of Chicago—collaboratively developed a pilot two-year EMS program. The CME Group Foundation provided generous support for two cohorts of teachers to enroll in the program. At the time this study began, the first

cohort was completing the second year of the program.

The teachers in the first cohort were Chicago Public School (CPS) teachers and the majority, 62% of them, had been teaching for less than 15 years, as shown in Figure 17.

FIGURE 17 | Most Teachers in the EMS Program Had Been Teaching for Less Than 15 Years

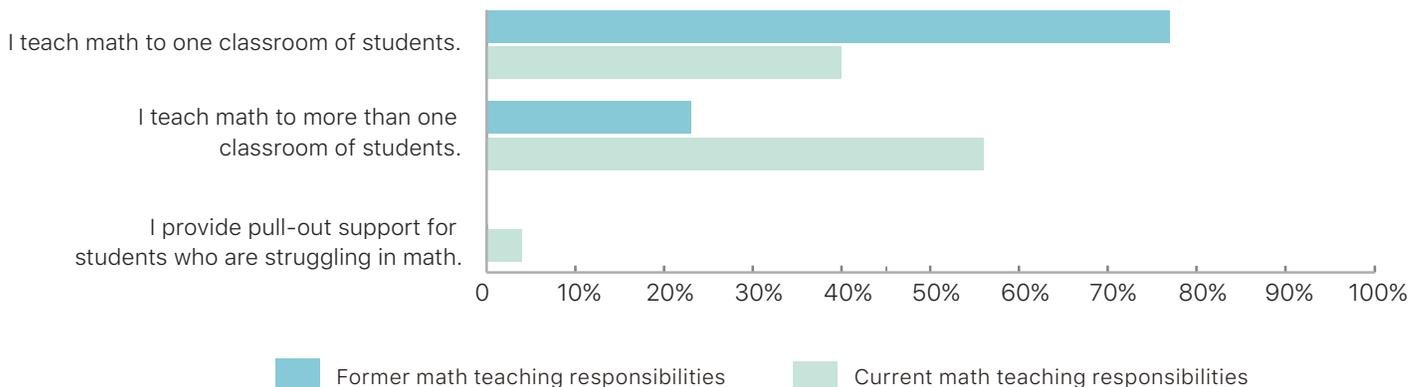


n = 26, missing = 0

Districts' interest in departmentalization (when teachers teach more than one mathematics class) in the lower grades was an impetus for the development of the EMS program. CPS mathematics leadership partnered with the three universities in recruiting

teachers and supported their schools in moving to departmentalization. As noted in Figure 18, the percent of teachers in the program who taught mathematics in a departmentalized format increased from 23% to 56%.

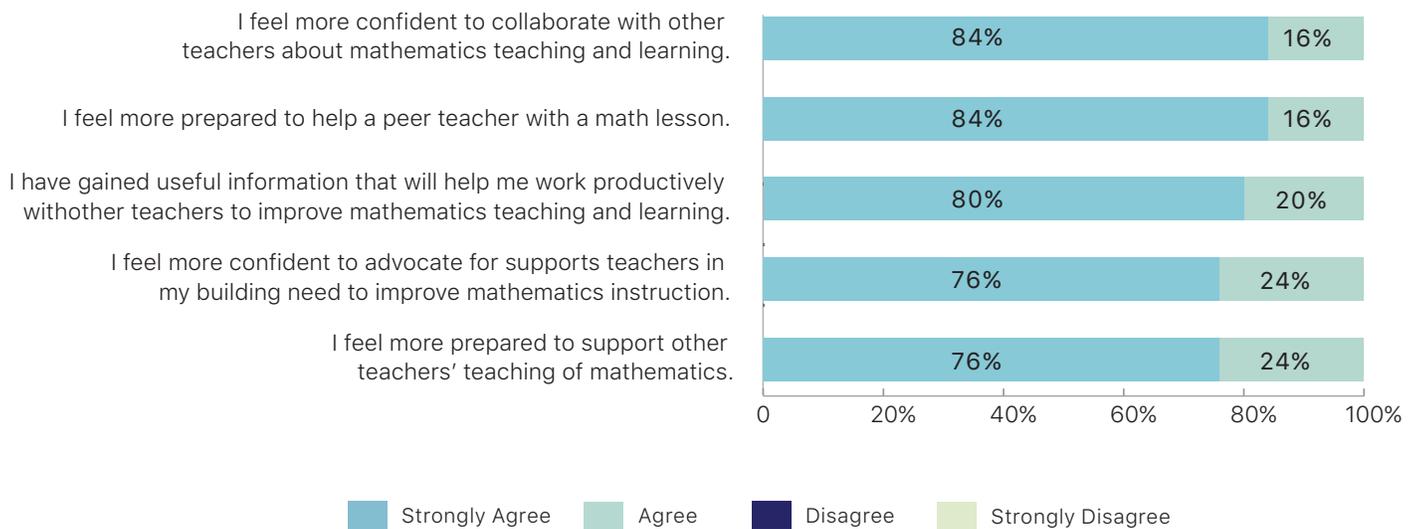
FIGURE 18 | A Shift to More Departmentalized Teaching in Math



n = 26, missing = 0 for former math duties; n = 25, missing = 1 for current math duties

Attitudinal items in the survey relating to collaboration with teachers, feeling more prepared to help peers with mathematics lessons, and having learned useful information that will help them work productively with other teachers received strong agreement by at least 80% of the teachers (Figure 19).

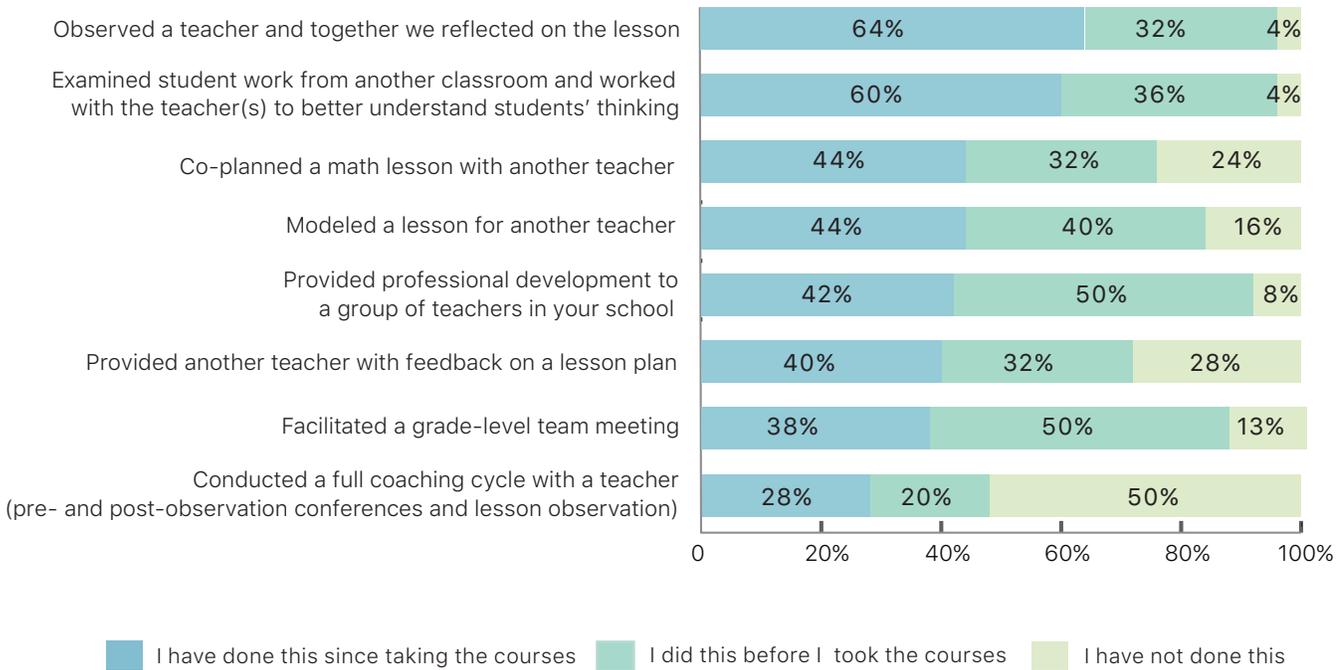
FIGURE 19 | EMS Cohort Teachers Collaborating and Supporting Colleagues



n = 25, missing = 1

In addition to understanding how Cohort 1 teachers felt about various elements of leadership, they were asked whether they had performed specific leadership activities (Figure 20). Although there were teachers who had performed some of these activities prior to beginning the pilot, there were typically 40% or more of teachers who performed these activities only since they began taking the courses.

FIGURE 20 | EMS Cohort Teachers Engaging More in Leadership Activities



n = 25, missing = 1; n = 24, missing = 2 for providing professional development and facilitating grade-level team meetings

Cohort 1 teachers also shared how they changed their mathematics teaching practices since they began taking these courses. Below are a few quotes.

Since taking these courses, I can say that I have stepped away from the procedural mathematics and [am now] approaching it more in the conceptual and exploration way. [I'm] giving students an opportunity to participate in productive struggle to push their thinking. I think I have made math more of a collaborative environment. (CPS teacher)

I am more reflective and intentional in my instructional practices and planning of instruction. (CPS teacher)

My mathematics practices have changed since I began taking these courses by [my being] more knowledgeable about content, strategies, differentiation, and instruction. The content can be explored through low-floor, high-ceiling activities in which students can have access to the rich mathematical content and build Agency and Authority. (CPS teacher)

EMS Programs in Other States



Leaders from four states, California, Maryland, Oregon, and Pennsylvania, were interviewed to understand how these states undertook development of their credentials. Each state uses different terms for their teacher license and for the elementary mathematics specialist credential, thus state-specific terms are used in this section. In all four states, individuals must hold a teaching license before pursuing these credentials. University leaders from three universities reported that these mathematics courses can count toward a master's in education degree and one university leader offered this advice:

*I would encourage you to have multiple tracks. In other words, because you're going to find two populations: "I don't want to do a master's degree, I already have a master's degree. All I want is the certification."
(University leader)*

It is difficult to know who earns the credentials, because teachers don't always pursue adding the credentials to their licenses, given that it costs money to do so and may not add value beyond increased knowledge for teaching. A university leader lamented that without some incentives for teachers, such as specific jobs, increased salary, or some form of recognition from the district, teachers may not opt to pay tuition and spend time to develop their expertise in math. However, all university leaders cited evidence, including the large number of teachers taking the courses, though not always applying for the credential, that teachers take the courses even without these incentives. One university leader stated,

*It's like I've had high school teachers, probably 10, complete two or more of the other courses that we currently offer. Just because they feel like, "I never got any of this when I went through my teacher [education] program." It just wasn't the focus when you're taking classes in the math department, to think about how students think, and how that develops over time, and how that might influence your instruction.
(University leader)*

Teachers with these credentials are employed in different roles. Some teachers serve roles in their district offices, such as mathematics supervisor, curriculum lead, or mathematics specialist who has responsibility over a group of district schools; others serve as mathematics coaches within schools; and others work for state organizations providing professional development to teachers.

University leaders were asked if there were any unintended consequences to having these credentials and most reported positive ones.

*Nothing negative. I think the one positive has been more school districts being aware of the fact that they need teachers to be stronger with math content and some of the math coaches that have graduated go back and they're starting to talk to their principals and their principals are starting to see the value of having them [complete] these courses and [use] them to help do some professional development with their own districts.
(University leader)*

*No. But I think the bottom line is it's going to help kids and that's what this is all about."
(University leader)*

Another reported that these individuals get tapped as assistant principals or never leave their mathematics coach roles, and thus, other teachers with the credential do not have an opportunity to obtain a mathematics coach position, because so few are needed. Teachers can also feel disheartened if their district does not craft official mathematics leadership roles.

The overarching sense from the group of university leaders is that the additional knowledge and skills gained in the courses are critical to improvements in mathematics teaching and learning.

*I think there's tremendous need for such specialists in school districts around the country.
(University leader)*

California



California's efforts were initiated by the California Commission on Teacher Credentialing. The Commission convened an advisory panel to identify ways to improve mathematics teaching, particularly to address the poor performance of eighth grade students on the Algebra test (the result of California's previous "early algebra for all" policy) and a concern that the California college system was not producing sufficient California residents with mathematics or science degrees. The group had a range of perspectives and expertise, which led to some difficult discussions. Key issues that arose included the grade span for the credentials and the level of mathematics content covered. District leaders wanted the credential to cover K–12 to ensure flexibility in hiring staff, while some university members wanted to focus on the elementary grades as elementary teachers had the greatest need for increased content knowledge. In the end, the focus on the elementary grades and content did not occur. Enacting the credential took under two years.

California is the only state that has a mathematics teacher credential (Mathematics Instructional Added Authorization [MIAA]) and a mathematics coach credential (Mathematics Instructional Leadership Specialist [MIL]), similar to those proposed in Illinois. These credentials were begun in 2010 and serve K–12. The MIAA has two routes, K–Pre-Algebra or K–Algebra 1. Only individuals who have earned the MIAA credential may earn a MIL credential (California Commission on Teacher Credentialing, 2010). Only one university offers the MIAA credential and only one MIL has been earned in the last three years (California Commission on Teacher Credentialing staff, personal communication, November 18, 2019).

IMPLICATIONS FOR ILLINOIS

- Develop partnerships with districts.
- Foster university buy-in.

Maryland

In 2010, Maryland developed the Mathematics Instructional Leader, Pre-K–6 (18 semester hours) and Mathematics Instructional Leader, Grades 4–9, (24 semester hours) credentials, which may only be earned by teachers with three years of teaching experience (Elementary Mathematics Specialists & Teacher Leaders Project, 2019). The difference in these two endorsements is the coursework required with the Pre-K–6 coursework ending with data analysis and probability and the Grades 4–9 endorsement requiring coursework in calculus and discrete mathematics as well as teachers having a certificate in Middle School Mathematics. Currently, two universities offer the Pre-K–6 and the Grades 4–9 credentials and a third university

offers only the Pre-K–6 program (all online except for the internship) (Maryland Higher Education Commission, 2019).

Maryland's department of education convened a commission to examine mathematics education in 2001. One of the commission's recommendations was to create standards for elementary mathematics specialists. Although it took a decade to get the endorsements approved, once the department of education mathematics staff began discussions with the accreditation staff, developing the endorsements was easy, as described by a key leader in this effort.

IMPLICATIONS FOR ILLINOIS

- Advocate. Be persistent.
- Partner with districts.
- Provide different pathways for teachers; endorsement or master's in mathematics education.
- Obtain grant funding for cohort models when possible.
- Offer the courses online to address demand from teachers beyond your region.
- Consider a partnership across universities that allows teachers to take courses across institutions.



Oregon

Oregon initiated the Elementary Mathematics Instructional Leader (EMIL) specialization in Grades K–8 in 2015, but one university started offering the courses in 2008 and provided a university certificate of completion. In order to earn the EMIL, individuals must have a teaching license, have completed three years of teaching mathematics in Grades K–8, and have completed a 16-semester hours program that includes a practicum (Elementary Mathematics Specialists & Teacher Leaders Project, 2019). Only two universities offer the program in Oregon.

A team of individuals from the state of Oregon, universities, districts, and the state organization for administrators attended the Association of Mathematics Teacher Educators (AMTE) conference in 2011 on developing elementary mathematics specialists. This group advocated for the specialization and received support from the Oregon Math Education Council. It took two years to get the specializations approved. Initially, the state did not grasp the value of a specialization credential for high school teachers. An evaluation of a three-year project in which teachers earned the EMIL revealed the effectiveness of the specialization, which led the state to create an EMIL for Grades 6–12.

Oregon has had 80 teachers complete the EMIL at two universities. One university offers a certificate of completion for the eight EMIL courses in addition to having the courses count toward a master's in mathematics education. This university reported having over 250 teachers in these courses since it began offering them. When Oregon added a secondary mathematics coach specialization, this university allowed some existing elementary courses

to count toward both specializations. Though, for this to work, the faculty teaching the courses need to be mindful of the grades being taught by the teachers and adjust the tasks utilized.

Mathematics coach roles may be available in districts during stronger budget times, but these either become generic instructional coach roles or disappear altogether in leaner times. For this reason, one university leader tries to ensure the teachers see their leadership roles more broadly and helps them think about how to take advantage of opportunities that arise.

And even if there are coaching positions for a time period, they often morph, or change, or get cut as soon as [there are] any sort of budget concerns, and so I really try to help folks see themselves as leaders, no matter where they're interacting with people. So, if you're working your classroom, or working in your [Professional Learning Community], you're a leader, and you have an opportunity to influence not only the kids you're impacting, but also your colleagues in the way they're doing their work. ... And then what happens over time is then the district calls on you more formally to do things when opportunities arise. (University leader)

As part of the coursework, teachers create a mathematics leadership portfolio to help them think about and communicate their skills and the quality of their work.



IMPLICATIONS FOR ILLINOIS

- Develop partnerships with school districts. These have been critical for teacher recruitment and successful implementation of specialists.
- Provide courses in convenient locations for teachers and understand that teachers may need to take the courses slowly, over time, due to time commitments and reimbursement allowances for taking courses from their districts.
- Allow for multiple paths: a certificate of completion, a credential, and a master's in mathematics education.
- Obtain grant funding for cohort models when possible.
- Document the impact on teacher learning and student achievement.
- Promote understanding of leadership opportunities broadly among teachers and districts and assist districts in identifying innovative ways for teachers with these credentials to support other teachers' knowledge and practice.

Pennsylvania



In 2010, Pennsylvania enacted a Pre-K–12 mathematics coach endorsement that can only be earned after teaching for three years and completion of a 12-semester-hour program that includes some field experience (Pennsylvania Department of Education, 2013). The endorsement provides teachers with more knowledge of mathematics and pedagogy. Three universities offer the Pre-K–12 endorsement. One of the universities offers four courses—number and operations, data analysis/probability, algebra functions, and geometry and measurement—and embeds coaching elements in each course. This university will be providing the courses in a synchronous online version to address demand beyond their geographic location.

Pennsylvania took a team of stakeholders, including state leaders, to the AMTE conference on developing mathematics specialists and worked in partnership with state leaders to develop an endorsement that meets the needs of districts and addresses the gaps in elementary mathematics teaching. This effort was initiated by university faculty. The Pennsylvania group reviewed endorsements and certificates already on the books and determined that this endorsement was needed. Districts supported an endorsement that spans the Pre-K–12 continuum. Development of this endorsement took three years and had the support of the Pennsylvania Council of Teachers of Math, the Pennsylvania Council of Supervisors of Math, and the Pennsylvania Association of Math

Teacher Educators. A key argument for the endorsement was that the state had reading specialists, because they wanted individuals who really knew reading, and they understood that mathematics should be the same.

Pennsylvania also has an instructional coach endorsement and in 2015–16, 45 earned this endorsement, while four earned the mathematics coach endorsement. The numbers of teachers who earned these endorsements in 2016–17 were 15 and 3, respectively, while in 2017–18, the numbers shifted, with 18 earning the instructional coach endorsement and 29 the mathematics coaching

endorsement. University faculty indicated that 75 teachers completed the program in one year through a math and science partnership grant but noted that typically about 10 teachers complete the program annually.

Some teachers were supported by their districts to pursue the credential but, due to budget constraints, have not been released of their teaching duties. Instead, they support teachers after school and in return receive time off to attend a mathematics conference paid for by the district.

IMPLICATIONS FOR ILLINOIS

- Understand the needs of school districts.
- Convince state leaders that current endorsements do not meet the need.
- Get letters of support from the various stakeholders.
- Develop understanding of mathematics expectations across grade levels by having elementary and high school teachers taking courses together.
- Be flexible. Some teachers care more about the learning than getting the credential.
- Offer the courses online to address demand from teachers beyond your region.
- Obtain grant funding for cohort models when possible.
- Create innovative solutions for utilizing teachers with these credentials, even if full-time coaching positions are not financially feasible.



Coaching and Content Specialization



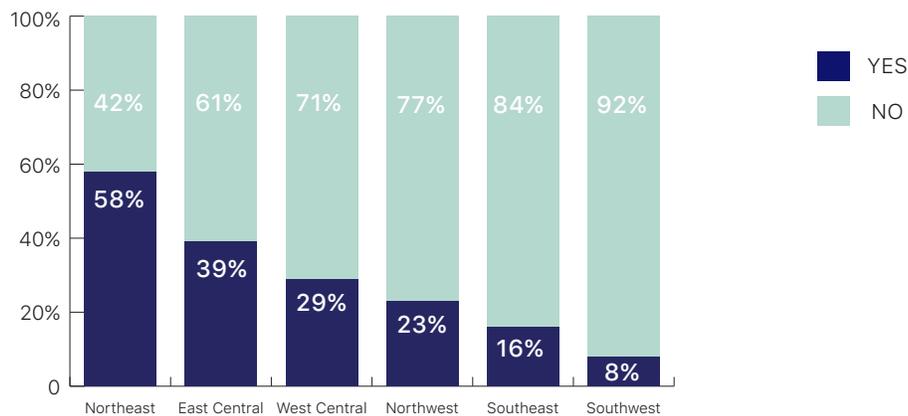
COACHING

Coaching has been recognized as a key lever for improving teaching and student achievement (Brosnan & Erchick, 2010; Campbell & Malkus, 2010; Conaim, 2010). Nationally, 56% of schools have a teacher or coach who does not have classroom teaching responsibilities but provides one-on-one coaching in mathematics, and 31% of schools have a district administrator (which includes science and mathematics supervisors and coordinators) who provides coaching in mathematics (Banilower, 2018). However, as one Illinois university faculty member stated, many districts have begun to use instructional coaches, but these individuals are not always supported in developing the knowledge and

competencies they need to serve as a coach: “I think sometimes...teachers move into a coaching role and are kind of left on their own to learn some of the best practices with coaching. I do see a need [for the specialist endorsement].” Furthermore, instructional coaches may not have the appropriate background in mathematics teaching and learning.

Among the responding districts, almost 40% offered coaching to teachers in mathematics. Differences among districts existed across regions, with the Northeast and East Central regions of the state offering it most; a much lower percentage of districts in Southeast and Southwest Illinois offered coaching (Figure 21).

FIGURE 21 | Coaching Most Prevalent in Northeast and East Central Illinois

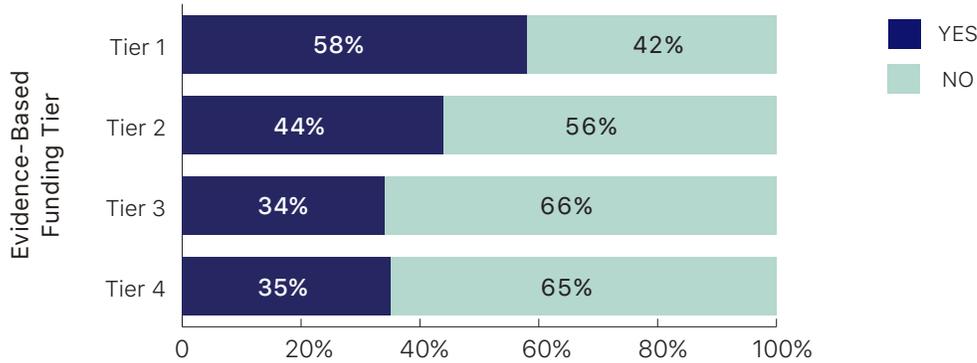


$n = 153$, missing = 0, $X^2 (5) = 22.729$, $p = 0.000$, Cramer's $V = 0.386$, indicating a moderate relationship between coaching and region

Coaching was also most prevalent in large school districts, with 57% of these districts indicating coaching in mathematics was provided to teachers, as compared to 34% of medium districts and 10% of small districts. This difference was significant with $X^2 (2) = 15.671$, $p < 0.000$, and a Cramer's $V = 0.320$, indicating a moderate relationship between coaching and district size.

Examining where coaching was provided by tier designation revealed that top-resourced districts provided coaching more than lower-tier districts, though even in the lower-tier districts, over one third of respondents offered coaching in their districts (Figure 22).

FIGURE 22 | Coaching Provided Most by Higher-Resourced School Districts

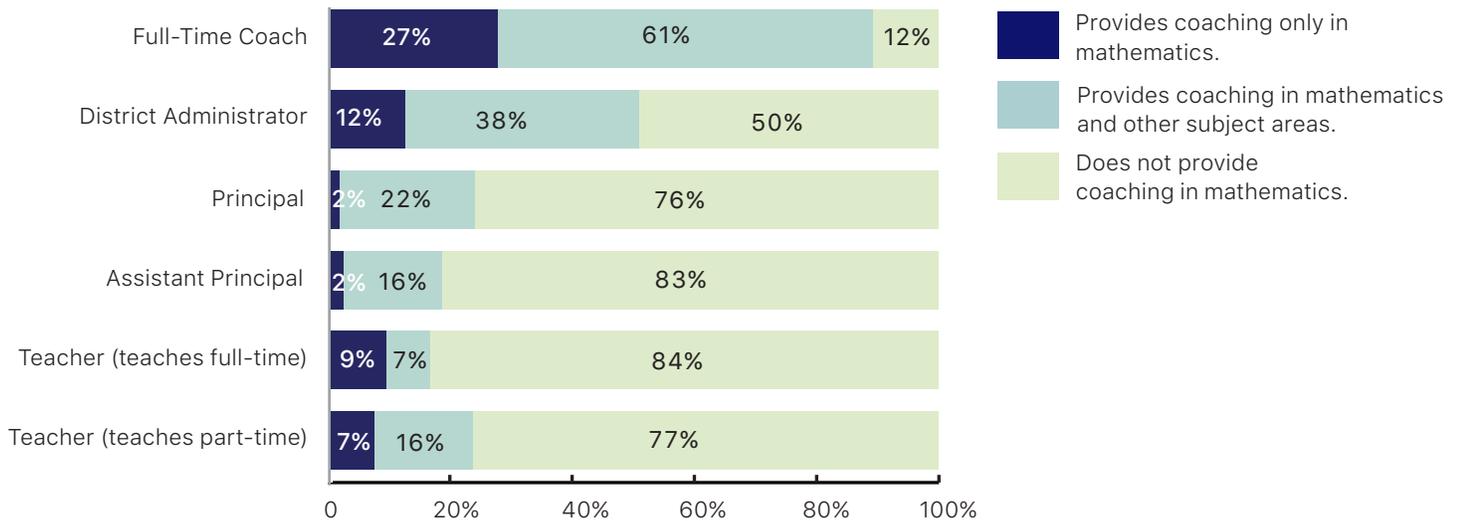


n = 153, missing = 0

The survey included questions about who provided the coaching and whether the coaching was provided by these individuals only in mathematics or in mathematics and other subjects (Figure 23). Twenty-seven percent of respondents indicated that a full-time coach provided coaching only in mathematics and 61% indicated that a full-time

coach provided coaching in mathematics and other subjects. District administrators were also responsible for coaching, with 12% providing coaching only in mathematics and 38% in mathematics and other subjects. It is worth noting that some districts utilize classroom teachers as coaches to their peers.

FIGURE 23 | Coaching Support Provided Most Often by Full-Time Coaches and District Administrators



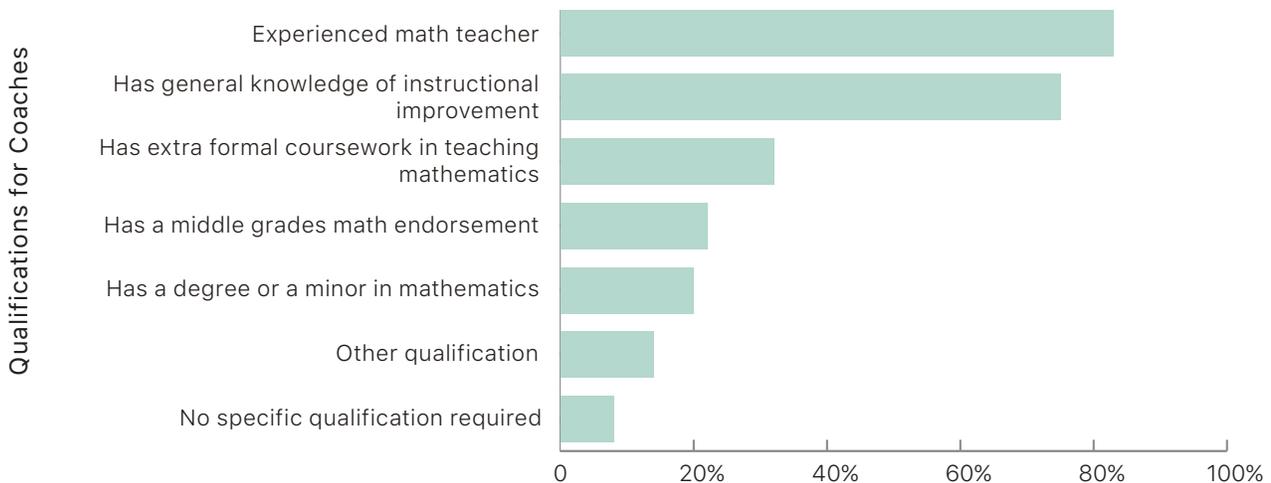
n = 57 to 59, missing = 1 to 3



As noted in Figure 23, some individuals responsible for coaching teachers only do so in mathematics, while others do so in mathematics and other subjects. But what were the qualifications sought by districts when choosing individuals to provide coaching support to teachers in math? Being an experienced mathematics teacher and having general knowledge of instructional

improvement were most often cited by districts as the qualifications used for selecting individuals to coach teachers in mathematics (Figure 24). Notably, formal coursework in mathematics was cited by 30% of the districts and about 20% cited having a middle grades math endorsement and having a degree or a minor in mathematics as a qualification.

FIGURE 24 | Experience as a Math Teacher and General Knowledge of Instructional Improvement Most Cited Qualifications for Individuals Coaching Teachers in Mathematics



n = 59, missing = 1; districts could have selected multiple responses

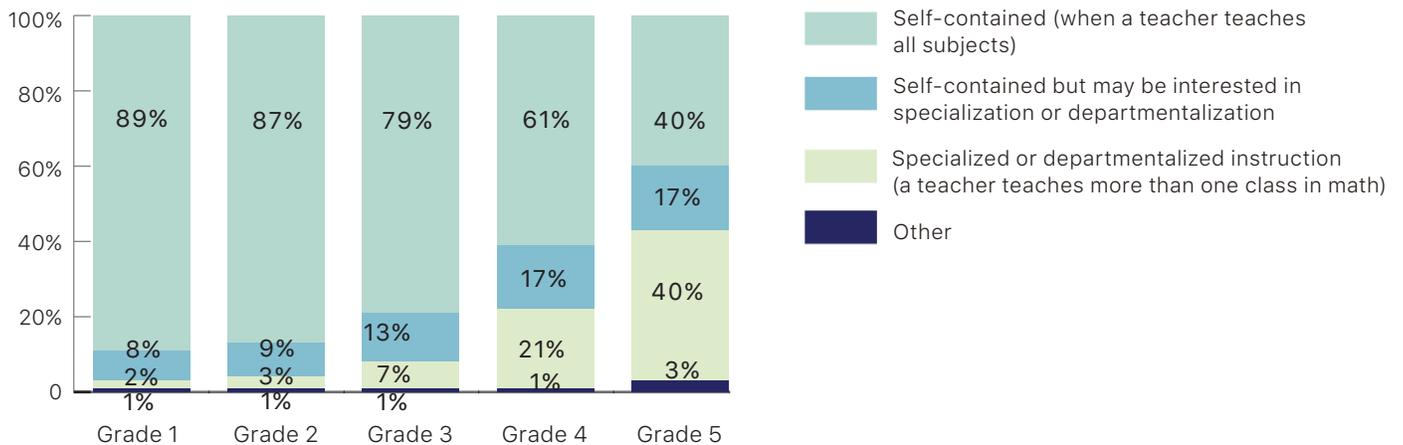


CONTENT SPECIALIZATION AND DEPARTMENTALIZATION

Elementary schools are not typically departmentalized. Elementary school teachers are known as generalists and typically are responsible for teaching one group of students all day in all core subjects—literacy and language arts, science, social studies, and mathematics. Being an elementary school teacher does not require having additional subject matter knowledge in any subject. However, a growing number of elementary schools are looking at departmentalization or specialization as a way to increase student achievement, particularly at the upper elementary grades (Hood, 2009; Gewertz, 2014).

Questions about whether school districts in Illinois have elected to use or are interested in using this strategy were included in the survey. Figure 25 shows that 40% of Illinois districts used a specialized structure to teach mathematics in fifth grade and another 17% are interested in specialization in that grade. For fourth grade, these figures were 21% and 17%, respectively. It is not surprising that much smaller percentages were seen in first grade (1% and 8%, respectively), as early childhood educators believe having one teacher across subjects is better for young children’s social and emotional development (Hood, 2009; Gewertz, 2014).

FIGURE 25 | Departmentalized Mathematics Classes Occur Most Often in Upper Elementary Grades

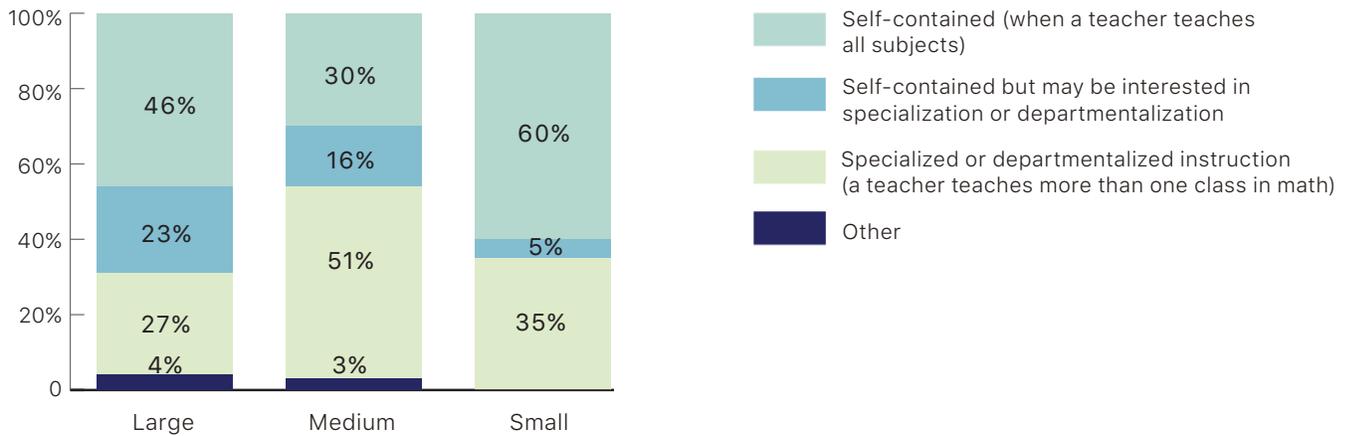


n = 150, missing = 3 for Grades 1-4; n = 149, missing = 4 for Grade 5

A closer look at districts use of and interest in specialization in fifth grade was performed. Medium-size school districts were more likely to report the use of and interest in using specialization than large or small districts (Figure 26). Although differences are seen by EBF tiers, there was no indication of a relationship

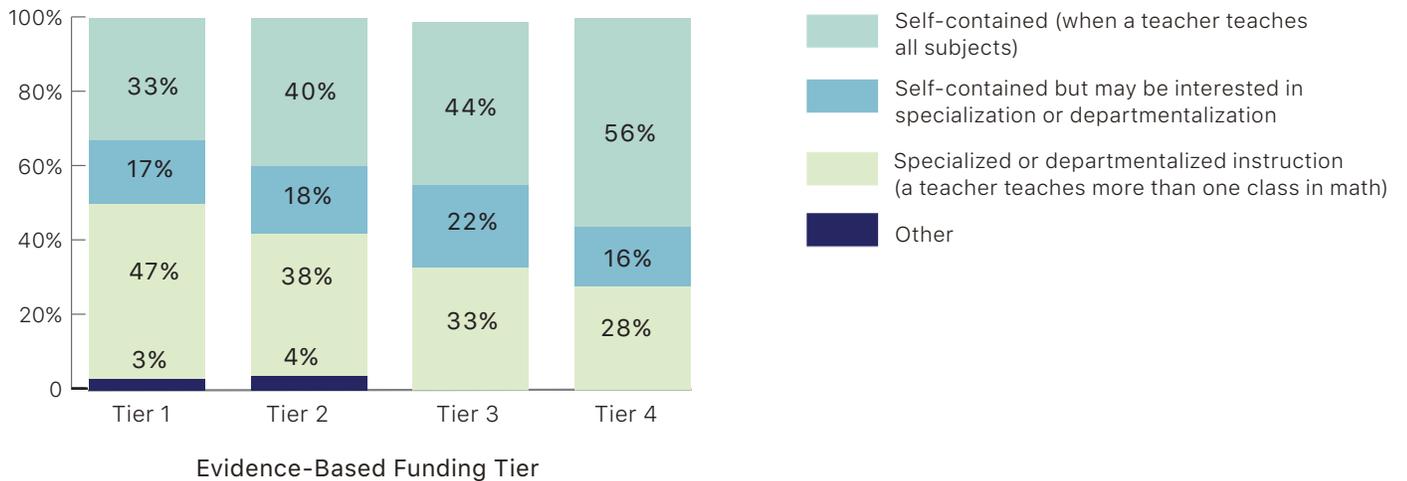
between being departmentalized in fifth grade and EBF tiers (Figure 27). Having a middle grades math endorsement and being an experienced mathematics teacher were most often cited as qualifications for selecting teachers for math-specialized positions (Figure 28).

FIGURE 26 | Medium-Size School Districts Have More Departmentalization in Fifth Grade



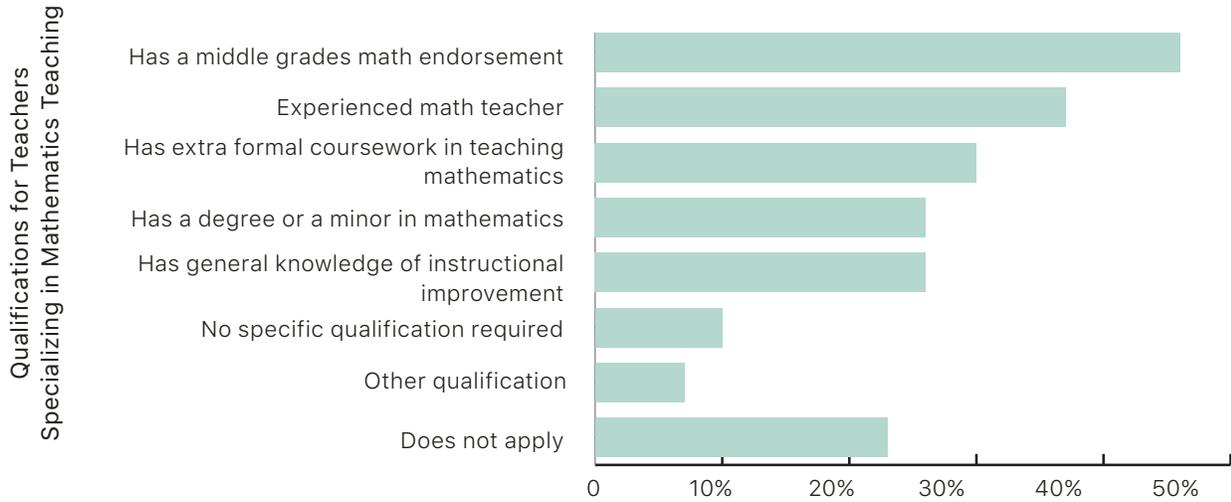
n = 149, missing = 4, likelihood ratio = 13.747, d.f. = 6. *p* = 0.033, Cramer's V = 0.206, indicating a small relationship between fifth grade departmentalization and district size

FIGURE 27 | A Greater Percent of Tier 1 Districts Report Specialization in Fifth Grade



n = 149, missing = 4

FIGURE 28 | Middle Grades Math Endorsement and Being an Experienced Math Teacher
 Most Cited Qualifications for Teachers Specializing in Mathematics Teaching



n = 147, missing = 6



Conclusion

Teaching is a complex endeavor that requires considerable knowledge and skills. Across the country, elementary teachers are tasked with a sizeable job but are not always prepared or supported sufficiently. Many elementary teachers recognize the need for additional knowledge in teaching different disciplines and are willing to address this gap in their teacher preparation. Elementary teachers in Illinois currently have the option to earn additional certification credentials in reading, special education, gifted education, and English as a Second Language but do not have the opportunity to earn a formal credential in teaching elementary mathematics.

The proposed endorsements can help address the concern that many elementary teachers have limited mathematical content knowledge and knowledge for teaching mathematics (Hill et al., 2008; CBMS, 2012; Hill & Ball, 2004) and this limited knowledge can impact teachers attitudes about and confidence in teaching mathematics (Sarama & DiBiase, 2004; Maloney & Beilock, 2012).

Moreover, as noted by some of the survey respondents and stakeholders interviewed, there are no current certification credentials for teacher leadership in mathematics. Current credentials in leadership are limited to school leadership, guidance counseling, reading, and district leadership.

“[Teachers] don’t want to go back to get a master’s degree in administration. They don’t want to get a degree in counseling. They are very, very happy and love what they’re doing, and they want to be [math teachers] all their [lives].” (ROE leader)

The proposed EMT and EMS endorsements can increase opportunities for teachers who want to pursue additional formal preparation in teaching mathematics in the elementary grades. It also provides opportunities for districts to incentivize additional training in mathematics to address an area of district need.

As local school districts and ISBE consider effective strategies for improving teaching and learning, building teachers’ content knowledge and pedagogical content knowledge are important prerequisites for any improvement efforts.

Building teachers’ content knowledge and pedagogical content knowledge may not be feasible across all 69,000 elementary school teachers in Illinois (ISBE, 2018a). However, focusing on building the capacity of a smaller group of teachers can be a reasonable strategy for improving teaching mathematics. One way to promote this is to create a certification system that will encourage teachers to enhance their knowledge base and encourage universities to offer quality programming to address the need.

As the results of this landscape study reveal, about 85% of district leaders and about 90% of school leaders who responded to the surveys indicated that the state of Illinois should offer the elementary mathematics teacher and specialist endorsements. Support for these endorsements extend to key education leaders in Regional Offices of Education, professional educator organizations, and university faculty and administration.

While there is extensive support from responding districts and schools across the state, a few district leaders noted in an optional comment section that they would not support the endorsements if they were made a requirement. Some educator organization and Regional Office of Education leaders also caution requiring the endorsements. As optional opportunities to gain mathematics content and pedagogical content knowledge, there is strong support for these endorsements.

A case in point of district support is the interest in the current EMS pilot program. What began with one cohort of CPS teachers, supported by a grant from the CME Group Foundation, is growing. In the second cohort, also supported by the CME Group Foundation, there are nine partner districts and about 80 teachers taking the courses. Moreover, districts have begun expressing interest in partnering with one of the universities, even absent private support.



For Consideration

Leaders from districts and schools, the ROEs, universities, educator organizations, and other states provided significant information about the proposed endorsements and mathematics teaching and learning. The landscape study underscores the interest in and need for the proposed endorsements among Illinois school districts and education leaders throughout the state. The three universities that developed the pilot EMS program have provided a viable model for programs of study in other institutions that can address the requirements of the proposed endorsements.

However, the landscape study also identifies some issues that might be considered as ISBE moves forward. Below is a summary of the issues and considerations raised in the surveys and interviews, organized into two groups: those that are already being addressed (in progress) and those that may be considered for future work.

In Progress

- Develop partnerships between universities and school districts to offer and support programs of study that lead to the proposed endorsements. This strategy is important for teacher recruitment and successful implementation of specialists.
- Foster university interest in developing EMS and EMT credentialing programs. Encouragement and support from ROEs and school districts can promote confidence that there will be sufficient interest to make it worthwhile to develop the new programs.
- Obtain grant funding for cohort models when possible. This strategy proved to be effective in promoting program enrollment in other states. The current EMS pilot program confirms that it can be effective in Illinois.
- Offer the courses to make them easily accessible to teachers, including online options and courses offered at ROEs or other convenient off-campus sites.
- Understand that teachers may need to take the courses slowly over time due to time commitments and district course reimbursement policies.
- Promote understanding of leadership opportunities broadly among teachers and districts and assist districts in identifying innovative ways for teachers with these credentials to support other teachers' knowledge and practice.

Future Work

- Allow for multiple paths: a certificate of completion, a credential, and a master's in mathematics education.
- Document the impact of the EMS endorsements on teacher learning and student achievement.
- Consider a partnership across universities that allows teachers to take courses across institutions. This would require substantial agreement across institutions on the content of each course.
- Allow teachers who hold a middle school math endorsement to obtain credit towards an EMT.
- Offer transcript reviews that take into consideration advanced coursework to be applied toward the endorsements.
- Support teachers in the programs to develop a mathematics leadership portfolio that outlines their knowledge base and skills as well as what type of position they wish to obtain.

Addendum

In February 2020, a team from the Illinois State Board of Education received an extended presentation of the landscape study findings. With the evidence from the study in hand, they agreed to move forward with creating credentials for teachers to become elementary mathematics teachers and specialists. By that time, however, ISBE was undergoing a significant restructuring of its teacher credentialing system. The changes include a revamping of the existing certification endorsements and a movement toward a new category of credentials: microcredentials. As a result, they recommended that the proposed EMS and EMT endorsements be reconfigured as microcredentials. Currently, as of June 2020, representatives from the EMS Working Group are collaborating with ISBE on the development of requirements for EMS and EMT microcredentials.

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Interest and Need



By Gudelia López, PhD, and
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