Mathematics RTI/MTSS Implementation: A Literature Review From the Perspective of Implementation Science

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This article reviewed published research on implementing the Response to Intervention (RTI)/Multi-tiered Systems of Support (MTSS) educational framework in mathematics at public schools. Today, all 50 states have adopted different forms of the tiered educational system, and the focus of these support systems is switching from model building to implementation. Currently, no literature has reviewed research in mathematics RTI/MTSS implementation practice at school. We utilized the Implementation Drivers framework to analyze current practices to fill this gap and promote scientific implementation. We also provided a context-based facilitator and barrier analysis to support researchers and stakeholders in understanding real-world practice. Findings showed that more research is needed to expand the investigations in Implementation Fidelity, Systems Intervention, Facilitative Administration, Decision-Support Data Systems, Coaching, and Selection.

Keywords: **response to intervention (RTI), multi-tiered systems of support (MTSS), implementation, mathematics, implementation science, implementation drivers**

Introduction

An Analysis from the Perspective of Implementation Science

The reauthorization of the Individuals with Disabilities Education Act (IDEA) in 2004 encouraged schools and educators to utilize Response to Intervention (RTI) to identify students with learning disabilities and to provide early interventions through the tiered support system (Fuchs & Fuchs, 2006; Jimerson et al., 2016; Werch & Runyons-Hiers, 2020) (Fuchs & Fuchs, 2006). Nearly two decades have passed since educators put RTI into practice, and RTI has been integrated into the Multi-tiered Systems of Support framework as the academic emphasis in the tiered support system (Sailor et al., 2021). Researchers observed a steady trend of using the phrase MTSS to substitute RTI in indicating the multiple-tiered support system (Berkeley et al., 2020).

Regardless of the continuing efforts from researchers to employ RTI/

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MTSS in improving students' academic performance, promising interventions from controlled research failed to be implemented in authentic school contexts and hardly helped at-risk students (Balu et al., 2015; Schumacher et al., 2017). Part of the reason for the research-to-practice gap was the shift from researchers to schoolteachers as implementers, the transition from a highly controlled research setting to the everyday school environment, and the change in implementation support from comprehensive support backed up by sufficient research funding to the individualized capacity that schools can offer (Grima-Farrell, 2017; Rycroft-Smith, 2022; Walpole et al., 2004). When examining the implementation of RTI/MTSS, Implementation Science - an innovation aimed at bridging the gap between research and practice (Eccles & Mittman, 2006) - offers a fresh perspective to analyze implementation issues and identify potential solutions to support school practices (Freeman et al., 2015; Hagermoser Sanetti & Collier-Meek, 2019).

Response to Intervention (RTI) and Multi-tiered Systems of Support (MTSS)

RTI was first used as an alternative method for identifying students with learning disabilities (Fuchs & Fuchs, 2006) and then to prioritize early identification and intervention for at-risk students (Gorski, 2019). Later, stakeholders extended a broader focus to include behavior (Positive Behavior Intervention and Supports, also called PBIS) and social-emotional learning supports into one system. The Multi-Tiered Systems of Supports (MTSS) was developed to reflect this scope adjustment. The reauthorization of the Elementary and Secondary Education Act, under the Every Student Succeeds Act (2015), marked the formal transition from using terminologies for different support systems (e.g., RTI, PBIS) to adopting an umbrella term MTSS for the integrated tiered support system. Now, MTSS has evolved into a more robust system of providing effective interventions and support to all students through evidence-based instruction, formative assessments, timely progress monitoring, and a multi-tiered level of support under a whole-child approach (Sugai & Horner, 2009). Currently, all states across the nation have adopted the tiered support model (Zhang et al., 2023); however, the transition is still in process, and we can still observe some states using RTI as an umbrella term to cover non-academic tiered support system, like use behavior RTI refer to PBIS). For this reason, we'll use RTI/MTSS in this literature review when describing the tiered support system.

The core principles of the RTI/MTSS tiered system are identification, intervention, universal screening, and progress monitoring (Basham et al., 2010). The multi-tiered model includes two to five tiers of interventions and delivers intensive support as students transit across the tiers (Fuchs & Fuchs, 2006). The most common model, the three-tiered RTI/MTSS system, operates in the following way: tier 1 focuses on in-class interventions, which include all students in the general education classroom and requires schools to provide

high-quality general education; tier 2 targets intensive interventions for students who do not respond to tier 1 instruction in a small group setting and provided more intensive and explicit instruction according to their needs; and tier 3 provides individualized interventions for students who do not respond to tier 2 instruction. If tier 3 interventions are ineffective, or instructors in any tier feel the need, students will be referred to special education assessment and evaluation (Gersten et al., 2009). Those students may qualify to receive special education services and individualized support while in or out of the tiered system (Bouck & Cosby, 2019).

RTI/ MTSS model adopted evidence-based practices (EBPs) to provide the best and necessary education service for every student (RTI Action Network, 2021). Much of the research explored the RTI /MTSS model's efficacy in both reading and mathematics. The findings showed that EBPs are promising for supporting at-risk students with reading difficulties and mathematics difficulties. This research includes but is not limited to Tier 1 classroom instructions (e.g., Clarke et al., 2011; Jitendra et al., 2018; Marchand-Martella et al., 2007), Tier 2 small group interventions (e.g., Bouck et al., 2019; Case et al., 2014; Rolfhus et al., 2012), and Tier 3 individualized instructions (e.g., Bryant et al., 2016; Denton et al., 2013; Wilson et al., 2013).

When taking a look at the tiered model implementation, unlike RTI/ MTSS reading, few schools have established protocols in mathematics RTI/ MTSS implementation (Pullen et al., 2019). Two decades of research on evidence-based mathematics interventions have given educators an arsenal of strategies for supporting children who need different levels of instruction. However, these promising interventions from the controlled condition often fall short when implemented in real school settings (Hagermoser Sanetti & Collier-Meek, 2019; Schumacher et al., 2017; Weiss et al., 2023). Understanding, analyzing, and improving the implementation practice is of key importance to improve the up taking of EBPs and activate the positive effects of the RTI/MTSS Framework at schools.

Implementation Science and Implementation Drivers (IDs)

Originating from the field of medicine (Sackett et al., 1996), Implementation Science works to investigate the process of transit practices from a scientist-controlled research context to practitioner-implemented real-life situations (Cook & Odom, 2013). It has been widely used in social work, public policy, engineering, psychology, and the education field (Forman et al., 2013; Kilbourne et al., 2020). Specifically, the Implementation Science frameworks, including the Implementation Drivers framework, have been utilized in many states' RTI/MTSS implementation practices (Berkeley et al., 2020; Zhang et al., 2023). The present research adopted the implementation science framework to analyze the current practice in mathematics RTI/MTSS implementation. No-

table, the current research focused on the system level of implementation rather than the intervention level of implementation. The key distinction between the two implementation levels is that system-level implementation focuses on improving organizational capacity, and intervention-level implementation centers on assessing and enhancing the effectiveness of specific interventions within authentic settings (Sanetti & Luh, 2019). Within the context of MTSS, system-level implementation encompasses a variety of elements, including school system evaluation, data-based decision-making systems, engagement of school leadership, and other components essential for successful implementation (Eagle et al., 2015; Werch & Runyons-Hiers, 2020).

Implementation Drivers (IDs) refer to the fundamental structural elements and core components that build up the system. IDs are the converting power engines that promote the systematical transforms (Fixsen et al., 2005). There are three types of drivers: Competency Drivers, Organization Drivers, and Leadership Driver. According to the comprehensive definition from Active Implementation Research Network (AIRN), Competency Drivers ensure staff competency to implement the program, which includes Selection, Training, Coaching, and Fidelity. The Organization Driver builds an effective system and creates a hospitable climate to support implementation practice. The three sub-drivers are Facilitative Administration, Decision Support Data System, and system intervention. The Leadership Driver manages to solve adaptive issues and technical problems throughout the implementation(AIRN, 2021).

Currently, no review is examining the implementation of mathematics RTI/MTSS. Therefore, the purpose of this study was to conduct a literature review of studies that investigated mathematics RTI/MTSS implementation. We adopted the IDs framework from the National Implementation Research Network (NIRN, 2021) to guide this literature review and synthesis.

Considering that the RTI model was formally introduced in the reauthorization of IDEA in 2004, we reviewed implementation studies published from 2004-2021. We addressed the following research questions:

1. What are the general characteristics of the included studies?
2. What IDs were discussed in the literature about mathematics RTI/MTSS implementation?
3. How did these IDs work in the specific context, as facilitators or barriers?

Method

The following procedures were conducted: 1. we conducted a comprehensive search for articles that examine RTI/MTSS implementation in mathematics, 2. we applied explicit inclusion and exclusion criteria to identify studies that meet the requirements, and 3. we coded each of the included studies according to the ID categorization of Implementation Science framework.

Comprehensive Literature Search

Studies reviewed in this article were gathered from 2004 to the present based on systematic searches in the electronic databases: Educational Resources Information Center (ERIC), PsycINFO, and Education Full Text (H.W. Wilson). The geography of the publication was limited to the United States as this review attempts to understand the implementation practice of the tiered support education initiative that originated in America. The search was limited to English-language peer-reviewed journal articles. Keywords used in the search were combinations of the root word descriptors ("response to intervention," "RTI," "multi-tiered system of support," "MTSS," "math*") with key implementation descriptors ("fidelity," "coaching," "training," "selection," "leadership," "organization," "progress monitoring," "screen," "support," "decision," "administrators," "implementation"). Eight hundred and eighty-five articles were identified after the electronic search. We then use the *Mendeley Desktop* citation managing software to remove 589 duplications. The abstracts of the resulting 296 were screened, and 23 articles were left for further assessment. Next, a complete article review was followed by applying inclusion and exclusion criteria. Eleven papers were identified and included in the present review.

Inclusion and Exclusion Criteria

For this review, we must distinguish between implementation and intervention studies for RTI/MTSS implementation. Whereas "implementation" means the "efforts to incorporate a program or practice at the community, agency, or practitioner levels," "intervention" means the "treatment or prevention efforts at the consumer level" (Fixsen et al., 2005). In the present review, the authors aim not to check the effectiveness of interventions but to examine the implementation practice. After applying this exclusion criterion, 11 studies were ruled out because the studies focused on intervention, not implementation (e.g., Bouck & Cosby, 2019; Choi et al., 2017; Johnson et al., 2013; Nelson et al., 2019; Pool et al., 2013; Ruby et al., 2011; Scott et al., 2019; Vanderheyden & Burns, 2009; Weisenburgh-Snyder et al., 2015). Additionally, Bouck and Cosby (2017) were excluded as it was a position paper rather than an empirical study.

The following inclusion criteria determine which research qualifies for inclusion in this review. The study has to (a) be empirical research, (b) be published in a peer-reviewed journal, (c) use the RTI/MTSS framework as the framework for the intervention, and (d) study the implementation of the RTI framework on mathematics. Additionally, exclusion criteria were utilized to exclude articles that meet the inclusion criteria but contain features that are not aligned with the intention of this review: (a) research done out of America, (b) implement the framework out of the K-12 school setting, and (c) intervention studies which only focusing on the intervention effectiveness. After applying the abovementioned criteria, 11 published peer-reviewed studies were identified and included in the current review.

Data Coding

Two levels of data coding were applied in the included studies. The first level of coding focused on each study's general characteristics, including the research design or method, school level, participant, number of participants, and implementation stage description. The Implementation Science ID framework guided the second-level coding. A codebook was developed according to the definition of IDs from NIRN and AIRN. Specifically, main IDs were defined as 1. Competency Drivers: activities to develop, maintain, and improve the capability of practitioners and administrators in implementing the practice; 2. Organization Drivers: the initiatives that facilitate and construct a hospitable climate for innovations; and 3. Leadership Driver: the leadership and management of the new program implementation (AIRN, 2021; NIRN, 2021). Sub drivers of the competency drivers were defined as (a) Selection: the criteria for selecting qualified candidates; (b) Training: professional learning opportunities to build the knowledge of the program; (c) Coaching: a mechanism of using feedback to improve the quality of practice; and (d) Fidelity: the assessment to gauge to what degree that practitioners followed the instruction. The sub-drivers of the Organization Drivers were (a) Decision-Support Data systems: decision-making was built upon reliable data collection and analysis; (b) Facilitative Administration: administrative support to assist the program implementation; and (c) systems interventions: external support to facilitate the program practice.

Intercoder Reliability

A graduate student in the special education program conducted a reliability check for article selection based on the set inclusion/exclusion criteria. The first run of interrater reliability was 70%. The most disagreements were in identifying if the paper researched the RTI/MTSS framework. Disagreements were resolved by both coders reviewing the entire paper and applying the set criteria. After the full-text review, the agreement reached 100%.

Results

The purpose of this study is to utilize the IDs framework from Implementation Science to analyze and understand the current RTI/MTSS implementation practices. Specifically, we queried the following research questions through the literature review: 1. What are the general characteristics of the included study? 2. What IDs were discussed in the literature about mathematics RTI/MTSS implementation? 3. How did these IDs work in the specific context, as facilitators or barriers?

Study Characteristics

Table 1. ***Characteristics of Included Studies***

Study	Method	School level	Participant	No. of Participants	Implementation Stage Description	Geographic Description
Printy & Williams (2015)	Case study - I	MS	SPs	6	Three years prior to data collection for this study, the state superintendent of instruction had increased his expectations for the ISDs to examine the impact of their work within the classrooms in their regions.	Michigan, both rural and urban areas
Werts et al. (2009)	SU	K-12	SEDs	199	RTI training for special education administrators has been offered through the Department of Public Instruction in North Carolina. Some, but not all, persons had received training. Some districts were in the implementation process, some were in the planning phase, and yet others had not yet started the process.	North Carolina, in general
Donovan and Shepherd (2013)	Case study - I & O	ES & MS	Ss	14/9	The district had begun implementation of the RTI model in mathematics six to twelve months prior to the study.	Northeastern US, rural district
Mason et al. (2019)	Case study	ESs	Ss	8	The school district already had several key characteristics of an MTSS framework in place. A data team structure and process were established, and teams were provided professional development and ongoing feedback regarding the use of multiple forms of data in reading.	Missouri, urban Midwestern district

Table 1. ***Characteristics of Included Studie (continued)***

Schumacher et al. (2017)	Mixed methods - I & SU	ESs	Ss	8	The research team designed and provided professional Development (PD) on a monthly basis to help site-based intervention teams advance their knowledge and skills about effective mathematics intervention and the DBI process. Formal data were collected through year-end surveys as well as site-based interviews with school intervention teams.	Pacific Northwest Region, urban-adjacent school district
Bartholomew and de Jong (2017)	I	HS	SPs	9	N/S	N/S
Robinson et al. (2018)	Mixed methods - I & O	ESs	T, SP, MT	13/1/1	The schools were about to complete their first year of implementation	Southeastern US, rural school district
Ryan et al. (2011)	Case study	ES	S	1	The participant school went through the pilot year of 2009-2010 and has settled an action plan that offered specific strategies to build consensus and support, conduct universal screening, provide core instruction, monitor progress, identify research-based intervention strategies, and a well-performed Leadership team.	Virginia, suburban or urban area

Table 1. ***Characteristics of Included Studie (continued)***

Swanson et al. (2012)	I & O	ESs	SETs	17 in Year 1 / 12 in Year 2	During the previous 5 years, the selected district had implemented an RTI framework.	Southwestern US, near a large city
Regan et al. (2015)	Mixed methods - SU & I	K-12	Ts & As	63 surveys / 11 interviews	Middle schools were in the second year of implementation, and high school was beginning the first year.	Virginia, suburban area
Braun et al. (2020)	Case study	ES	Ts	19	NA	A large Midwestern city, urban area

Note. I = interview, SU = Survey, O = observations, MS = Middle school, ES = Elementary School, HS = High school, SP = School principal, SED = Special education directors, S = schools, T = Teacher, MT = MTSS team, SET = Special education teacher, A = administrators, N/S = No specific information can be found.

The main study characteristics of the 11 studies were coded and presented in Table 1. In summary, most of the studies are qualitative studies, including case studies (adopt one research method or a combination of interview, survey, and observation; n = 6), survey studies (n = 1), and interview studies (n = 1). The rest of the three studies are mixed-methods studies emphasizing qualitative analysis. Most of the implementation practices reported were from elementary schools (n = 6), two from school districts that provide k-12 education, and the rest were from middle school (n = 1), high school (n = 1), and elementary and middle schools (n = 1). The participants consisted of school principals (n = 18), special education directors (n = 199), teachers (both special education teachers and general education teachers; n = 109), administrators (n = 1), paraprofessionals (n = 2), math specialist (n = 2), and the whole school (for schoolwide practice observations; n = 2). The reviewed studies cover a diverse range of geographic regions across the United States, including rural, urban, suburban, and urban-adjacent areas in the Midwest, Northeast, Southeast, Southwest, and Pacific Northwest. The areas span from the state level down to specific school districts and cities.

Mathematics RTI/MTSS IDs and Facilitators and Barriers Analysis

Table 2. ***Implementation Drive Analysis of Current RTI/MTSS Implementation Studies in Mathematics***

Study	Competency Drivers				Organization Drivers			Leadership Driver
	Selection	Training	Coaching	Fidelity	Decision-Support Data Systems	Facilitative Administration	Systems Intervention	Leadership Driver
Printy & Williams (2015)		√	√		√		√	√
Werts et al. (2009)		√			√			
Donovan & Shepherd (2013)	√	√						√
Mason et al. (2019)	√		√			√		
Schumacher et al. (2017)		√	√					
Bartholomew & de Jong (2017)	√	√						
Robinson et al. (2018)		√		√	√	√		√
Ryan et al. (2011)								√
Swanson et al. (2012)	√							
Regan et al. (2015)		√				√		
Braun et al. (2020)		√			√	√		√
Frequency Count	36.4%	63.6%	27.3%	9.1%	36.4%	36.4%	9.1%	45.5%

The most frequently mentioned ID is Competency Drivers. Organization Drivers are the least mentioned aspects of the school's tiered support system. As for the sub-drivers, only two studies reported a Systems Intervention driver, three discussed the Facilitative Administration driver, and three discussed decision Support Data systems. Table 2 presents the IDs that have been identified in each reviewed study. IDs are the essential elements that construct the implementation process. Next, we present the facilitators and barriers analysis (Table 3) in the school implementation practices with examples to illustrate how each ID has been utilized to deliver the implementation.

Table 3. ***Facilitators and Barriers Analysis***

Main Code	Sub-Code	Facilitators	Barriers
CD	S	1. Personnel were recruited explicitly for the RTI/MTSS system building in several cases.	1. Identifying the changing agency was a concern after the facilitator from the district and university left. 2. Lack of staff to perform an adequate job of progress monitoring for all students. 3. Need for additional staff as a result of increased paperwork and scheduling challenges.
	T	1. Considerable amount of training was provided by the government department of education. 2. The specialized Training was effective in preparing personnel spearhead for the RTI implementation processes. 3. The training increase teachers' expertise in strategies and interventions for supporting at-risk learners in mathematics. 4. Staff and administrators found state-supported workshops in evidence-based reading to be helpful and important 5. The professional development directly related to boosting teachers' confidence in using data to improve identification and intervention	1. No implementation plan due to lack of training was also present in some of the principal interviews. 2. Fewer teachers (as a percentage of faculty) were trained for Tier 2 interventions. 3. The amount of training different from school to school. 4. Professional development opportunities through these sources are limited due to location and technology deficits.
	C	1. Frequent meetings (once a month), Coaching, and consultation were directly related to increasing teacher's confidence in adopting data-based decision-making for students' placement in the tiered system	1. It was expensive to add the expense of coaches
	F	1. The participating schools checked Fidelity via the required paperwork	1. There were no direct fidelity checks for assessing administration support, 2. Need resources for implementation fidelity check in each tier 3. Lack of decision-making procedure fidelity check

Table 3. ***Facilitators and Barriers Analysis***

Main Code	Sub-Code	Facilitators	Barriers
OD	D	1. A culture of data-based decision-making was beginning to develop in the participating schools 2. Principals for the schools of integrated communities collaborate with their superintendents to review data and monitor the progress of implementation.	1. Need more clear instructions on curriculum selection 2. Need procedure consensus on when to initiate discussion regarding the results of RTI processes and Selection of the best evidence-based practice 3. Screening for students struggling in math was largely dependent upon standardized assessments, which were only given to some grade levels once a year. These screeners were not based on the schools' curricula, and thus could not pinpoint the specific areas in which students needed additional assistance
	FA	1. Received some administrative support	1. Schedule the time for general and special education teachers' collaboration is challenging 2. Coordinating interventions for students who receive different types of intervention was challenging 3. Hard to schedule enough time for the teachers to focus on mathematics MTSS interventions.
	SI	1. Principals for the schools of integrated communities kept collaborating with their superintendents to review data and monitor the progress of implementation.	1. Principals for the schools of differentiated communities depended only on their own interpretations of RTI without clear guidance or resource support from the district.

Table 3. ***Facilitators and Barriers Analysis***

Main Code	Sub-Code	Facilitators	Barriers
LD	LD	1. In integrated school communities, school leadership shared broadly with the principal and teacher leaders working toward a common vision of RTI to improve instruction for all students. 2. Schools established an overall "team approach" to the math curriculum. The math intervention teams met regularly to plan lessons, review student progress, and develop instructional materials. These meetings were viewed by the math teams as very important for their successful model implementation.	1. Transformational leadership alone is an insufficient condition for improving teaching and learning. The principal must also (a) stay closely connected to instructional concerns, such as through a review of data, and (b) invite teachers to share in the decision-making required to implement the instructional program. 2. Leader did not have a plan for the problem-solving process 3. No implementation plan

Note. CD = Competency Drivers, S = Selection Driver, T = Training Driver, C = Coaching Driver, F = Fidelity Driver, OD = Organization Drivers, D = Decision-support Data Systems Driver, FA = Facilitative Administration Driver, SI = Systems Interventions Driver, LD = Leadership Driver.

Competency Drivers

Competency Drivers have four subcomponents: Selection, Training, Coaching, and Fidelity. Within the Competency Drivers, the sub-driver training is the most studied ID (n = 8), followed by Selection (n = 4), Coaching (n = 3), and Fidelity (n = 1). Leadership is the next studied ID (n = 4).

Selection Driver. The selection driver has been identified as a facilitator in one study. Donovan and Shepherd (2013) analyzed the benefits and challenges of implementing mathematics RTI in elementary and middle schools. Through an interview with school personnel and observations, Donovan and Shepherd identified five themes in the school's implementation: shifting structures, increasing collaboration, improving support for at-risk students, enhancing knowledge of mathematics instructional strategies, and boosting the RTI/MTSS model adoption. Donovan and Shepherd pointed out that recruiting personnel for building the RTI/MTSS team brought a lot of benefits, including providing more expertise, better time management, and extra support for classroom teachers to build students' fundamental knowledge in Tier 1 instruction.

Three studies indicated the selection driver as a barrier, including hard to identify a change agent when experts from the district and university left (Mason et al., 2019) and not enough staff being selected to perform an adequate job (Bartholomew & de Jong, 2017; Swanson et al., 2012). For example, Swanson and colleagues (2012) used focus groups, interviews, and classroom academic instruction observations to evaluate special educators' experiences of RTI implementation. As documented in the article, there was not enough staff to implement the RTI/MTSS model. Instead, special educators were expected to undertake much additional work (e.g., collecting data) outside their regular job description to support the RTI/MTSS implementation.

Training Driver. Five studies reported the training driver as a facilitator of implementation (Donovan & Shepherd, 2013; Robinson et al., 2018; Schumacher et al., 2017; Werts et al., 2009). As an illustration, Schumacher and colleagues (2017) adopted a mixed research method and examined the challenges merged when implementing intensive interventions in mathematics at eight elementary schools in one school district. The participating schools described a positive effect between the training and teachers' confidence in applying strategies to identify students for tier 3 intervention.

Four studies identified the training driver as an impediment. For example, Bartholomew and de Jong (2017) conducted an interview study with nine high school principals to examine RTI/MTSS implementation at their schools. The school principals reflected in the interview that insufficient prerequisite knowledge caused failure to develop the implementation plan and thus impeded the practice. Similarly, Printy & Williams (2015) and Werts et al. (2009) recognized that the amount of training was different at each school since training lev-

els varied and a limited number of teachers were trained for tier 2 intervention. The obstacles identified by Regan et al. (2015) include inadequate training to support assessments, instruction procedures, and the use of data to make decisions on students' placement.

Coaching Driver. While Schumacher et al. (2017) described the coaching driver significantly boosted practitioners' confidence in the program implementation, Printy and Williams (2015) reported that in the differentiated school communities, coaches either did not exist or lacked cooperation with school teachers. To be specific, Printy and Williams investigated the principals' understanding of RTI/MTSS implementation through the lens of policy ecology. After interviews with six middle school principals, Printy and Williams identified two types of implementation communities: integrated or differentiated. In the integrated community, an integrated implementation ecology was formed, and the key actors from the government and school supported the implementation of RTI/ MTSS in the same direction. On the contrary, the policy ecology fell apart in the differentiated school community, resulting in less support for the program implementation.

Fidelity Driver. Only one study discussed Fidelity Driver in detail and showed both benefits and obstacles in its implementation. Robinson et al. (2018) adopted an exploratory method to investigate RTI/MTSS implementation in two rural elementary schools through interviews with 15 school personnel and classroom observations. The findings reflected impediments to improving implementation fidelity in rural education agencies. On the one hand, the two participant schools have established fidelity checks through the required paperwork. On the other hand, the existing fidelity check did not cover essential parts of the implementation, such as the administration assessment, tier implementation, and decision-making model operation.

Organization Drivers

The organization driver includes three sub-drivers: Decision Support Data System, Systems Intervention, and Facilitative Administration Driver.

Decision Support Data System Driver. Three papers reported decision-support data system drivers. Both Printy and Williams (2015) and Robinson et al. (2018) illustrated a welcome climate at school and the development of a data-based decision-making system to facilitate the RTI/MTSS implementation. In contrast, Werts et al. (2009) stated that a lack of consensus in sharing data, utilizing the data, and making data-based decisions hinders the implementation practices. Werts and colleagues sent an email survey to 199 special education directors to investigate the RTI/MTSS implementation practice in North Carolina. The data revealed that special education directors knew RTI was a way

for learning disability identification but had limited understanding of how to implement the RTI implementation process.

Facilitative Administration Driver. While most of the studies admitted received some degree of support from their administrations, two studies indicated that scheduling time for team collaboration on tiered instructions was a big challenge and should be addressed (Mason et al., 2019; Robinson et al., 2018). Using a case study method, Mason et al. (2019) presented university-school district cooperation in providing professional development support to enhance the mathematics MTSS implementation in eight elementary schools. Through focus group interviews and classroom observations, Mason and colleagues showed the perceived biggest challenge was scheduling time for the school team to work together for mathematics RTI/MTSS implementation. Another administration barrier was revealed by Regan et al. (2015). Regan and colleagues explored elementary and secondary educators' experiences of the RTI/MTSS program through a mixed methods study approach. Findings from the educators' perspective indicated that they were less supported in scheduling, including structured time for tier 2 and tier 3 instruction, training, planning, and collaboration.

Systems Intervention Driver. The majority of studies generally stated that the school's RTI/MTSS team obtained support from the government, superintendent, and university. Only one study illustrated the systems intervention driver. Superintendents were specific system intervention drivers in Printy and Williams (2015) study. As mentioned above, Printy and Williams categorized schools by particular characteristics into integrated or differentiated communities. While close partnerships between the integrated school communities and the superintendents were reported, there was a lack of guidance and resource support from superintendents in the differentiated school communities.

Leadership Driver

Four papers discussed the Leadership Driver. Three papers reported that positive and effective leadership leads to a successfully implemented RTI/MTSS program (Donovan & Shepherd, 2013; Printy & Williams, 2015; Ryan et al., 2011). For instance, in a case study by Ryan et al. (2011), the authors described how an elementary school implemented the RTI/MTSS model with a focus on the role of the school counselor. School counselors were identified as key leadership personnel in the RTI/MTSS team at the participant school. Ryan et al. asserted that the involvement of school counselors enhanced the collaboration between the counseling program and program teachers and promoted the implementation of the RTI/MTSS model. Conversely, Robinson and colleagues (2018) recognized that leaders' lack of implementation plan was a major impediment.

Discussion

As a brief summary, the present paper analyzed the current studies that focus on investigating implementing RTI/MTSS in mathematics in the school setting. A mixed effect was observed on each ID's work in different school contexts. The findings indicated that: (a) most research has been conducted at the elementary school level, highlighting a need for more studies at the secondary school level; (b) while the training driver has been extensively researched, the fidelity driver and system intervention driver require further investigation; and (c) the reviewed studies suggest that each driver operates differently depending on specific contexts and school practices, emphasizing the critical need to gather more contextual information regarding the implementation environment (e.g., rural or urban area, have or lack of access to implementation resources).

Lack of RTI/MTSS Implementation Research in Secondary School

It is a decades-long effort from researchers, government agencies, stakeholders, and practitioners to generate, launch, practice, test, and reflect on the RTI/MTSS framework. The RTI/MTSS framework is widely accepted across the United States to provide targeted support to facilitate students' needs regarding academic, behavior, and social-emotional perspectives.

While much research has provided examples at the elementary school level, the research field has inadequate research in secondary schools (Bartholomew & De Jong, 2017; Bouck & Cosby, 2017; Bouck et al., 2019). Compared with elementary schools' practice in implementing the RTI/MTSS framework, the present review revealed the limited research exploring secondary school's experience.

There are many differences between primary and secondary education, which caused the low adoption and implementation in the RTI/MTSS framework. Durrance (2023) mentioned several challenges for secondary schools in adopting the RTI/MTSS Model. First, Instructional Structure difference: while primary schools often use a more holistic and integrated approach to instruction, secondary schools typically have subject-specific instruction, which can make it more challenging to implement RTI/MTSS consistently across all subject areas and grade levels. Second, class management approach difference: in primary schools, students are often grouped within a single classroom with one teacher, making it easier to provide targeted interventions and monitor progress; in contrast, secondary schools typically have students moving between different teachers and classes throughout the day which can complicate the implementation of RTI/MTSS. And third, available resources difference: elementary schools were more prepared to allocate intervention resources (i.e., EBPs), offering training to school practitioners and staffing intervention personnel; however, in secondary education, there's a lack of EBPs at the grade level and lack of professionals who been appropriately trained to work with secondary students providing tiered interventions.

In addition to the previously mentioned challenges in implementing RTI/MTSS in secondary schools, the present research also revealed that stakeholders lack knowledge of applying the framework in school practice. Bartholomew and de Jong's study highlights that while high school principals were trained on broader topics related to management and knowledge-building around the RTI/MTSS framework, they received insufficient information on the execution of the implementation and intervention process. This lack of knowledge at the leadership level could significantly impact RTI/MTSS implementation, hindering intervention planning, limiting support for implementation, reducing process monitoring, and isolating the responsibility of intervention to specific individuals rather than adopting a team-based approach. More in-depth research is needed to understand and facilitate secondary schools' experience in implementing the RTI/MTSS framework.

IDs in RTI/MTSS Implementation

The IDs framework provided a logic analysis tool for this literature review and greatly supported the systematic exploration of the RTI/MTSS practice. We found that Competency Drivers are the most studied ID. This result was aligned with the implementation practice as Competency Drivers provide a basis for any implementation practice at any stage. At the beginning of the RTI/MTSS program implementation, the school should select personnel to form the RTI/MTSS team, train the team members, coach the practitioners, and check the Fidelity.

However, as data shows, only one study focused on the fidelity driver and indicated a lack of fidelity checks in the RTI/MTSS implementation. Fidelity is paramount in ensuring the accuracy and efficacy of RTI/MTSS (Center on Multi-Tiered Systems of Support, 2022; Keller-Margulis, 2012). Without establishing a fidelity data collection system and implementing a routine for collecting fidelity data, we will not be able to accurately assess the effectiveness of the program (Bos et al., 2023; Sanetti et al., 2021). Currently, there are two major resource school practitioners could adopt to monitor the fidelity data. One of them is from the Center on Multi-Tiered Systems of Support (CMTSS). The Center generated the MTSS Fidelity of Implementation Rubric and Summary Sheet that guides school stakeholders in monitoring the implementation fidelity (Center on Multi-Tiered Systems of Support, 2022). The MTSS Fidelity of Implementation Rubric provided detailed instructions on the overview and steps to complete the fidelity check and rubrics for five sections of fidelity measurement regarding universal screening, progress monitoring, data-decision making, a tiered prevention system, and school infrastructure and support mechanisms. Another resource is the Integrated MTSS Fidelity Rubric (IMFR) from the American Institutes for Research (AIR, American Institutes for Research, 2024). The IMFR comprises 14 items for evaluation across four

domains: Instruction and Intervention, Assessment, Data-Based Decision Making, and Infrastructure. Both resources offer a comprehensive and systematic approach to assist schools in constructing a fidelity data system tailored to their specific needs.

Another less-researched implementation element is the systems intervention driver. Systems intervention focuses on how the school involves external experts to support and sustain the system implementation. Involving outside experts can compensate for the knowledge shortage, bring a neutral perspective, and support more resources to facilitate the implementation (Fixsen et al., 2005). In the current review, some schools collaborate together to provide feedback and share experiences regarding data collection and progress monitoring. However, this collaboration is limited to connections within the school district rather than a broader sense of community. We agree with the implementation scientist from Frontiers that emphasizing community capital is essential to supplement the necessities and improve implementation, especially in rural areas (Emery et al., 2006; Flora et al., 2018). Due to school resource limitations, the external experts would largely benefit the school's implementation effort. The common outside expert supporters in the RTI/MTSS framework could be from the state department of education, state or local universities, and organizations dedicated to improving RTI/MTSS implementation (e.g., CMTSS, AIR).

When involving outside experts in RTI/MTSS implementation, it is crucial to understand the assets and limitations of the school's current practices. A careful self-evaluation is warranted as the first step in seeking external support. Stockslager and colleagues (2016) developed a Self-Assessment of MTSS (SAM), which is widely used across states to facilitate self-assessment of a school's RTI/MTSS implementation practices. After school RTI/MTSS team members complete the assessment, a review by school stakeholders and external experts can reveal strengths and weaknesses, providing a data basis for designing an action plan to improve implementation and optimize the use of external experts.

Facilitators and Barriers of RTI/MTSS Implementation

The results of this review reveal that all the IDs functioned as both facilitators and impediments in the mathematics RTI/MTSS implementation literature. However, some IDs were disproportionately reported as either facilitators or barriers. While Training Drivers were more frequently reported as facilitators, Selection Driver, Fidelity Driver, Decision Support Data System, Facilitative Administration Driver, and Leadership Driver were more commonly reported as barriers than facilitators. The Coaching Driver and Systems Intervention Driver were reported to have both supported and limited the RTI/MTSS implementation.

Training Driver is the only ID that primarily facilitated implementation rather than posing limitations in the specific context of the study. Several

features were recorded to make the training successful in practice. Those highlighted features included finding a destinated time for training, giving sufficient training time, providing targeted and high-quality training context, and working on boosting teachers' confidence in implementation. On the other hand, the reviewed paper reported that some RTI/MTSS staff did not have enough training to design the implementation plan, not every tier had been covered in the training, and there's a disparity of training resources between schools in the different geographic locations.

When looking at IDs that were mentioned more as limitations, it becomes clear how they operated within specific situations that influenced the implementation of mathematics RTI/MTSS. There is also a clear, interactive relationship between the IDs. Both the Leadership Driver and the Facilitative Administration Driver emphasize the importance of leadership in guiding the implementation process, decision-making, and coordination. In the reviewed studies, school leadership plays a crucial role in shaping the culture of implementation, and when leaders (principals and administrators) are not actively engaged in reviewing data, problem-solving, and supporting collaboration between general and special education staff, then the Facilitative Administration and overall RTI/MTSS process suffer.

Data-based decision-making and Fidelity are interconnected, as effective use of data ensures that interventions are aligned with student needs and that the implementation is proceeding as planned. Schools that develop strong data systems are better positioned to monitor the Fidelity of RTI/MTSS implementation, as they can track progress, identify gaps, and adjust interventions based on concrete data. However, it is evident in the reviewed paper that without consistent fidelity checks, data might not be reliable or fully integrated into decision-making.

A follow-up issue in examining the implementation of the mathematics RTI/MTSS is the challenge of classifying each school's implementation to a certain stage. According to Fixsen et al. (2015), implementation is a series of processes that can be discerned as different stages (i.e., Exploration, Installation, Initial implementation, and Full implementation), but the stage classification does not depend on how long the implementation had been carried out or how many key elements is ready, each stage is in an interactive status that influence by the environment and people engaged. A clear implementation stage identification has to be done through a systematic evaluation of the contextual characteristics of the school/school district.

Limitations

A constraint of this review is the limited number of included papers. While substantial research exists on the development of mathematics interventions, there is insufficient focus on understanding key components of math-

ematics intervention implementation in natural settings. Implementation study is a specialized field that systematically analyzes the ecology of research applications, and it holds unique value and needs dedicated expertise. With the limited amount of research exploring the implementation aspect of mathematics RTI/MTSS, the application of the current study is limited.

Implications

As the RTI/MTSS framework is broadly implemented across the United States, this review provided valuable insight for stakeholders to develop the program, the school leaders to lead and monitor the operation, practitioners to implement it, and researchers to navigate the practices. The results of this review revealed significant gaps in implementation knowledge in the field of RTI/MTSS frameworks. First, although many mathematics intervention strategies and programs have been developed to improve students' performance under the RTI/MTSS framework, few studies focused on the implementation practice from the organizational level. This limitation needs to be addressed as the RTI/MTSS framework is not a specific instruction or intervention but a system renovation. We need to use particular knowledge (e.g., implementation science) to understand the implementation components, guide the implementation strategies, allocate resources, evaluate the implementation effort, and make any adjustments to contribute to a positive and active effort in supporting RTI/MTSS implementation in mathematics.

Second, when applying the IDs framework to analyze the implementation components in the current literature, our results demonstrated that many efforts need to be made to investigate the school's current situation and address the issues in Implementation Fidelity, Systems Intervention, Facilitative Administration, Decision-Support Data Systems, Coaching, and Selection drivers when implementing the RTI/MTSS framework. Training Driver has been discussed heavily across the included studies, and our results also discovered that there were an equal number of studies addressing either benefits or impediments in the training practice. This situation calls for more research on improving the professional development of implementation team members, including school practitioners, principals, and administrators. The training should also focus on operationalizing each part of the RTI/MTSS model, such as how to use the data system to make placement decisions, how to provide tiered instruction at each level, how to establish and evaluate Fidelity, and how to coordinate behavioral and social-emotional aspects of MTSS to largely benefit student's academic performance.

Thirdly, while external support from the state department of education may vary from state to state (Zhang et al., 2023), establishing university-school collaborations holds significant potential in supporting local education agencies

in various ways, especially in the less resources rural areas. Firstly, universities can conduct external evaluations to assess schools' assets and readiness to implement RTI/MTSS. Second, universities can provide comprehensive training for school practitioners, covering topics such as the RTI/MTSS model, effective implementation of tiered interventions, data collection for decision-making, the establishment of fidelity evaluation systems, and the collection of fidelity data. Additionally, universities can offer coaching and support to practitioners when needed, provide suggestions on evidence-based interventions tailored to teacher and student needs, and evaluate the effectiveness of implementation practices.

Fourth, future research should provide a more contextual investigation into the specific characteristics of participants, like the demographic characteristics of schools (i.e., rural or urban areas) and the accessibility to RTI/MTSS implementation support. This could include examining variations in funding, staffing, and professional development opportunities, as well as the availability of resources such as technology and instructional materials. Understanding these contextual factors is crucial for implementing mathematics interventions that are equitable and effective across diverse educational environments.

Last, from a broader perspective, studies preparing future educators for effective implementation of the RTI/MTSS in mathematics are also crucial and promising in providing pre-exposal and intervention to solve aforementioned struggles at school in their future works. The benefit of preparing high-quality pre-service teachers in implementing RTI/MTSS in mathematics includes establishing a strong buy-in of the tiered approach, building a concrete understanding of RTI/MTSS framework, integrating different tiered intervention in practice, forming a strong data-based decision-making approach, an emphasis on Fidelity of implementation, and form a strong teamwork approach.

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Appendix 1

PRISMA 2020 Flow Diagram