K–12 Integrated STEM Education Landscape Scan

Erika Kessler, PhD and Amy Trauth, PhD
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Introduction

The concept of integrated science, technology, engineering, and mathematics (STEM) education has gained significant traction in educational research and policy, yet its definition and relationship to related constructs such as multidisciplinary, interdisciplinary, and transdisciplinary STEM remain contested (English, 2016; Kelley & Knowles, 2016; NRC, 2014; Martín-Páez et al., 2019; Portillo-Blanco et al., 2025). At its core, integrated STEM refers to educational approaches that purposefully connect two or more of the STEM disciplines—science, technology, engineering, and mathematics—within learning experiences, often through real-world problems or design challenges (English, 2016; Kelley & Knowles, 2016; NRC, 2014). A persistent challenge is the lack of consensus on what constitutes integrated STEM, as well as inconsistent use of related terms (Martín-Páez et al., 2019; NRC, 2014; Portillo-Blanco et al., 2025). Many studies and interventions claim to be "STEM" or "integrated STEM" without clearly articulating the nature or depth of integration, leading to confusion and difficulties in comparing outcomes (Martín-Páez et al., 2019; NRC, 2014). As Portillo-Blanco et al. (2025) argued, there is a need for greater clarity and consistency in defining and operationalizing iSTEM principles, including the relationships among integration, real-world problems, design, inquiry, and teamwork.

Herein, we define "integrated STEM" (iSTEM) as the intentional blending of content and practices from at least two STEM disciplines, to deepen students' understanding and ability to apply knowledge in authentic contexts (Kelley & Knowles, 2016; NRC, 2014; Martín-Páez et al., 2019). The National Research Council (NRC, 2014) described integrated STEM as "working in the context of complex phenomena or situations on tasks that require students to use knowledge and skills from multiple disciplines" (p. 52). This integration can occur at various levels, from lesson and unit design to schoolwide or systemwide initiatives (NRC, 2014; English, 2016). When implemented well, integrated STEM education transcends traditional disciplinary boundaries, offering students opportunities to develop and apply skills that cross disciplinary boundaries, thus representing knowledge-in-use that is more closely aligned to the work of professionals in STEM-related and STEM-adjacent fields (Martín-Páez et al., 2019; Portillo-Blanco et al., 2025; Takeuchi et al., 2020). We investigated two research questions (RQs):

> **RQ1.** What are the most common characteristics of K–12 integrated STEM education programs and initiatives in states and federally funded projects?
>
> **RQ2.** What are the most common metrics of success in integrated K–12 STEM education programs and initiatives reported by states and federally funded projects?

The chief goal of this study was to characterize integrated STEM across the United States to illustrate the similarities and areas of divergence in state approaches and those taken by STEM education researchers. We conducted a landscape scan of documents from state departments of education, STEM ecosystems, and state-level initiatives. We also conducted a literature review of peer-reviewed research on integrated STEM in K–12 settings in the last 15 years. Overall, we endeavored to synthesize common characteristics that shape K–12 integrated STEM education policy and practice, which could shape future initiatives in supporting teacher professional learning and student outcomes related to STEM fields.

Data Sources

State-Level Program and Initiative Reports

We searched state-level programs and initiatives in K–12 integrated STEM education. This effort included searches for state-level reports and data dashboards on the published websites of state departments of education, state STEM ecosystems or networks (e.g., the Ohio STEM Learning Network), and regional education service centers in states. We compiled within a database state-level, integrated STEM education reports, frameworks, and guidance materials for all 50 U.S. states; Puerto Rico; and Washington, DC. We then initially reviewed these documents by identifying states that included the most comprehensive information on integrated STEM aligned to the NRC's (2014) four features of integrated STEM: *nature and scope of integration*, *implementation*, *goals*, and *outcomes*. We identified reports from 20 states that had the most comprehensive information based on NRC's (2014) four features. A total of 62 documents from these 20 states formed the corpus of the state-level data that we analyzed. These documents included the following types:

- **Integrated STEM framework/guidance materials**—documents that provide local education agencies, schools, and school communities with definitions, theories of action, objectives, strategies, and indicators for implementing integrated STEM. They serve as guiding documents for creating customized STEM programs and ensuring that students are prepared for future STEM pathways.
- **Integrated STEM program evaluations**—documents that involve assessing the components, implementation, goals, and outcomes of integrated STEM programs.
- **Integrated STEM research reports**—documents that present empirical findings from a combination of sources, including more than one evaluation, study, and/or program within the state. Our analysis included annual reports or those that presented findings from multiyear initiatives on integrated STEM in a state.

The number and type of each document by state are listed in Exhibit 1. A full list of references for each document by state can be found in Appendix A-1.

Exhibit 1. Number and Types of State Documents Coded for the K–12 Integrated STEM Landscape Scan

State	Document type		
	Framework/guidance	Program evaluation	Research report
Alabama (AL)	1	–	–
Arizona (AZ)	2	–	–
Arkansas (AR)	1	–	–
District of Columbia (DC)	1	–	–
Georgia (GA)	3	–	–
Idaho (ID)	1	–	1
Indiana (IN)	6	–	1
Iowa (IA)	1	–	1
Louisiana (LA)	1	–	1
Massachusetts (MA)	2	–	–
Michigan (MI)	–	1	2
Nevada (NV)	1	1	1
North Carolina (NC)	2	–	1
Ohio (OH)	5	–	–
Oregon (OR)	2	1	–
Tennessee (TN)	3	2	1
Texas (TX)	5	–	–
Utah (UT)	2	–	2
Washington (WA)	1	3	–
Wisconsin (WI)	2	–	1
Total (*n* = 62)	42	8	12

Note. A dash (–) means not present. STEM = science, technology, engineering, and math. Data on integrated STEM state documents were sourced from search queries on state education agency websites and other state-level education websites. Counts in this table should be interpreted as the number of documents included in the analysis for each document type across states (*n* = 62).

Program Evaluations and Research Articles

AIR searched research articles evaluating or researching programs and initiatives in K–12 integrated STEM education. To identify the sample, we conducted a comprehensive search of research articles on integrated STEM education using three major academic databases: Google

Scholar, EBSCOhost, and Web of Science. Search terms included combinations of “integrated STEM”, “interdisciplinary OR multidisciplinary OR transdisciplinary OR cross-disciplinary STEM education”, “quasi-experimental”, “randomized controlled-trial”, “evaluation”, and/or “STEM education.” Filters were applied to include only research journal articles published in English within the last 15 years (2010–2025). We compiled all relevant research articles in a database (n = 62). We then conducted an initial review and considered articles by identifying the methodology/research design, study location (domestic or international), and STEM education focus (student literacy, teacher professional learning, curricula development, program case studies).

We identified 30 research articles that included findings related to K–12 student and/or teacher learning. These 30 articles formed the corpus of the research data that we analyzed. All articles were quantitative or mixed-methods studies that included approaches such as randomized controlled trials, quasi-experimental, correlational, or descriptive. Articles were a mixture of both domestic and international studies. International studies are included in this analysis because they offer comparative insights and evidence-based practices that enrich understanding of effective integrated STEM implementation. Additionally, there were four meta-analyses focused on student literacy and achievement outcomes. The 30 articles in our analysis focused on the following topics:

- **Student STEM Literacy and Achievement—**research that examined the impact of integrated STEM programs on students’ academic performance, conceptual understanding, and STEM literacy across disciplines.
- **Student Dispositions, Attitudes, or Perceptions**—research that explored how integrated STEM experiences influenced students’ interest, motivation, self-efficacy, and perceptions of STEM subjects or careers.
- **Teacher Dispositions, Attitudes, or Perceptions—**research that investigated how educators’ beliefs, confidence, and attitudes toward integrated STEM teaching evolved through participation in programs or interventions.
- **Teaching Professional Learning, Development, or Preservice Learning—**research that evaluated the design, implementation, and outcomes of professional development or preservice training programs for equipping teachers with skills and knowledge for integrated STEM instruction.

The number of research articles by topic is listed in Exhibit 2. A full list of references for research articles can be found in Appendix A–2.

Exhibit 2. Number of Research Articles Coded for the K–12 Integrated STEM Landscape Scan by Primary Focus

Research article focus	Number of research articles
Student Literacy and Achievement	20
Student Dispositions, Attitudes, or Perceptions	3
Teacher Dispositions, Attitudes, or Perceptions	2
Teaching Professional Learning, Development, or Preservice Learning	5
Total (*n* = 30)	30

Note. Table counts articles based on the primary focus area; articles may include other focus areas but are considered secondary or tertiary foci in the research article. Data on integrated STEM research articles were sourced from search queries using major academic databases such as Google Scholar, EBSCOhost, and Web of Science. Counts in this table should be interpreted as the number of articles included in the analysis for each document focus (*n* = 30).

Data Analysis

AIR developed a standardized binary-coding protocol to analyze state-level report documents and research articles (see Exhibit 3). Our coding protocol aligned with the NRC's (2014) four features of integrated STEM: *nature and scope of integration*, *implementation*, *goals*, and *outcomes*. We used binary coding to indicate whether criteria were present or absent in the document. For example, in the nature and scope-of-integration criteria, we coded whether documents or articles included a definition of integrated STEM and whether that definition included terms such as integrated (yes/no), interdisciplinary (yes/no), transdisciplinary (yes/no), cross-disciplinary (yes/no), or multidisciplinary (yes/no). We also coded documents to track which of the four disciplines in STEM were emphasized.

Exhibit 3. K–12 Integrated STEM Landscape Scan Analytic Coding Protocol

Criteria	Program components and measures
RQ1. What are the most commonly reported characteristics of K–12 integrated STEM education programs and initiatives in states and federally funded projects?	
Nature and scope of integration	How "integration" is defined—integrated, interdisciplinary, cross-disciplinary, transdisciplinary, etc. Disciplinary emphases—science, technology/computer science, engineering, and/or mathematics
Implementation	Learning context—formal (students, in school), informal (students, extracurricular or out of school), professional learning (educators) Educator supports—PLCs, coaching, curriculum materials, etc. Instructional design—problem-based learning, project-based learning, design-based learning, inquiry, etc.

Criteria	Program components and measures	
	Program characteristics—culturally relevant, authentic/real world, industry partnerships, career exploration, etc. Program components—advisory board, STEM-focused school leadership, interdisciplinary curriculum teams, personalized teacher professional learning, etc.	
RQ2. What are the most common metrics of success in integrated K–12 STEM education programs and initiatives reported by states and federally funded projects?		
Goals	**Students** STEM literacy/proficiency STEM interest and engagement STEM career awareness STEM content knowledge and skills College and career readiness 21st-century competencies	**Educators** STEM content knowledge STEM pedagogical content knowledge and skills STEM career awareness Self-efficacy/confidence/attitudes/ dispositions for STEM teaching
Outcomes	**Students** STEM interest, motivation, and identity STEM learning and achievement STEM career awareness College and career readiness 21st-century competencies	**Educators** STEM content knowledge STEM pedagogical content knowledge and skills STEM career awareness STEM educator self-efficacy, attitudes, confidence, and dispositions Changes to STEM educator practice

Note. STEM = science, technology, engineering, and mathematics; PLC = professional learning community.

Findings

In this section, we report the findings from our analysis of state-level report documents (*n* = 62) from 20 states and research articles (*n* = 30) evaluating integrated STEM initiatives. In the findings that follow, we present frequencies and proportions of different integrated STEM components within these documents and articles based on the four criteria outlined in the coding protocol: *nature and scope of integration*, *implementation*, *goals*, and *outcomes* of integrated STEM. Findings are summarized **by state document** (*n* = 62) and by state (*n* = 20) for state-level reports and **by research article** for peer-reviewed journal articles (*n* = 30).

RQ1. What are the characteristics of the most commonly reported K–12 integrated STEM education programs and initiatives in other states and federally funded projects?

To address RQ1, in the following section we first discuss the *nature and scope* of K–12 integrated STEM education programs outlined documents (*n* = 62) and research articles (*n* = 30). We synthesize how state documents and research articles define the term "integrated

STEM" and which STEM disciplines are emphasized in documents and articles. Second, we examine the components of effective integrated STEM *implementation* described across state documents and research articles. Components of implementation include types of learning contexts (i.e., formal and informal), supports provided to educators, and overall program characteristics of integrated STEM programs.

Nature and Scope of K–12 STEM Integration

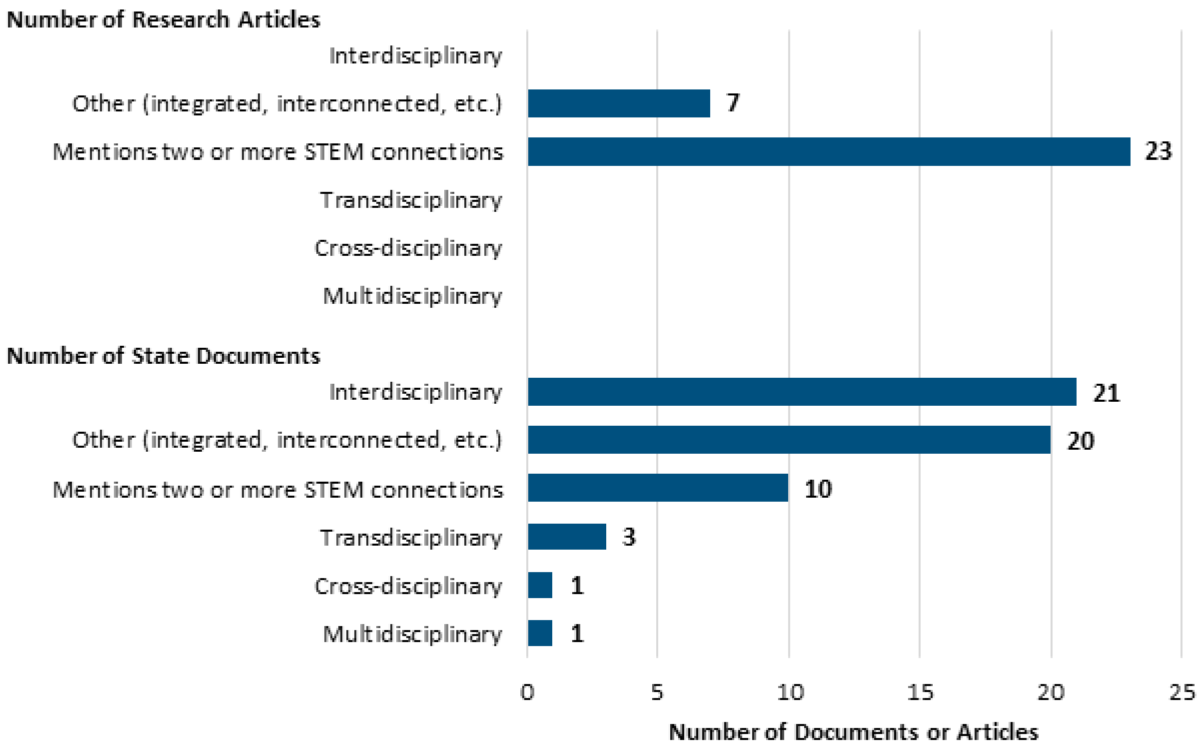
The nature of K–12 STEM integration refers to the type of STEM connections and disciplinary emphasis in education programs and teacher professional learning. As outlined below, we found that not all documents or articles described integrated STEM in the same way, nor did they place equivalent emphasis on all four domains of STEM. Our reporting synthesizes types of STEM connections and disciplinary emphasis to show commonalities across documents and articles. The scope of STEM integration refers to the duration, size, and complexity of programming. As is detailed in the findings below, we found that state documents prioritized yearlong, school-level integrated STEM programming that included connections with career and industry. Research articles evaluating integrated STEM programming and curriculum, however, prioritized shorter term, classroom-level, integrated STEM programming that emphasized authentic, real-world design and inquiry-based learning.

FINDING 1

Across state documents and research articles, we found that a variety of terms are used to characterize the nature and scope of STEM integration, including transdisciplinary, interdisciplinary, and cross-disciplinary. The nature and scope of STEM integration signaled by these terms can be used to inform the characteristics and structure of integrated STEM learning environments and the types of support offered to teachers. Regardless of the terms used to describe the nature and scope of integrated STEM, all four domains—science, technology, engineering, and math—were described as equally important for students to learn.

Research on integrated STEM points to three essential elements that determine the nature and scope of integration: the types of STEM connections; disciplinary emphasis; and the initiative's duration, size, and complexity (English, 2016; Kelley & Knowles, 2016; NRC, 2014). State documents and research articles used a variety of terms to describe the integration of two or more STEM disciplines: *interdisciplinary* STEM, *multidisciplinary* STEM, *cross-disciplinary* STEM, and/or *transdisciplinary* STEM. To capture the broadest cross-section of state documents and research articles related to the integration of two or more STEM disciplines in K–12 education, we searched for documents and articles that included one or more of these terms. In this report, we use “integrated STEM” to broadly encompass all these terms. In our analysis, we evaluated how integrated STEM was defined on the basis of these related terms (see Exhibit 4).

Exhibit 4. Number of State Documents and Research Articles That Use Related Terms to Define Integrated STEM



Note. STEM = science, technology, engineering, and math. Data on integrated STEM state documents were sourced from search queries on state education agency websites and other state-level education websites. Data on integrated STEM research articles were sourced from search queries using major academic databases such as Google Scholar, EBSCOhost, and Web of Science. Counts in this chart should be interpreted as the number of documents and articles included in analysis for each term to define “integrated STEM” in documents (n = 62) across states (n = 20) and in research articles (n = 30).

Integrated STEM was described in a variety of ways in the state documents that we analyzed. Eight states (AR, AZ, IN, MI, OH, TN, TX, WI; 40%) had documents that comprehensively defined integrated STEM. For example, Texas included a robust definition of integrated STEM through guidance on integration strategies that removed traditional boundaries between disciplines using multidisciplinary, interdisciplinary, cross-disciplinary, or transdisciplinary approaches. Texas documents provided definitions for each of these approaches and how they could be applied in STEM instruction (Texas Education Agency, n.d.).

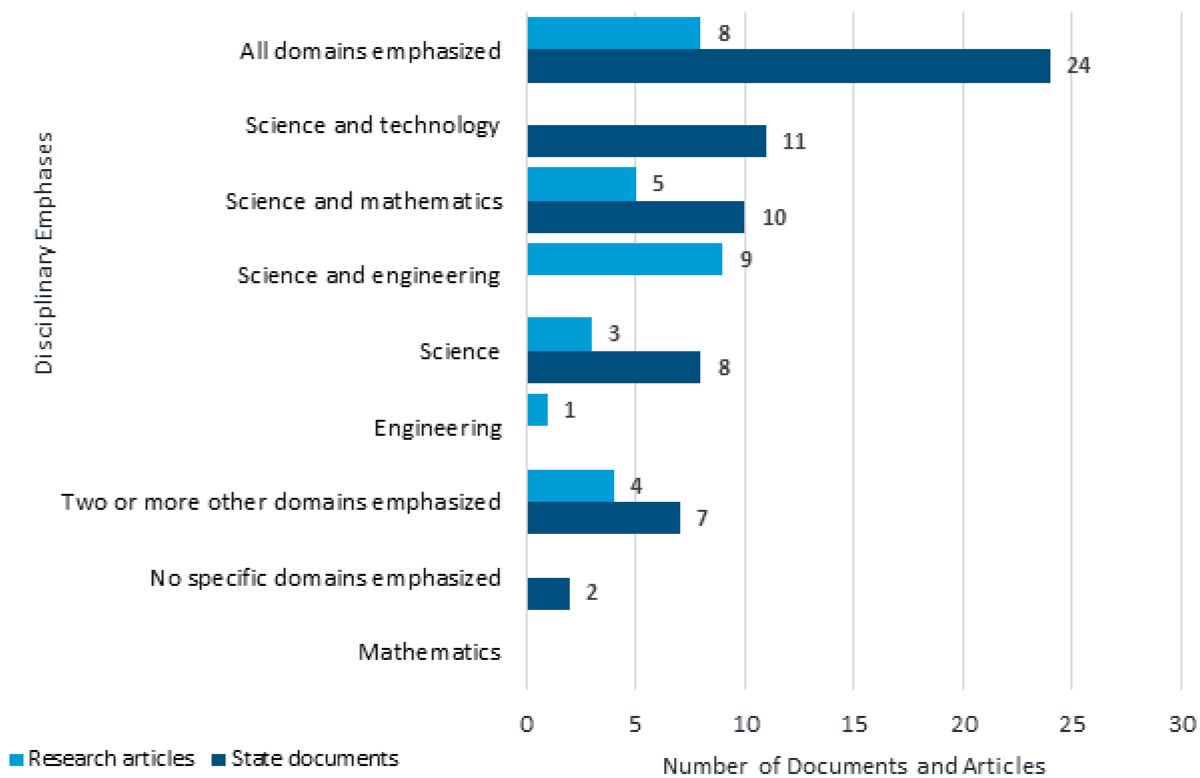
All but two research articles provided a comprehensive definition of integrated STEM. Overall, a majority of research articles (93%, 28 articles) emphasized integrated STEM as an instructional approach that includes at least two STEM subjects by combining skills and concepts across disciplines and applying that knowledge and those skills in addressing real-world problems (e.g., Arshad et al., 2021; Chen & Chang, 2018; Chen et al., 2025; Menon et al., 2023). Often, the integration of STEM disciplines is accomplished through engineering design (e.g., Han et al., 2023; Thomason & Hsu, 2024) and technology-focused projects (Thibaut et al., 2018).

Across state documents, we found that the word "interdisciplinary" was used most often to describe integrated STEM (21 documents [34%] across 12 states [60%]). For example, Georgia defined "integrated STEM" as engaging students in interdisciplinary activities in which they use science, math, technology, and engineering design practices in interdisciplinary lessons and projects (Georgia Department of Education, 2023a, 2023b). Other terms, such as "interconnected" or "integrated STEM", were nearly as frequent (20 documents [32%] across 12 states [60%] and seven articles [23%]). Five states (25%) mentioned two or more integrated STEM-related terms across 10 documents (IN, OH, TN, TX, WI; 16%). For example, Wisconsin's Department of Instruction mentioned that the characteristics of quality STEM education include STEM that is integrated and thematic and that infuses true collaboration across STEM disciplines (Surr et al., 2016). Documents in a few states described STEM programming as transdisciplinary (OH, TN), cross-disciplinary (IN), or multidisciplinary (MA).

A majority of research articles mentioned two or more STEM-related terms to describe integrated STEM (23 articles, 77%). For example, Gao et al. (2020) described STEM education as integrated, interdisciplinary, and transdisciplinary, which means that STEM education links learning across the STEM disciplines in layered ways. Where transdisciplinary approaches disregard discipline boundaries and focus on the issue at hand, interdisciplinary approaches juxtapose and integrate disciplines as still discreet components. Integration combines these approaches into a seamless whole. The term "integrated STEM" was used solely in seven research articles (23%); no other term was included. For example, Means et al. (2016) argued that integrated STEM is a more descriptive rather than prescriptive stance toward STEM education. No research articles used terms such as "interdisciplinary", "transdisciplinary", "multidisciplinary", or "cross-disciplinary" on their own to describe STEM.

A majority of state documents and research articles emphasized multiple disciplines in their definitions of integrated STEM. Twenty-four state documents (39%) and eight research articles (27%) emphasized all four disciplines for integrated STEM (see Exhibit 5). Ten documents (16%) from eight states (35%) and five research articles (17%) identified science and math as the primary disciplines of focus for integrated STEM (AL, DC, IA, IN, MI, NV, UT, WA). Nine research articles focused on science and engineering (30%); however, zero state documents did. In contrast, six states (AL, DC, ID, MI, NV, OR; 30%) identified science and technology/computer science as the primary disciplines (11 documents, 18%); however, no research articles did. Five states (ID, MA, NV, OR, TN; 25%) prioritized science as the primary discipline, with other disciplines serving a secondary role in integrated STEM programming (eight documents), as well as in three research articles. For instance, Indiana's STEM certification process and rubric guidance primarily emphasized science and engineering practices but also provided secondary emphases on using technology and math education (Indiana Department of Education, 2024).

Exhibit 5. Disciplinary Emphases Within State Documents and Research Articles Used as Indicators of Integrated STEM



Note. STEM = science, technology, engineering, and math. Data on state-integrated STEM documents were sourced from search queries on state education agency websites and other state-level education websites. Data on research-integrated STEM articles were sourced from search queries using major academic databases such as Google Scholar, EBSCOhost, and Web of Science. Counts in this chart should be interpreted as the number of documents and articles included in the analysis for each term to define "integrated STEM" in documents (n = 62) across states (n = 20) and in articles (n = 30).

K–12 Integrated STEM Implementation

There are a range of factors that state policymakers and education researchers consider when advocating for or directly supporting the *implementation* of integrated STEM. These factors include when and where integrated STEM programming is offered to students (e.g., during the school day and/or as an extracurricular activity), the types of supports offered to educators who facilitate integrated STEM learning, and the types of instructional designs that align with the goals and expected outcomes of integrated STEM education. Our analysis of state documents and research articles tracked descriptions of these factors to clarify the most common contexts and characteristics of integrated STEM programming in K–12 schools.

FINDING 2

State documents and research articles most commonly describe the effective instructional designs for integrated STEM as problem- and project-based learning of two or more STEM disciplines grounded in relevant, authentic contexts. Although variation exists in successful integrated STEM education, classroom environments, extracurricular programming, and teacher professional learning could be shaped by these principles.

Integrated STEM Learning Contexts For Teachers and Students

State documents focused on formal learning contexts, informal (extracurricular) settings, and teacher professional learning for integrated STEM (22 documents [35%] across 14 states [70%]). For instance, Michigan's MiSTEM Network's Annual Report for 2023 outlined four pillars for advancing STEM. Two pillars aimed to empower educators through professional learning and to ensure high-quality STEM in classrooms. The other two pillars aimed to integrate industry with education through extracurricular activities and internship opportunities and to create a STEM culture within the state of Michigan through cross-school STEM programming, awards, and extracurricular experiences (MiSTEM Advisory Council, 2023). In all, seven states (GA, IA, LA, OH, TN, TX, UT; 35%) and 18 documents (29%) offered guidance, frameworks, or empirical outcomes on integrated STEM learning in formal and informal environments and/or teacher professional learning.

Research articles most often focused on formal learning contexts—student learning in classrooms and teacher professional learning (13 articles, 43%). Eight articles focused on at least two or more learning contexts (27%). There were seven articles (23%) that focused particularly on teacher professional learning, either for preservice teachers (Burrows et al., 2021; Johnson et al., 2021; Menon et al., 2023) or through inservice teacher professional learning programs and initiatives (Feng et al., 2020; Havice et al., 2018; Kelley & Knowles, 2020; Thibaut et al., 2018). Two articles (7%) examined informal (extracurricular) integrated STEM programming (Blanchard et al., 2015; Simeon et al., 2022).

Across the majority of state documents and research articles, effective integrated STEM is described as that which provides students with opportunities to actively engage and apply

their knowledge in practical ways. We found problem-based learning to be a frequently recommended or cited instructional design for integrated STEM in state documents (*n* = 37, 60%) and in research articles (*n* = 17, 57%). Although problem-based learning was most frequently cited across state documents, inquiry and design-based learning were most frequently cited in research articles (*n* = 21, 70% and *n* = 20, 67%). Design-based learning was cited in only 12 state documents (19%), and inquiry was cited in 15 state documents (24%). Nearly half of the documents (47%) across a majority of states (60%) and a majority of research articles (67%) described effective integrated STEM instructional design as that which combines more than one instructional approach. For example, the Ohio Department of Education indicated that schools aspiring to an innovative instructional model for STEM should integrate STEM curriculum in ways that engaged students in "authentic, problem-based learning and design thinking" and "project-based learning [as] embedded in these learning opportunities" (Ohio Department of Education, 2024). Notably, Ohio emphasized that when implemented well, problem-based learning should anchor a school's instructional model instead of serving as an ancillary or add-on component (Ohio Department of Education, 2024). Twenty-five of 62 state documents that we analyzed (40%) did not include any information about effective integrated STEM instructional design.

Integrated STEM Professional Learning for Teachers

Fewer than half of state documents included information about effective educator supports for integrated STEM programming (*n* = 25, 40%). These documents represent 12 states (40% of states included in this analysis). In these documents, the most commonly cited strategies for effective integrated STEM included collaborative time for teachers from across disciplines to work together to plan for implementation, professional learning opportunities on integrated STEM, and adequate funding for professional learning. In some states, educator hubs have been implemented to facilitate cross-school learning on integrated STEM, such as in ID, IA, MI, OR, TN, and UT. For instance, Idaho's STEM Action Center has established three regional hubs to serve educators and students across the state. The STEM Action Center also includes an i-STEM library, which provides access to a standardized repository of high-quality STEM learning materials (Idaho STEM Action Center, 2022). Other states offer STEM certification to teachers who complete continuing education and provide stipends for teachers to participate in integrated STEM professional learning. For instance, a recent report published by RAND and sponsored by the Louisiana Department of Education evaluated 18 STEM microcredentials and their implementation for supporting teachers (Doss et al., 2024). This report found that teachers were more likely to complete STEM microcredentials when these opportunities were tied to professional growth and pay increases. In addition, when microcredentials were offered with enough time and space for teachers to engage in them during the school day, the burden for completing these credentials was reduced. The report recommended cohort models to support collaboration among teachers working on microcredentials.

In contrast, a majority of the research articles we analyzed included information about effective teacher support for integrated STEM programming (*n* = 17, 57%). Several articles evaluating integrated STEM curriculum or program implementation also considered professional learning supports for teachers. For instance, Anwar et al. (2022) found that effective implementation of an integrated STEM curriculum was supported by a structured teacher professional development program that equipped educators to facilitate authentic, design-based science learning experiences. Means et al. (2021) evaluated five STEM high school programs across North Carolina, Texas, and Ohio and reported that teacher supports were integrated into the programming. For example, in Ohio the integrated STEM programs were supported by the Ohio STEM Learning Network, providing collaboration opportunities, joint classes, site visits, and educator-to-educator professional learning opportunities (Means et al., 2021). Research articles consistently emphasize that supporting teachers is essential for enhancing instructional practices and improving student achievement in integrated STEM learning environments.

Integrated STEM Program Characteristics

A large majority of state documents and research articles identified the linkage of STEM knowledge with real-world problems as an essential characteristic of integrated STEM programs (see Exhibits 6 and 7). Our analysis revealed that most states (*n* = 16, 80%) across documents (36 documents, 58%) and research articles (24 articles, 80%) emphasized the need for integrated STEM programming to include authentic, real-world learning experiences. Many state documents emphasized the importance of student access to industry partnerships (12 states, 60%; 20 documents, 32%) and affording students opportunities for career exploration (13 states, 65%; 27 documents, 44%). The state of Washington reported that a characteristic of STEM programming was offering students dual high school–college credit through a research practice partnership. In contrast, industry partnerships were mentioned in only one research article. Career exploration opportunities were described in only four research articles (13%). Documents from six states (GA, MI, OH, TX, UT, WI; 30%) indicated the need for integrated STEM instruction to be culturally relevant to students. Culturally relevant teaching and learning were mentioned in eight research articles and were present across focus areas for teachers and students (27%).

Exhibit 6. Number of Instances of Effective Integrated STEM Program Characteristics in State Documents, by State

State	Authentic learning opportunities	Career exploration	Industry partnerships	Culturally relevant teaching/learning
Alabama (AL)	1	–	–	–
Arizona (AZ)	–	–	–	–
Arkansas (AR)	1	1	1	–
District of Columbia (DC)	1	1	1	–
Georgia (GA)	2	2	2	1
Idaho (ID)	2	2	2	–
Indiana (IN)	5	4	2	–
Iowa (IA)	–	–	–	–
Louisiana (LA)	1	1	1	–
Massachusetts (MA)	2	1	–	–
Michigan (MI)	1	2	2	2
Nevada (NV)	–	–	–	–
North Carolina (NC)	3	1	–	–
Ohio (OH)	4	4	4	1
Oregon (OR)	2	2	2	–
Tennessee (TN)	4	3	1	–
Texas (TX)	4	3	1	3
Utah (UT)	2	–	1	1
Washington (WA)	–	–	–	–
Wisconsin (WI)	1	–	–	1
Total instances	36	27	12	9

Note. A dash (–) means not present. STEM = science, technology, engineering, and math. Data on state-integrated STEM documents were sourced from search queries on state education agency websites and other state-level education websites. Counts in this table should be interpreted as the number of instances in which effective STEM program characteristics were identified or described across the 62 state documents that we analyzed.

Exhibit 7. Number of Instances of Effective Integrated STEM Program Characteristics in Research Articles, by Topic

Focus Area	Authentic learning opportunities	Career exploration	Industry partnerships	Culturally relevant teaching/learning
Student Literacy or Proficiency	17	2	1	5
Student Dispositions, Attitudes, or Perceptions	3	1	–	1
Teacher Dispositions, Attitudes, or Perceptions	1	1	–	1
Teaching Professional Learning, Development, or Preservice Learning	3	–	–	1
Total instances	24	4	1	8

Note. A dash (–) means not present. STEM = science, technology, engineering, and math. Integrated STEM research articles were sourced from search queries using major academic databases such as Google Scholar, EBSCOhost, and Web of Science. The counts in this table should be interpreted as the number of articles included in the analysis for each instance of effective integrated STEM program characteristics in articles (*n* = 30).

Integrated STEM Program Components

Our analysis focused on five key program components of effective integrated STEM programs, as outlined in NRC (2014): (1) an advisory board, (2) interdisciplinary curriculum teams, (3) integrated STEM curricula, (4) teacher professional learning, and (5) STEM-focused school leadership. Not all documents or articles that we reviewed included these five integrated STEM program components.

We identified 39 documents (63%) from 19 states (95%) that included information on one or more of the five components of effective integrated STEM programs. As shown in Exhibit 8, integrated STEM curricula were the most frequently cited component in state documents that we examined (30 documents, 48%; 15 states, 75%). STEM-focused school leadership was the second most common component (22 documents, 35%; 12 states, 60%). Advisory boards were cited in 21 documents (34%) across 13 states (65%). Interdisciplinary curriculum teams were described in 19 documents (30%) across 13 states (65%). Finally, teacher professional learning was mentioned in 13 documents (20%) across nine states (45%). Other program components did emerge during the analysis. These other components, for instance, included external partnerships and teacher externships to extend learning partnerships (IA, OH, TN, and WI), STEM diplomas for student graduation (ID), and computer science programming (IA, MA, and TN).

Exhibit 8. Number of Instances of Effective Integrated STEM Program Components, by State

State	STEM curricula	STEM-focused school leadership	Advisory board	Interdisciplinary curriculum teams	Teacher professional learning	Other
Alabama (AL)	1	–	–	–	–	–
Arizona (AZ)	–	–	–	–	–	–
Arkansas (AR)	1	1	–	1	1	–
District of Columbia (DC)	1	–	–	–	–	–
Georgia (GA)	2	2	2	2	2	–
Idaho (ID)	1	–	1	1	–	1
Indiana (IN)	4	4	4	3	4	–
Iowa (IA)	1	1	–	1	1	1
Louisiana (LA)	2	1	2	2	1	–
Massachusetts (MA)	–	–	1	–	–	1
Michigan (MI)	2	–	2	–	–	–
Nevada (NV)	–	–	1	–	–	–
North Carolina (NC)	3	2	1	1	2	–
Ohio (OH)	3	3	3	3	3	1
Oregon (OR)	1	1	1	1	1	–
Tennessee (TN)	2	2	1	1	2	1
Texas (TX)	3	2	–	1	2	–
Utah (UT)	3	2	1	1	2	–
Washington (WA)	–	1	1	–	1	–
Wisconsin (WI)	–	–	–	1	–	1
Total instances	30	22	21	19	13	6

Note. A dash (–) means not present. STEM = science, technology, engineering, and math. Data on state-integrated STEM documents were sourced from search queries on state education agency websites and other state-level education websites. Counts in this table should be interpreted as instances in which effective STEM program components were identified or described across the 62 state documents that we analyzed.

We identified 27 research articles (90%) that included information on one or more of the five components of effective integrated STEM programs. Like findings for the state documents, integrated STEM curricula was the most frequently cited component in the articles examined (27 documents, 90%). Integrated STEM curricula described across articles include specialized modules on topics such as agriculture (Vallera & Bodzin, 2020), space research (Piila et al., 2021), life science (Anwar et al., 2022), and sailboats (Chen & Chang, 2018). Other STEM curricula in programs are more general (e.g., Arshad et al., 2021; Becker & Park, 2011; Blanchard et al., 2015; Guzey & Li, 2023). Although the majority of research articles mentioned integrated STEM curricula, only six articles mentioned interdisciplinary curriculum teams (20%). Similar to findings in state documents, 17 research articles mentioned teacher professional learning as a component of programs and initiatives (57%). In contrast to the findings on state documents, research articles did not examine integrated STEM programs that included advisory boards or other program components (see Exhibit 9).

Exhibit 9. Number of Instances of Effective Integrated STEM Program Components in Research Articles

State	STEM curricula	STEM-focused school leadership	Advisory board	Interdisciplinary curriculum teams	Teacher professional learning	Other
Total instances	27	1	–	6	17	–

Note. A dash (–) means not present. STEM = science, technology, engineering, and math. Data on integrated STEM research articles were sourced from search queries using major academic databases such as Google Scholar, EBSCOhost, and Web of Science. Counts in this table should be interpreted as instances in which effective STEM program components were identified or described across articles (*n* = 30).

RQ2. What are the most common metrics of success in integrated K–12 STEM education programs and initiatives reported by other states and federally funded projects?

To address RQ2, we first discuss *goals* for K–12 integrated STEM education programs outlined in state documents and research articles. Then we report on the measured *outcomes* of integrated STEM programming included in state documents and research articles. We further organize our reporting of goals and outcomes at the student, teacher, and school levels.

Goals for K–12 Integrated STEM Education Programs

FINDING 3

Across state documents and research articles, the central goals of integrated STEM were to improve students' STEM literacy or proficiency and their STEM interest, self-efficacy, and confidence. Student goals were frequently coupled with teacher- and school-level goals, which included continuous professional learning to build the capacity of integrated STEM teaching and building a school culture where integrated STEM is accessible to all students and linked to industry, career pathways, and community needs.

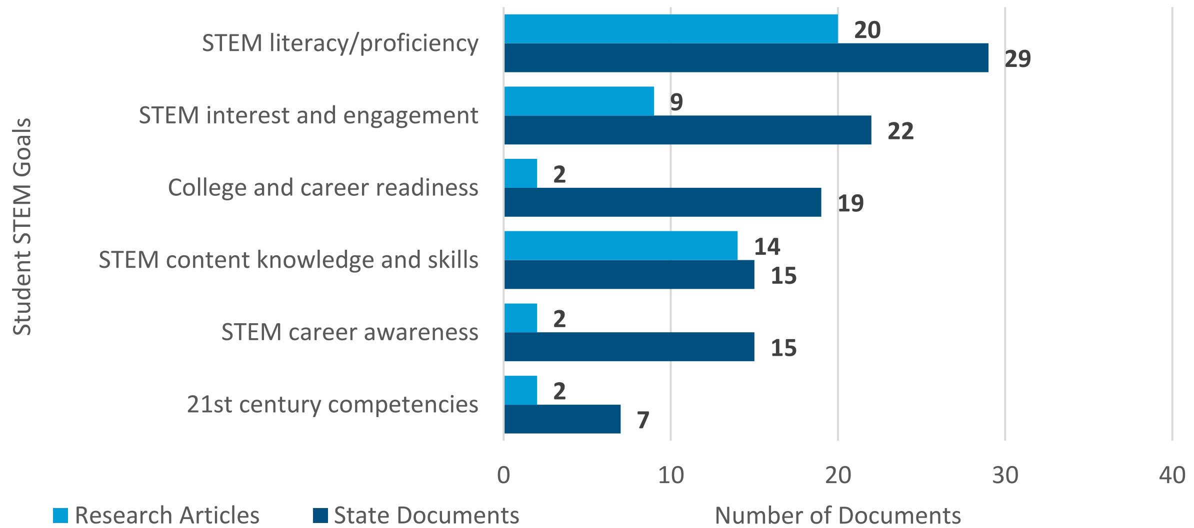
Student Goals

We analyzed state documents and research articles for the presence of six student goals related to integrated STEM programs, which included the development of STEM literacy or proficiency, STEM interest and engagement, STEM career awareness, STEM content knowledge and skills, college and career readiness, and 21st-century competencies (NRC, 2014).

> **Goals vs. Outcomes**
>
> In this section, we refer to goals and outcomes. To clarify for readers, we offer brief definitions.
>
> **Goals.** The intended *objectives* or *targets* of an education program or professional learning initiative.
>
> **Outcomes.** The *measurable changes* or *effects* observed in student or teacher factors as a result of participating in a program or initiative.

Overall, integrated STEM goals for students described in state documents and research articles most frequently focused on increasing STEM literacy or proficiency (see Exhibit 10). For state documents, STEM literacy or proficiency was identified by 16 states (80%) in 29 documents (47%). In all types of state documents, "STEM literacy or proficiency" was defined as grade-level achievement of content standards and most often measured by science and math achievement on state standardized tests. For instance, North Carolina's STEM Education Strategic Plan includes goals for increasing student STEM achievement (e.g., science proficiency, Algebra I and Algebra II completion, AP course completion, remediation rates in math). Some states, such as Louisiana, describe STEM literacy more holistically, with the overall goal for students to demonstrate the ability to integrate content knowledge and practices within the individual disciplines of STEM and solve relevant, authentic problems (Louisiana Department of Education, 2024). STEM literacy/proficiency goals were identified in 20 research articles. Common goals for STEM literacy and proficiency across articles include goals of increased student science and engineering knowledge as measured by pre-/post-tests (e.g., Chen et al., 2025; Cox et al., 2016; Cunningham et al., 2020; Han et al., 2023; Kelley et al., 2023).

Exhibit 10. Count of State Documents and Research Articles, by Student STEM Goal



Note. STEM = science, technology, engineering, and math. Data on state-integrated STEM documents were sourced from search queries on state education agency websites and other state-level education websites. Data on research-integrated STEM articles were sourced from search queries using major academic databases such as Google Scholar, EBSCOhost, and Web of Science. The counts in this chart should be interpreted as the number of state documents (n = 62) and research articles (n = 30) included in the analysis for each type of student STEM goal.

STEM interest and engagement were mentioned in 22 state documents (35%) across 14 states (70%). Nine research articles mentioned STEM interest and engagement (30%). College and career readiness was mentioned in 19 state documents (31%) across 13 states (65%) but mentioned in only two research articles (7%). STEM content knowledge and skills and STEM career awareness goals were mentioned in equal measure (15 state documents, 24%) across nine states (45%). Goals related to the development of 21st-century competencies were less common, described in seven state documents (11%) across five states (AZ, GA, ID, IN, OH; 25%) and two research articles (7%).

In contrast, research articles more frequently mentioned STEM content knowledge and skills as a goal (n = 15, 50%). Research articles rarely mentioned STEM career awareness (n = 2, 7%) or college and career readiness (n = 2, 7%) as a goal. STEM content knowledge and skills are often paired with goals of STEM literacy or proficiency. For instance, Chen et al. (2025) conducted a meta-analysis of 124 studies on integrated STEM between 2010 and 2022 and found that these studies collectively prioritized student STEM content knowledge acquisition, disciplinary skills, problem solving, and positive perceptions of STEM fields.

Notably, where two or more student-related goals were mentioned in state documents, student interest and engagement, college and career readiness, and STEM career awareness were often tied together and supported by state standards. For example, Indiana Department of Education's STEM school certification rubric indicated that effective STEM schools should aim to increase and measure student attitudes toward STEM and interest in STEM classes and career pathways. These goals aligned with state standards (Indiana Department of Education, 2018).

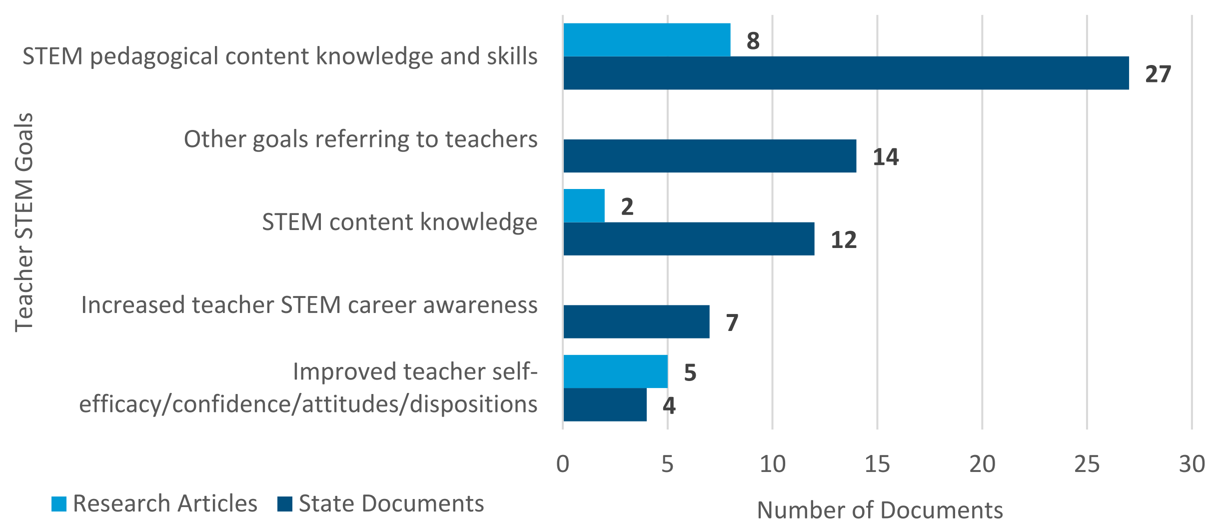
Teacher Goals

For teachers, we analyzed documents for goals related to professional knowledge and skills: (1) STEM content knowledge, (2) STEM pedagogical content knowledge and skills, (3) STEM career awareness, and (4) affective attributes (e.g., self-efficacy, confidence, attitudes, dispositions) for STEM teaching (NRC, 2014).

Integrated STEM goals for teachers described in state documents and research articles most frequently focused on supporting or improving STEM pedagogical content knowledge and skills and STEM disciplinary content knowledge (see Exhibit 11). Improving STEM teachers' pedagogical content knowledge and skills was mentioned in 27 state documents (44%) in 15 states (75%) and in eight research articles (27%). Improving teachers' STEM disciplinary content knowledge was mentioned as a teacher goal in 12 documents (19%) from nine states (AR, AZ, GA, IN, LA, NV, TN, TX, UT; 45%) and in two research articles (7%). Tennessee, as a state example, published guidelines for STEM school designation describing the utility of teachers observing others' classroom practices and engaging in formal reflection on the types of STEM pedagogical practices used by their peers (Tennessee Department of Education, 2024). Tennessee guidelines also described the essential nature of teacher collaboration to design integrated STEM project- and problem-based learning in instructional modules or units that aligned with state academic standards (Tennessee Department of Education, 2024). Research articles emphasize this goal as critical for effective instruction in integrated STEM and for comprehensive implementation of integrated STEM programs (Burrows et al., 2021; Feng et al., 2020; Han et al., 2023; Johnson et al., 2020; Kelley et al., 2020; Menon et al., 2023; Thibaut et al., 2018). Improving affective teacher attributes was mentioned as a goal in five research articles and four state documents (6%) from four states (LA, MI, NC, TN; 20%).

Some goals were not mentioned in the selected research articles but were mentioned in state documents. For instance, in state documents, we found that improving teachers' STEM disciplinary content knowledge was mentioned as a teacher goal in 12 documents (19%) from nine states (AR, AZ, GA, IN, LA, NV, TN, TX, UT; 45%). Increased teacher STEM career awareness was mentioned in seven documents (11%) across six states (AR, NC, NV, TN, TX, UT; 30%). Improving affective teacher attributes were mentioned in only four documents (6%) from four states (LA, MI, NC, TN; 20%). Fourteen documents from 11 states described unique teacher STEM goals not captured by other analytic categories; we labeled them as other goals referring to teachers. Other goals referring to teachers included, for example, improving preservice teacher recruitment and preparation, increasing the number of qualified STEM teachers, and building the capacity of school leaders in STEM education. For a full list of other goals related to teachers, see Appendix A–3.

Exhibit 11. Count of State Documents and Research Articles, by Teacher STEM Goal



Note. Data on state integrated STEM documents were sourced from search queries on state education agency websites and other state-level education websites. Data on research-integrated STEM articles were sourced from search queries using major academic databases such as Google Scholar, EBSCOhost, and Web of Science. The counts in this chart should be interpreted as the number of state documents (n = 62) and research articles (n = 30) included in the analysis for each type of teacher STEM goal.

School-Level Goals

Across 12 states (AR, GA, IN, MI, NC, NV, OH, OR, TN, TX, UT, WI; 60%) and 46 documents (74%), our analysis found common goals for integrated STEM implementation at the school level. These goals are supported by findings from two research articles (Means et al., 2016, 2021). Common goals for successful implementation include building an inclusive school culture for integrated STEM; emphasizing problem solving as an essential component for learning; providing access to integrated STEM education for all students, not just a selected few; establishing strong, cooperative community partnerships; and linking STEM education to industry, career pathways, and community needs. Several states encouraged schools to meet these goals by providing a STEM certification or STEM designation to those that did (GA, IN, NC, OH, TN, TX; 30% in 29 documents; 47%). For instance, Georgia's STEM certification program encourages interdisciplinary instruction that is driven by project-based learning and engineering design principles. As part of the certification process, the Georgia Department of Education guides schools through planning and implementing integrated STEM with a certification framework and rubrics that outline specific requirements for certification and describe the certification tiers (i.e., launching, advancing, executing, and excelling) in each criteria area (Georgia Department of Education, 2023).

Outcomes and Measures of K–12 Integrated STEM Programming

Integrated STEM education goals should be closely tied to outcomes (NRC, 2014). In other words, successful integrated STEM programs should be tied to evidence of outcomes consistent with program goals. In our analysis of state documents, we found that *anticipated* outcomes were more commonly described than *actual* outcomes supported by evidence. Where state documents described actual outcomes, we tracked the measures used to gather data on student and teacher outcomes. In addition to our state analysis, we found research articles often reported *actual* outcomes, supported by various measures of student achievement, attitudes, perceptions, and career awareness.

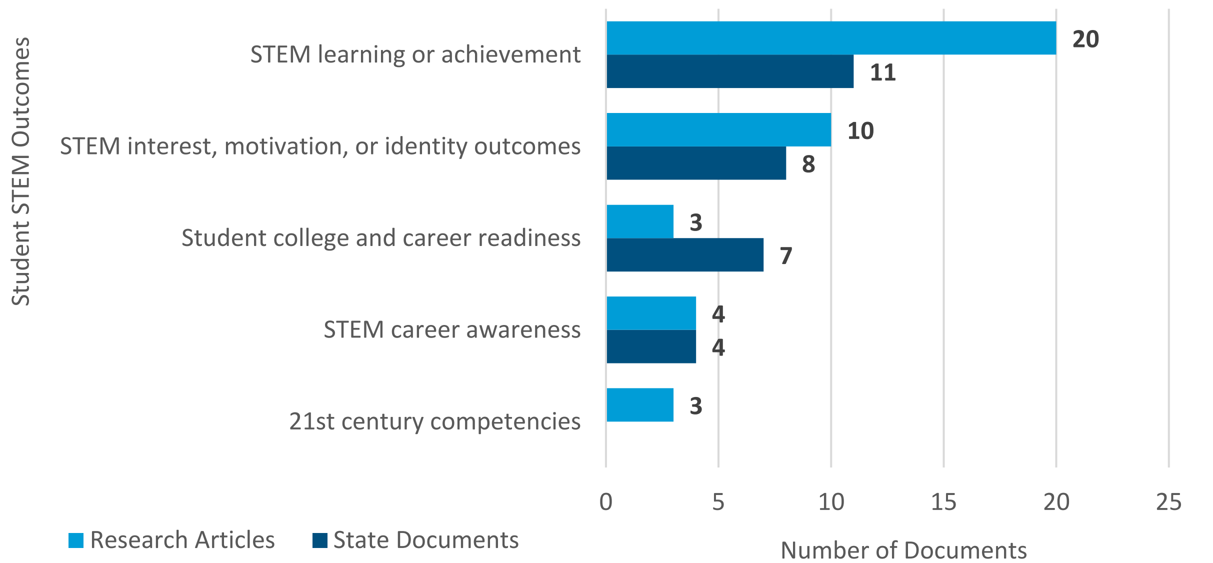
FINDING 4

Improved STEM learning and achievement was the most frequently measured student outcome of integrated STEM education programs; however, affective factors such as interest, self-efficacy, and engagement were nearly equal in reported outcomes. Likewise, for teachers, improvements in self-efficacy, attitudes, and confidence related to integrated STEM teaching were reported nearly as frequently as improvements in STEM content knowledge and pedagogical skills.

Student Outcomes

Improved STEM learning and achievement were the most common measured outcomes for students (see Exhibit 12). We identified reported outcomes in 20 research articles (67%) and anticipated outcomes in 11 state documents (18%) across nine states (IA, ID, IN, LA, MI, NC, NV, UT, WA; 45%). Across research articles, outcomes measures for student learning, proficiency, and achievement were either researcher-developed knowledge assessments (including pre- and post-tests) or standardized test scores specific to the intervention's content, approach, and skills. The outcome measures in state documents were primarily standardized test scores in math and science. Student STEM interest, motivation, or identity outcomes were mentioned in 10 research articles (33%) and eight state documents (13%) across six states (IA, MI, NC, NV, OR, WA; 30%). Student surveys and interviews or focus groups were the most common methods of collecting data related to STEM interest, motivation, and identity. Student college and career readiness was mentioned as an outcome measure in seven state documents (11%) across five states (IA, MI, NV, TN, WA; 45%) and three research articles. Student STEM career awareness, specifically, was mentioned as an outcome measure in four research articles and four documents (6%) across four states (IA, IN, NC, NV; 20%). Measures of student college and career readiness and STEM career awareness included student surveys items, graduation rates, postsecondary enrollment rates, and workforce outcomes. Measuring improvement in 21st-century competencies was not mentioned by any state; however, it was mentioned in three research articles.

Exhibit 12. Count of State Documents and Research Articles, by Student STEM Outcomes



Note. Data on state integrated STEM documents were sourced from search queries on state education agency websites and other state-level education websites. Data on integrated STEM research articles were sourced from search queries using major academic databases such as Google Scholar, EBSCOhost, and Web of Science. Counts in this chart should be interpreted as the number of state documents (n = 62) and research articles (n = 30) included in the analysis for each type of student STEM outcome in documents and across states.

In the majority of state documents that we analyzed, actual student outcomes were not accompanied by empirical data unless the document was a program evaluation or research report.[1] For this report, we analyzed eight program evaluations from five states (MI, NV, OR, TN, WA; 25%) and 12 research reports from 10 states (IA, ID, IN, LA, MI, NC, NV, TN, UT, WI; 50%). One example of student outcomes data appeared in Nevada's 2018 evaluation of its K–5 STEM grant program. The Nevada evaluation showed that providing teachers with STEM instructional materials was associated with an increase in students' interest and awareness of STEM professions (Nevada Governor's Office of Science, Innovation & Technology, 2018). Washington's report on the state STEM Education Alliance and the STEM Challenge reported

[1] See, for example, Doss et al., 2024; Heiden et al., 2023; Idaho STEM Action Center, 2024; Nevada Governor's Office of Science, Innovation & Technology, 2018; STE(A)M Hubs of Oregon, 2023; and Tennessee Department of Education, 2024.

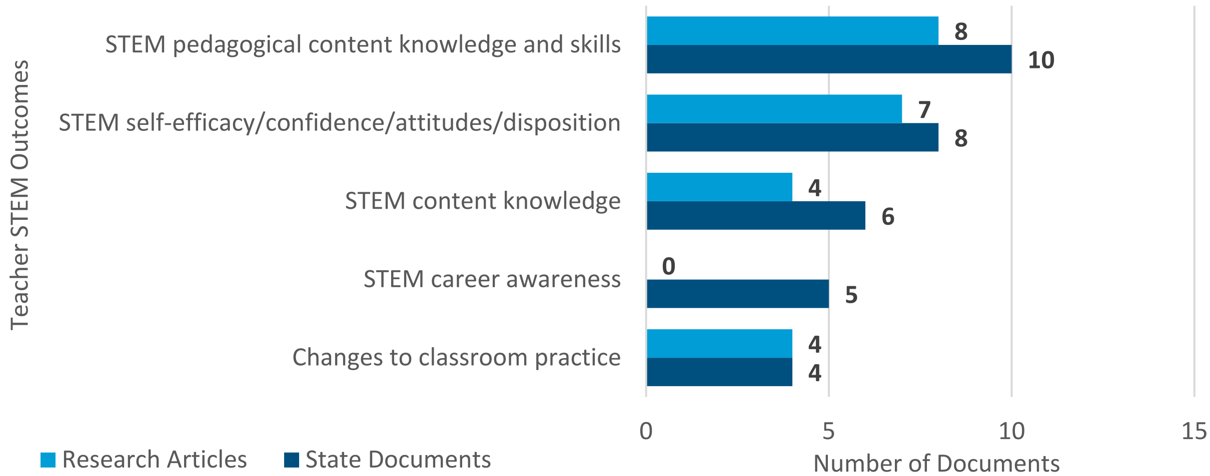
declines in proportions of students who met grade-level math and science standards since 2022, especially those from low-income households and/or identifying as Hispanic, Black, American Indian or Native Hawaiian/Pacific Islander (Washington State STEM Innovation Alliance, 2023). Iowa's 2021–22 STEM education evaluation included outcomes related to student achievement and interest in STEM. Overall evaluation results indicated that students statewide had high interest in pursuing STEM careers, especially those in grades 3–5 (Heiden et al., 2023).

Compared to state documents, a majority of research articles reported empirical data on actual student outcomes (22 articles, 73%). For example, Guzey et al. (2017) conducted a longitudinal study to examine the impact of interdisciplinary engineering education on students' understanding of science, engineering, and mathematics using pre- and post-assessments. The findings demonstrated that interdisciplinary instruction significantly improved students' knowledge acquisition, with consistent benefits observed across different student populations, regardless of race, gender, or language proficiency. Chen et al. (2025) conducted a meta-analysis on the effects of integrated STEM education on K–12 student achievement. They examined student learning outcomes on knowledge, skills acquisition, problem-solving performance, and student perceptions. Their meta-analysis revealed that adopting integrated STEM education yielded positive effects on student outcomes. They recommended that student outcomes in integrated STEM learning environments should be assessed across multiple dimensions, such as knowledge acquisition, student perceptions, skill development, and problem-solving task performance.

Teacher Outcomes and Measures

Similar to findings on teacher goals in state documents and research articles, the most frequently measured teacher outcomes were improvement of STEM teachers' pedagogical content knowledge and skills (10 documents [16%] across nine states [45%] and eight research articles, 27%). See Exhibit 13. Teacher STEM content knowledge outcomes were reported in six documents (10%) from five states (25%) and four articles (13%) using measures similar to those for pedagogical content knowledge and skills. Outcomes related to teacher STEM pedagogical content knowledge and skills were measured by classroom observations, teacher self-reported knowledge and skills through surveys, and numbers and observations of teachers who pursued STEM-related credentials and/or numbers and types of STEM professional learning opportunities offered to teachers. Research articles also included project materials (e.g., documents, reports, classroom artifacts) and focused specifically on observing teacher professional practices.

Exhibit 13. Count of State Documents and Research Articles, by Teacher STEM Outcomes



Note. Data on state integrated STEM documents were sourced from search queries on state education agency websites and other state-level education websites. Data on integrated STEM research articles were sourced from search queries using major academic databases such as Google Scholar, EBSCOhost, and Web of Science. The counts in this chart should be interpreted as the number of state documents (n = 62) and research articles (n = 30) included in the analysis for each type of teacher STEM outcome.

Teachers' STEM attitudes and self-efficacy outcomes were reported in eight state documents (13%) across seven states (IA, LA, MI, NC, NV, OR, TN; 35%) and seven research articles (23%). These outcomes were measured primarily through interviews/focus groups and surveys. Evidence from state documents and research articles suggest that well-planned and comprehensive teacher professional learning opportunities have significant positive gains on teacher attitudes and self-efficacy (e.g., Burrows et al., 2021; Feng et al., 2020; Han et al., 2022; Havice et al., 2018; Johnson et al., 2020; Kelley & Knowles, 2020; Menon et al., 2023; Thibaut et al., 2017). Some research articles indicated that although pedagogical and disciplinary content knowledge alone does not directly lead to effective teaching of integrated STEM, teachers with less content knowledge are less confident and effective in leveraging core instructional skills (Burrows et al., 2021). Additionally, educators value professional learning when they are able to increase pedagogical content knowledge and disciplinary content knowledge (Burrows et al., 2021; Feng et al., 2020; Han et al., 2022).

Changes to teachers' classroom practices were reported in four state documents (6%) across four states (NC, NV, OR, UT; 20%) and four research articles (13%). Changes to classroom practices were measured primarily through classroom observations and teacher self-reports. STEM career awareness was mentioned only in four state documents (6%) across four states (IA, MI, NC, OR; 20%). STEM career awareness outcomes were measured through teacher self-reporting in surveys and interviews.

All research articles focusing on teacher outcomes provided empirical data that suggest teacher professional development and/or opportunities to use integrated STEM curricula have positive impacts on teacher outcomes (seven articles, 23%). For example, Kelley et al. (2020) evaluated the impact of the TRAILS professional development program on high school science and engineering technology teachers' self-efficacy for integrated STEM instruction. Using pre- and post- surveys, the authors found significant increases in teachers' self-efficacy; however, engineering technology teachers showed no significant change. The gains in teacher confidence were attributed to hands-on, collaborative lesson design and implementation. Similarly, Havice et al. (2018) evaluated the immediate and long-term effects of an integrative STEM Education Institute for K–8 teachers and administrators in North Carolina. Using pre- and post-surveys and a longitudinal survey, this study found statistically significant increases in self-efficacy across eight learning objectives (e.g., using STEM as a curricular organizer, interdisciplinary teaching). In long-term follow-up, two thirds of teachers from the institute reported still implementing integrated STEM.

Although the majority of states (75%) identified desired teacher outcomes, few provided actual data to demonstrate progress toward those outcomes.[2] Among the exceptions, the Utah State Board of Education's 2021 report measured the number of science educators who participated in comprehensive science and engineering professional learning opportunities and the number of STEM endorsements earned by Utah educators in 2019. Iowa's 2021–22 evaluation of statewide STEM Scale-Up programs examined levels of educator confidence and skills after participating in Scale-Up programs (Heiden et al., 2023). Through a survey, the evaluation found that teachers reported an increase in confidence and skills for teaching STEM topics (Heiden et al., 2023).

Conclusion

Overall, our study indicated that K–12 integrated STEM education is widely valued across states and the research literature, with strong alignment around its core purposes: improving students' STEM learning and achievement, fostering interest and engagement, and building teachers' pedagogical capacity to deliver authentic problem- and project-based instruction. Across states, integrated STEM initiatives most often emphasize interdisciplinary connections grounded in real-world problems, career exploration, and—to a lesser extent—culturally relevant learning. Research evidence generally supports positive impacts on student learning and teacher self-efficacy when integrated STEM is implemented with well-designed curricula and sustained professional learning. However, the study also revealed important gaps,

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[2] See, for example, Doss et al., 2024; Idaho STEM Action Center, 2025; Nevada Governor's Office of Science, Innovation and Technology, 2018; STE(A)M Hubs of Oregon, 2023; Tennessee STEM Innovation Network, 2024; and Utah State Board of Education, 2021.

particularly the lack of consistency in how the term “integrated STEM” is defined and implemented across states, uneven attention to teacher professional learning systems, and a persistent reliance on anticipated rather than empirically measured outcomes in state reporting. Strengthening coherence, professional learning infrastructure, and evidence-building efforts will be essential for improving the quality and impact of integrated STEM education across state initiatives.

Based on our findings, we offer the following recommendations:

Strengthen coherence and clarity in integrated STEM definitions and design.

States should adopt and operationalize clear, shared definitions of integrated STEM that specify the depth of disciplinary integration, instructional approaches (e.g., problem-, project-, design-, and inquiry-based learning), and expected student and teacher outcomes. Clear guidance can reduce variation in implementation quality and support comparability across programs and districts.

Invest in sustained, job-embedded professional learning systems for teachers.

Professional learning should move beyond one-time workshops to include collaborative planning time, coaching, communities of practice, and aligned microcredentials that support interdisciplinary curriculum design and classroom implementation. Evidence from both state initiatives and research articles suggests that sustained, collaborative professional learning is closely linked to improvements in teacher confidence, instructional practice, and program fidelity.

Expand access to high-quality instructional resources and interdisciplinary curriculum teams.

States and districts should support repositories of vetted integrated STEM curricula and provide structures for interdisciplinary teacher teams to adapt and co-develop materials aligned to standards, local contexts, and student needs. This approach can improve instructional consistency while still allowing flexibility for authentic, place-based learning experiences.

Strengthen state-level program evaluation and empirical evidence building.

States should invest in more rigorous and systematic evaluation of integrated STEM initiatives, including the use of common outcome measures, mixed-methods designs, and longitudinal data to track both student and teacher outcomes. Moving beyond anticipated outcomes to empirically documented impacts will enable states to identify effective models, guide continuous improvement, and inform policy and funding decisions.

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Appendix A. STEM Landscape Scan State Documents and Research Articles

State Documents and Reports

Exhibit A–1. STEM Education Landscape State Documents and Reports Bibliography

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Exhibit A–3. STEM Education Landscape Scan: Examples of Other Teacher Goals

Examples of Other Teacher Goals
Preservice STEM Educator Preparation recruiting and preparing a cadre of well-qualified educators
Support Growth and Sustainability of the AR STEM Teacher Pipeline
Encourage family engagement
Support implementation of evidence-based practices STEM teacher effectiveness. - Increase the retention rate of effective and highly effective STEM educators. - All DC schools have access to highly qualified and effective STEM teachers.
General education teachers and appropriate special education/support service teachers (High Ability, English as a New Language, interpreters, etc.) collaboratively plan for necessary STEM material development and refinement for different learners based upon their understanding of students' academic needs.
Teachers perceive the microcredentials as giving them opportunities to build a portfolio of work, access collaborative discussions, and receive meaningful feedback that helps them revise and improve their teaching.
Increase the number of teachers prepared and delivering integrated STEM education
Overseen by the Tennessee STEM Innovation Network, the Tennessee Rural STEM Collaborative is open to any K–12 public school educator in Tennessee who wants to participate, regardless of what subject(s) they teach—as long as they want to learn more about delivering engaging, high-quality STEM learning opportunities for their students.
Building the capacity of LEA leaders

Appendix B. STEM Landscape Analysis Codes

This appendix contains the definitions for the codes used to analyze K–12 STEM education landscape reports.

Exhibit B–1. STEM Education Landscape Reports: Definitions of Codes

Code	Definition
Nature and Scope of Integration	
Type of Document	Guidance; Program Evaluation; Research Report; Framework
Type of Stem Connection	Interdisciplinary; Multidisciplinary; Transdisciplinary; Cross-disciplinary; Other; If Other, describe
Disciplinary Emphasis (Primary)	Science; Technology/Computer Science; Engineering; Mathematics; All equal; None are mentioned
Disciplinary Emphasis (Secondary)	Science; Technology/Computer Science; Engineering; Mathematics
How is *integrated STEM* defined?	Open text
Goals	
What goals are mentioned for STUDENTS? Check all that apply.	STEM literacy/proficiency; STEM interest and engagement; STEM career awareness; College and career readiness; 21st-century competencies; STEM content knowledge and skills; Other
If student [insert selected goal] is mentioned, provide goal text	Open text
What goals are mentioned in this document for TEACHERS?	Stem content knowledge; STEM pedagogical content knowledge and skills; Self-efficacy/confidence/attitudes/dispositions for STEM teaching; STEM career awareness; Other; If Other, describe
If teacher [insert selected goal] is mentioned, provide goal text	Open text
Implementation	
What is the learning context?	Formal (classroom); Informal (extracurricular); Teacher professional learning
What is the instructional design?	PBL; PcBL; DBL; Inquiry; Other; If Other, describe
Does it mention educational supports?	Yes; No; If Yes, describe the educator supports
What are the program/initiative characteristics?	Culturally relevant; Authentic (real world); Industry partnerships; Career exploration; Other; If Other, describe
What are the program components?	Advisory board; STEM-focused school leadership; Interdisciplinary curriculum teams; STEM curricula; Personalized TPL; Other; If Other, describe

Code	Definition
Recommendations for Implementation	Learning context; Instructional design; Educator supports; Program/Initiative characteristics; Program components; Other implementation recommendations
If recommendations related to [*insert recommendation*], list them here	Open text
Measures	
What student measures?	Survey; Focus group/Interview; Project materials (documents, reports, art); Observation of Behavior (ex. Engagement, participation); Observation of STEM skills (ex. Coding, laboratory techniques); District and State Standardized Assessment; Researcher or Teacher Developed Standardized Assessment
What teacher measures?	Survey; Focus group/interview; Project materials (documents, reports, art); Observation of professional development participation; Observation of Instructional Practices; STEM teaching Certification/Specialty/Designation; Collaboration activities
Outcomes	
What STUDENT outcomes are mentioned in this document?	STEM interest, motivation, and identity; STEM learning and achievement; College and career readiness; 21st-century competencies; STEM career awareness; Other
If student [*insert outcome*] is mentioned, provide metrics, measures, and/or outcomes	Open text
What TEACHER outcomes are mentioned in this document?	STEM content knowledge; STEM pedagogical content knowledge and skills; STEM teaching self-efficacy, attitudes, confidence, and/or dispositions; Changes to STEM classroom practices; STEM career awareness; Other; If Other, describe
If teacher [*insert outcome*] is mentioned, provide metrics, measures, and/or outcomes	Open text
Recommendations/Implications related to Student Goals/Outcomes	STEM interest, motivation, identity; STEM learning and achievement; STEM career awareness; College and career readiness; 21st-century competencies; Other student goals/outcomes
If recommendations related to STEM [insert recommendation /implication] list them	Open text
Recommendations/Implications related to Teacher Goals/Outcomes	Stem content knowledge; STEM pedagogical knowledge and skills; Self-efficacy/confidence/attitudes/dispositions for STEM teaching; STEM career awareness; Other recommendations related to teacher goals/outcomes

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AIR® Headquarters
1400 Crystal Drive, 10th Floor
Arlington, VA 22202-3289
+1.202.403.5000 | **AIR.ORG**

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