The Future of
Engineering Education
2024 Annual Conference & Exposition

Oregon Convention Center
Portland, OR . June 23 - 26, 2024

ASEE

Paper ID #42084

Work-in-Progress: Pursuing STEM/STEAM Certification as a Method for Maintaining an Integrated STEM/STEAM Learning Environment

Talia Capozzoli Kessler, Georgia Institute of Technology

Talia Kessler, MSPP is a research associate at The Center for Education Integrating Science, Mathematics, and Computing (CEISMC) at Georgia Tech. As a research associate, she works on research and evaluation projects centering on K-12 STEM education. She has a Master's degree in Public Policy from Georgia Tech and is currently studying towards a PhD in Educational Policy Studies at Georgia State University.

Keisha Simmons, Georgia Institute of Technology
Ms. Katherine Leigh Boice, Georgia Institute of Technology

Katherine (Katie) Boice is currently a Research Associate at the Georgia Institute of Technology's Center for Education Integrating Science, Mathematics, and Computing (CEISMC). With a background in applied developmental science, she contributes her knowledge of developmental psychology and research methodologies to various projects in informal and formal education spaces. Her current work focuses on STEAM education, out-of-school-time STEM, culturally-responsive evaluation methods, and educator wellbeing. She holds B.A. degrees in Psychology and Music from Emory University and an M.Ed. in Child Studies from Vanderbilt University's Peabody College of Education.

Justina Jackson, Georgia Institute of Technology

Justina Jackson (PhD) is a Research Scientist at Georgia Tech's Center for Education Integrating Science, Mathematics, and Computing (CEISMC). As part of the Research and Evaluation Team at CEISMC, she is involved in the study of STEM/STEAM programs and initiatives in K-12 and university settings. She earned her Ph.D. in Educational Policy with a Certificate in Qualitative Research and Certificate in Excellence in College Teaching from Georgia State University.

Jasmine Choi, Georgia Institute of Technology

Jasmine Choi is a Research Scientist II at the Georgia Institute of Technology in the Center for Education Integrating Science, Mathematics, and Computing (CEISMC). Her research focuses on investigating evidence-based teaching and learning approaches and the impact of learning technologies in STEM K-12 classrooms.

Dr. Meltem Alemdar, Georgia Institute of Technology

Dr. Meltem Alemdar is a Associate Director and Principal Research Scientist at Georgia Institute of Technology's Center for Education Integrating Science, Mathematics, and Computing (CEISMC), Dr. Alemdar made significant contributions to the fields of STEM education. Her research focuses on improving K-12 STEM education through research on curriculum development, teacher professional development, and student learning in integrated STEM environments. Dr. Alemdar currently serves as PI and co-PI for research on various NSF funded projects that focuses on engineering education, teacher networks and STEM learning environments. Her expertise includes program evaluation, social network analysis, mixed methods, and advanced quantitative methods. Dr. Alemdar is passionate advocate for equitable and inclusive STEM education. She actively engages with educators, students, and communities to promote the importance of STEM disciplines and education research in preparing the next generation for the challenges of the future. She received her Ph.D. in Educational Policy, with a concentration in Research, Measurement, and Statistics, from Georgia State University.

Work-in-Progress: Pursuing STEM/STEAM Certification as a Method for Maintaining an Integrated STEM/STEAM Learning Environment

Abstract

A five-year long STEAM initiative, the GoSTEAM@Tech program, was designed by the Georgia Institute of Technology to develop and evaluate a model for STEAM professional learning for K-12 teachers. Specifically, program objectives focused on art integration within three STEM subjects: engineering, computer science, and innovation/entrepreneurship. Throughout the five-year program, GoSTEAM partnered with three local school districts in the surrounding metropolitan area to implement this model, centering on teacher professional learning and community building in STEAM. As a method to sustain program efforts, GoSTEAM collaborated with these schools to support their work pursuing and obtaining state-level STEM or STEAM certification through the Georgia Department of Education. By acquiring STEM or STEAM certification, schools demonstrate evidence of expertise in multidisciplinary teaching and learning. As a part of the state certification process, schools are assessed by evaluators on a multi-part continuum, measuring five school characteristics: STEM or STEAM culture, instructional practices, professional learning, community partnerships, and sustainability of STEM or STEAM learning. Acquiring STEM or STEAM certification can be a lengthy process for schools, as it may require hiring specialized coordinators, implementing new STEM or STEAM-based instruction, or partnering with community organizations. While the certification process has become increasingly popular with school districts and other policymakers, few studies analyze the STEM or STEAM certification process, especially the impact on K-12 environments. In this work-in-progress paper, we will conduct a retrospective policy analysis [1] regarding Georgia's STEM and STEAM certification process and the implications of this process on participating schools. We will also reference qualitative data collected in focus groups and interviews with administrators at GoSTEAM schools to highlight school administrators' perceptions of state STEM or STEAM certification. Preliminary findings indicate that administrators identified several school contextual factors that contributed to their perception of both the STEM or STEAM certification process as well as interest in pursuing the certification process, such as district mandates, levels of student achievement, and teacher instructional change. As more school districts consider STEM or STEAM certification, the findings presented in this work-in-progress paper may inform policymakers and school administrators on the relationship between STEM or STEAM certification and multidisciplinary teaching and learning.

Introduction

Across the United States (U.S.), leaders in education have displayed an interest in delivering high-quality STEM (Science, Technology, Engineering, and Mathematics) and STEAM (Science, Technology, Engineering, Arts, and Mathematics) education [2] – [4]. Often, the motivation to implement STEM or STEAM instruction is rooted in a national goal of expanding the STEM and STEAM workforce, as these sectors are viewed as catalysts for economic growth [2] – [4]. With a national interest in STEM and STEAM education, local K-12 school districts and state-level

Departments of Education (DOE) often encourage their schools to implement high-quality STEM and STEAM instruction [5] – [7].

One method for K-12 schools to demonstrate their proficiency in these forms of instruction is to obtain STEM or STEAM certification. In this work-in-progress paper, we explore certification in the context of the state of Georgia. In Georgia, the state's DOE provides a certification option in which a school's STEM or STEAM learning environment is assessed on five core standards [5]. The certification process can be cumbersome, taking schools at least 3 years to achieve [8]. However, since its inception, dozens of schools in this state have already obtained STEM and STEAM certification, with several others currently attempting the certification process [5].

As more schools pursue certification, there is a growing interest in understanding the implications of certification on K-12 learning environments [9], [10]. Towards this end, this work-in-progress paper uses a two-pronged approach to examine the impact of the Georgia DOE (GaDOE) STEM and STEAM certification processes. Specifically, we utilize a retrospective policy analysis [1] of the GaDOE STEM and STEAM certification processes, as well as qualitative data gathered in focus groups and interviews with administrators at schools participating in the K-12 STEAM teacher professional development program, GoSTEAM@Tech (GoSTEAM). We then explore the school administrators' perceptions of the GaDOE certification process, as well as how STEM and STEAM certification may contribute towards the STEM or STEAM learning environment at their school.

Literature Review

STEM and STEAM

Over the last two decades, STEM has become a popular form of instruction in K-12 schools [11] – [13]. Since its development, several federal policies in the U.S. have called for increasing STEM instruction in K-12 educational spaces as a method for advancing technology and innovation [2], [3]. These calls are made with the understanding that STEM education can develop a student's critical thinking skills and their ability to draw connections to real-world concepts, as well as foster student interest in STEM subjects, in general [13] – [15]. Integrating arts into STEM can further cultivate student understanding of these subjects. Studies have found that STEAM learning contributes to students' critical thinking and problem-solving skills in a more creative manner, by incorporating real-world concepts and project-based instruction [16] – [18]. This instructional method has become increasingly common over the last decade, with more schools throughout the U.S. turning towards STEAM, not just STEM, learning [17].

STEM Certification

Studies of STEM schools have presented mixed findings regarding the impact of certification on student achievement. For example, authors of a quantitative study aimed to understand the difference in college and career readiness of fourth- and fifth-grade students attending STEM certified and non-certified elementary schools [9]. The results of their study illuminated one significant relationship, such that students at STEM schools displayed higher English Language Arts (ELA) median growth percentiles than students at non-certified schools. Findings among

other subjects and grade levels were insignificant, however. Similarly, a study of third- and fifth-grade students identified a positive relationship between attending a STEM-certified school and student achievement in third grade but a negative relationship in fifth grade [19]. At the high school level, research has indicated that STEM high schools can provide students with the skills necessary to succeed in STEM subjects in college, and students from STEM high schools even outperform their peers on standardized tests [20], [21].

Other studies describe the perceptions of school administrators at STEM schools. In a dissertation centered on STEM-certified elementary schools, Mickens [22] interviewed school principals and teachers to understand their perceptions of STEM learning. The findings suggest a need for teachers and principals to invest in their teachers' continued growth and understanding of STEM pedagogies, STEM partnerships, and STEM implementation to maintain a quality STEM educational environment for their students [22]. In another dissertation, several barriers were identified as a part of the STEM certification process [23]. Specifically, the author found that, though school administrators are a necessary driver for attempting certification, teacher buy-in is also needed [23]. Additionally, observing instruction at schools that are STEM certified, as well as successfully transitioning instruction to project-based learning, were considered essential for obtaining STEM certification [23].

STEAM Certification

There are some studies focused specifically on STEAM certification. In particular, McCullough [24] utilized a descriptive case study analysis of educators at STEAM-certified elementary schools to understand the conceptualization of STEAM education. This case recognizes that STEAM instruction is subjective, suggesting that the implementation of STEAM does not have to be uniform but can (and should) be individualized to reflect the specific classroom of instruction [24]. A similar finding was identified in STEAM-focused schools with a high representation of minority students [25]. Specifically, the authors describe the necessity for STEAM curriculum to center "the cultural lives of minoritized students," referencing a method termed Black Futurity STEAM [25]. As research on STEAM-certified schools is limited, future studies should explore new developments in the space, providing additional context on the impact STEAM certification has on learning environments.

Method

Utilizing a policy analysis lens and qualitative methods, this work-in-progress paper aims to understand how school administrators perceive the GaDOE STEM or STEAM certification process and the impacts on their school's STEM or STEAM learning environments. Specifically, we utilize a retrospective policy analysis [1] and qualitative methods to address the following questions:

1. What are the perceived benefits and costs of receiving GaDOE STEM or STEAM certification, based on school administrators' perceptions?
2. How does becoming certified in STEM or STEAM impact a school's STEM or STEAM learning environment?

This paper employs a retrospective policy analysis, a methodology often used to understand how an existing policy impacts its intended audience [1]. In this case, we present a description of the GaDOE STEM and STEAM certification processes, followed by an exploration of how the policy impacts K-12 schools invested in STEM or STEAM instruction through focus groups and interviews with school administrators. Data were gathered from administrators at six schools within the metro-Atlanta area, who were recruited through their school's involvement in GoSTEAM. The program, first piloted by Georgia Institute of Technology in 2019, was designed with the goal of creating a model for effective STEAM education through enhancing teachers' professional growth in STEAM. Now in its fifth and final year, the program focuses on the sustainability of STEAM initiatives and supporting schools' efforts to pursue the GaDOE STEM or STEAM certification.

Data Collection

Focus groups and interviews were conducted at the end of GoSTEAM's fourth year, between April and May 2023. The focus group and interview protocol was designed in a semi-structured format, with items developed to better understand the impact of the GaDOE STEM and STEAM certification processes. Specifically, items included in the protocol center on school administrators' decision to pursue (or intent to pursue) STEM or STEAM certification, as well as which certification process their school has or is planning to obtain. Administrators were also asked to describe any perceived benefits and costs of acquiring STEM or STEAM certification and potential impacts on the learning environment at their school.

Participants

As a part of this study, nine administrators participated in focus groups and interviews, representing six schools. Administrators held various positions at their schools, as some were principals or vice principals, while others were STEM or STEAM coordinators. Most participants had served as an administrator at their school for at least two years. Additionally, each school represented in the study participated in the GoSTEAM program over multiple years, suggesting administrators had an interest in multidisciplinary instruction at their schools, in general.

The six schools represented came from three school districts. An overview of the schools and their certification status can be found in Table 1 below. Notably, two districts (1 & 3) strongly encourage their schools to pursue STEM or STEAM certification. District 1 schools were previously permitted to pursue certification by either the GaDOE or by a private organization named Cognia; however, in 2022, the district mandated that all schools undergo the GaDOE STEM or STEAM certification process by the 2025-26 school year. Thus, despite the three District 1 schools previously obtaining STEM certification through Cognia, they were all pursuing GaDOE STEM or STEAM certification as well.

Table 1. Certification Status

School	School District	School Level	Current Certification Status	Plans for Certification	Encouraged by School District?
School A	District 1	K-8	STEM Certified by Cognia	Pursuing GaDOE STEAM Certification	Yes
School B	District 1	K-8	STEM Certified by Cognia	Pursuing GaDOE STEAM Certification	Yes
School C	District 1	Elementary	STEM Certified by Cognia	Pursuing GaDOE STEM Certification	Yes
School D	District 2	High School	GaDOE STEM Certified	No Future Certification Plans	No
School E	District 3	High School	Not Currently Certified	Pursuing STEM Certification by Cognia	Yes
School F	District 3	Elementary	Not Currently Certified	No Future Certification Plans	Yes

Data Analysis

To describe the data collected from school administrators, transcripts from the focus groups and interviews were analyzed in NVivo coding software using an inductive coding process, with a qualitative content analysis approach [26]. More specifically, initial codes were created following a multiple cycle descriptive coding strategy, followed by a second round of coding to refine the codes initially developed [27]. Codes were then further organized by theme, which are described as within the results.

Results

Within the results section, we employ a retrospective policy analysis. Specifically, the results are structured to first present a description of GaDOE STEM and STEAM certification. The policy description is then followed by findings from focus groups and interviews conducted with administrators at schools participating in GoSTEAM, as a way to investigate the impact of the policy on K-12 schools in the state.

GaDOE STEM and STEAM Certification

In Georgia, the history of the GaDOE STEM and STEAM certification processes reflects a concerted effort to elevate the quality of K-12 education. In particular, the state has recognized the importance of fostering a strong foundation in STEM and STEAM among students, which evolved in response to the growing demand for a workforce skilled in STEM and STEAM fields [5]. The first K-12 school in the state became GaDOE STEM certified over a decade ago [28], and a few years later, the first K-12 school in the state obtained GaDOE STEAM certification [29]. Since its inception, the state has witnessed the establishment of new standards, frameworks,

and partnerships between educational institutions and community organizations [5]. As such, the STEM and STEAM certification processes aim to equip K-12 educators with the tools and strategies needed to provide effective STEM or STEAM instruction, preparing students for the challenges and opportunities of the real world [5], [30].

Georgia DOE STEM and STEAM Certification Process. In order to become certified in STEM or STEAM, schools must complete the certification process, which includes five phases (Table 2) [30]. While schools can move through the process at their own pace, the certification process often takes three to five years to complete, and it may include repeating a phase before moving on to the next [8], [30]. Once certified, a school maintains their status for up to five years [8]. Additionally, though any school in the state can apply for GaDOE STEM or STEAM certification, elementary schools can only seek STEM or STEAM certification as an entire school, whereas middle schools and high schools can pursue certification for either their school or a specific program at their school [8].

Table 2. GaDOE STEM and STEAM Certification Process Phases [30]

Phase	Description
Ask	Schools assess and reflect on the need for STEM or STEAM at their school.
Imagine	Schools identify the resources and goals needed to reach STEM or STEAM certification.
Plan	Schools establish the integrated approach they intend to implement, according to state DOE standards.
Create	Schools implement the decided approach within the school context.
Share and Improve	The DOE evaluates the implemented integrated approach, and the schools either refine their approach or are granted STEM or STEAM certification. Schools continue to implement the approach for the duration of their certification.

STEM/STEAM Continuum. During the "Share and Improve" phase of the STEM or STEAM certification process, schools are assessed by GaDOE staff and STEM or STEAM content experts using a tool titled the "STEM/STEAM Continuum" [31], [32]. The STEM/STEAM Continuum is often used by schools as a guide throughout the certification process, as it outlines the specific requirements for achieving certification [31], [32]. As of 2023, there are two continuums utilized by the GaDOE: an elementary STEM/STEAM Continuum, used to assess elementary schools [31], and a secondary STEM/STEAM Continuum, used to assess middle and high schools [32].

It is important to note that, though there are two different continuums for elementary and secondary schools, there is only one continuum for both the STEM and STEAM certification processes. This means that an elementary school pursuing STEM certification will be evaluated using the same continuum as an elementary school pursing STEAM certification. There is one difference, which is that schools pursuing STEAM certification must integrate fine art subjects, according to GaDOE standards [31], [32]. Because the language presented by the GaDOE often refers to the STEM and STEAM processes collectively, this work-in-progress paper utilizes similar language to ensure consistency with the policy. In moments where the STEM and STEAM processes are referenced separately, we will also differentiate between the two.

Both the elementary and secondary STEM/STEAM Continuums contain specific evaluation criteria, which are categorized into five areas (Table 3) [31], [32]. Schools are assessed on the criteria by GaDOE evaluators, who award one of four ratings: launching, advancing, executing, and excelling [31], [32]. In order to obtain STEM/STEAM certification, schools must at least achieve the "executing" rating in each area [31], [32].

Table 3. DOE Rubric [31], [32]

Area	Evaluation Criteria
Culture of STEM/STEAM	- School Vision and Culture - Non-Traditional Student Participation (Program Certification in Secondary Schools Only) - Non-Traditional Career Exposure - Characteristics of Curriculum
Instructional Practices	- Instructional Rigor, Relevance, and Instructional Quality - STEM or STEAM Curriculum: Project-Based Learning (PBL) - STEM or STEAM Curriculum: Day-to-Day Interdisciplinary Instruction - Student Internships and/or Capstone Project (HS Only) - Problem Solving Practices for Developing Solutions - Technology Integration - Investigative Research - STEM/STEAM Journals
Professional Learning	- Content Knowledge - Pedagogical Content Knowledge - Teacher Collaboration
Community Partnerships	- Business, Community, and Post-Secondary Partnerships - Career Access and Exploration - STEM/STEAM Competitions, Exhibits, and/or Clubs
Sustainability	- Accountability/Sustainability - School Leadership - STEM/STEAM Advisory Council

Other Forms of Certification. In the state, several school districts encourage schools to obtain STEM and STEAM certification through the GaDOE. However, as briefly mentioned, a private accrediting body named Cognia, provides an alternative to the GaDOE STEM certification process. Cognia allows any school accredited through their organization to obtain STEM certification, as long as the school is successful in implementing their ten STEM performance standards [33]. This process is not free, as a school must pay to be accredited through Cognia and must pay an additional cost to be evaluated for STEM certification [34]. Moreover, Cognia only awards STEM certification, not STEAM [34]. Regardless, several K-12 schools in the state have pursued and obtained STEM certification through Cognia, making it a common alternative to the GaDOE STEM certification process.

Focus Group and Interview Findings

In focus groups and interviews, administrators described their experience with the STEM/STEAM certification process. Specifically, participants shared their school's motivation for pursuing certification, any perceived benefits or challenges of becoming STEM/STEAM certified, and any perceived impacts to their school's STEM/STEAM learning environment. Commonly, administrators stated that their motivation to pursue STEM/STEAM certification was driven by encouragement or mandates from their district. While several schools were STEM-certified through Cognia, administrators often explained that pursuing certification through the GaDOE was seen as the gold standard by themselves or their school district. In particular, administrators in District 1 shared that despite maintaining certification through Cognia, their school district requires GaDOE STEM/STEAM certification because "*some places don't recognize [Cognia certification]*" anymore. This was similarly mentioned by an administrator in District 2, who explained that while their school was not required to obtain certification, they perceived the GaDOE STEM/STEAM certification to be "*the most rigorous of all the processes,*" and that other STEM/STEAM certifications were "*less reliable...because you were a customer, you paid, and you got certification.*"

Administrators often explained that STEM/STEAM certification provides their school with a "*sense of pride,*" as it demonstrates how the instruction taking place at their school is "*different*" and "*unique.*" These comments speak to the GaDOE's ability to implement a thorough certification process that demonstrates the occurrence of high-quality STEM/STEAM instruction. Especially, administrators considered certification to be a method for recognizing the "*top-tier instruction*" ocurring at their school and "*[validating] the work that [they're] doing*" every day. Obtaining STEM/STEAM certification was just "*the icing on the cake,*" though, as participants explained that the real benefit was the change in teacher practice from engaging in STEM/STEAM instruction. These findings speak to the impact the GaDOE STEM/STEAM certification process has on the instruction transpiring at schools participating in the process, as administrators observed growth in their teachers' ability to implement STEM/STEAM instruction.

Most administrators believed becoming STEM/STEAM certified would positively impact their students' skill development, as the process requires the instruction of "*soft skills that every employer is looking for,*" such as becoming "*problem solvers and increasing [students'] critical thinking skills.*" Certification was also mentioned as a way to ensure students become "*global citizens,*" through providing opportunities for students to make an "*impact in their community.*" In this way, administrators' view of STEM/STEAM learning as connected to future career and economic success mimics the GaDOE's stated reasons for encouraging STEM/STEAM instruction.

In contrast, one administrator described reluctance to pursue STEM/STEAM certification because of a belief that it might hinder students' learning. This administrator shared that, since the COVID-19 pandemic, their students have struggled with academics, and they would like to focus on increasing their state test scores before attempting certification. This school was also concerned about the stability of their teacher workforce, sharing that while they have a "*high retention rate with their teachers,*" they were uncertain about "*how the overall climate will*"

change over the next two years." Thus, STEM/STEAM certification was instead described as a long-term goal of the school.

As a part of the GaDOE STEM/STEAM Continuum, schools are required to work with community partners or other external organizations. These partnerships were seen as a positive impact of becoming STEM/STEAM-certified, with administrators finding these partnerships "*very important*" for students. Specifically, participants explained how the partnerships prepare students "*for the real world*" and demonstrate that their coursework "*isn't just in isolation, it's transferable*" to future careers. Additionally, the certification process encourages partnerships between STEM/STEAM-certified schools, helping administrators discover the various "*ways that STEAM happens in other schools around the state.*" For example, an administrator explained that as a part of the GaDOE STEAM certification process, they visited other schools that maintain STEAM certification. The school visits provided this administrator with a direct understanding of how hands-on instruction can contribute to student learning, providing context for implementation at their own school, similar to findings referenced in Khatib [23].

Generally, administrators found some of the requirements of the GaDOE certification process to be challenging. The GaDOE certification process entails "*a lot of legwork*" as there are "*a lot of layers*" to becoming certified. There also needs to be "*teacher buy-in*" or a "*change in the mindset*" of their staff in order to undertake the certification process, which is something similarly mentioned in the literature [22], [23]. Administrators commonly described how certification necessitates significant effort *"to make all the shifts instructionally to get the teachers to change what they were doing fundamentally*" and to "*train new people and actually do the work*" required of STEM/STEAM implementation. Regardless, administrators often explained how, in the midst of these challenges, the GoSTEAM program supported their school's certification efforts. In particular, the program gave teachers a *"seamless"* transition into integrated STEM/STEAM instruction. Program staff also completed trial runs of the certification assessment and "*gave [the school] some feedback,*" which schools were able to incorporate into their certification plans. These comments reflect the value administrators placed on external partnerships to not only support STEAM efforts, but also to support certification efforts.

Discussion and Limitations

While prior studies have provided mixed results on the impact of STEM certification on student test scores, STEM and STEAM instruction have been shown to support academic and 21st century skill development, particularly at the high school level [12], [13], [16] – [18]. In our study, administrators at GoSTEAM schools described similar impacts on students, explaining how GaDOE STEM/STEAM certification contributes to an integrated STEM/STEAM learning environment that increases students' critical thinking skills and ability to problem-solve real-world issues. Additionally, administrators described teacher buy-in and change in teacher practice as barriers of the certification process, similar to previous studies [22], [23]. Though requiring a significant effort, administrators still identified a commitment to growing their teachers' understandings of STEM/STEAM instructional practice, indicating interest in persevering through these barriers towards obtaining GaDOE STEM/STEAM certification.

Furthermore, McCullough [24] presented evidence that the learning environment created needs to be individualized for the school context, and the findings from administrators suggest that their school community has worked together to evaluate what is best for their teachers and students in terms of STEM/STEAM instruction. While the GaDOE certification process and STEM/STEAM Continuum lays out a roadmap towards certification, it leaves space for the school to tailor their instruction, including the methods of sustainability and partnerships developed. The individualized nature of the process also allows schools to draw real-world connections to issues happening in their community, providing students with an understanding of how their education connects to their daily lives [25]. However, the various STEM/STEAM school contexts may limit the scope of the study. In particular, the findings represent only a snapshot of each school's participation in the certification process. Because each school is in different phases of the process, and certification takes years to achieve, further study will seek to understand how perceptions change throughout the process.

While it takes significant effort to gather teacher buy-in and contribute to a change in teacher instructional practice, school administrators perceived the GaDOE STEM/STEAM certification process to be a worthy undertaking. As previously noted, the GaDOE certification process uses a rubric that does not distinguish between STEM and STEAM except to note areas to include arts standards. Similarly, administrators did not differentiate between STEM and STEAM, which led to a conflation between the terms "STEM" and "STEAM." This point warrants further study to better understand school administrators' perceptions between the two certifications, and why they are pursuing one instead of the other.

Future Study

The findings of this work-in-progress paper suggests there are unique factors that contribute to a school's interest and ability to pursue GaDOE STEM/STEAM certification. Pursuing GaDOE STEM/STEAM certification takes a significant amount of time, energy, and resources, and it is possible that perceptions of the certification process may shift over time. Thus, we plan to continue data collection with school administrators about perceptions of the certification process, and how schools intend to sustain their work to provide STEM/STEAM instruction. Additionally, as more literature is developed regarding STEAM certification, we aim to expand our understanding of implications of STEAM certification beyond the study, through additional contributions to the literature. Regardless, the vested interest of school administrators in the GaDOE STEM/STEAM certification process speaks to administrators' perceptions that certification can be a positive impact on their school and is a relevant GaDOE initiative.

References

[1] W. N. Dunn. *Public Policy Analysis: An Integrated Approach,* 5th ed. New York, NY: Routledge, 2012.

[2] The White House Office of Science and Technology Policy, "Equity and Excellence: A Vision to Transform and Enhance the U.S. STEMM Ecosystem," *The White House*, 2022. [Online]. Available: https://www.whitehouse.gov/ostp/news-updates/2022/12/12/equity-and-excellence-a-vision-to-transform-and-enhance-the-u-s-stemm-ecosystem/. [Accessed January 30, 2024].

[3] The White House Office of Science and Technology Policy, "Progress Report on the Implementation of the Federal STEM Education Strategic Plan," *The White House*, 2021. [Online]. Available: https://www.whitehouse.gov/wp-content/uploads/2022/01/2021-CoSTEM-Progress-Report-OSTP.pdf. [Accessed January 30, 2024].

[4] Society of Women Engineers, "Global STEM Workforce," *Society of Women Engineers*, 2023. [Online]. Available: https://swe.org/research/2023/global-stem-workforce/. [Accessed January 30, 2024].

[5] Georgia Department of Education, "STEM/STEAM Georgia," *Georgia Department of Education*, 2023. [Online]. Available: https://www.gadoe.org/Curriculum-Instruction-and-Assessment/CTAE/Pages/STEM.aspx. [Accessed January 31, 2024].

[6] Ohio Department of Education and Workforce, "STEM and STEAM School Designation," *Ohio Department of Education and Workforce*, 2023. [Online]. Available: https://education.ohio.gov/Topics/STEM-Science-Technology-Engineering-and-Mathem/STEM-and-STEAM-School-Designation. [Accessed January 31, 2024].

[7] Indiana Department of Education, "STEM Education," *Indiana Department of Education*, 2023. [Online]. Available: https://www.in.gov/doe/students/stem-education/. [Accessed January 31, 2024].

[8] STEM/STEAM Georgia, "Frequently Asked Questions," *Georgia Department of Education*, 2023. [Online]. Available: https://stemsteamgeorgia.com/faq.html. [Accessed January 31, 2024].

[9] D. E. Proudfoot, M. Green, J. W. Otter, and D. K. Cook, "STEM Certification in Georgia's Schools: A Causal Comparative Study Using the Georgia Student Growth Model," *Georgia Educational Researcher*, vol. 15, no. 1, 2018. [Online]. Available: doi: 10.20429/ger.2018.15102. [Accessed January 31, 2024].

[10] S. Newman, T. Kahn, M. Guo, A. Gerber, A. Burgess, and V. L. Akerson, "Public Portrayals of Indiana STEM Certified Schools," *Critical Questions in STEM Education*, vol. 51, 2020. [Online]. Available: https://doi.org/10.1007/978-3-030-57646-2_10. [Accessed January 31, 2024].

[11] American University School of Education, "STEM vs. STEAM: Why One Letter Matters," *American University*, 2018. [Online]. Available: https://soeonline.american.edu/blog/stem-vs-steam/. [Accessed January 31, 2024].

[12] S. L. Green and N. M. Anid, "Training K-12 Teachers in STEM education: A multi-disciplinary approach," in *2013 IEEE Integrated STEM Education Conference, Princeton, NJ, USA, 2013*. [Online]. Available: doi: 10.1109/ISECon.2013.6525206. [Accessed January 31, 2024].

[13] L. D. English, "STEM education K-12: perspectives on integration," *International Journal of STEM Education*, vol. 3, no. 3, 2016. [Online]. Available: https://doi.org/10.1186/s40594-016-0036-1. [Accessed January 31, 2024].

[14] S. E. Berryman, "Who Will Do Science? Trends, and Their Cases in Minority and Female Representation among Holders of Advanced Degrees in Science and Mathematics," Rockefeller Foundation, 1983. [Online]. Available: https://files.eric.ed.gov/fulltext/ED245052.pdf. [Accessed January 31, 2024].

[15] M. A. Cannady, E. Greenwald, and K. N. Harris, "Problematizing the STEM Pipeline Metaphor: Is the STEM Pipeline Metaphor Serving Our Students and the STEM Workforce," *Science Education Policy*, vol. 98, no. 3, pp. 443-460, 2014. [Online]. Available: https://doi.org/10.1002/sce.21108. [Accessed January 31, 2024].

[16] C. F. Quigley, D. Herro, and A. Baker, "Moving Toward Transdisciplinary Instruction: A Longitudinal Examination of STEAM Teaching Practices: Theory and Practice," in *STEM Education: Theory and Practice*, M. Khine and S. Areepattamannil, Switzerland: Springer, 2019, pp. 143-164.

[17] M. Dell'Erba, "Preparing Students for Learning, Work and Life through STEAM Education. Policy Brief.," Education Commission of the States, 2019. [Online]. Available: https://eric.ed.gov/?id=ED598088. [Accessed January 31, 2024].

[18] B. Lee and E. Change, "A cross cultural study on STEAM education in Korea and United States," *Korea Sci Art Forum*, vol. 30, pp. 277-288 2017. [Online]. Available: https://www.dbpia.co.kr/Journal/articleDetail?nodeId=NODE07248502. [Accessed January 31, 2024].

[19] J. L. Wendt, A. Rockinson-Szapkiw, and M. Cordes, "Examining the influence of a STEM certification model on female, minority science outcomes," *The Journal of Educational Research*, vol. 111, no. 6, pp. 666-677, 2018. [Online]. Available: https://www.tandfonline.com/doi/epdf/10.1080/00220671.2017.1396437?needAccess=true. [Accessed January 31, 2024].

[20] S. Daniels, "Georgia's STEM High Schools Alumni Perceived Preparedness for College STEM Programs: A Qualitative Case Study," Doctor of Education dissertation, School of Education, Northcentral Univ., La Jolla, CA, USA, 2020. [Online]. Available:

https://www.proquest.com/docview/2444600301?pq-origsite=gscholar&fromopenview=true.
[Accessed January 31, 2024].

[21] C. E. Scott, "An Investigation of Science, Technology, Engineering and Mathematics (STEM) focused High schools in the U.S.," *Journal of STEM Education: Innovations and Research*, vol. 13, no. 5, 2012. [Online]. Available:
https://www.jstem.org/jstem/index.php/JSTEM/article/view/1629. [Accessed January 31, 2024].

[22] A. Mickens, "Implications of STEM Certification on Indiana Elementary Schools in Areas of School Culture, Student Learning, Partnerships, and Instructional Strategies for STEM Integration," Doctor of Philosophy dissertation, Dept. of Educational Leadership, Indiana State Univ., Terre Haute, IN, USA, 2021. [Online]. Available:
https://www.proquest.com/docview/2638939952?pq-origsite=gscholar&fromopenview=true&sourcetype=Dissertations%20&%20Theses. [Accessed January 31, 2024].

[23] E. R. Khatib, "Examining State STEM Certification in a Metro Atlanta, Georgia Elementary School," Doctor of Education dissertation, Dept. of Educational Leadership and Policy Studies, Florida State Univ., Tallahassee, FL, USA, 2020. [Online]. Available:
https://www.proquest.com/docview/2490786514?fromopenview=true&pq-origsite=gscholar&sourcetype=Dissertations%20&%20Theses. [Accessed January 31, 2024].

[24] V. O. McCullough, "Conceptualization of STEAM Education in the Elementary Classroom," Doctor of Education dissertation, Columbus State Univ., 2022. [Online]. Available:
https://csuepress.columbusstate.edu/theses_dissertations/464/. [Accessed January 31, 2024].

[25] T. Sengupta-Irving and L. Schiffrin-Sands, "Principals, Paradigms, and Possibilities: STEAM Education Reform and the Centering of Black Life," *Urban Education*, 2023. [Online]. Available: https://doi.org/10.1177/00420859231170636. [Accessed January 31, 2024].

[26] C. Grbich, *Qualitative Data Analysis: An Introduction*. London: SAGE Publications, 2013.

[27] J. Saldana, *The Coding Manual for Qualitative Researchers,* 2nd ed. London: SAGE Publications, 2013.

[28] M. Walz, "Georgia Certifies First STEM School," *Georgia Public Broadcasting*, 2012. [Online]. Available: https://www.gpb.org/news/2012/03/07/georgia-certifies-first-stem-school#:~:text=And%20that's%20where%20the%20innovation,the%20Georgia%20Department%20of%20Education. [Accessed January 31, 2024].

[29] M. Cardoza, "Henderson Mill Elementary is the first Georgia school to earn STEAM certification from Georgia Department of Education," *Georgia Department of Education*, 2017. [Online]. Available: https://www.gadoe.org/External-Affairs-and-Policy/communications/Pages/PressReleaseDetails.aspx?PressView=default&pid=527#:~:text=Henderson%20Mill%20is%20Georgia's%20first,the%20school%20on%20April%2018. [Accessed January 31, 2024].

[30] STEM/STEAM, "Certification Process," *Georgia Department of Education,* 2023. [Online]. Available: https://stemsteamgeorgia.com/certificationprocess.html. [Accessed January 31, 2024].

[31] STEM/STEAM, "STEM STEAM Continuum Secondary Certification," *Georgia Department of Education*, 2023. [Online]. Available: https://lor2.gadoe.org/gadoe/file/2cc72070-e5d2-47dc-9989-5bd8ec8657e4/1/Secondary%20STEM%20STEAM%20Continuum%202023.pdf. [Accessed January 31, 2024].

[32]] STEM/STEAM, "STEM STEAM Continuum Elementary Certification," *Georgia Department of Education*, 2023. [Online]. Available: https://lor2.gadoe.org/gadoe/file/2cc72070-e5d2-47dc-9989-5bd8ec8657e4/1/Elementary%20STEM%20STEAM%20Continuum%202023.pdf. [Accessed January 31, 2024].

[33] V. Denmark, "AdvancED Launches STEM Certification Pilot," *Cognia*, 2015. [Online]. Available: https://source.cognia.org/issue-article/advanced-launches-stem-certification-pilot/#:~:text=Beginning%20in%20August%202014%2C%20AdvancED,such%20as%20in%20specific%20grades. [Accessed January 31, 2024].

[34] Cognia, "Accreditation & Certification," *Cognia,* 2024. [Online]. Available: https://www.cognia.org/services/accreditation-certification/. [Accessed January 31, 2024].