Sustaining Teachers' Learning to Teach NGSS-aligned Science and Engineering: Teachers' Experiences with Modest Supports

Abstract (120 words)

Teachers in rural schools have consistently faced challenges in accessing high-quality professional learning (PL). Approximately 150 rural teachers in four states received intensive, online summer PL paired with a variety of Modest Supports throughout the following school year. We used Picciano's multi-modal online educational model in characterizing the online summer PL and to evaluate the effectiveness of the Modest Supports. End-of-year surveys and interviews with teachers asked about their experiences with and perceptions of the Modest Supports. Initial descriptive statistics and thematic analysis found that teachers reported using the collaborative Modest Supports much more frequently than others and that they were more helpful and created a sense of community within the project while also supporting their NGSS learning and implementation.

Objectives

Teachers in rural communities may be geographically isolated and have limited exposure to current best practices for teaching science and engineering, as suggested in the Next Generation Science Standards (NGSS). Moreover, research highlights significant challenges involved in achieving lasting changes in pedagogy. Changes introduced through short professional learning (PL) programs often do not sustain (Coburn et al., 2012; Hubers, 2020). Furthermore, Drits-Esser and colleagues (2017) identified insufficient funding for sustained teacher engagement as a major barrier to maintaining changes. This issue is particularly acute for rural teachers who already face limited support for implementing innovative practices in their classrooms (Authors, 2024). To achieve educational renewal and equity, particularly in rural contexts with limited support, there is a need for sustained PL. This aligns with Dewey's (1899) notion that education is the midwife of democracy; by enhancing teachers' instructional practices, we can support the development of an informed and engaged citizenry. To support this renewal, we provided intensive online summer PL followed by various Modest Supports to rural elementary teachers from four U.S. states. The primary objective of the Modest Supports was to help teachers maintain and build on progress made during the summer PL. This study aims to understand teachers' experiences with these supports and assess their effectiveness in sustaining instructional changes. Here, we address the following research questions:

- How did teachers respond to four different types of Modest Supports?
- How effective were the Modest Supports in sustaining teacher learning from the summer professional learning?

Theoretical Framework

Pedagogical considerations of virtual learning are evolving as online educational opportunities and technologies advance. Extensive literature on learning theory has provided the foundation for emerging models that seek to include unique components that virtual learning environments offer (e.g., Anderson, 2011; Bosch, 2016; Garrison et al., 2000). Building on some of these models, Picciano (2017) developed a multi-modal online educational (MMOE) model for learning communities, which is composed of seven components that interact and impact the development of an online learning community (Figure 1): *content* (both what is presented and how, including learning management systems), *social-emotional* (opportunities to connect with the instructor), *self-paced/independent study*, *dialectic/questioning* (through prompts and discussions to probe understanding), *evaluation/assessment* (through varied and diverse methods afforded by technological tools), *collaboration/student-generated content/peer review* (group work in online settings), and *reflection* (personal and shared). The particular goals of the online learning opportunity determine which of these components will be most in use. We believe the MMOE model provides a useful and relevant framework for describing the features and pedagogical considerations of the online Modest Supports for our cohort of rural teachers and the lens through which we understand its impact to practice, learning outcomes, and development of a community of learners.

Methods

Over 150 rural elementary teachers across four western states participated in a five-day online summer PL. The goal of this PL was to enhance elementary teachers' understanding of NGSS instructional shifts. It introduced three-dimensional instruction, authentic science and engineering lessons, building on prior knowledge, and formative assessments. Teachers engaged in synchronous (e.g., breakout rooms, waterfall chat, Google Jamboard) and asynchronous activities (e.g., reading, reflection), collaborating across different grades and states.

During the following academic year, teachers were offered various synchronous and asynchronous Modest Supports. Synchronous Modest Supports consisted of 90-minute-long whole group (3 sessions) and state-level (4 sessions) PLC-style virtual sessions that supported colleague interaction, content and assessment support, and discussion around implementation efforts, all informed by teacher needs and intended to extend summer PL topics (Figure 2). During some of these sessions, participants were given a specific task (engineering lesson plan, performance-based assessment task), given time to work with colleagues to modify the task to align with their classroom context, and asked to implement it before coming back to discuss with colleagues (i.e., (A)synchronous Collaborative Modest Supports, Figure 3). Asynchronous Individual Modest Supports (Figure 4) included articles, newsletters, and online resources introduced to teachers throughout the year to refresh and expand what they engaged with during the summer PL. The last type of Modest Supports were tasks intended to support community building (identity slide), success sharing (brag board), and deepening understanding of one's own community assets (community walk slide). For each of these Asynchronous Collaborative Modest Supports (Figure 5), participants engaged in posting or creating a slide before a PLC session, looking at each other's posts, and sharing in breakout rooms at the session. All the collaborative supports were offered to keep participants connected with each other and enrich their professional networks in ways that may not be available to them typically.

Data Sources & Analysis

End-of-year Survey

The end-of-year survey was collected (n=105) after the last Modest Support was delivered in May 2023. The survey included items regarding teacher demographics, usefulness of Modest Supports, teacher capacity to deliver science and engineering instruction, understanding of NGSS, implementation impacts, and instructional time. Specific to this study, we focused on items that reflected teachers' perceptions of the Modest Supports. Descriptive analysis was conducted as preliminary analysis.

Interview

Individual interviews were conducted to a sub-group of teachers (n=33) purposefully selected to represent a range of grades (3rd-5th grades) and states. During the 45-minute Zoom interview, we asked whether and how they engaged in each support and whether they transferred ideas to other parts of their teaching or thinking. When analyzing the interview, we followed the

six-step thematic analysis process (Braun & Clark, 2012). Five authors individually coded the data by writing analytical memos. Then, we had a collaborative sense-making session to discuss the descriptive codes (Saldaña, 2021) to establish final codes and themes. We reflected on these findings using the MMOE framework (Picciano, 2017) to identify components that were found to be more/less useful for sustaining teachers' learning from the Summer PL.

Results

Table 1 shows how each of the Modest Supports targeted the seven components of the MMOE framework.

Asynchronous Modest Supports

The end-of-year survey uncovered that a third of teachers (36%) accessed the NSTA Hub resource at least *once or twice a month*, while 33% *rarely*—less than a few times all year—accessed it. About half of the teachers (n=49; 46.6%) subscribed to the NGSS Now Newsletter, but only 10 teachers reported reading it *every month*, while 19 teachers *rarely* or *never* read it.

In the interview, the majority of teachers shared that they had not used the asynchronous resources, which aligns with the survey results. A few shared that the Newsletter was useful for motivating them to further develop their science and engineering lessons:

> "It's like a motivator in a sense… It just made me think about doing science and it was just kind of a trigger point to go out and start searching for off-the-wall things to focus on or not use the same lessons and examples that I've always used."

For those who used them, this type of Modest Support was helpful in terms of informing teachers of ongoing topics about science and engineering education, providing "some ideas of what I could do with my own students," and promoting teachers to think about "how [to] better implement NGSS."

Asynchronous Collaborative Modest Supports

In general, teachers valued getting involved in this type of Modest Support. 30% of the teachers revisited the Google classroom more than once or twice a month, 32% a few times a year, and 38% *rarely* (less than once or twice a year). The majority of the teachers (86%) *often* (more than once or twice a week) used the landing page to go back to the content from the Summer PL and Modest Supports.

The community walk and the identity slides were beneficial for teachers to see "other teachers who were in similar settings, so we could see how they're doing things." From this connectedness, they received emotional support: "I kind of feel like I'm an island out here sometimes…so it's really allowed me to feel like there is a community out there for me." Many teachers spoke highly of the brag board because they could see how others approached the task while also reflecting on their own teaching.

> You have your experience with doing [the engineering lesson], and you just think that's how it goes, but then to see what other people had done with it. It was actually awesome. It gave me lots of ideas…and got me thinking outside of my own kind of tunnel vision.

They also appreciated engaging with the asynchronous components at any time, which allowed them to learn and reflect at their own pace. Overall, teachers reported that this type of Modest Support was effective in reflecting on and getting ideas.

Synchronous Collaborative Modest Supports

Overall, teachers found these Modest Supports to be helpful in building community, understanding, and access to high-quality resources. After implementation of both the assessment task and the engineering lesson, the majority of teachers said they were *likely* or *extremely likely* to use them next year (79%). The assessment task process left most teachers (82%) feeling their understanding of performance assessment in science was fair to thorough with only 4 teachers still feeling like they had a low understanding. With implementation of the CRED lesson, 102 of the teachers (92%) felt they had some to a thorough understanding of engineering design.

Based on interviews, teachers further emphasized the role that these supports played in their own reflection and the importance of the collaborative aspects of the tasks on their learning:

> I really, really liked the SCALE task … it was really neat to see what my students answered … When we worked on it at our last session with the other teachers, it was kind of neat to see what their students said and comparing different grade levels to how their way of thinking might have changed.

These supports also provided teachers an example that "was really all spelled out" and "had room for [them] to make adjustments so it could fit the class." This type of Modest Support was effective for building community through the implementation of a given task and reflection on it and students' performance.

Synchronous Modest Supports: PLC sessions

A majority of teachers (58–70%; see Figures and) said that all PLC sessions were *very* to *extremely helpful* for both their own professional development and learning and for implementing science and engineering in their classroom. The Showcase and the first state-specific PLC were the least helpful to teachers (16–18% and 12–14% said *not at all* or *slightly helpful* about these PLCs, respectively). However, the purpose of these PLCs were to get teachers familiar with the project, and to showcase their learning from the year rather than focusing on supporting their learning and classroom implementation.

Interview data revealed the impact that these sessions had on their sense of community and the social, emotional, and conceptual components of learning promoted through the sessions' structures. For multiple of the teachers interviewed, the sessions were

> …a learning environment for us. And so, I think the way it was set up…really fostered that. Okay, you do this, see how it works, and then bring it back and then talk to others

who did it and see what you guys can learn from each other. And that's exactly what a PLC's supposed to be.

Additionally, the discussions following implementation efforts were especially important for many of the interviewed teachers, as is demonstrated by this teacher's response: "it gave me more language to really support what I was missing and then change my own teaching." This type of Modest Support was effective for building relationships among the participating teachers and pushing their thinking.

Significance of the Study

The findings show how teachers engaged in different types of Modest Supports. In our presentation, we will further examine these supports along the MMOE framework to discuss their effectiveness in sustaining teachers' learning after the Summer PL. We believe this study allows access to high-quality science teacher education for those who may be isolated or have limited collegial networks, which contributes to the conference theme—just education renewal.

References

Authors. (2024).

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. Qualitative Research in Psychology, 3(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Coburn, C. E., Russell, J. L., Kaufman, J. H., & Stein, M. K. (2012). Supporting sustainability: Teachers' advice networks and ambitious instructional reform. *American Journal of Education, 119*(1), 137–182. https://doi.org/10.1086/667699

Drits-Esser, D., Gess-Newsome, J., & Stark, L. A. (2017). Examining the sustainability of teacher learning following a year-long science professional development programme for inservice primary school teachers. *Professional Development in Education, 43*(3), 375–396. https://doi.org/10.1080/19415257.2016.1179664

Dewey, J. (1899). The school and society: Being three lectures. University of Chicago Press.

Hubers, M. D. (2020). In pursuit of sustainable educational change: Introduction to the special section. *Teaching and Teacher Education, 93*. https://doi.org/10.1016/j.tate.2020.103084

Picciano, A. G. (2017). Theories and frameworks for online education: Seeking an integrated model. *Online Learning, 21*(3), 166-190. https://doi.org/10.24059/olj.v21i3.1225

Saldana, J. (2021). *The Coding Manual for Qualitative Researchers*. Thousand Oaks, CA: SAGE Publications Limited.

Tables

Table 1. Targeted Components of MMOE Framework for Each Type of Modest Supports

	Asynchronous	Asynchronous Collaborative	Synchronous Collaborative	Synchronous
Content	X	X	X	X
Social/Emotional	X	X	X	X
Dialectic/questioning		X	X	X
Collaboration/Student-generated content/Peer Review		X	X	X
Self-paced	X	X	X	
Reflection	X	X		X
Evaluation/assessment (SCALE task)				X

Figures

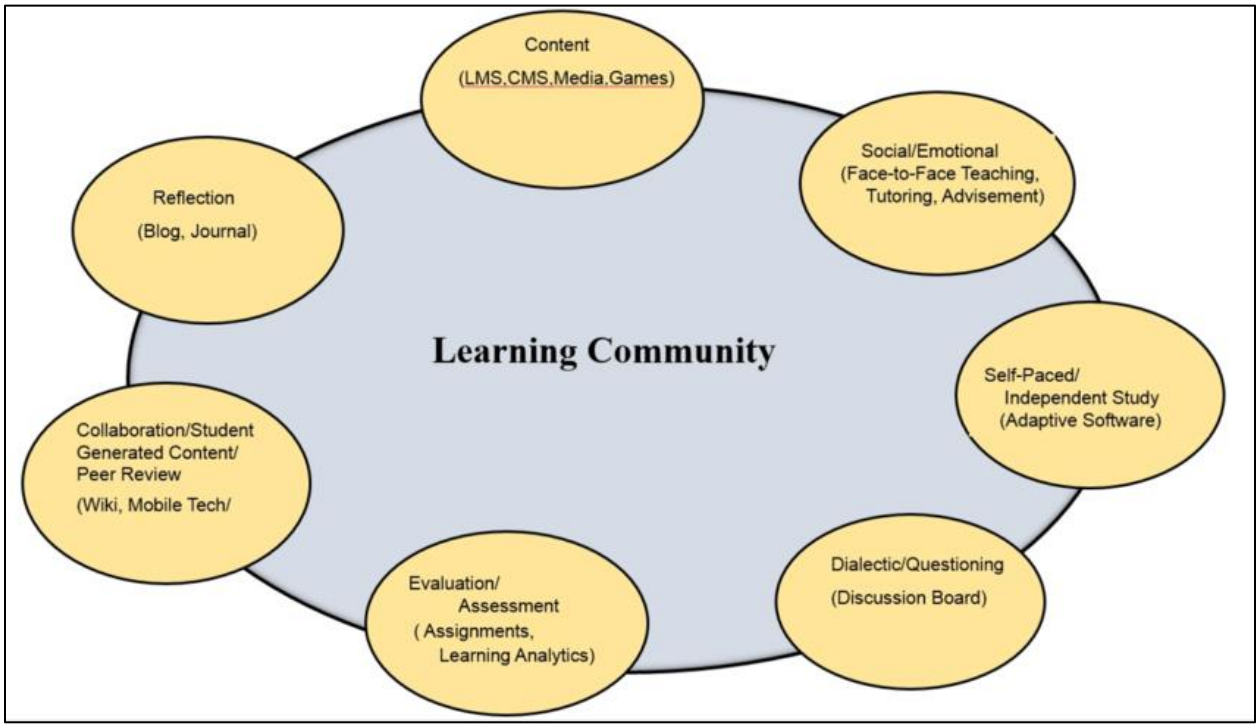

Figure 1. Multimodal Model for Online Education by Picciano (2017)

PLC sessions: Contents

September State Cohort PLC #1 Walkthrough of modest supports	• Revisited STEM STRONG goal statement and vision • Recap of Summer PL • Walkthrough of 2023-2024 Modest Supports • Introduced Google classroom
October Whole PLC #1 Elementary engineering education with Nico	• Shared "Community Walk" slides • Recap of Engineering Lesson (extreme weather) from Summer PL • CRED framework & Lesson plan • Compared d.school EDP with CRED EDP
December State Cohort PLC #2 Supporting each other while implementing engineering	• Review CRED framework • Started filling out lesson plan as a group in BOR

January Whole PLC #2
Formative assessment
	• Introduce SCALE task: "Planning a Park"
	  ○ NGSS Dimensions
	  ○ How to Introduce the Assessment to Students

February State Cohort PLC #3 Supporting each other while implementing science	• Celebrating Success: Engineering brag board • Engineering Lesson Debriefing: Share how you felt about incorporating engineering teaching in your classroom • Ask clarifying, probing questions about experience related to SCALE task

April Whole PLC #3
Review SCALE task w/ student artifacts &
Reflect on NGSS 3-dimensional instruction
	• Analyzed Student Work from Planning a Park Task
	  ○ Color coding of the student responses for each of dimensions & Label as Emerging, Developing, or Proficient
	  ○ Finished table for the Common Trends (Strength & Need) & Next Instructional Move

May State Cohort PLC #4 Spring Showcase & Next steps	• Celebration!

Figure 2. Synchronous Modest Supports

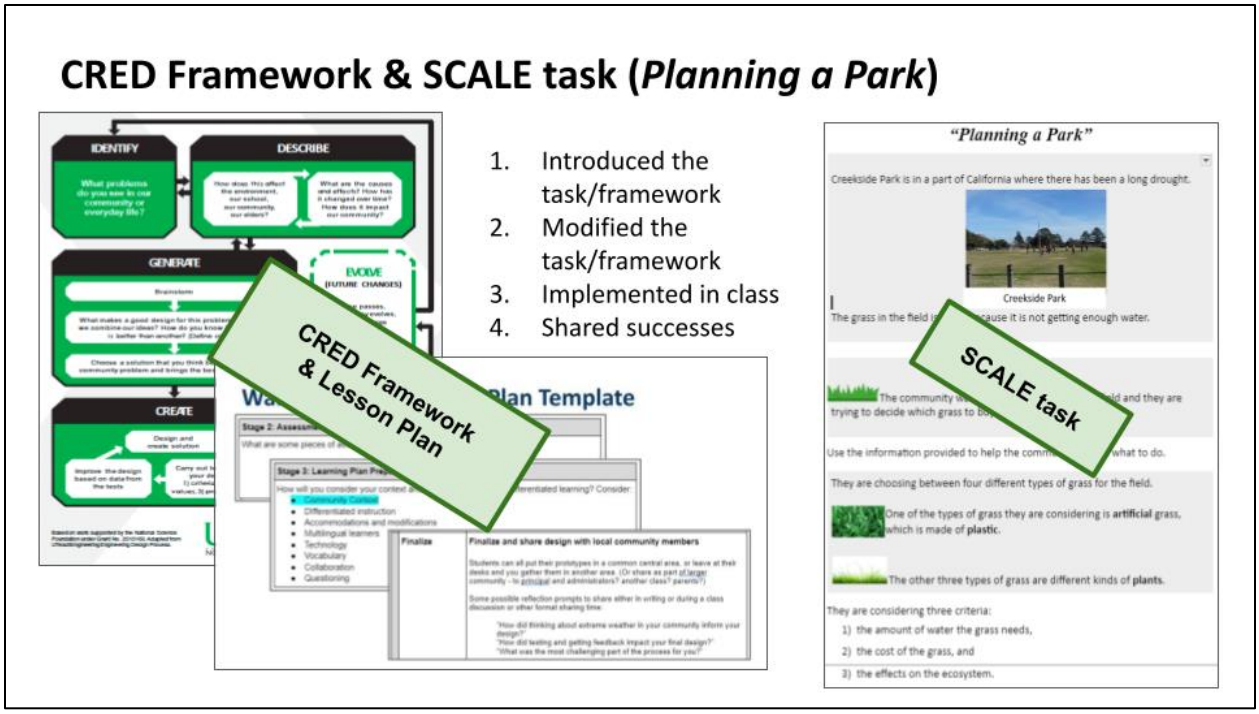

Figure 3. (A)Synchronous Collaborative Modest Supports

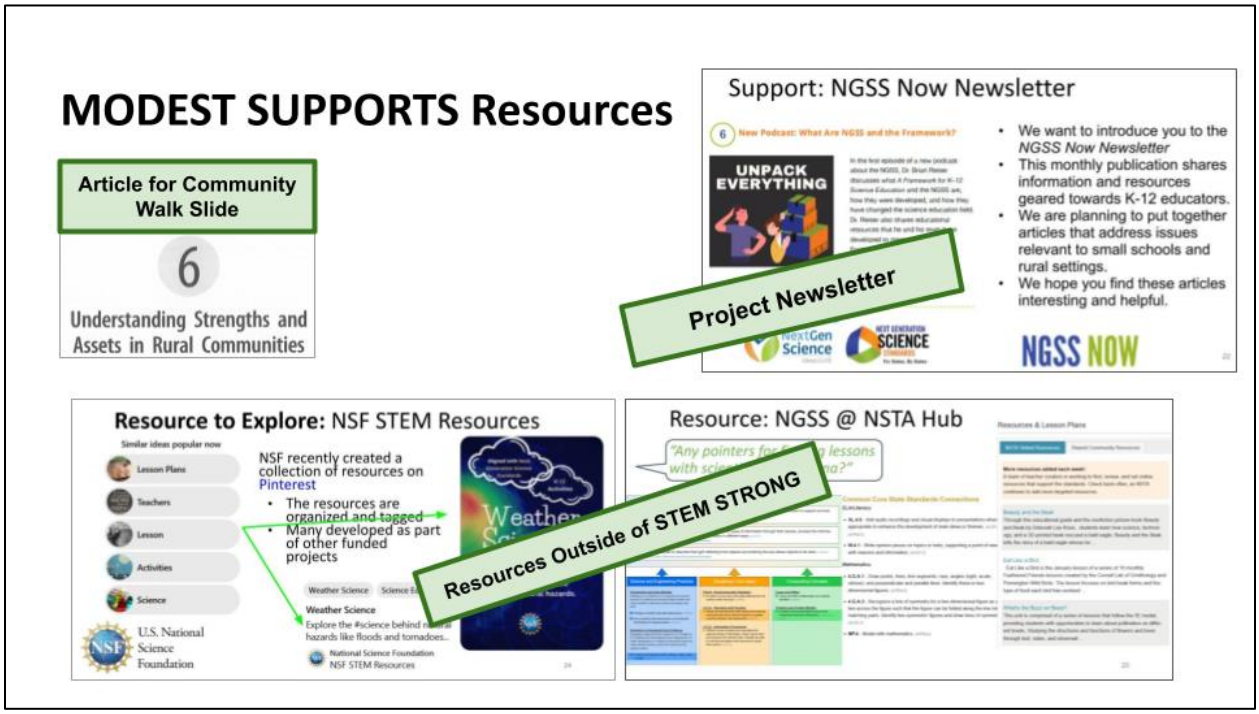

Figure 4. Asynchronous Modest Supports

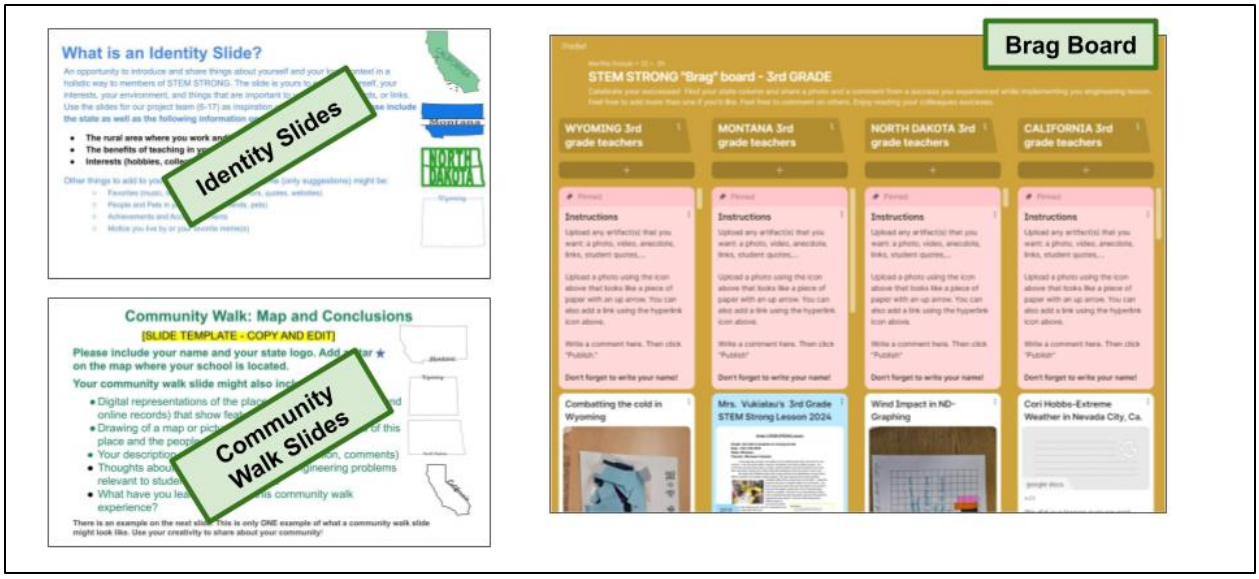

Figure 5. Asynchronous Collaborative Modest Supports

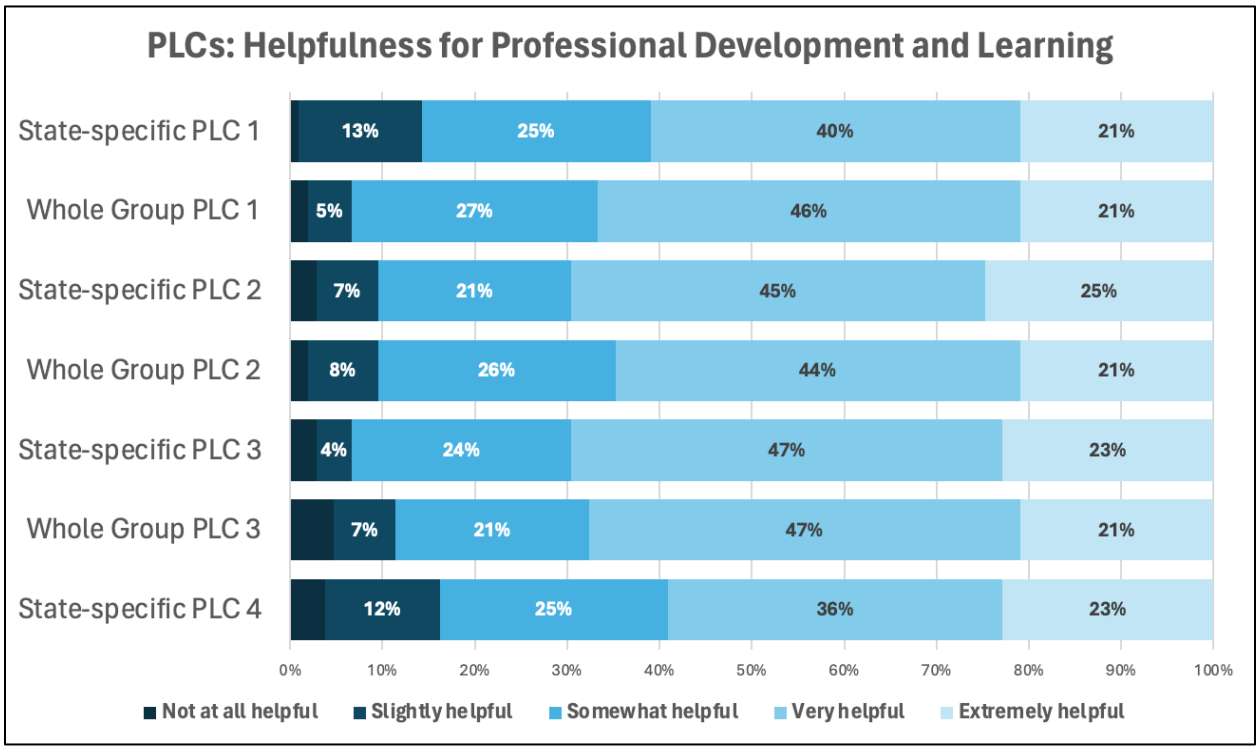

Figure 6. Survey Responses: Helpfulness of PLCs for Professional Development and Learning

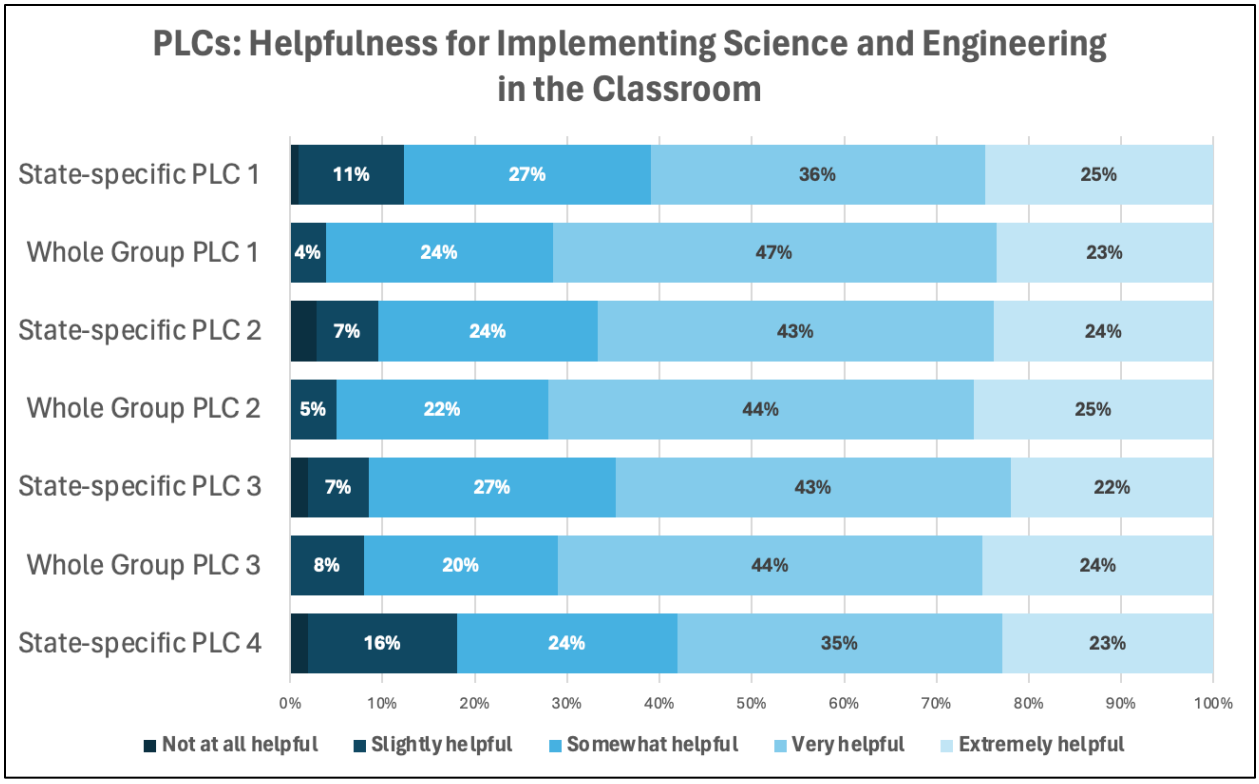

Figure 7. Survey Responses: Helpfulness of PLCs for Implementing Science and Engineering in the Classroom