Themed Paper Set for 2024 ASTE International Conference

A practitioner's perspective on engaging in cross-stakeholder collaborations to enhance secondary science preservice preparation programs

Contact Information
Abraham S. Lo
E-mail: alo@bscs.org

Themed Paper Set Citation
Lo, A. S., Bekins, A., Gagnon, R., Knight, J., Knoblock, R., Larm, R., Lindsay, W., Martin, A., Newberg, J., Scott, A., Smith, J., Strode, P., Stennett, B., Cherbow, K. (2024, Jan). *A practitioner's perspective on engaging in cross-stakeholder collaborations to enhance secondary science preservice preparation programs* [Themed Paper Set]. 2024 Association for Science Teacher Education International Conference, New Orleans, LA.

Acknowledgements
The research reported here was supported by the National Science Foundation through Grant DRL-1725389 to BSCS Science Learning. Any opinions, findings, and conclusions or recommendations expressed in this research are those of the authors and do not necessarily reflect the views of the National Science Foundation.

A practitioner's perspective on engaging in cross-stakeholder collaborations to enhance secondary science preservice preparation programs

Preparing new secondary science teachers to navigate the multiple and sometimes conflicting images of what effective science teaching looks like, sounds like, and feels like in the age of the Next Generation Science Standards (NGSS) is a complex challenge for preservice science teacher (PST) programs. Darling-Hammond (2014) identified common features of effective teacher preparation programs that made a difference in producing graduates who were "extraordinarily well prepared from the first days in the classroom" (p. 548). Among those features, Darling-Hammond noted that effective teacher preparation programs were characterized by strong relationships, common knowledge, and shared beliefs among all those who influence the preparation of new teachers, including university and school-based instructors, supervisors, and mentors. These programs were grounded in a common, clear vision of good teaching that "permeated all coursework and clinical experiences" to create a coherent image for new teachers. Korthagen et al. (2006) went further to state that learning about teaching is enhanced when "the teaching and learning approaches advocated in the program are modeled by the teacher educators in their own practice" (p. 1036). To reach these goals, Zeichner (2010) advocated for creating third spaces in teacher education that allow for boundary-crossing with a sharing of knowledge and expertise among all aspects of university instruction and field experiences. While many programs strive for coherence between university-based teacher education and secondary school settings, these efforts are often stymied in the face of complex university and school district institutional contexts, the siloed knowledge bases of education and science faculty and mentor teachers, and the varied background knowledge and beliefs of stakeholders invested in the success of teacher candidates (Korthagen et al., 2006; Nordine et al., 2021; Zeichner, 2010). These factors hinder opportunities to collaborate and co-develop a shared vision for organizing secondary science teacher preparation.

Given this backdrop, the STeLLA CO^2 project was developed to study how building community among stakeholders committed to preparing preservice science teachers and developing a well-articulated, *Framework*-aligned vision of secondary science teaching that could enhance the effectiveness and coherence of secondary science teacher preparation programs at three universities: University of Colorado at Colorado Springs (UCCS), University of Northern Colorado (UNC), and the University of Colorado at Boulder (CU Boulder). This work preceded the adoption of the 2020 Colorado Science Academic Standards in Colorado, which adapted the NGSS. These teams were composed of university science faculty, who contributed to PSTs' science content knowledge and vision for how science is taught and learned; university education faculty, who contributed to PSTs' content and pedagogical content knowledge (Shulman, 1986); and secondary classroom teachers, who mentored PSTs' field experiences.

Theoretical Framing

This work is grounded in the reform vision found in the National Research Council (2012)'s Framework for K-12 Teaching and the STeLLA (**S**cience **Te**achers **L**earning from **L**esson **A**nalysis) Conceptual Framework (see Figure 1, Roth et al., 2017), which includes strategies that students and teachers can employ to realize this reform vision. The STeLLA Conceptual Framework has two lenses: 1) the Student Thinking Lens, which includes strategies to reveal and challenge student thinking, and 2) the Science Content Storyline Lens, which includes strategies

to support students in developing strong, coherent connections to science concepts. There is a long line of research that establishes the value of the STeLLA approach in improving teacher science content knowledge, pedagogical content knowledge and teaching practice, as well as improved science content knowledge outcomes for the students of in-service (Roth et al., 2019; Taylor et al., 2017) and preservice teachers (Wilson et al., 2017) who have participated in the program.

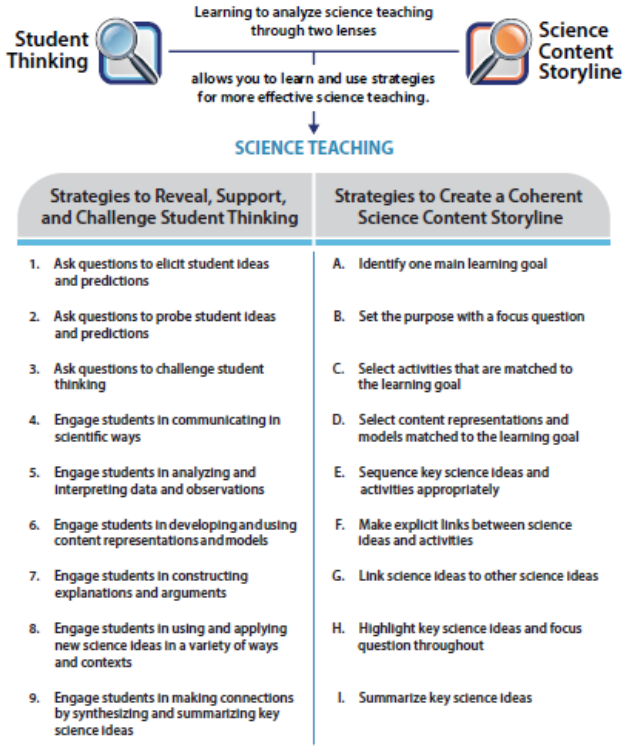

Figure 1. STeLLA Conceptual Framework (Roth et al., 2017; BSCS Science Learning, 2018)

The STeLLA CO^2 Approach

Figure 2 illustrates our theory of change for how the STeLLA CO^2 approach fostered cross-stakeholder collaborations to enhance the coherence of PST preparation programs. This theory of change represents how the roles and relationships that the university team stakeholders and the STeLLA CO^2 team changed as they progressed through different stages of the project to develop a more coherent and effective preservice science teacher preparation program at each university setting.

Figure 2a represents Phase 0 or the typical stakeholder roles. University education and science faculty are loosely connected due to their university affiliation, but do not always explicitly work together to achieve goals for students. Mentor teachers often have a working relationship with education faculty or their designates, as they host PSTs in their classrooms. However, the nature of the relationship is not always bidirectional. University education faculty often dictate the parameters for the field work that mentor teachers support in their classrooms. However, mentor teachers do not always have insight into what is happening at the university level or have a mechanism to provide feedback on the work that occurs in PST programs. Figures 2b-d represent the different phases of work that the STeLLA CO^2 facilitated as we sought to develop a common vision among university team members (Phase 1, Figure 2b) and leverage their collective expertise to develop (Phase 2, Figure 2c) and enact (Phase 3, Figure 2d)

revisions to their undergraduate preservice science teacher education programs. Each team was given a $25,000 budget to support the team's development and implementation of their plans and identify ways to sustain the work beyond the grant period.

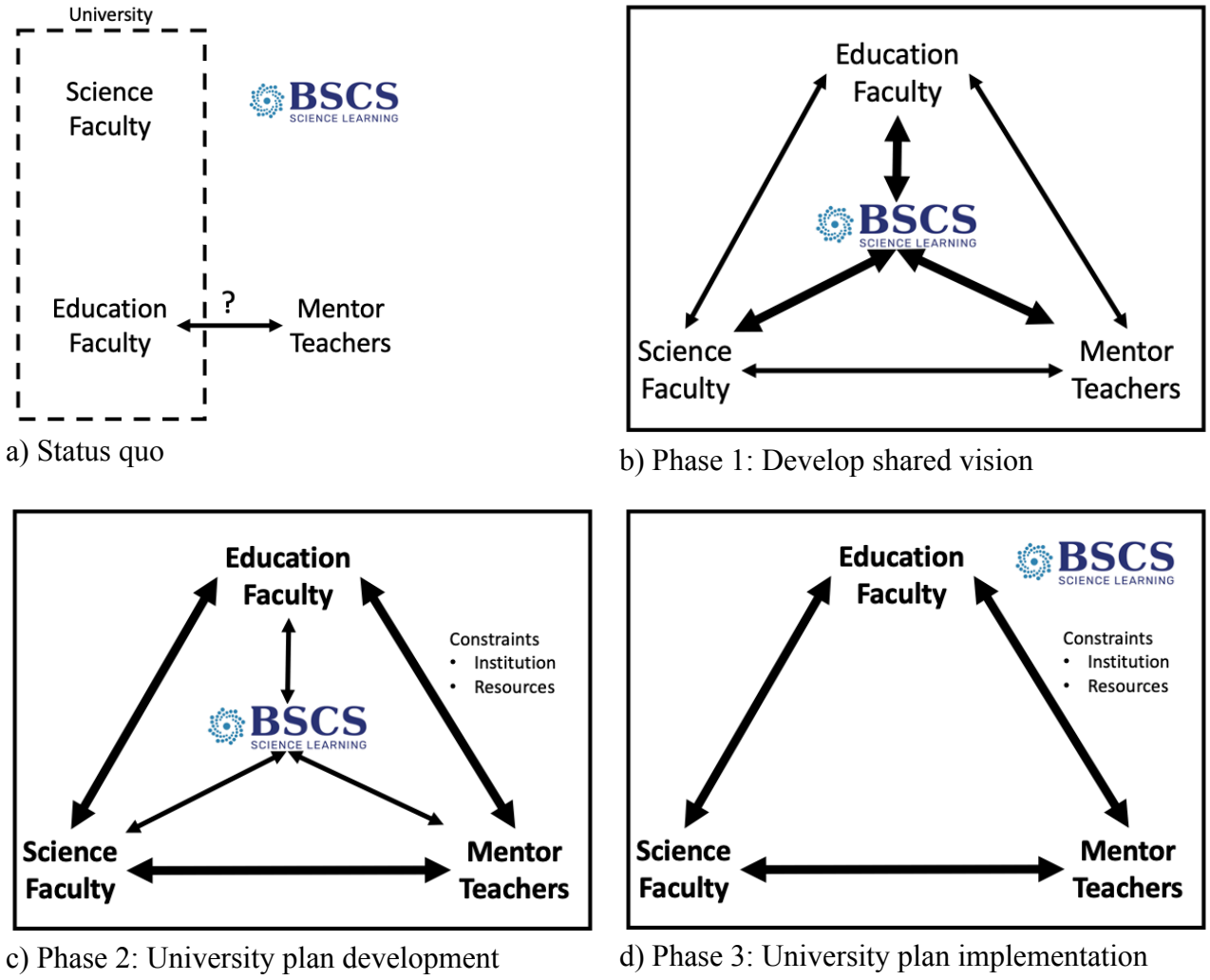

Figure 2. STeLLA CO^2 Project Theory of Change

During Phase 1, university science and education faculty and MTs participated in STeLLA CO^2 staff-facilitated synchronous sessions and asynchronous institutes and study groups with two cohorts of stakeholders over a four-month period. During these sessions, we developed a community of practice among stakeholders, who may have previously worked in isolation from one another, to cultivate a common vision for effective science teaching and learning using the STeLLA conceptual framework. Participants then considered how they might apply what they had learned to their teaching practice. Central to this work was the analysis of classroom video of teachers using the STeLLA strategies. Teams first analyzed the video of other teachers' classrooms before filming and analyzing videos of their own classroom practice. This phase of work resulted in enhanced relationships between university faculty and mentor teachers that included a shared understanding of what the STeLLA strategies are and how they could be broadly applied in their respective contexts. These discussions also provided the foundation for discussing the need to align each different level of the undergraduate learner experience with a

common vision for effective science teaching and the use of strategies to realize that vision. Although the ideas embodied in the STeLLA strategies may not have been new for some participants, this collaborative work contributed to the development of a shared language that participants could use to describe desired classroom practices and reinforce the need to use and support the use of these strategies consistently. The representation in Figure 2b shows the central role that BSCS played in organizing these teams and the developing connections between stakeholders.

During Phase 2 (Figure 2c), BSCS fostered conversations among team members to reflect on the extent to which this shared vision for effective science teaching and learning was evident across the different components of the PST program and how they might work together to develop plans to enhance the effectiveness and coherence of their university PST programs within institutional constraints and available resources. A core feature of this work involved positioning team members as equal partners with valuable perspectives and expertise, while creating space for stakeholders to adopt different roles than they might traditionally adopt. For example, mentor teachers could help co-design revisions to university courses with faculty. University science faculty might work with their team members to ensure that PSTs' experience learning and teaching science is aligned with a vision of science teaching and learning that is effective and authentic. The bolder arrows between the stakeholders in Figure 2c represents the joint efforts of the stakeholders in working together to develop their plans. Each university team was led by one or more of the team members and given the autonomy to use what they have learned to revise their programs to meet their needs. At the same time, BSCS still played an important role in the development work. Each team had one BSCS staff member, who played a facilitator and advisory role in the team's work to ensure that stakeholders' ideas were heard and respected, regardless of their position or role in preparing PSTs, and that the planned work would support the development of a more coherent learning experience for PSTs.

Phase 3 (Figure 2d) represents the final stage of the STeLLA CO^2 work, in which teams implemented components of their plans to enhance their university's PST programs. In practice, Phase 3 occurred over an extended period, as teams made their plans a reality and revised them as they enacted their planned revisions with students. During this phase, BSCS played an advisory role, which involved supporting the work of the team and the team's leadership. Although we monitored the progress of the team, we did not play a central role in implementing the work. Figure 2d represents BSCS's advisory role as external to the central work of the team, but still part of the work. The targeted product of this work is greater coherence in not only the vision of science teaching and learning guiding each step of the PST learner experience, but also in the strategies used by stakeholders to better prepare PSTs and support the learning of their students. Although considering the sustainability of their planned revisions was part of the plan development work in Phase 2, ensuring that the work was done in a sustainable way was an important consideration in Phase 3. Central to this work was reflecting on how the team's work impacted PSTs and ensuring that there was a mechanism to continue the most important parts after the grant funding concluded. A key part of this sustainability mechanism was ensuring that important key decision makers outside of the university teams, such as department chairs or school administrators, were aware of the team's work and could provide resources to sustain key components of the team's work in the future.

Introduction to Themed Paper Set

This themed paper set includes three case studies that were written by members of each university team to address a common research question, *What are the successes and challenges of fostering cross-stakeholder collaborations to enhance the effectiveness and coherence of secondary science preservice preparation programs?* In *Successes and challenges of developing cross-stakeholder collaborations to enhance preservice teacher preparation*, Newberg et al. describes the journey of the UCCS team towards developing a common vision for supporting PSTs' use of the STeLLA strategies and develop a mutually respectful and productive collaborative team to realize this common vision. The team shares how they incorporated the STeLLA strategies into their courses and involved mentor teachers in co-teaching their courses. In *Importance of clear roles and shared goals for supporting meaningful collaborations*, Lindsay et al. describes not only the work completed by the CU Boulder team to integrate STeLLA into their PST programs, but also the successes and challenges of defining and integrating the role of university science faculty to enhance the coherence of the PST learner experiences. In *Continuing a Partnership: Sustaining program changes through training of new university faculty and mentor teachers*, Bekins et al. addresses the unique context of housing secondary science teacher preparation courses in UNC's College of Natural Sciences and discusses their work in redesigning a 4-course practicum seminar series to make explicit use of the STeLLA strategies and the benefits of involving MTs as guest instructors to support PST learning and enhance the coherence of their PST program. We conclude the paper set with a discussion of lessons learned from these efforts to develop and engage in cross stakeholder collaborations to enhance the coherence and effectiveness of their PSTs and sustainable ways. Suggested citations for the themed paper set and individual papers are included on the title page.

Successes and challenges of developing cross-stakeholder collaborations to enhance preservice teacher preparation

Jennifer Newberg, District 49, Colorado Springs
Josie Smith, University of Colorado, Colorado Springs
Robert Gagnon, Space Foundation
Abraham S. Lo, BSCS Science Learning
Renee Larm, District 49, Colorado Springs

The University of Colorado in Colorado Springs (UCCS) team embarked on a journey to enhance the coherence and effectiveness of the UCCSTeach secondary science preservice teachers' (PST) program. A typical PST would engage in eight, sixteen-week long courses prior to student teaching (see Table 1). Our team consisted of two university education faculty members, seven mentor teachers (MTs), and one university science faculty member. During our initial planning meetings, the MTs shared the need for UCCS PSTs to have greater command of strategies to elicit and build on secondary students' thinking. Our team deliberated on how we could use what we learned about the STeLLA strategies to better support PSTs. In addition, the team identified the need to create additional fieldwork and mentoring opportunities with MTs to allow PSTs the opportunity to practice using the strategies they had learned in their education courses and leverage the expertise of teachers who use them daily.

The Beginning

As a team, we targeted the Science Research Methods course for revision, as it was taught in the fall and preceded PSTs spring student teaching semester. The course did not originally have a field component and would be a fruitful starting point for developing ways to integrate the STeLLA strategies into the coursework and design opportunities for PSTs to learn how to use them effectively in an actual classroom with support from MTs. Furthermore, it was a valuable opportunity for both the university education faculty and MTs to discuss desired mechanisms for enhancing PST teaching and secondary science students' learning.

During the Fall 2019 semester, we implemented the first iteration of the revised Science Research Methods course that focused on learning about the STeLLA strategies and designing a culminating lab activity, in which PSTs worked with a MT to design a series of inquiry-based lessons using the STeLLA strategies to elicit, probe, and challenge student thinking and support students in analyzing and interpreting data collected from the planned investigations. In doing so, we desired to shift the PSTs' focus from the mechanics of doing the planned investigations to supporting student sensemaking during the investigations. PSTs were paired with a MT involved in the STeLLA CO^2 project to support their use of the STeLLA strategies.

Our initial findings were varied. During our debrief sessions, the team shared that PSTs had challenges using the STeLLA strategies when designing and carrying out their lessons. We realized that reading about the strategies was not sufficient for preparing teachers to use the strategies with students. Our debrief revealed a lack of consistency in the level of explicitness for using the STeLLA strategies in their university coursework that prevented the PSTs from developing a common language or vision for how the STeLLA strategies could support students' learning. To better support PSTs, the team decided that we needed to cultivate a common vision for indicators of a successful lesson and better leverage one another's strengths.

Learning and Growing: Making Better Change

To help us develop a common vision and enhance our collaboration, we took steps to better understand one another's classroom practices and make visible how we sought to use the STeLLA strategies with students. We participated in team study groups to analyze videos of one another using the STeLLA strategies and consider how the STeLLA strategies could improve our own practices. Understanding what was emphasized in the university education courses could help MTs better support PSTs during their field experiences. As we continued to work together in service of our PSTs, rather than each person advocating for their own viewpoints, we learned how to better support one another as a team. Through this collaboration, we developed three goals that framed our design work to support PSTs:

Goal 1. The first goal was to better support PSTs' intentional use of the STeLLA strategies through explicit instruction in their education classes and incrementally introduce opportunities for PSTs to learn about and practice using the strategies as they progressed through the UCCSTeach program. To effectively do this, MTs who had classroom experience using the STeLLA strategies designed and facilitated classroom sessions related to the STeLLA strategies with PSTs in their university education courses. These same MTs then supported the use of the STeLLA strategies during field experiences in their classrooms. Education faculty also modeled the use of the STeLLA strategies in their instruction and periodically took off their "teacher hat" to talk about which STeLLA strategies they were using and why. Through this complementary work, MTs and education faculty worked together to enhance the coherence of the PSTs' learner experiences by allowing PSTs to observe the STeLLA strategies in action and understand not only how they could use them with secondary students, but also experience how the strategies impacted their own learning.

Goal 2. The second goal involved MTs designing and hosting workshops for PSTs to complement the revised university courses and provide PSTs with lesson planning support and more opportunities to learn about the use of STeLLA strategies while deepening relationships with MTs. This goal married the ideas of strategic incorporation of these STeLLA strategies within the UCCSTeach program and deeper collaboration between university education faculty, MTs, and PSTs.

Goal 3. The third goal involved disseminating the successes and outcomes of our collaborative work to incorporate STeLLA. Part of this work involved sharing and encouraging other UCCSTeach faculty to consider the relevance of the STeLLA strategies for their courses. This goal was synergistic with our desire to build sustainable changes to our program so that relevant stakeholders understood the significance of the work and would be willing to invest in it in the future.

Articulating these three goals provided a shared vision for how our team was going to work together going forward to develop a shared understanding for the intentional use of the STeLLA strategies to support student learning Since the UCCSTeach program involved both math and science students, courses were chosen based on their ability to impact science students and involvement by STeLLA CO^2-associated faculty in their teaching (see Table 1 for the current and planned revisions to courses).

Table 1
Current and planned course revisions to UCCSTeach program

Typical PST Path	**Modifications with STeLLA Currently Implementing**	**Future Planned Implementations**
Step 1 and Step 2	Introduction Class (Combined Step 1 and 2 course with STeLLA strategies embedded in course)	Continue implementation and refinement to meet needs of PST.
Knowing and Learning	-	-
Classroom Interactions	-	Redesign to add elements of STeLLA strategies to course
Science Research Methods (Science only)	Field Experience with STeLLA strategies embedded in the course and work with MT to develop further understanding of strategies	Continue implementation and refinement to meet needs of PST.
Perspectives on Science and Mathematics	-	-
Reading in the Content Area	-	-
Project Based Learning	-	Redesign to add elements of STeLLA strategies to course
Student Teaching	Work with MT to continue practicing strategies	

The team developed revisions to the courses and created synergistic opportunities for PSTs to practice what they have learned in their education courses in science classrooms with the support of MTs. Revisions were made so that students' exposure and opportunities to deepen their understanding of the STeLLA strategies would develop over time. For example, PSTs in introductory courses would receive support in designing inquiry-based lessons that make explicit use of a limited number of STeLLA strategies learned in class. By the time the PSTs got to Science Research Methods, which preceded their student teaching semester, the hope was that PSTs would have developed sufficient capacity to plan and enact their own lessons. Cycles of reflection and feedback from stakeholders were incorporated at the end of each semester, which then informed the design of revisions.

In what follows, we describe steps that we've taken to achieve Goals 1 and 3. In particular, we outline revisions that were made to the Science Research Methods and the first two courses of the UCCSTeach sequence (Step 1 and 2) that foregrounded the collaborative work between education faculty and MTs to enhance the coherence of the PST learner experience and better support PSTs' use of the STeLLA strategies to support secondary science students' learning.

Science Research Methods: Use of STeLLA strategies to support structured inquiry

The Science Research Methods course went through two further rounds of revisions starting in Fall 2020 to better support students in using the STeLLA strategies and adopt classroom

practices that aligned with the new Colorado Academic Standards for Science (2020). Central to these revisions involved supporting students in using evidence to iteratively develop models to explain phenomena.

MTs designed a learner experience allowing PSTs to experience using a phenomenon-based approach. The MTs modeled and engaged in explicit discussions about how the STeLLA strategies of *Identifying a main learning goal* and *Setting a purpose with a focus question* could support coherent learning from the students' perspective (BSCS Science Learning, 2018). In addition, MTs designed lessons to support PSTs in using the Claim, Evidence, Reasoning (CER) framework (McNeill, 2009) to support the development of evidence-based explanations. Through these revisions, PSTs had the opportunity to ask questions and learn how to use these strategies in intentional ways with their lessons before using the learned strategies to develop inquiry lessons that they would enact with secondary science students in the MTs' classrooms. Education faculty complemented these lessons with additional learner experiences using different phenomena and learner experiences. Initial feedback from PSTs and MTs was promising.

After these revisions, MTs and faculty reported that PSTs had a stronger conceptual understanding of what the inquiry process looked like and how to use the STeLLA questioning strategies to elicit, probe, and challenge student thinking. MTs also reported a much more solid experience for their secondary students, which included how the PSTs supported inquiry and designed activities that were focused on the explanation of phenomena. The team also identified the need to provide additional support for PSTs in planning lessons and activities that were linked to one main learning goal.

Combining of Step 1 and 2 Courses: Beginning program coherence

Throughout the project, the STeLLA CO^2 education faculty had been continually updating and sharing the products of our collaboration with the rest of the UCCSTeach faculty, with the desire to incorporate the STeLLA strategies in additional courses to support the coherence of PSTs' learner experience in the program and design additional field experiences for PSTs to work with MTs. In parallel to these discussions, the UCCSTeach program had discussed streamlining the program by combining the first two field-based courses, which supported students in designing and implementing lessons with elementary and middle school students. The UCCSTeach program faculty was encouraged by the initial feedback from the STeLLA CO^2 team's revisions to the Science Research Methods course.

During the Spring 2021 semester, the team discussed with the UCCSTeach faculty a proposal, which was accepted, to support the faculty in developing the proposed combined course. Through this work, the team could begin thinking about the intentional, incremental development of a common language and understanding among all PSTs using the STeLLA strategies that could be built upon by all stakeholders through the PSTs' experience in the UCCSTeach program. The STeLLA strategy booklet (BSCS Science Learning, 2018) became required reading for the course. There are 18 STeLLA strategies, so our team decided to introduce a fewer number of high leverage strategies in this course, leaving space to add additional strategies in later courses with the goal of exposing PSTs to most of the strategies before student teaching. The STeLLA questioning strategies, *Communicating in Scientific Ways*, and *Identify one main learning goal* were the strategies chosen for this course. We chose these strategies because we felt they were easy to understand and could be put into practice quickly to support student learning. In addition, PSTs could utilize those specific strategies in all their

remaining courses to help them grow and aid in their journey toward a successful student teaching.

The existing Step 1 and 2 courses used the BSCS 5E instructional model (Bybee et al., 2006) as a framework for planning lessons. During our initial planning, we restructured the course in two key ways. First, we separated each of the Es and identified STeLLA strategies that would support the knowledge-building work occurring in each E. Second, we incorporated additional field experiences in elementary and middle schools to allow them time to observe and practice using the learned STeLLA strategies. In total, we designed twelve different field experiences (three at the elementary level and nine at the middle school level) during the course, which included classroom observations, opportunities for mentorship, feedback on designed lessons, co-teaching experiences with MTs, and solo teaching experiences. Thus, experiences in the university classroom were reinforced through field experiences and a debrief with education faculty.

The first part of the class focused on the Engage and Explore phases of a 5E lesson plan and the STeLLA questioning strategies. When PSTs went into elementary classrooms to observe, they would think about how the STeLLA strategies were evident in the Engage and Explore phases in teacher's lessons and document what questions were asked during those phases. In their education classes, faculty and MTs worked collaboratively to teach PSTs about the STeLLA strategies through reading about the strategies in the STeLLA strategy booklet and analyzing video excerpts from a STeLLA-trained, elementary MT's classroom to identify examples of the three types of questioning strategies. The video clips shown during the class helped start a discussion about the purpose for using the various question types. PSTs then revisited the questions they documented from their classroom observation to see whether they could then categorize those questions using the STeLLA framework. To supplement the discussion, the MT facilitating the discussion shared personal experiences using the questioning strategies in her eighth-grade classroom. She shared how the different question types could be used and what their purpose was in a specific lesson she taught which helped PST deepen their understanding of the questioning strategies. Learning about the strategies in this way allowed PSTs to see the theory of questioning put into practice from different points of view: readings about strategies with examples, observations in elementary MT classrooms, classroom video, and anecdotes from the MTs' classroom experiences. In each experience, PSTs could unpack their understanding of the strategies and how they impacted student learning. Education faculty continued to explicitly model the questioning strategies, which elevated the importance of using the questioning strategies and provided additional time for PSTs to practice and reflect on the use of the STeLLA strategies.

The second part of the course involved using the STeLLA strategies to design lessons that were aligned with the standards. We focused on the *Communicating in Scientific (and Mathematic) Ways* and *Identify one main learning goal* strategies. The Communicating in Scientific (and Mathematics) Ways strategy incorporates sentence stems to help support disciplinary discourse in the classroom. Although originally written with scientific goals in mind, we found them to be helpful for supporting mathematical discourse as well. During this part, students worked with both science and math MTs to design lessons using the STeLLA strategies. PSTs designed lessons using the questioning strategies learned during the first part of the course and the *Communicating in Scientific and Mathematical Ways* strategy to support classroom discussions to address the main learning goal of the lesson. After the lesson, PSTs and their MTs debriefed about their use of the STeLLA strategies to make visible students' learning. The

revisions to the first part of the course paid dividends for PSTs when they taught their lessons at the middle school level. MTs shared that PSTs remembered their experiences with the questioning strategies and were able to employ them with greater confidence and intentionality compared to previous PST cohorts. Because the PST had more opportunities to work with their MT compared to previous groups, the MTs had already established a relationship to support PSTs' lesson planning and use of the questioning strategies.

Moving Forward and Lessons Learned

Our goal is to use our model for collaboration to continue to revise additional courses in the UCCSTeach program to include more intentional use of the STeLLA strategies to enhance the coherence for PSTs. Our model of collaboration involved 1) stakeholders identifying areas in need of growth, 2) identifying common goals and expectations, 3) identify examples to illustrate aspects of desired practices, 4) modeling the use of the strategies with PSTs, and 5) providing structured support for PSTs in enacting this work with secondary science students.

We have currently developed two courses that can serve as models for future revisions. We are also exploring how to utilize the STeLLA strategies as a shared language, not only within the UCCS STeLLA CO^2 team but also among other UCCSTeach faculty who collaborated with our team in co-teaching these courses. Within the framework of a community of practice, these faculty members may have initially occupied a peripheral role. Over time, as they engaged in legitimate peripheral participation by co-teaching lessons alongside STeLLA CO^2 faculty and MTs, the objective was for them to grasp the value of the strategies and the course enhancements in their work (Lave & Wenger, 1991) and become familiar with the common language that was being explicitly developed in these courses. Through observation and reinforcing what was learned during parts of the class that explicitly support the use of the STeLLA strategies, these faculty members became familiar with the STeLLA strategies and were able to continue utilizing them throughout the rest of the course. Continuing to include MTs in the review, re-design, and implementation of revised lessons will be important as we move forward. From our initial investment in Science Research Methods, we have seen a huge difference from previous years. The PSTs have shown improvement in their ability to question students to reveal, support, and challenge student thinking, and they have also demonstrated enhanced proficiency in providing evidence-based explanations for scientific phenomena.

As we look towards the future, it is vital to review the sustainability of the project long term. Our approach fully immersed PSTs in the STeLLA strategies through explicit instruction of specific STeLLA strategies, such as questioning, scientific communication, and contextual application of content, along with the emphasis on setting clear learning objectives and purposeful focus questions in the initial PST coursework. As they progress through the program, PSTs have opportunities to observe their MT applying these strategies in classroom settings, actively engage in practicing these techniques themselves, and benefit from watching video examples featuring secondary teachers demonstrating the effective implementation of these strategies. The question we must ask ourselves though, is how can we continue with changes in funding, MTs, and UCCSTeach faculty?

Our journey has involved various personnel changes and evolving roles. In the beginning of the 2022-23 school year, one of the MTs transitioned into a coaching role, but remained involved in a consultant capacity. Another UCCSTeach faculty member transitioned from the program. Although this could initially have been viewed negatively, the movement presented an opportunity to expand the influence of STeLLA strategies by introducing them to a different set

of science educators. However, this new cohort may not possess the same depth of knowledge or immersive experiences as the initial team due to lack of training and experience. New mentor teachers who are hosting PSTs continue to reach out to former MTs to enhance their understanding and application of the strategies with both PSTs and their own students. Given the high demand for STeLLA-trained MTs to sustain reforms in the UCCSTeach program, our team is seeking solutions to familiarize MTs with the STeLLA strategies.

From the UCCSTeach program's perspective, the turnover from the past two years has caused some challenges with sustaining changes that we had implemented in the UCCSTeach program. With these faculty changes, not all members of the UCCSTeach team have had the opportunity to dive thoughtfully into learning STeLLA to understand how and why the STeLLA strategies were useful or how to use them. As such, some university faculty may not have fully appreciated the value of employing these strategies with PSTs. Similar to the situation with MTs who have transitioned out of the classroom, it became difficult to replace education faculty members who have actively practiced STeLLA in their classroom settings. Although the goal is to support the new faculty member's growth with STeLLA strategies long term, our current PSTs no longer receive the same level of in-depth modeling from which their predecessors once benefitted.

Despite the persistent challenges and turnover within our team, we remain determined in our pursuit of Goals 2 and 3. We plan to continue work on Goals 2 and 3 through several strategies. We have initiated contact and collaboration with various local, district, and state-level groups so our first strategy involves partnering with Peak Area Leadership in Science (PALS) to train additional MTs in the application of STeLLA strategies within their own classrooms and subsequently with assigned PSTs. This represents a crucial step toward achieving our current objectives.

Next, we plan to expand the implementation of STeLLA strategies across the state. To accomplish this, we plan to offer free professional development opportunities for members of the Colorado Association of Science Teachers (CAST) on the STeLLA strategies. This will enable us to expand our network of MTs available to mentor PST teachers. Our outreach efforts will also benefit other teachers, as it will engage MTs who attend CAST conferences and other professional development events. From these interactions, we aim to stimulate interest among districts to incorporate teacher PD classes, training sessions, and participation in conferences, allowing us to share the progress we have achieved and facilitate replication in their respective districts. In addition, we plan to partner with the CU Boulder STeLLA CO^2 group to offer workshops for practicing teachers who are interested in learning more about the STeLLA strategies. This will provide an opportunity to not only train more teachers, but also have the potential to utilize those teachers as MTs for PSTs in the future. Lastly, we will maintain regular meetings with UCCS faculty to ensure the continued integration of STeLLA strategies in PST courses.

We created a comprehensive website designed to supplement the training of PSTs and support faculty in learning about the STeLLA strategies. The website features a specialized training module centered around the topic of questioning. This module seamlessly integrates the STeLLA booklet, instructional videos, and a hands-on questioning activity that allows PSTs to practice and refine their skills in crafting different types of questions. Beyond honing their questioning techniques, PSTs also gain insights into the rationale behind each question and its intended purpose. This deeper analysis empowers PSTs to understand the pedagogical strategies employed by their mentors. Another section of the website is designed to help MTs learn about

the STeLLA strategies so that they can support PSTs' use of the STeLLA strategies that have been learned over the course of the program.. The website serves as a valuable tool for both PSTs and MTs as it encourages a shared vision and, as it is publicly accessible, it helps promote transparency and collaboration among all stakeholders in the teacher preparation process.

Our team has experienced significant growth pains, yet this journey has culminated in the formation of a united and cohesive group of professionals who have cultivated trust among themselves and forged a shared vision for effectively preparing PSTs. With a growth mindset, we have prioritized communication and community building. As a team, we are constantly reflecting and re-evaluating our goals to ensure we stay on track with the needs of our PST and attend to all the voices and concerns on the team. We recognize limitations on our own personal capacity, amidst competing demands on our time, and programmatic constraints. At the same time, our focus on a common goal allows us to be creative in how we can meet the desired outcomes. Undoubtedly, our work has shown that this is possible, and we look forward to creating the best teacher preparation program possible. The trust and mutual respect among us have flourished as we have collectively striven towards a common goal.

We hope that others in the science education community can learn from our experience of partnering together as university faculty and MTs to develop more effective teacher preparation programs. Promoting institutional shifts at this scale can be a complex challenge. It was important for us to identify opportunities for making small changes that were within our sphere of control and learning from those efforts. Through many iterations, we identified important ways in which these small changes led to important shifts in classroom teaching for the PSTs. These small efforts served as important stepping stones for promoting broader, programmatic shifts. Involving MTs and their perspectives from the classroom was critical to these efforts. As such, thinking about ways to increase capacity to sustain these changes over time will be important.

Paper 2: **Importance of clear roles and shared goals for supporting meaningful collaborations**

William Lindsay, Andrew Martin, Jenny Knight
University of Colorado, Boulder

Paul Strode
Boulder Valley School District

Abraham S. Lo
BSCS Science Learning

The STeLLA CO^2 project brought together mentor teachers and university education and science faculty from the University of Colorado, Boulder over a period of six years to create a community of practice among science educators invested in preparing future science teachers. These stakeholders played unique roles in shaping a novice teacher's vision of effective science teaching and maintaining coherence among the different facets of their preservice education. We experienced successes and challenges when working together as a cross-stakeholder team of science educators that underscored the importance of co-developing shared goals and defining clear roles.

Developing the CU Boulder STeLLA CO^2 Community

Our journey through this program included an initial professional development experience to learn about the STeLLA strategies (Roth et al., 2017). Cross-stakeholder teams learned strategies for effective science teaching through analyzing videos of classroom practice and engaged in honest and safe discussions about how they might enhance our classroom practice. Through this work, we developed connections with our peers at surrounding schools. This process of reflection promoted a general growth mindset attitude, helping to remind us that teaching is an evolving craft that requires active revision. Through our interactions, we were reminded that having a coherent framework and engaging in substantive reflection helped us further develop as science educators working at different levels in the K-16 system. Specifically, university science faculty found this experience valuable in demonstrating how the skills and strategies used by our colleagues in middle and high school could be enacted at the university level and provided a more coherent and NGSS-aligned educational experience for students.

Developing our plan

After the professional development, our team began to organize and plan for how we would use STeLLA within CU Teach, our preservice science teacher (PST) preparation program. Each stakeholder group came to the collaboration with different purposes, expertise, experience, and perspectives that we describe below:

- The education faculty members' goals included: 1) integrating strategies and perspectives used by preservice and mentor teachers into CU Teach courses and tools; and 2) building community, capacity, and vertical coherence across diverse stakeholders involved in secondary STEM education.
- The goals of the middle and high school mentor teachers included: 1) deliberately practicing the STeLLA strategies in their classrooms to make student thinking visible and move students from their initial student ideas toward more accurate science ideas; 2)

working with pre-service teachers to give them opportunities to practice the strategies in an authentic setting and reflect on those practices; and 3) building better lessons and units using the STeLLA strategies of identifying learning goals, using student-facing focus questions, and generating storylines around which to build instruction and activities.

- The undergraduate science faculty members' goals included: 1) making operational connections with local schools to improve their understanding of how students in the community are taught science and what content and practices are emphasized; 2) developing a university peer mentor training program in biology that emphasized revealing, supporting and challenging student thinking as strategies for supporting undergraduate biology student learning; and 3) becoming familiar with STeLLA, a well-researched pedagogical framework that was aligned with the Next Generation Science Standards (NGSS; NGSS Lead States, 2013), and considering it as a possible structure for enacting professional development at the university level.

The team decided that the focus of the team's work would involve creating tools, such as lesson plan templates and observation protocols, to support PSTs' use of the STeLLA strategies in their field work with mentor teachers. Education faculty would engage students in learning about the STeLLA strategies through readings, discussions, and video analysis and explicitly model the usage of STeLLA strategies in their courses. During this plan development time, the two education faculty members worked together to coordinate work across the team, including scheduling and facilitating meetings, and setting team goals.

While the education faculty and mentor teachers' work was closely tied to improving the CU Teach program, this work was not aligned with the university science faculty members' work or interests, which focused on how to integrate the STeLLA strategies into different undergraduate science courses to increase active learning, student-centeredness, and coherence for students. This divide in purpose served to create a separation between the work to enhance PSTs' work in their education and science courses. The STeLLA CO^2 university science faculty then pursued parallel work to enhance the Teaching and Learning Biology course, which supports teachers in learning pedagogical strategies that would be helpful for teaching biology at the secondary or college level. In the section that follows we describe the successes and challenges related to leveraging a range of perspectives when revising a course to integrate the use of the STeLLA strategies.

Successes and Challenges: Teaching and Learning Biology Course

One of the goals of this collaboration was to develop and sustainably offer a course focused on teaching and learning biology that could serve two purposes: 1) provide training and credit for students seeking to become licensed secondary school teachers and 2) introduce biology teaching and learning principles to students who may be interested in pursuing a career in teaching biology at the college level. This course was a joint effort between the three biology departments at CU (Ecology and Evolutionary Biology (EBIO), Molecular, Cellular and Developmental Biology (MCDB), and Integrative Physiology (IPHY)) and the School of Education. A Teaching and Learning Biology course was already present on campus, originally co-developed by a biology professor and a School of Education professor in 2013 prior to the widespread adoption of the NGSS and the emergence of the STeLLA strategies as a coherent method for enacting NGSS-aligned curricula.

Martin, a STeLLA CO^2 EBIO faculty member, and Strode, a STeLLA CO^2 mentor teacher, worked with the original developer of the Teaching and Learning Biology course to offer

a revised version built on the synergy of the NGSS and the STeLLA strategies. Strode was able to represent the School of Education in this collaboration due to his long-standing relationship with the school and his work on the STeLLA CO^2 project. This partnership had the potential to enhance the existing course because Strode could offer perspectives on how to use the STeLLA strategies at the secondary level, while Martin could share his perspective on how to use the strategies at the college level.

The first iteration of the revised course was launched during the pandemic in the Fall 2020 semester and was taught online with an enrollment of 30 undergraduate and graduate students, equally distributed among EBIO, MCDB, and the School of Education. Even before the course began, there were differences of opinion on how to enact the course. Martin and Strode worked closely together to develop the curricula in ways that emphasized the NGSS and the STeLLA conceptual framework. However, the other faculty member was tied to the original course approach and materials in ways that created conflict with the revised emphasis on the STeLLA strategies. Moreover, while Martin and Strode appreciated the different backgrounds of the enrolled students and the shared goals of learning to teach and improve science communication skills, the original faculty member focused on emphasizing mastery of molecular and cellular biology using a specific pedagogical approach. This instructor primarily focused on whether the enrolled students were well-versed in that sub-discipline rather than focusing on the NGSS and enacting the STeLLA strategies. This inability to coalesce on one unifying theme for the course led to frustration and a breakdown in communication between the new instructors and the original instructor.

Martin and Strode shared their experience with the CU Boulder STeLLA CO^2 team, which agreed to include this work as part of the team's broader plan to enhance the coherence of CU PST preparation and allocated financial support to continue Strode's work in teaching the course. Strode worked with Knight, an MCDB faculty member and a member of the STeLLA CO^2 university team, to offer the course again in Fall 2022. Martin was unable to join them due to his department chair responsibilities. Enrollment was lower in this iteration (eight students), possibly due to a required change in the original course name and number. Nonetheless, the enrolled students represented all three CU biology departments and the School of Education. Strode and Knight worked in a highly synergistic way to develop and refine the integration of the NGSS and STeLLA strategies into the course curriculum. They capitalized on their sub-discipline expertise (ecology and molecular biology) and levels of instruction (high school and undergraduate science) to bring varied content and different methodologies to the students. Both instructors had the experience of actively learning from each other and from their interactions with the students throughout the course. This dynamic resulted in a positive, growth-oriented learning experience for all involved.

A third iteration of the course happened in fall 2023. The original biology faculty member, aware of the breakdown in communication that occurred in the first iteration of the course, approached Lindsay, and asked if he would be willing to again revise the course to attend to the unique needs of pre-service teachers and majors in his specific sub-discipline that were not seeking careers as secondary educators. This work attempted to both build upon the work developed in the second iteration of the course developed by members of the STeLLA CO^2 team, alongside integrating the original biology faculty member's goal of ensuring that preservice educators and sub-discipline majors had deep conceptual knowledge of biological ideas. During the summer, the education and original faculty member came to consensus on two key student learning objectives for the course: 1) Engage in scientific practices to induce, test, and deepen

their conceptual understandings of core biological concepts with a focus on those included in state and national standards; and 2) Develop strategies for designing learning environments where K-16 students can apply scientific practices to figure out explanations of biological phenomena. Learning from the collaboration challenges that occurred in the first iteration of the course and the successes of the second iteration, Lindsay and the original biology faculty member made a commitment to co-planning and co-teaching each course session. They modeled and discussed using STeLLA and NGSS-aligned strategies for teaching and learning biology and leveraged the curricular materials produced in the second iteration of the course when planning and enacting lessons. This approach resulted in a more positive teaching experience with the original biology faculty member, who now supported integrating this redesigned course into the set of Teaching and Learning Science courses— including Chemistry, Geology, Physics and Biology—that forms one core set of courses required for licensure. Our goal is to bring in a third university biology department and offer the course once a year and keep members of the STeLLA CO^2 team, including Strode, as core members of the course's faculty.

Teaching at the secondary and tertiary levels is connected in theory, but most college professors likely are unaware of how biology is taught at the high school level. Our collaboration brought together a mentor teacher, school of education faculty, and biology faculty to help bridge this divide and broaden the perspective and capacity of all. One of the important successes of offering a course that fostered cooperative teaching opportunities between educators operating in different settings is that each member of the cross-stakeholder teaching team learned about how teaching happened at both the high school and college levels, which also helped PSTs visualize how the education process was or could be connected. To be more specific, the process of course development and implementation between the high school and college professors resulted in reciprocal illumination with respect to the use of STeLLA strategies and the NGSS and contributed to important professional learning for all members of the teaching team. Strode brought critical perspectives to the work for how these strategies can support student learning at the secondary level. For example, Strode introduced to the team secondary science lessons related to race and genetics that were further iterated upon and used by Martin in an EBIO course. The experience underscored the value of creating more continuity between high school curriculum assessment and with what happens in college, especially for the first- and second-year college courses. Additionally, there were opportunities for the high school and college professors to share approaches for engaging in data-driven revision of pedagogy.

This case also illustrates the challenges of cross-departmental work, where individual departments may have particular ways of approaching the teaching and learning of biology. Once university faculty were able to coalesce around shared goals for the revised courses, the team was able to successfully move forward in enacting the curriculum and create experiences that leveraged the shared expertise between instructors working in different settings, including PST education, high school biology, and university science courses.

Developing revised shared goals among our team

Our team experienced turnover in the team leadership during the pandemic. The two education faculty, who had undergone STeLLA training, coordinated the team, and helped set initial group goals, retired. One retired at the end of the 2019-2020 academic year, while the second retired at the end of the 2020-21 academic year. This loss of leadership, on top of existing pandemic challenges, hindered the team's progress on CU Teach-related development work. In August 2021, Lindsay and another faculty member were hired to co-direct the CU Teach program. The

education faculty member hired to lead the math licensure program decided to remain peripheral to the team, while Lindsay, who was hired to lead the science licensure program, felt the efforts were beneficial to deepening connections and establishing common language across educators teaching in diverse contexts. While some components of the STeLLA project were easily integrated into the existing structure used by the PST education program, such as, prompting students to design main learning goals and focus questions in their lesson plan templates, Lindsay felt some initial tensions to ensure that the STeLLA CO^2 project team members' plans were aligned with his plans for revising the CU Teach program.

With the need to integrate Lindsay into the CU team's work, there was an opportunity to revisit the team's goals and develop new goals for the remainder of the project. This opportunity allowed everyone on the team, including science faculty, to inform the direction of the group's work and ensure that their roles were clear. New goals were proposed to continue integration of STeLLA into coursework, which was of interest to the university science faculty, and to increase the number of mentor teachers who were familiar with STeLLA. Team members also decided to plan and deliver a professional learning workshop for new mentor teachers to engage in the STeLLA strategies, lesson analysis, and NGSS 3-dimensional learning experiences. A STeLLA CO2 team member, who was a district coordinator for science instruction, took an active leadership role in the work. Each day of the workshop was facilitated by a different pair of cross-stakeholders, including the two university science faculty. The workshop was attended by 22 teachers. Several teachers were new to the university education community and subsequently hosted practicum students during the 2022-2023 school year. The workshop engaged participants in research-based science instruction and served to reenergize the university education community, which has historically come together for in-person professional learning opportunities, and increased connections with teachers in the region.

Implications

To summarize, even though our university team experienced some challenges, we had marked success in creating a more coherent experience for the PSTs that go through the teacher training program. Products that enhanced coherence included greater integration of STeLLA strategies into CU Boulder undergraduate science and education curriculum, and professional learning opportunities for members of the STeLLA CO^2 team and the broader CU Boulder STEM education community. We also found that shared goals and clear roles were essential for ensuring that the work of STeLLA CO^2 group sustained and evolved through a period of essential stakeholder transitions, transitions that may be endemic to cross-stakeholder collaborations in science education. Each of these findings may help support the ultimate goals of our effort: increased learning by and engagement of students in science classrooms.

Paper 3: Continuing a Partnership: Sustaining program changes through training of new university faculty and mentor teachers

Amy Bekins, Tony Scott, and Ryan Knoblock
Greeley-Evans Weld County School District 6

The University of Northern Colorado has a robust secondary science teacher education program with a unique context. Whereas education foundation courses are taught in the School of Teacher Education, all science practicum and teaching methods courses are taught by university science faculty and housed within the College of Natural and Health Sciences. While the University of Northern Colorado prides itself on its strong teaching faculty in every discipline, university science faculty do not necessarily have formal training in educational theory or pedagogy. The belief is that by utilizing content area faculty, they will bolster preservice science teachers' (PSTs) confidence in their content area, while allowing them to apply concepts learned from the School of Teacher Education. Faculty from the Chemistry/Biochemistry, Physics/Astronomy, Earth and Atmospheric Sciences, and Biology departments rotate each semester to teach three practicum seminars and one methods course. Historically, each science faculty instructor has drawn on their own experience and expertise, individually crafting the content of the assigned courses. As a result, there was a lack of coherence in the content of each course both within the program and from year to year.

Issues Identified with Previous Program

With many different faculty teaching the teacher education program, there was a lack of consistency in learning topics and assignments that each rotating faculty member utilized and presented in their teaching. This lack of continuity presented challenges for the PSTs and mentor teachers (MTs). The PSTs were often exposed to repetitive information and did not receive pertinent information as they advanced through the program. Further, the roles and expectations of MTs in supporting PSTs across the three practicum seminars and student teaching experiences were not clearly defined and the three levels were not well differentiated from each other.

As our team began participation in the STeLLA CO^2 project, we realized that there were inconsistencies in the program that we needed to come together to address. First, PSTs were not provided with a clearly articulated vision of effective science instruction across the seminar and method course sequence. Each instructor had their own vision and goals, which were not consistent across the secondary science teacher education program. Additionally, each instructor described and modeled inquiry instruction and effective questioning strategies differently, using their own experiences as a guide. They also did not necessarily use similar language to convey ideas about effective teaching and learning, which led to issues with creating consistent pedagogy, instruction, and flow through the secondary science education program. Second, there were differences between what was being taught at the university and was modeled by MTs during field placements. Students would receive instruction from the university yet often observe different strategies within their field placements, additionally getting varied experiences depending on their location of placement. Inconsistencies in instruction at the university, in addition to the varied experiences of the classroom placements, created confusion and conflicting messages between the instruction taught at the university and the instruction that PSTs were receiving from their MTs. There was no guidance to MTs about how they were to shape the experience for the PSTs, and sometimes MTs would also use and explain pedagogy that was

different from that of the university which created even further confusion. All this contributed to a varied, and often confusing, experience for the PSTs.

Coming Together to Redesign the Program

Through the STeLLA CO^2 project, a team of MTs from local districts, university science faculty, and the Dean of the College of Natural Sciences were brought together to develop a common vision of high-quality science instruction. Through a series of professional learning institutes over the course of a full year, which included extensive work in analyzing video of effective science teaching, the MTs and university science faculty came to some common understandings. This included a common understanding of how to develop students' thinking using multiple strategies that revealed and supported student scientific discourse and reasoning, as well as how to improve science instructional planning using a coherent science content storyline. Both MTs and university science faculty were encouraged to enact and model these strategies in their own teaching by developing strong storylines and using NGSS-aligned instructional practices to encourage student thinking and reasoning. The university science faculty were to both enact these strategies in their own science courses and teach the strategies to PSTs through the seminars and methods course. Additionally, MTs and university science faculty began utilizing a common vocabulary set to communicate consistently, with considerably less disparity in the messages being conveyed, with the PSTs.

To support these changes in practice, MTs and university science faculty analyzed their use of the strategies by filming their own classrooms and sharing their clips with the team. In doing so, all team members could reflect on their practice and discuss the nuances of their own disciplinary content and classroom contexts, share their challenges and successes, reflect on their own growth, and deepen their connection as a community of teacher-learners. The videos also created more knowledge and connection between the university instructors and MTs creating a shared vision among the team.

Revisions to the PST program

Having the Dean as a part of our team was instrumental, as he had the power and ability to enact larger changes at the university level. Our team realized that we had a great opportunity to revise the three practicum seminars to slowly introduce the STeLLA strategies in a clear and intentional way – despite the rotating faculty involvement. The STeLLA strategies were part of a framework that could be used to create a flow of content that could be utilized and taught, regardless of the instructor. The first step was to create a common vision, followed by a common curriculum. Creating a common vision and curriculum for the classes created consistency with instruction and vision regardless of which instructor was teaching. This also allowed science faculty to become more familiar with instructional strategies and better be able to model and use those strategies both in the teaching of their science content and science education classes. The PSTs were then placed in classrooms with STeLLA trained MTs to ensure they were observing classroom teaching that was more consistent with what they were learning through their university courses.

Working together, MTs and university science faculty developed a syllabus for each course, designating a sequence for introducing specific strategies that aligned with the course goals to be sure that the strategies were meaningfully included throughout practicum observations, teaching experiences, and course assignments. In our program, most of this instruction takes place in courses tied to the practicum experience and culminates in the science

methods course. By building and incorporating strategies throughout the course and field experiences, students were able to build on and add to their instructional toolbox as they progressed throughout the program. A coherent sequence of strategies also helped to alleviate some of the challenges of having different university instructors with varying levels of educational experience and created consistency in both what was taught, regardless of instructor, and direction for students' learning.

To best embed the STeLLA strategies in the real world, the university invited MTs who were part of our STeLLA CO^2 project team to serve as guest instructors at the university to introduce new strategies as well as engage PSTs in analysis of video from various classrooms designed to demonstrate those strategies. In this way, the university was able to deepen their collaborative partnership with MTs in the community. Serving as guest instructors also allowed MTs who were trained and experienced in STeLLA to expose the university science faculty to the STeLLA strategies while they were instructing the PSTs. Non-STeLLA faculty were typically excited to have MTs come in and support their program. As the MTs were classroom science teachers, these guest instructors provided the classroom experience and applications that PSTs were eager for. The guest instruction also provided opportunities for non-STeLLA faculty to be exposed to the STeLLA strategies. These STeLLA strategies provided university science faculty with effective strategies to connect to the common language, vision, and direction for the science teacher education program that were coherent with strategies that PSTs were observing and practicing with STeLLA-trained MTs. This has helped to create a true 'team' approach to the development of PSTs and allowed the PSTs to feel part of a single coherent system.

We still had another big challenge. With students needing placements in secondary classrooms during three different courses and student teaching, there were not enough MTs with STeLLA experience for PSTs to see the strategies modeled effectively throughout their university-based course of study and student teaching. It was important for strategies taught at the university to be modeled within their practicum experiences to allow a common language between the university science faculty, MTs, and PSTs, as well as coherence with what was being taught at the university and within classroom observations. This coherence would also increase the buy-in of PSTs in the STeLLA strategies as they saw them in practice after learning about them in the classroom.

To address this challenge, a group of MTs, university science faculty and former PSTs met to revise and create more meaningful observation assignments. These assignments allowed them to see STeLLA strategies within the classroom regardless of their MTs experience with STeLLA. MTs often used the strategies in various ways that PSTs could observe and bring back to the seminar to discuss. This has led to more in depth and higher quality discussion of the observation time that PSTs have spent in their host classrooms. These assignments allowed for more connection between the theory of the strategies and the practice in the host classrooms. As the funding that allowed the MTs to be guest instructors was nearing an end, one MT, Scott, was hired by the university to become adjunct faculty and teach two of the seminar classes. This allowed for the instruction of the STeLLA strategies to be maintained at a high level by someone familiar with them that had also used them in practice in the classroom. The assignments have also continued to be refined in the semesters after being created by Scott. In addition, he used solicited input from the PSTs to make additional improvements.

Another important aspect of this collaboration was the creation of specifically tailored expectations of PSTs for the progression of courses through the program as well as expectations for MTs. This included identifying which STeLLA strategies each course focused on and the

assignments that were tied to them. We also created a Schoology group for MTs within the neighboring school district, which included the expectations, the STeLLA strategies booklet, and the actual assignments the PSTs would be completing, to 1) improve communication between MTs and the university and 2) help MTs know more about what was going on at each level of the program. All of this has served to strengthen the program, make it more cohesive, and have a tool that future faculty can use when teaching the seminar and methods courses.

Outcomes and Challenges

One outcome of the collaboration between our MTs and university science faculty was the development of a sense of teacher-leader in the MTs. Prior to the STeLLA CO^2 collaboration, MTs would host PSTs within their classrooms, but did not have knowledge of what was being taught at the university or knowledge of what was expected of them. They would not meet with university faculty unless they were hosting a student teacher, and there was no guidance as to what MTs needed to do with PSTs. The UNC STeLLA CO^2 partnership clarified the role of MTs throughout the program so that MTs could better support PSTs within their classroom and provide more alignment between what PSTs were being taught at the university and what they observed in the classroom.

The MTs believed so strongly in these strategies and coherent storyline planning frameworks they wanted to teach them to their colleagues. Our MTs worked with one local district to begin leading STeLLA-based professional learning during district-sponsored release time. This effort was cut short with the pandemic, but the MTs that had already been trained, along with the strategies now being embedded in the university curriculum, allowed for additional colleagues to become familiar with the STeLLA strategies. Finally, we worked with our university placement office to ensure the science PSTs would be placed, as much as possible, with MTs who were familiar with STeLLA. This contributed to closing the loop for the PSTs so they could see in action the same strategies and coherent storyline planning practices they learned about on campus in practice in the field. For the PSTs, this helped eliminate the discord they often experienced prior to the STeLLA CO^2 project and enabled them to feel more confident in the practices that they were learning would be effective in their own future classrooms.

We interviewed former PSTs that had been through the revised PST program to reflect on the program and how well they were prepared for the classroom. PSTs noticed a difference in their field placements when placed with MTs who had been trained in the STeLLA strategies compared to those who had not been trained. They discussed noticing the changes in the program and appreciating the focus on the STeLLA strategies as well as the impact that the new curriculum had when they started their careers. One of the PSTs who was there during the transition in the program said that she noticed “it was more consistent” following the changes (PST interview, 6/8/23). Former PSTs discussed feeling more prepared for the classroom and excited to implement the strategies. Many talked about the first year of teaching being chaotic, but gained confidence and pushed more of the STeLLA strategies moving into year two. One former PST said, “My first year I was getting my footing, but I still included things like how are you communicating. But then last year I have been more specific with different strategies” (PST Interview, 6/10/23).

Though many PSTs had positive experiences during their university courses and in MT classrooms, many encountered resistance to implementing the strategies as they began their own careers. The PSTs found challenges as they began their careers in schools where other teachers were unfamiliar with the use of the STeLLA strategies. Sometimes these involved simple

challenges, such as utilizing different language or implementation of differing storyline sequences. In other situations, PSTs encountered challenges working to collaborate with established teachers that desired to maintain unaligned teaching pedagogy. Simply by being the 'new person,' it can be challenging to spread new ideas. Despite these challenges, the new teachers were still excited about the strategies and were trying to be agents of change within their buildings. New teachers communicated that they felt prepared for the classroom and were ready to implement the STeLLA strategies as a result of the changes within the university curriculum.

With the creation of relatively easy-to-implement curriculum outlines and assignments for each of the seminar courses, and the connections created between the university and MTs, the changes that were implemented during this program were set up to have lasting effects on the university and surrounding school districts. MTs are still an integral part of the university instruction providing additional experience and expertise for PSTs throughout their program. PSTs reported feeling more prepared for their first year of teaching than PSTs did prior to these changes (PST Interviews, 6/23). As the university continues to try to make sure that all PSTs are ready and prepared for the challenges of the classroom, STeLLA provides a beneficial tool and common language for MTs and PSTs to collaborate and implement high quality instruction and planning. Our capacity has grown through the collaboration process, so that more university science faculty can model the STeLLA strategies in their own instruction and teach them explicitly in their secondary science seminars and courses.

Sustainability

An ongoing challenge with continued collaboration was communication to, and within, the university. As turnover occurred within the university, new faculty were not being made aware of the work that had been done. In addition, the dean that supported the initial work left to go to another university. His position was dissolved and split between multiple people. The people that took over the part of his position that supported the project were harder to get a hold of, did not have the same decision-making power as the original position, and didn't have the same buy-in and background experience for the STeLLA program.

Consequently, maintaining momentum within the university is becoming more difficult. As new faculty come in, they bring their own ideas and perspectives that may not include the STeLLA strategies as a primary focus. However, utilizing Scott, a MT who has been maintained as an adjunct faculty member, the core ideas of STeLLA have been able to continue in the curriculum for a majority of the seminar classes. Unfortunately, keeping STeLLA going in the methods course has not met with the same success due to the faculty member having other responsibilities that have made implementing the strategies difficult. Scott has maintained the STeLLA strategies in the seminar courses and is continuing work to get these ideas back into the methods course.

As this process finishes, there are lasting changes that have occurred at the university. Scott, the MT who became employed by the university, continues to both teach and support preservice teachers' use of the STeLLA strategies. Other MTs are still practicing the strategies and have worked with their coworkers to expand the use of the strategies within their schools. One of the MTs moved into an administrative position at another school and was able to expand the use of the strategies to that school as well. The goal of spreading the strategies to additional neighboring school districts, however, was cut short during the pandemic which led to additional challenges for PSTs as they found their first teaching positions.

The biggest emerging challenge we are facing is how we deal with changes among the faculty and mentor teachers who championed this work at UNC. We have already encountered changes, with a key retirement and changes within our team. As it becomes necessary to replace the initial mentor teachers that were trained and enthusiastic about the STeLLA program, it will be important to find individuals that are also enthusiastic and willing to become knowledgeable about the process and program that was developed and implemented during the STeLLA CO^2 project. Despite the creation and implementation of curriculum at the university level, this is leading to additional challenges with sustaining the program with fidelity as the curriculum is not required to be used. Each faculty member receives a course outline, which includes the use of the STeLLA strategies. Scott currently teaches the first and second seminar courses, and works with the instructor of the third course to ensure continued use of the STeLLA strategies, however, the methods course is not currently being taught with the STeLLA strategies as a focus. It might be possible to add additional STeLLA strategies into the seminar classes, but the natural fit is really within the methods course, so some conversations need to be had about why they are not being presented there and what we can do to remedy that. There has also been significant turnover at the university level, impacting communication chains that had been established. This leads to concerns that the STeLLA-focused curriculum would not be utilized, either at all or as intended, if new faculty take over the upper-level education seminars and methods courses.

Looking forward, we are hoping to maintain, and potentially increase, consistency at the university with instructors and curriculum, especially in regards to addressing faculty turnover. There are also hopes to continue to collaborate with MTs in the nearby districts, pulling them into the seminar and method courses to allow for more practical experiences within the university courses. Now that there are preservice teachers that have been trained in STeLLA strategies, it is possible to begin capitalizing on their expertise and enthusiasm for the program to continue to create additional mentor teachers that have experience in the STeLLA strategies and these are additional people that are willing to share those strategies with colleagues and the next generation of preservice teachers. There are opportunities to call on former pre-service teachers to come and be the guest lectures during the university classes as the current mentor teachers that started the program move to other positions.

In addition, we look to continue to develop professional development within the local and surrounding districts to continue to grow the pool of mentor teachers that can support the work as student teachers enter their classrooms. Building a pool of qualified teachers and mentor teachers allow the STeLLA strategies to continue to be implemented throughout the university and surrounding districts.

Lessons Learned

Collaboration and communication are key to implementing change within and around the university. Partnering with the local school district was essential in really getting student teachers to see the strategies that were being taught at the university in the mentor teachers' classrooms. This partnership was also critical in creating a common language between the university and the schools where the student teachers have been placed. Collaboration and communication can become difficult as people change positions and leave positions. Historically, faculty assigned to preservice education courses rotated so frequently that incoming faculty did not know what was expected or what was to be included in each course. The consistency provided by the MT teaching the seminar classes and an established rotation of the STeLLA strategies throughout the preservice education classes has mitigated this to an extent. With each semester that continues to

have a stable instructor teaching one of the seminar courses, it becomes more likely that others rotating in are more open to ideas of what is expected in the class and less likely to 'do what they want.'

The changes at the university created challenges in continuing the progress that was made. Everyone learned to continue to work with new people that are coming into positions to enable a smooth transition to continue with the work that has been done. Continuing to implement the program and further the work that has already been accomplished requires for new professionals to be willing to learn the strategies themselves as well as use the provided curriculum and course progression.

Having people that were invested and believed in STeLLA and the impact that it could have on the program was key to allowing all the changes to the program to take place. The consistent team meetings with BSCS, university faculty, and MTs allowed for consistent communication and planning to take place as well as ensured that everyone remained on the same page. Observing the simplicity as well as the effectiveness of the strategies allows for others to continue to get on board with the process. This is becoming increasingly challenging, however, with the changes on the university team and the loss of the dean.

Getting new stakeholders on board with the process is the greatest challenge going forward. While most teachers, professors and administrators say they like the system and the changes, they are not always willing to be a part of it if it means more work for them. The meeting of theory and practice, however, appears to be the great unifier that can show all stakeholders involved the power of this system as well as having a common language to talk about the theory and the practice. The video analysis protocols and amazing library of instructional videos also make self-paced options realistic to attract more stakeholders. The more people that are exposed to STeLLA at each level, the easier it becomes to bring on more. We also found that one of the keys to sustainability may be in bringing back those pre-service teachers that have fully gone through the program to become the next champions of it. As more teachers go through the program that are already trained on the strategies, they are able to further support the work that has been done with the strategies. These former students are now able to continue to have those conversations and continue the work of developing strong science teachers. Thus, the work done at the university is able to continue to grow its own educators that are then able to continue to support the work in their own classrooms and with future teachers that get placed in their classrooms.

Discussion

While the value of coherence in teacher education has long been documented (e.g. Darling-Hammond et al., 2005; Richmond et al., 2019; Smeby & Heggen, 2014), the connections between university- and school-based settings have remained limited (Canrinus, Klette, & Hammerness, 2019; Southgate, Reynolds, & Howley, 2013; Grossman et al., 2008). Universities have traditionally been resistant to large-scale changes due to the presence of multiple stakeholders, their traditional silos, and the complexities of working with schools, districts, and university departments (Canrinus et al., 2017; Korthagen, 2010; Darling-Hammond, 2006). As a result, recent research in teacher education has recognized the importance of third spaces (Zeichner, 2010), where teacher educators from both schools and universities collaborate to develop and maintain program coherence in preservice teacher programs (Daza et al., 2021; Nordine et al., 2021; Darling-Hammond, 2017).

Through the STeLLA CO^2 project, we created a third space, where key stakeholders invested in the successful preparation of PSTs adopted different roles and fostered new working relationships to use their collective expertise to enhance the coherence and effectiveness of their PST programs. As illustrated across the three cases studies, we argue that systematic reform to enhance the coherence of PST programs can be accomplished using a community-driven approach that is anchored by 1) a shared vision for effective science teaching, 2) a shared understanding about the goals and rationale for any planned interventions, 3) an explicit understanding of the value of key stakeholders in supporting planned revisions, 4) a willingness for stakeholders to adopt different roles to enact planned changes, and 5) a sustainability plan to institutionalize reforms. In what follows, we synthesize how these components were evident in the three cases.

Coherent teacher education programs require a consistent vision of good teaching that is revisited across a range of teacher education experiences (Darling-Hammond & Oakes, 2019). Through the STeLLA CO^2 project, each team developed a shared vision for effective science teaching that informed their evaluation of the areas of success and needed improvement in their existing programs. Specifically, teams developed a common language and vision for how the STeLLA strategies could support student learning through group video analysis and their efforts to use the strategies in their classrooms. Traditional power dynamics were reduced and relational trust was built as participants used their unique perspectives to support one another in learning about and using these strategies in their classrooms. For example, mentor teachers could leverage their own experience using the STeLLA strategies to support university faculty who desired to use these strategies in their classrooms.

Effective stakeholder partnerships in preservice teacher education require participants to cross institutional boundaries and foster hybrid, less hierarchical relations (Zeichner, Payne, & Brayko, 2015; Zeichner, 2012). During the STeLLA CO^2 project, each team encountered success when stakeholders were given the opportunity to provide their opinions and contribute to shaping the university plan. Plans that were developed unilaterally were not as effective or sustainable as those developed in coordination with relevant stakeholders. For example, the UCCS team's initial steps towards supporting PSTs' use of the STeLLA strategies were not effective until the education faculty understood the mentor teachers' perspectives and why they were advocating for PSTs to receive more explicit support with using the STeLLA strategies as part of their university course work. Subsequent efforts were more successful when mentor teachers and education faculty worked together to jointly develop and enact their goals and their plans. The

CU Boulder team's work did not initially involve a vision for how university science faculty's work with undergraduate science students could complement work to support PST preparation, which resulted in the development of parallel initiatives. During the relaunch of the team's work, the team was able to coalesce around a revised set of goals that made clear how each stakeholder group, including the university science faculty, could work together to support the coherent preparation of the PSTs. These initiatives included activities that were done together, such as the development of a professional learning institute for future mentor teachers, but also synergistic endeavors, such as the revised teaching and learning biology courses.

Successful initiatives also involved stakeholders adopting new and expansive roles, often different from their traditional roles prior to their involvement with the STeLLA CO^2 program. Stakeholders, such as mentor teachers, typically have limited opportunities to share their insights on mentoring and teaching practices with university-based teacher educators (Orland-Barak, & Wang, 2021; Marciano et al., 2019). The UCCS and UNC teams involved mentor teachers in revising and co-teaching components of education courses related to use of the STeLLA strategies. At UCCS, mentor teachers helped develop companion field experiences that provided PSTs with the opportunity to practice using the STeLLA strategies they were learning about in their university courses or providing feedback on designed lessons. Similar roles were adopted in the various iterations of the Teaching and Learning Biology courses at CU Boulder, where one of the mentor teachers contributed to the redesign of the course to ensure that the strategies that course students were learning and teaching could be applied in the secondary and university contexts. At each of these contexts, the teams leveraged mentor teachers' experiences using the STeLLA strategies in their secondary classrooms as assets and provided opportunities for them to support the teaching of PSTs at the university level to complement their traditional role of supporting PSTs during their field experiences.

Explicit attention to the sustainability of planned reforms was a key feature of each university plan. One strategy employed by each university was the institutionalization of reforms through revised curriculum materials or tools that supported preservice teachers' (PSTs) use of the STeLLA strategies. This ensured continuity, even in the event of personnel changes or when other faculty members taught the courses. However, having an advocate on each team with the authority to support this institutionalization was critical. For example, two of the teams had department chairs present that could ensure that planned revisions were enacted. At UCCS, the team shared with university leadership about the fruits of their work, which led to university buy-in to allow the STeLLA CO^2 to introduce broader initiatives to use STeLLA throughout the UCCSTeach program. Another strategy included involving multiple stakeholders in the enactment of planned reforms. At UCCS, many of the education courses are co-taught by multiple faculty members. Thus, involving STeLLA CO^2 education faculty and mentor teachers in those courses, in addition to the redesign of the core curriculum, allowed other faculty to become familiar with STeLLA and the rationales for designed activities and partnerships. Similarly, UNC science faculty routinely rotated through the teaching of the STEP courses. Involving mentor teachers in the teaching of the STeLLA strategies while science faculty attended, ensured that those components were taught and enhanced the familiarity of the STeLLA strategies among UNC faculty.

While we know that innovations that work well in one setting do not always translate to a different context and set of individuals, we do believe that our work through the STeLLA CO^2 project can help others who seek to do similar work in their contexts. We hope that the cases presented from the voices of each stakeholder encourages other universities to consider the

power of engaging relevant stakeholders in expansive cross-stakeholder collaborations to enhance their PST programs.

References

BSCS Science Learning. (2018). *Strategies for Effective Science Teaching: The Student Thinking and Science Content Storyline Lenses*.

Bybee, R. W., Taylor, J. A., Gardner, A., Van Scotter, P., Carlson Powell, J., Westbrook, A., & Landes, N. (2006). *The BSCS 5E instructional model: Origins, effectiveness and applications*. Retrieved from https://bscs.org/reports/the-bscs-5e-instructional-model-origins-and-effectiveness

Canrinus, E. T., Bergem, O. K., Klette, K., & Hammerness, K. (2017). Coherent teacher education programmes: Taking a student perspective. *Journal of Curriculum Studies, 49*(3), 313-333. https://doi.org/10.1080/00220272.2015.1124145

Canrinus, E. T., Klette, K., & Hammerness, K. (2019). Diversity in coherence: Strengths and opportunities of three programs. *Journal of Teacher Education, 70*(3), 192-205. https://doi.org/10.1177/0022487117737305

Colorado Department of Education. (2020). *Colorado Academic Standards for Science.*

Darling-Hammond, L. (2006). *Powerful teacher education: Lessons from exemplary programs*. John Wiley & Sons.

Darling-Hammond, L. (2014). Strengthening Clinical Preparation: The Holy Grail of Teacher Education. *Peabody Journal of Education*, *89*(4), 547-561. https://doi.org/10.1080/0161956X.2014.939009

Darling-Hammond, L. (2017). Teacher education around the world: What can we learn from international practice?. *European journal of teacher education, 40*(3), 291-309. https://doi.org/10.1080/02619768.2017.1315399

Darling-Hammond, L., Hammerness, K., Grossman, P., Russ, F., & Shulman, L. S. (2005). The design of teacher education programs. In L. Darling-Hammond & J. Bransford (Eds.), *Preparing teachers for a changing world: What teachers should learn and be able to do* (1st ed., pp. 390–441). Jossey- Bass.

Darling-Hammond, L., & Oakes, J. (2019). *Preparing teachers for deeper learning*. Harvard Education Press.

Daza, V., Gudmundsdottir, G. B., & Lund, A. (2021). Partnerships as third spaces for professional practice in initial teacher education: A scoping review. *Teaching and Teacher Education*, 102, 103338. https://doi.org/10.1016/j.tate.2021.103338

Grossman, P., Hammerness, K. M., McDonald, M., & Ronfeldt, M. (2008). Constructing coherence: Structural predictors of perceptions of coherence in NYC teacher education programs. *Journal of teacher education, 59*(4), 273-287. https://doi.org/10.1177/0022487108322127

Korthagen, F. A. (2010). How teacher education can make a difference. *Journal of education for teaching, 36*(4), 407-423. https://doi.org/10.1080/02607476.2010.513854

Korthagen, F., Loughran, J., & Russell, T. (2006). Developing fundamental principles for teacher education programs and practices. *Teaching and Teacher Education*, *22*(8), 1020-1041. https://doi.org/https://doi.org/10.1016/j.tate.2006.04.022

Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge University Press.

Lo, A. S., Stennett, B., Hvidsten, C., & Askinas, K. (2021, Jan 14). *Developing a common vision for supporting coherence in three preservice science teacher education programs* Paper presented at 2021 ASTE International Conference,

Marciano, J. E., Farver, S. D., Guenther, A., Wexler, L. J., Jansen, K., & Stanulis, R. N. (2019). Reflections from the room where it happens: Examining mentoring in the moment. *International Journal of Mentoring and Coaching in Education, 8*(2), 134-148. https://doi.org/10.1108/IJMCE-08-2018-0047

McNeill, K. L. (2009). Teachers' use of curriculum to support students in writing scientific arguments to explain phenomena. *Science Education*, *93*(2), 233-268. https://doi.org/10.1002/sce.20294

National Research Council. (2012). *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*. The National Academies Press. https://doi.org/10.17226/13165

NGSS Lead States. 2013. *Next Generation Science Standards: For States, By States*. Washington, DC: The National Academies Press.

Nordine, J., Sorge, S., Delen, I., Evans, R., Juuti, K., Lavonen, J., Nilsson, P., Ropohl, M., & Stadler, M. (2021). Promoting Coherent Science Instruction through Coherent Science Teacher Education: A Model Framework for Program Design. *Journal of Science Teacher Education*, 1-23. https://doi.org/10.1080/1046560X.2021.1902631

Orland-Barak, L., & Wang, J. (2021). Teacher mentoring in service of preservice teachers' learning to teach: Conceptual bases, characteristics, and challenges for teacher education reform. *Journal of teacher education, 72*(1), 86-99. https://doi.org/10.1177/0022487119894230

Richmond, G., Bartell, T., Carter Andrews, D. J., & Neville, M. L. (2019). Reexamining coherence in teacher education. *Journal of Teacher Education, 70*(3), 188-191. https://doi.org/10.1177/0022487119838230

Roth, K. J., Bintz, J., Wickler, N. I. Z., Hvidsten, C., Taylor, J., Beardsley, P. M., Caine, A., & Wilson, C. D. (2017). Design principles for effective video-based professional development. *International Journal of STEM Education*, *4*(1), 31. https://doi.org/10.1186/s40594-017-0091-2

Roth, K. J., Wilson, C. D., Taylor, J. A., Stuhlsatz, M. A. M., & Hvidsten, C. (2019). Comparing the Effects of Analysis-of-Practice and Content-Based Professional Development on Teacher and Student Outcomes in Science. *American Educational Research Journal*, *56*(4), 1217-1253. https://doi.org/10.3102/0002831218814759

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher*, *15*(2), 4-14. http://search.ebscohost.com/login.aspx?direct=true&db=eric&AN=EJ330821&site=ehost-live

Smeby, J. C., & Heggen, K. (2014). Coherence and the development of professional knowledge and skills. *Journal of Education and Work, 27*(1), 71-91. https://doi.org/10.1080/13639080.2012.718749

Southgate, E., Reynolds, R., & Howley, P. (2013). Professional experience as a wicked problem in initial teacher education. *Teaching and Teacher Education, 31*, 13-22. https://doi.org/10.1016/j.tate.2012.11.005

Stennett, B., Hvidsten, C., Slykhuis, D., Gagnon, R., & Lo, A. S. (2020, Jan 9-11). *STeLLA CO2: A New Vision for Coherent Science Teacher Preparation* 2020 ASTE International Conference, San Antonio, TX.

Taylor, J. A., Roth, K., Wilson, C. D., Stuhlsatz, M. A. M., & Tipton, E. (2017). The Effect of an Analysis-of-Practice, Videocase-Based, Teacher Professional Development Program on

Elementary Students' Science Achievement. *Journal of Research on Educational Effectiveness*, *10*(2), 241-271. https://doi.org/10.1080/19345747.2016.1147628

Wilson, C. D., Stuhlsatz, M. A. M., Hvidsten, C., & Stennett, B. (2017, January). *ViSTA Plus: Initial Findings from a 3-Year Program Preparing Elementary Teachers to Teach Science* Annual Conference of the Association of Science Teacher Educators, Des Moines, IA.

Zeichner, K. (2010). Rethinking the Connections Between Campus Courses and Field Experiences in College- and University-Based Teacher Education. *Journal of Teacher Education*, *61*(1-2), 89-99. https://doi.org/10.1177/0022487109347671

Zeichner, K. (2012). The turn once again toward practice-based teacher education. *Journal of Teacher Education, 63*(5), 376e382 https://doi.org/10.1177/0022487112445789

Zeichner, K., Payne, K. A., & Brayko, K. (2015). Democratizing teacher education. *Journal of teacher education, 66*(2), 122-135. https://doi.org/10.1177/0022487114560908