AN IMPLEMENTATION HANDBOOK FOR THE TRIAD PROJECT:

A PROFESSIONAL DEVELOPMENT MODEL

FOR SCIENCE EDUCATORS

A Project

Presented

to the Faculty of

California State University, Chico

In Partial Fulfillment

of the Requirement for the Degree

Master of Arts

in

Education

Curriculum and Instruction Option

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by

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Fall 2018

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ABSTRACT

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The Next Generation Science Standards were adopted in 2013, and with the new standards came new pedagogical practices. The combination of these changes created a need for science teacher professional development. The Triad Project, a grant-funded, science professional development for educators was formed and implemented in Chico, California to provide professional development around the Next Generation Science Standards. The Triad Project is backed by research of effective professional development. Because of the proven effectiveness of the Triad Project's model, other universities have shown interest in developing the model in their own contexts, creating a need for an implementation handbook

I created a Triad implementation handbook that includes four sections: an introduction to the Triad model, information regarding the partnership, a description of how to build three-person Triads, and the cornerstones of the Triad Project. With the

handbook, individual districts/universities will be able to implement effective science professional development programs.

CHAPTER I

INTRODUCTION

In 2013, California adopted the Next Generation Science Standards (NGSS). Teachers needed to become familiar with a new set of standards and new pedagogical practices inherent in the NGSS. In their research, Krajcik et al. (2014) pointed out that the framework and NGSS changed the focus of science education. They moved away from learning content and inquiry in isolation. Instead, the framework and NGSS are practice-focused, with performance expectations integrating three dimensions of science learning: disciplinary core ideas, science and engineering practices, and crosscutting concepts.

> The Framework and NGSS move teaching away from coverage of many isolated facts to a focus on smaller number of disciplinary core ideas (DCI) and crosscutting concepts that can be used to explain phenomena and solve problems by engaging in science and engineering practices. (Krajcik et al., 2014, p. 159)

The NGSS is intended to engage students to think at higher, deeper levels through three-dimensional learning. The intent of these new standards is to bring students to a deeper understanding of science while enhancing critical thinking (NGSS Lead States, 2013). Because the NGSS has set the stage for many educational reforms, teacher professional development, school programs, assessments, and accountability have become a central focus in science education (Bybee, 2014).

As a result of these changes, teacher education programs were called upon to consider how to best prepare teacher candidates to understand and implement the standards (Hanuscin & Zangori, 2016). Goodnough (2016) claims,

> Primary/elementary teachers are uniquely positioned in terms of their need for ongoing science focused professional development. They are often generalists,

> having limited preparation for teaching science, and often do not feel prepared or comfortable in teaching science. (p. 1)

Darling-Hammond, Hyler, and Gardner (2017) discussed how the new standards demand that learners dive deeper in their learning, collaborate, problem solve, communicate and increase their own self-direction in learning. With these demands on learners, the NGSS have created the need for teachers to learn new standards and relearn the pedagogies that are required to teach all the above skills.

Two educational organizations in Chico, California—Chico Unified School District and California State University Chico—partnered to meet the immediate needs of science teacher professional development. Implemented in 2015, the Triad Project is a science professional development model designed to provide professional development for people at all levels: university science educators, Chico Unified school teachers, and their cooperating teachers who work with the university. Triad is funded by a large grant from the S. D. Bechtel, Jr. Foundation. The three-person "Triad" is a collaboration between a science or engineering university professor, a veteran teacher and a teaching credential candidate. Together in the Triad, the three partners all gain mastery of the NGSS by attending workshops while working together to create and teach an NGSS Unit in a K-12 classroom. Because of the proven effectiveness of the Triad Project's model (Schademan & Miller, 2018), other universities have shown interest in developing the model in their own contexts, creating a need for an implementation handbook.

Scope of the Project

The project is designed to assist teacher educators as they use the Triad Project model to implement NGSS professional development in their local contexts. The

document has four main sections with several subsections. The handbook begins with an introduction to the Triad Project. It gives a brief history of the Triad Project and its development. The second section is the infrastructure; subsections include the development of the university/school district partnership, roles, and responsibilities of the university and school district, and funding requirements. Section three guides the implementer through the building of the "Triad." In this section, the reader learns the recruiting process of Triad participants as well as their roles and responsibilities. Section four describes the essential elements of the Triad Project implementation. Included in this section are an outline and useable attachments of the three NGSS professional development workshops, as well as an easy-to-use guide of the various meetings and workshops associated with the Triad Project.

Significance of the Project

This project is significant because it enables an effective professional development model to be disseminated and used in other contexts. The Triad Project aligns with previous research on effective teacher professional development (Coenders & Terlouw, 2015; Darling-Hammond et al, 2017; Desimone, 2009; Whitworth & Chiu, 2015). For example, following Desimone (2009), it is collaborative, content focused, includes active learning, expert support, and occurs over a long duration. In addition, the Triad model was designed as an activity system, with individuals working toward a common goal (Engstrom & Miettinen, 1999; Leont'ev, 1981; Roth 2010). Because of the Triad Project's alignment with previous research, it is no surprise data results have been positive and that others have shown interest in replicating the Triad model.

Project leaders had various documents explaining the Triad Project model, but nowhere was there a synthesis of this model that was detailed enough for the project to be replicated. The need for an implementation handbook became apparent and this is where the project idea began.

Limitations

The implementation of the handbook could be limited by resources, need and use. A fundamental part of the Triad Project is creating the units. The units require collaboration between the Triad group members who each bring an important skill set to the group. The grant creates a limitation for any district that does not have access to each of these Triad participants. All districts have the same need for science professional development but may not have a local university to fulfill the other two partners in the Triad—the cooperating teacher and the science professor.

Another limitation to this specific project is that other states that have not adopted the NGSS will not be able to fully implement this NGSS-based handbook. They will be able to implement the idea of an activity system and use of its nodes for science professional development, but the professional development they implement will look very different than that of the Triad Project.

Definition of Terms

Active Learning

> Active learning is any approach to instruction in which all students are asked to engage in the learning process. Active learning stands in contrast to “traditional” modes of instruction in which students are passive recipients of knowledge from an expert. (Center for Active Learning, University of Minnesota, 2018)

Activity Theory

> Activity Theory is a framework or descriptive tool for a system. People are socio-culturally embedded actors (not processors or system components). There exists a hierarchical analysis of motivated human action (levels of activity analysis). (David, 2007)

Cross-Cutting Concepts

"These concepts help provide students with an organizational framework for connecting knowledge from the various disciplines into a coherent and scientifically based view of the world" ("Crosscutting Concept," 2018).

Disciplinary Core Ideas (DCI)

> The fundamental ideas that are necessary for understanding a given science discipline. The core ideas all have broad importance within or across science or engineering disciplines, provide a key tool for understanding or investigating complex ideas and solving problems, relate to societal or personal concerns, and can be taught over multiple grade levels at progressive levels of depth and complexity. ("Disciplinary Core Ideas," 2018)

Framework

> The foundational report produced by the National Research Council (NRC) that forms the basis for the NGSS. It calls for a new approach to science education based in scientific and educational research. The NGSS draws its content across the three dimensions, as well as the three-dimensional approach to learning. (Next Generation Science Standards, n.d.)

Inquiry

"A systematic investigation often of a matter of public interest" ("Inquiry," 2011).

Pedagogical Practices

"The strategies that teachers use to teach students" (Kervin, Mantei, & Herrington, 2009).

Phenomena

"Observable events that students can use the three dimensions to explain or make sense of" ("Phenomena," n.d.).

Standards

"End of instruction goals or benchmarks for student proficiency" ("Standards," n.d.).

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

Tyler Ames (2014) in his article *A Review of Science Standard History Culminating with Next Generation Science Standard* lays out the long history of science standards starting with the successful launch of Sputnik by the Soviet Union. Ames claims that in order to understand the creation of the NGSS, you must understand the history of the original science standards. Our president at the time, John F. Kennedy, felt the competitive pressure to do better. Kennedy was determined to get to the moon.

> Although the history of science education reveals numerous committee reports, yearbooks, and other publications that served as 'standards' one can reasonably argue that it was the late 1980s and early 1990s that brought the term standards into the science education community. (Bybee, 2014, p. 12)

Ames (2014) continued to explain that the state standards were adopted because after a decade of going to the moon. A report from the National Commission on Excellence in Education revealed that the quality of our nation's education was very poor. The United States took on the immediate task to improve our education system. The solution was to create benchmarks for science literacy. The nature of science however was not being addressed in the Framework for K-12 Science education (Bybee, 2014) therefore another reform of the science standards began to occur. This reform was called the NGSS.

Next Generation Science Standards (NGSS)

The beginning process of the NGSS started in 2010 and then was adopted officially in 2013. "The Next Generation Science Standards (NGSS) is constructed to

address thoroughly the needs of today's youth" (Asowayan, Ashreef, & Omar, 2017, p. 63). Harris, Sithole, and Kibirige (2017) explained in more detail the specific needs of today's youth. They explain that the NGSS was created to align students in grades K-12 with career needs and current trends in technology.

NGSS was the solution to concerns about the quality of science education in the United States. The NGSS was intended to engage students in higher and deeper levels of thinking across all three dimensions of science: science and engineering practices, disciplinary ideas, and cross cutting concepts. Through this, students would gain a deeper understanding and gratitude for the nature of science that would create a lifetime of critical thinking (Schademan & Miller, 2018). Krajcik et al. (2014) pointed out that the framework and NGSS changed the focus of science education. The two focus on disciplinary core ideas (DCI) and cross cutting concepts rather than covering isolated facts and teaching content and inquiry in isolation. Krajcik et al. (2014) further stressed

> If we want students to learn the content, they have to engage in the practice. But if we want students to learn the science and engineering practice, then they have to engage in content. Leave one out, and students will not develop proficiency in the other. If we want students to use content, problem-solve, think critically and make statements based on evidence, then we must have all three dimensions working together, linking practice with content. (p. 159)

Although the new standards were innovative, their introduction required new pedagogical practices, which in turn impacted teacher preparation. Deborah Hanuscin and Laura Zangori (2016) performed a study where they examined the development of prospective elementary teachers' practical knowledge of the NGSS. The prospective teachers participated in a collaborative field experience and methods course. The study identified how the teachers viewed and used the standards: as a useful guide when planning their instruction, as a gauge for student and self-evaluation and finally as an

attainable vision for teaching and learning. However, their study found gaps in prospective students' practical knowledge. They did not develop an understanding of how to use the crosscutting concepts to achieve the kind of three-dimensional learning the NGSS supports. "We cannot count on elementary majors' science coursework to be a sufficient preparation. Without an explicit focus within science coursework, bridging this divide is challenging" (Hanuscin & Zangori, 2016, p. 814). The new standards call for change in pedagogical practice and what students learn, therefore teacher education programs prepare teacher candidates to understand and implement the standards through courses and curriculum (Hanuscin & Zangori, 2016).

A second study's finding expanded on this idea of teacher preparedness for the NGSS. Harris et al. (2017) conducted a needs and preparedness assessment on public K-12 teachers. What emerged from their findings was that, while NGSS goals are valued, the implementation of the goals still causes problems. Their study highlighted the lack of teacher knowledge of the NGSS and the unease from most teachers about how the NGSS could be integrated in K-12 education system. Teachers struggled with many challenges that included accommodating their current curricula to meet NGSS objectives, feasibility of the program, and how to set the timelines to complete syllabi successfully. In concluding their study, Harris et al. (2017) made a claim that

> There is need to close knowledge gaps between k-12 education policy makers and teachers in the field. There are several platforms that can be used to achieve this goal; teacher professional development-this can be implemented through workshops, seminars, conferences, etc. (p. 60)

Darling-Hammond et al. (2017) discussed how the new standards demand that learners dive deeper in their learning, collaborate, problem solve, communicate and increase their own self-direction in learning. With these demands on learners, the

standards have created the need for teachers to learn and relearn the pedagogies that are required to teach the above skills. Bybee (2014) explained that science teacher educators need to address the educational shifts that NGSS caused. The three major components that were the cause for the educational shift include the three dimensions of science: disciplinary core ideas, scientific and engineering practices, and crosscutting concepts. Teacher educators needed to recognize NGSS-instilled learning progressions that build understanding and abilities throughout a student's k-12 science education. Science teacher educators needed to include engineering design because NGSS included both engineering and science. Bybee (2014) stated that "Consequently, science teachers express a concern about their lack of understanding engineering, in particular the differences between scientific inquiry and engineering design" (p. 12). These novel demands placed upon teachers demonstrated the need of teacher professional development in the area of science.

Science Professional Development

The literature confirms that the NGSS created a need for science teacher professional development. Elementary teachers need continuous science focused professional development. The fact that they teach multiple subjects creates a generalist approach and limits preparation for teaching science. Often teachers do not feel prepared or comfortable in teaching science (Goodnough, 2016).

Garet, Porter, Desimone, Birman, and Yoom (2001) examined the relationship between different features of professional development and self-reported changes in teachers' knowledge, skills, and classroom teaching practices. Their findings indicated that long and rigorous professional development has more of an impact on teacher

participants than shorter professional development. Additionally, professional development that is coherent, focuses on content, while the teachers are actively learning, will more likely receive a positive outcome of enhanced knowledge and skill (Garet et al., 2001).

> Results of our study indicate that if we are serious about using professional development as a mechanism to improve teaching, we need to invest in activities that have the characteristics that research shows foster improvements in teaching. (Garet et al., 2001, p. 937)

Other studies have also contributed to the understanding of what constitutes effective professional development. Banilower, Heck, and Weiss (2005) explored the results of the national local systemic change (LSC) professional development model, implemented by the National Science Foundation. The LSC professional development model included several features that previous research had found to be important in teacher professional development. LSC's professional development activities planned to prepare teachers to use inquiry-based practices during their implementation of high-quality mathematics and science materials in their classes. The LSC theory predicted that with constant support, the teachers would be more willing to change their instruction. The study concluded that the teachers were more inclined to execute a set of instructional materials if they were trained first on those materials. Similarly, Southerland et al. (2016) followed 106 teachers who participated in PD programs to determine the affect the programs had on teaching thinking and practice. One of the takeaways from that study was that

> research participation in itself is not sufficient to shape teachers use of scientific practices in the classroom. Teachers must have an opportunity to make sense of their research experiences with others if they are to undergo the necessary changes in affect and belief to result in changes in practice. (Southerland et al., 2016, p. 13)

Additionally, Kleickman, Trobst, Jonen, Vehmeyer, and Kornelia, (2016) revealed clear evidence that expert scaffolding in professional development has an advantage.

Desimone (2009) proposed a basic consensus model to be used in all experimental studies of professional development. The consensus model included five core features of professional development: content focus, active learning, coherence, duration, and collective participation. According to Desimone, the presence of the core features in professional development would increase teacher knowledge and skills, change attitudes and beliefs about teaching, and improve student learning. Darling-Hammond et al. (2017) added two more core features to Desimone's original five. Taking the work of Desimone and Darling-Hammond et al. together, the seven research-based practices for effective teacher professional development are as follows: being content focused, incorporating active learning, supporting collaboration, using models of effective practice, providing coaching and expert support, offering feedback and reflection, and occurring over a sustained duration. The extensive research on effective professional development paved the way for a clear understanding of what a valuable professional development could look like.

The Triad Project

Two educational organizations in Chico, California—Chico Unified School District and California State University Chico—partnered to meet the immediate needs of science teacher professional development due to California's adoption of the NGSS in 2013. As a result, the Triad Project began in 2015. The Triad Project is a science professional development program for Chico Unified School District teachers and the university's credential candidates. Triad is funded by a large grant from the S. D. Bechtel

Foundation. What makes the "Triad" element is the collaboration between a CSU, Chico Science or Engineer "expert," the Chico Unified mentor teacher and the CSU, Chico credential student. These three partners become masters of the NGSS by working together to create an NGSS Unit while attending NGSS workshops. The Triad Project is a well-designed, researched-based science professional development model. The Triad Project uses Engstrom and Miettinen's (1999) nodes from activity theory as a design tool. The Triad Project aligns with previous research on effective teacher professional development (Coenders & Terlouw, 2015; Darling-Hammond et al, 2017; Desimone, 2009; Whitworth & Chiu, 2015).

Engstrom and Miettinen (1999) developed a visual for how activity systems work together. The Triad Project uses the activity system as a design tool for their professional development. The seven nodes in Engstrom and Miettinen's (1999) model include: subjects/participants, rules/norms, community, division of labor, tools/mediating artifacts, object/goal and finally projected outcomes. Each of the seven nodes has a description. The *subjects/participants* of the "Triad" from the Triad Project include a teacher candidate, mentor teacher, university educator, and the university supervisor. The Triad's *rules and norms* state that the Triad is non-hierarchical, collaborative, longitudinal, and goal directed. The *community* includes the science educators, university, and the school district. The Triad *divided the labor* when working on the unit. The participants *individual responsibilities* include: teacher candidate is the lead author of the unit, the mentor teacher co-plans and co-teaches the unit, the content specialist is in charge as the content/pedagogy consultant. In addition, the university supervisor is available for support to the teacher candidate. The Triad *tools* include anything that helps

the Triad strengthen their understanding of the NGSS, such as the NGSS planning tool (backwards design, Bozeman Science NGSS Videos, NGSS@NSTA website), Triad timeline, and the resources from the professional development (PD) workshops (Schademan & Miller, 2018). The *goal* of Triad is to create an integrated NGSS/CCSS unit that meets the needs of all learners. *Outcomes* from the Triad Project Model include: Multiple-level professional development (teacher candidate and the mentor teacher), an increase of knowledge, use of skills, changes in beliefs, more effective science instruction for students, field-tested NGSS curriculum, and a collaborative university-district partnership (Schademan & Miller, 2018).

The workshops were designed around the consensus view of effective teacher professional development (Darling-Hammond et al., 2017; Desimone, 2009). The *content focus* in the Triad Project is science, while participants are *actively learning* the NGSS and how to teach them to their students through the creation of their own NGSS-based science unit. The *collaboration* between the Triad (a teacher candidate, mentor teacher, and a science content specialist) is fundamental in the creation of the units. NGSS workshops provide participants with *models of best practices* in science teaching, such as how to use a phenomenon to ignite the inquiry process with students. The Triad content specialist provides *expert support* as well as the teacher educator who is overseeing the process of the professional development and *offers feedback* as well. The unit is able to be implemented during the three-month *sustained duration* allowing time for participants to reflect upon the effectiveness of unit implementation.

Coenders and Terlouw (2015) expanded on Clarke and Hollingsworth's (2002) interconnected model of teacher's professional growth. Coenders and Terlouw

found that teachers whom developed material during professional development expanded their knowledge and beliefs. “As the combination of a development phase with a class enactment phase proved instrumental, an existing model, the interconnected model of teacher professional growth, was extended” (Coenders & Terlouw, 2015, p. 1). The Triad Project used Coenders and Terlouws expanded interconnected model of teacher’s professional growth by having the Triads create their own NGSS unit while attending the NGSS workshops. Like Coenders and Terlouw proved in their study, the combination of creating a NGSS unit and partaking in the NGSS workshops served well for the teacher participants and their learning of the NGSS standards and the new pedagogical practices associated with the implementation of NGSS (Schademan & Miller, 2018).

The partnership between CSU Chico and the Chico Unified School District has proven to be effective given the demonstrated success of the Triad Project (Schademan & Miller, 2018). Whitworth and Chiu (2015) found in their review of literature focusing on teacher professional development, a missing piece which needs to be researched even further, is the need for district leadership to be involved in teacher professional development:

> It is critical for us to consider the role of school and district leaders in facilitating teacher change if we want to have a more complete picture of the role of professional development in facilitating teacher and ultimately student learning in science. (Whitworth & Chiu, 2015, p. 132)

For real change to occur the Triad Project needed the inclusion and support of the district leaders. To help reach a large number of teachers, the district leaders are able to connect their district teachers with a well-researched and implemented teacher professional development program.

Because of the Triad Project's alignment with Engstrom and Miettinen (1999) nodes of activity theory, the principles of effective professional development (Darling-Hammond et al., 2017; Desimone, 2009), the incorporation of the learning domains (Coenders & Terlouw, 2015) and finally the focus on district leadership (Whitlock & Chui, 2015) results for the Triad Project have been positive (Schademan & Miller, 2018). Participants in the Triad reported the following: (a) an increase in confidence in putting NGSS into practice (b) Triad units met benchmarks for effective curriculum design and instruction (c) teachers adopted reform-based practices such as: student collaboration, 3D instruction, modeling, phenomena to deepen thinking, connections to NGSS outside of the classroom, high impact learning with literature, argumentation, project-based learning, interactive notebooks, and graphic organizers. (d) data showed the importance of non-hierarchical collaboration.

CHAPTER III

METHODOLOGY

I began this project with an interest in studying integrated thematic instruction. After conducting a literature review of this topic, I connected with faculty who had similar interests. It was then that I learned about the Triad Project. While preliminary studies showed that the Triad Project was highly effective in improving teacher confidence and improved pedagogical practices, the model did not have an effective method of distribution. The directors of the Triad Project indicated that other universities had asked how to implement the Triad model of professional development. In answer to that need, I created the Triad Project Implementation Handbook. The process of creating the handbook included five components: conducting a literature review, attending meetings of Triad participants and leaders, observing workshops, conducting interviews and gathering materials.

Conducting a Literature Review

I began the literature review by asking Triad Project directors for references that supported Triad's design. This led to a review of literature of the NGSS including its origin and its impact on teachers and students. I used search terms such as "NGSS and its effects." I also conducted a literature review of teacher professional development. My search terms included but were not limited to "elements of effective professional development." This review of the literature produced an understanding of the various theoretical models and research findings that contributed to the design of the Triad

Project. This knowledge led to the creation of the big picture vision for the implementation handbook.

Attending Meetings

I attended various meetings for the Triad Project that included grant team meetings (with grant leaders from the university and district) and Triad team meetings (with a candidate, cooperating teacher and content specialist). The grant meetings were held three times a semester after school at the downtown district office. The information obtained from the grant meetings helped me to further understand the Triad Project partnership. I was able to observe the university and district partners working in collaboration to plan and enact project components. For example, I witnessed the Triad team leaders discuss the process of Triad team placements.

In fall of 2017, I also attended meetings of one Triad team as the three team members planned their unit. Attending the Triad team meetings helped me to better understand the purpose and witness non-hierarchical collaboration. For example, I saw the Triad discuss their unit and the next steps that needed to be taken. The science expert was able to answer specific questions from both the teacher candidate and mentor teacher. All ideas at the meetings were discussed and respected.

Observing NGSS Workshops

An aspect of the Triad project is the attendance of three workshops that familiarize the teachers with the new NGSS standards as well as the new pedagogical styles. The workshops were held every Monday at a local junior high. All Triad team members, including cooperating teachers, credential candidates, and content specialists

attended. For cooperating teachers and content specialists who had attended in previous semesters, attendance was optional. The workshop series ran for three weeks in September and each session lasted 90 minutes. I took notes on the preprinted slide presentation and recorded each of the workshops. Attending these workshops allowed me to dive deeper into the understanding of the NGSS as a teacher and understand how a teacher educator would implement the workshops.

Conducting Interviews

Several interviews were conducted to gather information about the funding process, recruitment, and data analysis. I interviewed the co-director about both the funding process and recruitment of Triad participants. I interviewed the clinical coordinator about the recruitment of the teacher candidates and mentor teachers and the second co-director about the findings from the Triad data collection. All interviews were recorded for research verification purposes. I reviewed these interview recordings in order to add details to the handbook.

Gathering Materials

In addition to collecting data through meetings, workshops and interviews, I created a list of all the materials needed in order to create a Triad Project implementation handbook that was user-friendly. Through e-mail requests to the co-directors and Triad staff, I was able to gather the materials needed for workshops and meetings. These materials included slide presentations, meeting agendas, invitations, and NGSS tools. The materials were shared through Google docs. I was then able to convert the documents into a PDF version and include them into the project.

Conclusion

In summary, I began designing the Triad Project Implementation Handbook with a review of the literature to provide me, and the handbook user, with the theoretical foundation of the work. I then learned about the Triad Project and collected materials from meetings, interviews, and at workshops. Ultimately, this process allowed for a concise yet thorough handbook for widespread implementation of the Triad project.

CHAPTER IV

SUMMARY, CONCLUSIONS, RECOMMENDATIONS

Summary

The NGSS were adopted by California in 2013. With the new standards also came new pedagogical practices. The combination of these changes created a need for science teacher professional development. A grant-funded project called the Triad Project was formed and implemented in Chico, California. Through a partnership between California State University, Chico, and Chico Unified School District, mentor teacher and teacher candidates were offered a professional development program based on current research. After a year of implementation, the principal investigators of the Triad Project have collected and analyzed data demonstrating the program's effectiveness. Interest from other universities created a need for this professional development to have an implementation handbook that could be shared. Because of this new need, I created a Triad implementation handbook that included four sections: an introduction to the Triad model, information regarding the partnership, a description of how to build three-person Triads, and the cornerstones of the Triad Project. To create the handbook, I conducted a literature review, attended meetings of Triad participants and leaders, observed workshops, conducted interviews and gathered materials. The result is an implementation handbook for others to use when designing teacher professional development around the NGSS.

Conclusion

The review of literature brought to light the worthy attention given to the concerns of the readiness of science teachers with the NGSS. The literature indicates that teachers need to obtain knowledge about the NGSS and knowledge of how to execute the new pedagogical practices. The Triad Project Implementation Handbook is intended for universities, districts, and individual schools looking to implement professional development focused on the NGSS. This effective professional development aligns with research-based best practices for teacher professional development. The Triad model outlined in the handbook provides NGSS information with new pedagogical practices such as model-based instruction (Lehrer & Schauble, 2000) and argumentation (Sampson & Schleigh, 2013) to support university credential candidates and their cooperating teachers. With the handbook, individual districts will be able to implement an effective science professional development program for their cooperating teachers. The most important population served by the Triad Project is the K-12 students. With this effective science professional development, they will benefit from learning science in an interactive, creative collaboration where exploration is encouraged.

Recommendations

Based on my research conducted during the creation of this handbook, I have several recommendations regarding implementing the handbook, preparing educators to teach using NGSS, future research, and extensions to other subject areas.

1. The Triad project has been shown to be effective, and in order to obtain these same results, it is important to implement the handbook with fidelity. There are certain

foundational elements of the model, such as creating non-hierarchical collaboration within the three-person Triad, that are essential for success.

2. There is a need for more teacher professional development in the NGSS and corresponding curriculum so that educators will be better prepared to teach the NGSS. Teaching to these novel standards takes time, education, and materials.

3. There are many opportunities for future research on Triad and teacher professional development. Future research could compare Triad to other models of professional development to study their relative effectiveness. Extended research of science professional development only helps to fill the gaps in teacher needs when it comes to teacher preparedness.

4. With modifications of the materials, the Triad model and the corresponding handbook could be extended to other disciplines and then studied. For example, a math professional development would use the nodes from activity theory (Engstrom & Miettinen, 1999; Leont'ev, 1981; Roth 2010) as their design tool and the alignment with previous research on effective teacher professional development (Coenders & Terlouw, 2015; Darling-Hammond et al, 2017; Desimone, 2009; Whitworth & Chiu, 2015).

Following these recommendations will help users of the handbook to implement with fidelity, leading to increased NGSS professional development support to educators. Further research on the Triad Project could lead to an increased understanding of the power of this model and its promise as a professional development model to support a new generation of California educators.

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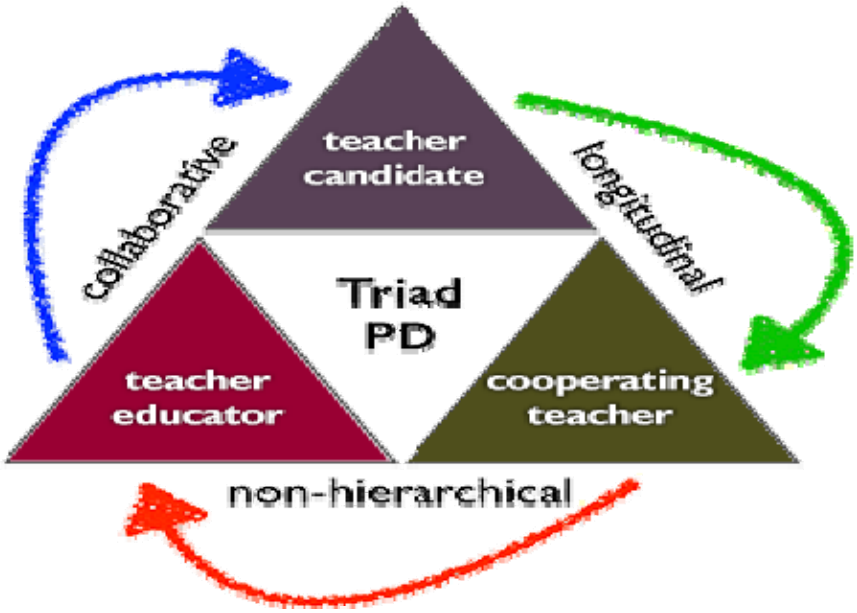
APPENDIX



The Triad Project

Implementation Handbook

Lindsey Cook Clifford Serrao

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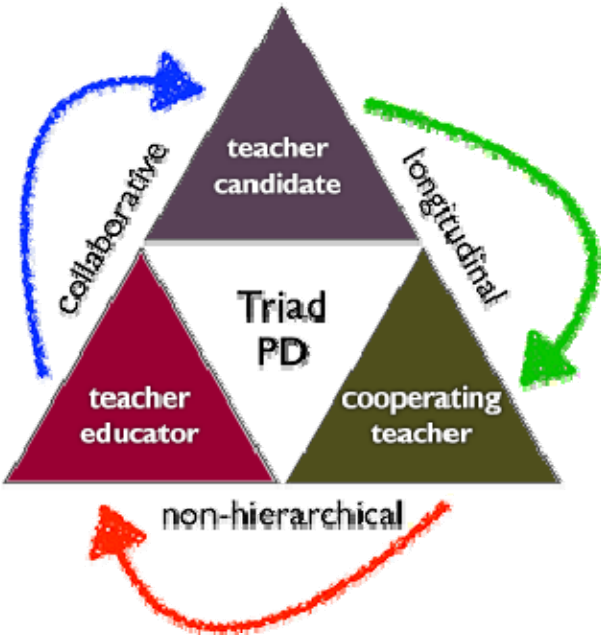
Introduction to The Triad Project



Introduction to the Triad Project

★ This section of the handbook explains what the Triad Project is, when and how it began, the research supporting the model, and how to use this guide.

WHAT IS THE TRIAD PROJECT?

Two educational organizations in Chico, California—Chico Unified School District and California State University Chico—partnered to meet the immediate needs of science teacher professional development due to California's adoption of the NGSS in 2013. As a result, the Triad Project began in 2015. The Triad Project is a science professional development program for Chico Unified School District teachers and the university's credential candidates. Triad is funded by a large grant from the S. D. Bechtel Foundation. What makes the "Triad" element is the collaboration between a CSU, Chico Science or Engineer "expert," the Chico Unified mentor teacher and the CSU, Chico credential student. These three partners become masters of the NGSS by working together to create an NGSS Unit while attending NGSS workshops. The Triad Project is a well-designed, researched-based science professional development model. The Triad Project uses Engstrom and Miettinen's (1999) nodes from activity theory as a design tool. The Triad Project aligns with previous research on effective teacher professional development (Coenders & Terlouw, 2015; Darling-Hammond et al, 2017; Desimone, 2009; Whitworth & Chiu, 2015).

RESEARCH SUPPORTING THE TRIAD PROJECT

Engstrom and Miettinen (1999) developed a visual for how activity systems work together. The Triad Project used the activity system as a design tool for their professional development. The seven nodes in Engstrom and Miettinen's (1999) model include: subjects/participants, rules/norms, community, division of labor, tools/mediating artifacts, object/goal and finally projected outcomes. Each of the seven nodes has a description. The *subjects/participants* of the "Triad" from the Triad Project include a teacher candidate, mentor teacher, university educator, and the university supervisor. The Triad's *rules and norms* state that the Triad is non-hierarchical, collaborative, longitudinal, and goal directed. The *community* includes the science educators, university, and the school

district. The Triad *divided the labor* when working on the goal. The participants *individual responsibilities* include: teacher candidate is the lead author of the unit, the mentor teacher co-plans and co-teaches the unit, the content specialist is in charge as the content/pedagogy consultant. In addition, the university supervisor is available for support to the teacher candidate. The Triad *tools* included anything that helped the Triad strengthen their understanding of the NGSS, such as the NGSS planning tool (backwards design, Bozeman Science NGSS Videos, NGSS@NSTA website), Triad timeline, and the resources from the professional development (PD) workshops (Schademan & Miller, 2018). The *goal* of Triad was to create an integrated NGSS/CCSS unit that meets the needs of all learners. Outcomes from the Triad Project Model include: Multiple-level professional development (teacher candidate and the mentor teacher), an increase of knowledge, use of skills, and changes in beliefs, more effective science instruction for students, field-tested NGSS Curricula, and a collaborative university-district partnership (Schademan & Miller, 2018).

The workshops were designed around the consensus view of effective teacher professional development (Darling-Hammond et al., 2017; Desimone, 2009). The *content focus* in the Triad Project is science, while participants are *actively learning* the NGSS and how to teach them to their students through the creation of their own NGSS-based science unit. The *collaboration* between the Triad (a teacher candidate, mentor teacher, and a science content specialist) is fundamental in the creation of the units. NGSS workshops provide participants with *models of best practices* in science teaching, such as how to use a phenomenon to ignite the inquiry process with students. The Triad content specialist provides *expert support* as well as the teacher educator who is overseeing the process of the professional development and *offers feedback* as well. The unit is able to be implemented during the three-month *sustained duration* allowing time for participants to reflect upon the effectiveness of unit implementation.

Coenders and Terlouw (2015) expanded on Clarke and Hollingsworth's (2002) interconnected model of teacher's professional growth. Coenders and Terlouw found that teachers whom developed material during professional development expanded their knowledge and beliefs. "As the combination of a development phase with a class

enactment phase proved instrumental, an existing model, the interconnected model of teacher professional growth, was extended" (Coenders & Terlouw, 2015, p. 1). The Triad Project used Coenders and Terlouws (2015) expanded interconnected model of teacher's professional growth by having the Triads create their own NGSS unit while attending the NGSS workshops. Like Coenders and Terlouw (2015) proved in their study, the combination of creating a NGSS unit and partaking in the NGSS workshops served well for the teacher participants and their learning of the NGSS standards and the new pedagogical practices associated with the implementation of NGSS (Schademan & Miller, 2018).

The partnership between CSU Chico and the Chico Unified School District has proven to be effective given the demonstrated success of the Triad Project (Schademan & Miller, 2018). Whitworth and Chiu (2015) found in their review of literature focusing on teacher professional development, a missing piece which needs to be researched even furthur, is the need for district leadership to be involved in teacher professional development: "It is critical for us to consider the role of school and district leaders in facilitating teacher change if we want to have a more complete picture of the role of professional development in facilitating teacher and ultimately student learning in science (p. 132). For real change to occur the Triad Project needed the inclusion and support of the district leaders. To help reach a large number of teachers, the district leaders are able to connect their district teachers with a well-researched and implemented teacher professional development program.

POSITIVE DATA

Because of the Triad Project's alignment with Engstrom and Miettinen (1999) nodes of activity theory, the principles of effective professional development (Darling-Hammond et al., 2017; Desimone, 2009), the incorporation of the learning domains (Coenders & Terlouw, 2015) and finally the focus on district leadership (Whitlock & Chui, 2015) results for the Triad Project have been positive (Schademan & Miller, 2018). Participants in the Triad reported the following: (a) an increase in confidence in putting NGSS into practice (b) Triad units met benchmarks for effective curriculum design and instruction (c) teachers adopted reform-based practices such as: student collaboration, 3D

instruction, modeling, phenomena to deepen thinking, connections to NGSS outside of the classroom, high impact learning with literature, argumentation, project-based learning, interactive notebooks, and graphic organizers. (d) data showed the importance of non-hierarchical collaboration.

USE OF THE HANDBOOK

Those interested in using this handbook for the first time should start at the first section and read through each section to familiarize themselves with the origin of the Triad Project and the research behind Triad's effectiveness. In the "Cornerstones of The Triad Project" section, the attachments can be altered to fit your needs.

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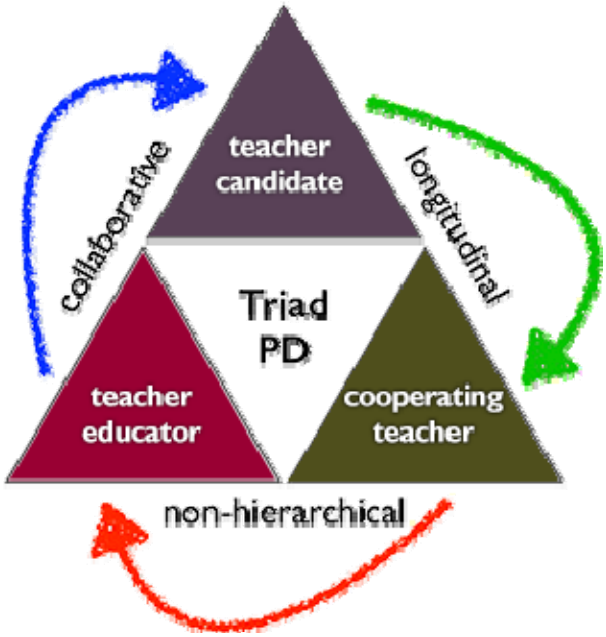
University/School District Partnership



University/School District Partnership

★ This section of the handbook describes the funding process, creation of a partnership and the roles and responsibilities of each of the members in the partnership.

FUNDING:

If private funding is unavailable, then funds will need to be acquired through a grant. The grant proposal will have guidelines. To help offset the costs of the project and continue the project beyond the grant allotted time and money, the Triad's university side of the partnership institutionalized materials and trainings. Such materials/trainings included the core rubric and the trainings involved with the proper implementation of the rubric. Institutionalizing everyday practices of the school of education helps fund the project through the university rather than with grants. What cannot be institutionalized, will be offset through the grant or private funding.

PARTNERSHIP:

Most grants will require a partnership and the partnership is initiated by the grant proposal. Specifically, for the Triad project, the partnership was between CSU Chico and the Chico Unified School District.

ROLES AND RESPONSIBILITIES OF THE TRIAD PROJECT PARTNERS:

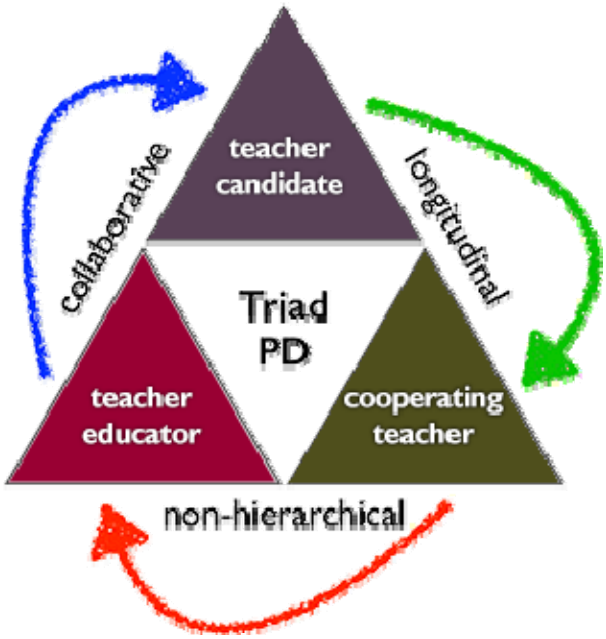
The roles and responsibilities of the leadership team are highlighted in Table 1. Table 1 is divided into three sections: The Role of each of the partners in Triad, the desired characteristics of that role and their responsibilities they each have in the Triad Project.

Table 1

Roles and Responsibilities

Role in Triad	**Desired Characteristics**	**Responsibility**
University: Project Co- Director	● Knowledge of NGSS ● Science Education Professor	● General oversight of project ● Facilitates NGSS workshops ● Recruits content specialists from university ● Teaches science methods courses to candidates
University: Project Co-Director Continuous Improvement Lead	● Expertise with elementary education and assessment	● Collects and analyzes data for grant reporting purposes ● Liaison with multiple subject program
University: Clinical Coordinator	● Expertise with clinical placements	● Works with school of education placement director to secure placements with cooperating teachers in district schools ● Works with elementary education liaison to recruit and secure cooperating teachers to mentor candidates ● Recruits and trains university supervisors to use observational instruments for clinical supervision
District: Project Lead	● Deep knowledge of elementary education and professional development ● Teacher in a semi-administrative role, such as teacher on special assignment	● With university co-director, organizes district teacher professional development around NGSS. ● Ensures that district has materials for Triad unit construction and implementation.
District: Elementary Education Liaison	● Position of authority in district, such as Director of Elementary Education	● Works with university clinical coordinator to recruit and secure cooperating teachers to mentor candidates
Continuous Improvement Co-Lead	● Assessment position in district, such as Director of Assessment and Accountability	● Works with university continuous improvement lead to collect and analyze data for grant reporting purposes
University: Project Assistant	● Understanding of teacher education programs, skills in organization and communication	● Provides administrative support to university co-directors. ● Prepares materials for all Triad events and meetings. ● Sends communications about events.

Building the "Triad"



BUILDING THE "TRIAD"

★ This section of the handbook explains the recruitment process of all three of the triad participants as well as their roles, responsibilities, norms and expectations.

THE RECRUITMENT PROCESS: The "Triad" in the Triad Project requires three participants; a content specialist, cooperating teacher and credential candidate. There is a recruitment process which occurs in order for the three positions to be filled. Below explains this process for each position.

Content Specialists:

The co-director is in charge of recruiting the content specialists. The recruitment process begins with emails with prospective professors, meetings with colleagues in the School of Education (SOE), or meetings with colleagues across campus who have an interest in science education. Such departments include Science Education, Biological Sciences, or Engineering. Information about the project, the pay, and the time commitment is communicated to those interested. After the first round of content specialists are recruited from campus, recruitment starts to become word of mouth. The new campus content specialists are asked to let their colleagues know about the Triad opportunity and to contact the co-director if interested. Once the resources on campus are exhausted, then the co-director reaches out to the local community college science departments. Local high school science teachers are recruited to be content specialists for elementary Triad teams, if they have previously worked with the Triad Project as a cooperating teacher. A list of recruited content specialist will be created. In order to prepare for the following semester, the co-director will send the recruited all an email to

ask if they are interested in being a content specialist for the next semester. Based on the response to the email, the content specialist list will be revised for the next semester.

The Cooperating Teacher:

The cooperating teacher recruitment is the responsibility of the university clinical coordinator. The recruitment process takes about two months. The district sends an annual letter to all teachers in the district with a box where the teachers can mark if they are interested in being a cooperating teacher in The Triad Project. The district principals create a list of approved possible cooperating teachers. This approved list goes to the director and assistant superintendent of the district for the final approval. Once Chico Unified has approved, they email the list to the university clinical coordinator. Once the clinical coordinator has the list then she/he pairs cooperating teachers with the credential candidates.

The Credential Candidate:

The placement coordinator for the School of Education provides the Triad clinical coordinator with a list of accepted credential students. The clinical coordinator then cross checks the students with high GPA's and test scores and marks who has passed the required entrance tests. This process is necessary because the Triad is an additional responsibility for the candidates from the credential program, therefore needing a student able to handle the added responsibility. Further, those who show interest in staying in Chico to work within Chico Unified have a higher chance of being recruited. The agreement in the partnership, is that Chico Unified will take into consideration hiring the credential students who participated in Triad.

THE ROLES AND RESPONSIBILITIES OF THE TRIAD PARTICIPANTS

Table 2 shows the roles and responsibilities of the Triad participants. Table 2 is divided into three sections: The Role of each of the partners in the "Triad," the desired characteristics of that role and their responsibilities they each have within the Triad team.

Table 2

Roles and Responsibilities of the Triad Participants

Role in the "Triad"	**Desired Characteristics**	**Responsibility**
University Credential Candidate	● A student in the university credential program ● A Student in the Science Methods Class	● First author of the Unit ● Primary responsibility is completing the NGSS Planning Tool (with support from Triad). ● Teacher candidates should be applying practices and approaches learned in their methods classes and PD workshops to their units.
District Cooperating Teacher	● Have the ability to help the Triad identify and meet the needs of diverse learners, including ELs and special needs students.	● Help the Triad choose a NGSS that fits within the curriculum map for their grade level. ● Identify available school resources(material, financial, and personnel). ● Provide instructional resources such as existing lesson plans that may work within the unit created. ● Help the Triad create lesson plans at the developmental level of the students. ● Purchase resources needed for the unit and obtain reimbursement from the school district leaders associated with the grant. Help to create the presentation for the symposium and co-present with their triad.
University: Clinical Coordinator	● Knowledge of science and /or engineering concepts and practices. ● Knowledge of the NGSS ● Able to research and access resources vital to the success of the Triad.	● Some content specialists will act as consultants, while others may play a more central role, actually taking the lead on designing at least one of the lessons and helping with implementation in the classroom. ● Content specialists should plan on dedicating anywhere between 8 to 20 hours of work to the Triad.

*The University Supervisor for the School of Education is a support for the "Triad." They are not considered part of what makes up the "Triad" They specifically support the candidate by conducting observations of the teacher candidate and providing feedback on teacher candidate progress in regard to meeting the Teacher Performance Expectations (TPEs), teacher dispositions, and goals of the grant.

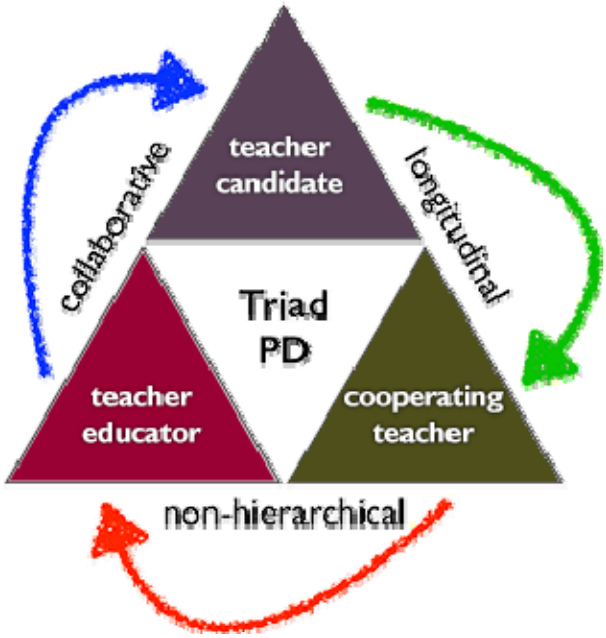
THE NORMS AND AGREEMENTS OF THE TRIAD PARTICIPANTS:

Below are the norms and agreements the Triad participants are expected to follow while participating in the Triad Project (screenshot from The Triad Guide [Schademan & Miller, 2018, n.pg.]):

The norms and agreements from the Triad Project are as follows:

1. All members bring backgrounds, resources, and ideas which are valued by all members of the triad.
2. All members are significant contributors to the unit from start to finish. All members are also learners. Regardless of years of experience, we can always learn from each other and new experiences.
3. All members share the workload. (In the past, teacher candidates have been burdened with a significant amount of the work in some triads. Prevent this from happening in your triad by knowing your responsibilities outlined below, delegating responsibilities between meetings, and then showing up at the next meeting with your tasks completed.)
4. All members are dedicated to creating an amazing unit that teaches science in ways that allow students to inquire about phenomena, share their ideas with each other, and allow students to take responsibility for their own learning.
5. Have fun and trust the process!

Cornerstones of the Triad Project



CORNERSTONES OF THE TRIAD PROJECT

★ This section of the handbook provides a layout for each of the meetings and workshops associated with the Triad Project. Included are implementable information and useable attachments.

The Kick-off Meeting

Purpose: The kick-off meeting is the first time all three of the Triad participants meet. The meeting is at a cafe where business can be attended to while creating an environment of comfort and relaxation for the "triads" to get to know one another. The meeting's agenda is to go over all aspects of Triad including background information, tools, logistics, and norms and agreements for Triad groups.

Frequency: Once **Duration:** 2.0 Hours

Participants: Co-directors, Candidates, Cooperating Teachers, Content Specialists, University Supervisors

To Prepare: *=Helpful/Useable attachments provided below*Invite all necessary parties to the Kick Off Meeting

1. Pre-order food from venue
2. *Create slideshow of necessary Triad information
3. *Create project folders and print handouts
4. *Create and print out end-of- meeting survey and payroll documents
5. *Create a sign-in sheet (which will be used at all workshops)
6. Set up the technology for the slide presentation
7. Set up the sign in table with name tags, a sign in sheet and the triad participant folders

Materials needed:

- Sign in table
- Survey
- Name tags
- Sign in sheet, pens
- Food
- Microphone
- Laptop
- Projector (with extension cord)
- Folders & handouts
- Payroll documents (timesheets, IC agreements)

Procedure:

1. Introductions of the Triad partners and the participants (Slide 1)
2. Background information about The Triad (Slides 2-7)
3. Information about the NGSS Planning Tool and a unit example (Slides 8-9)
4. Triad Timeline and overall components associated with Triad (Slide 10)
5. Previously published Triad Units (Slide 11)
6. Ways to help spread The Triad (Slide 12)

Helpful/Useable Attachment Samples: (Below this list are the visual examples in the order presented~ 1a-1g)

1a. Kickoff invitation:
https://docs.google.com/document/d/1rrZ_8jNKdzct83U8NxX0GyKIpKkStLSCBpJElTy5AV4/edit?usp=sharing

1b. The Triad Project sign in sheet:
https://docs.google.com/document/d/1SSpwWPMl1M-OHu_VXR1cWyDqOGuHN0-X7w3J5L2qI7c/edit?usp=sharing

1c. Kick-off sample agenda: https://docs.google.com/document/d/1_h8ChgPOL0vQ-h6GfEhX6mwR6Ehzx-MQcIrgOEeZvJc/edit?usp=sharing

1d. Kick-off slide presentation: https://docs.google.com/presentation/d/17--6nmnW2X1uZSeNqKYA_9QiJzKdIqLsESgWEmlUdQU/edit?usp=sharing

1e. Kick-off timeline:
https://docs.google.com/document/d/11X4DyyYqbjBJgWTT7jtukqfVFJ3Xxxj0PVE1eP4FRyM/edit?usp=sharin

1f. NGSS planning tool: https://docs.google.com/document/d/1XD4-nKZmvy1l-y41YNzu7y2vBgzdrJLPx4MayHVYAPQ/edit?usp=sharing

1g. The Triad guide:
https://docs.google.com/document/d/1jU1vX6eMjuk_HGPWaXpd8ucQr6R9oelhVzgi1ZtVAbM/edit?usp=sharing

1a. Kickoff invitation:

The Triad Project Kickoff Invitation

Greetings, Fall 2018 Triad Project Participants (and Triad Leadership)!

I'm writing to remind you of Triad's upcoming Kick-off Event (Click HERE to RSVP!), on Monday, August 27th, and to share additional details about the event.... As the Teacher Candidates, Cooperating Teachers, and Content Specialists, you are the very definition of the collaborators who make up a Triad - an academic, professional platform that provides support for the creation of successful NGSS-aligned units! We are excited to welcome the newcomers, but more importantly, allow each of you the opportunity to get acquainted with your Triad group and synchronize plans for this semester. There will be helpful materials, along with delicious appetizers to get your gears turning...

This is a required event for all Triad participants. As a courtesy, please confirm your planned attendance with an (RSVP here!).

Event Details for The TRIAD PROJECT's Fall 2018 Kickoff

- *Date:* Monday, August 27th
- *Time:* 3:30PM – 5:30PM (Please arrive as promptly as possible, so we can begin introductions and reserve extra time for each of you to meet individually with your Triad collaborators.)
- *Location:* Beatniks Coffee House (The venue has been reserved exclusively for participants of this event. Appetizer and select beverage options provided, with additional no-host bar options available by individual order.)
- *Google Map:* 1387 E. 8th St., Chico

Directional Tips, for those new to Beatniks:
Southbound on Hwy 99, take the Chester exit and turn right. You will be heading west on E. 8th, and should immediately turn left into the first parking lot entrance where Beatniks is visible from the road. (If you reach the Valero gas station, you have gone too far). Alternatively, if you are coming from downtown, you may head east on E. 9th St. and will turn into the last parking lot on your left before reaching the Hwy 99 overpass. This E. 9th parking lot entry also connects through to the parking lot accessible from E. 8th St.

If you have any questions, please feel free to contact the Triad Project's Grant Assistant, Rachael Beyers (contact information below).

Rachael Beyers
Office of Outreach, Research & Grants
Project Assistant/Recruiter
rlbeyers@csuchico.edu
(530)898-5025

1b. The Triad Project sign in sheet:

Triad Next Generation

Triad Teacher Candidate Check In

10/19/2018, 12-1 p.m., Modoc Hall, Room 116

Name	Signature

1c. Kick-off sample agenda:

Agenda for Triad Kick-off Meeting

Monday, August 27, 2018
3:30-5:30PM @ Beatniks Coffee House

Welcome!

- Introductions
- Agenda and Materials

Triad Project Overview

- Partnership
- The Big Picture
- Guiding Principles
- Goals and Outcomes

Triad Collaboration

- Norms and agreements
- Roles of Triad members
- Sample Triad meeting agenda

Unit Planning

- NGSS Unit Planning Tool
- Sample Unit

Timeline

- A breakdown of the scope of work over the semester

Triad Website

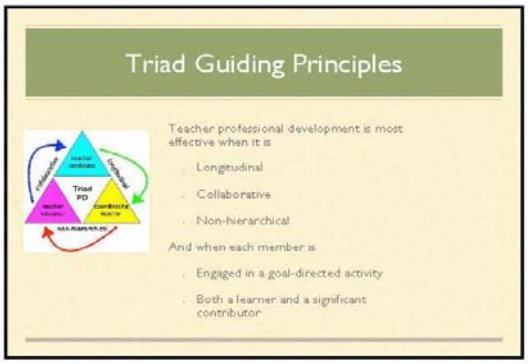
Logistics & Paperwork

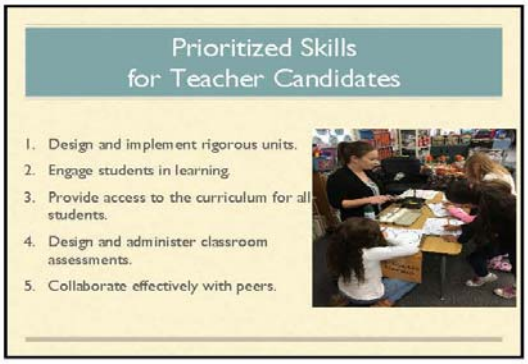
- Informed Consent Form (from Triad's Research Team)
- Photo/Video/Audio Permission Form
- Order Requests for Unit Supplies – Christi Bangsund
- Paperwork for University Supervisors and Content Specialists – Rachael Beyers

Time to Meet with Your Triad!

Thank you for attending our Fall 2018 Triad Kick-Off Meeting!
Please email any feedback about the event to rlbeyers@csuchico.edu

1d. Kick-off slide presentation:





And This…

NGSS Planning Tool

- Provides links to resources throughout the planning process.
- Emphasized in methods course.
- Provides template for final unit.
- Downloadable through http://mysoe.net/triad/

Triad Unit Example

Hydraulic Mining and the Transfer of Energy
Grade 4
Content Area: Physics
NGSS Standard: 4-PS3-4

Triad Timeline

- Attend Kick-Off Meeting
- Attend three, 1.5 hour PD Workshops
- Triads meet to plan unit
- Order materials
- Implement & revise unit
- Present unit at end of semester symposium
- Submit unit for publication

Triad Units Available Online!

http://mysoe.net/triad/

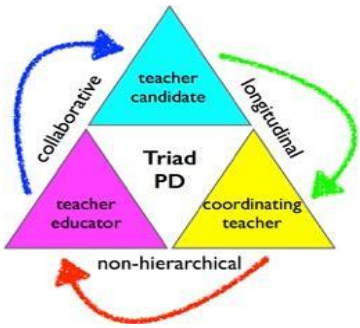
Follow Triad on Facebook!

Like

1e. Kick-off timeline:

Date	Accomplishment	✓ when completed
Mon 1/22 Week 1	Triad Kick-Off Meeting, 4-6 pm, Beatniks Coffee House, 1387 E. 8th St., Chico University semester begins	
Mon 2/5 Week 3	**Workshop 1: *NGSS: Reading and Interpreting the Standards* (3:30 – 5:00 PM) Student Union (MP Room 1001), Marsh Jr. High School	
By Fri 2/9 Week 3	Triad Unit Planning Meeting #1 *(CT, Candidate, Content Specialist)* Choose NGSS Standard for Triad Unit: Complete Section A of NGSS Planning Tool	
Mon 2/12 Week 4	**Workshop 2: *Translating NGSS into Practice: Modeling and 5E* (3:30 – 5:00 PM) Student Union (MP Room 1001), Marsh Jr. High School	
Mon 2/26 Week 6	**Workshop 3: *Translating NGSS into Practice: Argumentation* (3:30 – 5:00 PM) Student Union (MP Room 1001), Marsh Jr. High School	
By Fri 3/2 Week 6	Triad Unit Planning Meeting #2 *(CT, Candidate, Content Specialist)* Choose approach to teach standard: Modeling, 5E, Argumentation, Guided Discovery **Finalize materials order list and CT submit order to district office.**	
By Fri 3/9 Week 7	Complete On-Line Co-Teaching Modules/Workshop (3-4 hours total)	
3/5–3/30 Weeks 7-10 *(Spring Break 3/19-3/23)*	1. Triads meet occasionally to plan and refine unit. 2. Complete Sections B - D of the NGSS Planning Tool. a. Section B - **Content Research**: Outline of major concepts & sub-concepts for the unit. b. Section C - **Summative Assessment**: At this point, just a brief description of your summative assessment. You need to know what you want students to produce at the end of the unit, so that you can design instruction accordingly. This is backwards design, and it works. The important part is that the final assessment evaluates student performance for all three dimensions of the NGSS chosen. c. Section D - **The Unit Plan**: For each lesson, you should have a brief description in each box.	
4/3 - 5/4 Weeks 11-15	Teach your Triad Unit (one week) during this time frame.	
5/7-5/11 Week 16	Unit formatting meeting for candidates, time TBA	
Mon 5/14 Week 17	Triad Unit Presentations. Be prepared for roundtable-style presentation – Use handouts, PowerPoint, demonstration, realia, visuals.	
5/14-5/18 Week 17	1. Finalize Units and submit to Mimi for uploading to the website. 2. Complete Triad Survey. 3. Submit summative assessment data to Mimi for your Triad Unit. 4. Conduct exit interviews.	
5/18 Week 17	CUSD Cooperating Teachers: Submit hours to district after unit has been submitted.	

1f. NGSS planning tool:



Triad NGSS Unit Plan Tool

This planning tool is designed to help your Triad create an engaging, effective and enjoyable NGSS Unit that will meet the needs of all of your students. It is based upon Wiggins and McTighe's (1998) backwards design. Hyperlinks are embedded into the text to link you to resources that will define terms and provide explanations of innovative methods in order to support your work. It will also serve as a template for your final unit that will be downloadable for science teachers through our website.

Triad Team Names:
Teacher Candidate:
Science Cooperating Teacher:
Science Educator:
School and District:
Grade Level:
Science Content Area:

A. Grade Level and Standard *(Cut and paste from the standards into the spaces provided below)*

1. California NGSS (To learn more about the NGSS, go to http://ngss.nsta.org/Default.aspx). Go here to access the NGSS Evidence Statements:

   a. Three NGSS Dimensions Contained in the Standard:
      i. Science and Engineering Practice:
      ii. Disciplinary Core Idea:
      iii. Crosscutting Concept:

2. Common Core State Standard Connections:

   a. ELA/Literacy:

   b. Mathematics (if applicable):

3. ELD Standard (Search the ELD Standards using the ELA Standard(s) identified above.)

B. Content Research - Outline of Major Concept and Sub-Concepts in Unit

To begin your research, go to the Bozeman Science NGSS page and watch a short video on each of the three dimensions in your standard. After better understanding the three dimensions, then research your content textbooks and the Internet. ***Do not underestimate this step.*** *Science is complex, and if you do not have a good grasp of the complexities involved in your unit, your assessment and instruction will tend to focus on low-level knowledge rather than higher level reasoning and deep conceptual understandings.*

Using the research that you conducted above, identify the sub-concepts, practices, or ideas that students will need to understand in order to meet the standard and perform successfully on the summative assessment. You could present this either as an outline or as a concept map.

C. Summative Assessment

For your unit, you will need to create an assessment or assessments so that students can demonstrate their performance of all three dimensions of the NGSS that you chose for your unit. After conducting the research above, re-read the standard along with the assessment boundary and determine what assessment(s) would be developmentally appropriate for measuring the extent to which each student at your grade level has met the performance expectation. Blended performance assessments are encouraged. Blended performance assessments contain assessment items that assess student levels of performance on each dimension of an NGSS.

Describe your assessment(s) below. This can be general at this time, something to give you guidance for your lesson sequence.

D. The Unit Plan

Now that you have determined your standard and your summative assessment idea, use the table below to plan an integrated instructional sequence that will give all students access to the content, practices, core ideas, and the cross-cutting concept in preparation for the final assessment. ***Your unit should address ALL standards listed above, including CCSS for ELA and ELD. This assures that your unit contains a literacy piece and supports for ELs. Including the use of technology in at least one lesson is highly recommended. See the PhET Site for some great computer-based simulations.***

The overall approach for this unit could be model-based instruction, argumentation, the 5E Model of Inquiry, or a combination of these approaches. However, with integrated instructional units, you are encouraged to use a variety of instructional strategies to provide diverse learners access to science content, practices, and ideas, including Explicit Direct Instruction. We strongly encourage you to incorporate Universal Design for Learning Principles and Differentiated Instruction into your planning is order to meet the needs of all students, especially those who typically struggle with science content.

Here are two resources to get you started. Although we encourage you to be creative, you do not have to recreate the wheel. Check out the links below for vetted lessons that you could adapt for your own use. First, visit the Triad Project's Website for sample units from previous semesters. You can also visit the Classroom Resources from the NSTA and BetterLesson which include a number of lesson plans arranged by grade level, subject, and each NGSS.

Unit Plan Table*

Lesson	**Standard** (by number) **and Objective(s) for the Lesson**	**Primary Instructional Strategy****	**Summary of Instructional Sequence of Lesson**	**Strategies for Students Who Typically Struggle with Science** (English Learners, Exceptional Students)	**Assessment Summary** (Briefly describe and label as Diagnostic, Formative, or Summative)
1			*For this section, write a 3-4 sentence description of the lesson, followed by a numbered list of the lesson sequence:* *1. Anticipatory Set – Anchoring Event for the first lesson, but each lesson should have one* *2. First…* *3. Second…* *4. Third…* 5. *Closure*		
2					
3					
4					
5					

*Add rows to the table as needed.

**Strategies might include: guided discovery, model-based instruction, argumentation, 5E Model of Inquiry, direct instruction, computer-based or hands-on simulations, interactive video viewing, etc. At least one lesson should involve students collecting, analyzing, and/or interpreting data. You can use existing data sets.

E. Lesson Plans, Support Materials

In this section, include any support materials that you used for each lesson. Including your assessments is also recommended, since they play a central role in your curriculum design.

F. Summative Assessment

In this section, include your summative assessment for your unit. Include any rubrics that accompany your assessment.

Working with English Learners in Science

Three high leverage practices for working with ELs, or Emergent bilinguals, are as follows:

1. Hands-on Activities
2. Cooperative Learning with Strategic Grouping
3. Guarded Vocabulary

Here is a website with more detailed information about working with ELs.

http://www.rohac.com/sdaieinfo.htm

Also, see the list below of other SDAIE Techniques that you can incorporate into your unit as well:

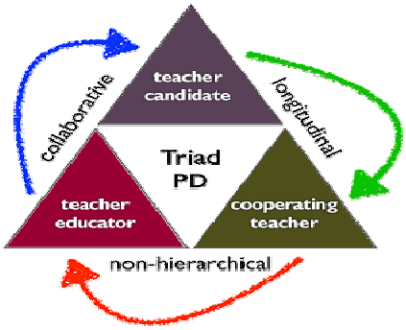
	SDAIE Techniques & Practices
	Input Simplification
1	clear enunciation, slower speech rate; longer pauses; increased redundancy
2	controlled vocabulary; limited use of idiomatic speech; simple verb tenses
3	shorter, less complex sentences and explanations
4	define unusual words and words with double meaning
5	readability level of written materials is low
6	mini lectures
7	use of cognates if possible

	Contextualization and Meaning
1	contextualized teacher delivery: comprehensible input, phrasing, rephrasing
2	Scaffolding; for example, modeling, bridging, contextualizations, schema building, metacognitive development, text representations
3	learners encounter a new topic through a shared, alluring, realistic, direct experience, a common introduction which serves as a foundation for (1) new skills to be acquired, (2) concepts to be learned, or investigated, and/or (3) about which the learners are to read, listen, speak, or write.
4	gestures; facial expressions; act out meaning
5	frequent use of labels
6	props & realia
7	illustrations, pictures, motion pictures, maps, charts, flowcharts, overheads, and graphs
8	bulletin boards with labels whenever appropriate
9	word banks
10	identify key topics organized around main themes
11	extend mental set
12	comprehensible input: provision of information and/or experiences that learners recognize as valuable and meaningful
	Emphasis on Success and Comprehension
1	comprehension is stressed more than form or grammar, semantics more than syntax; utility of ideas, investigations, and skills is the major criterion for success
2	hands-on activities, manipulatives
3	listening and speaking activities precede reading and writing activities
4	reading assignments include pre-reading, during reading, post reading activities
5	writing activities preceded by pre-writing activities
6	cooperative activities

7	adequate time for pupils to complete their work
8	appropriate pacing and difficulty level
9	variety of grouping strategies
10	use of various modalities
11	vocabulary development
12	review of main topics and key vocabulary
	Check Frequently for Attention and Understanding
	Formative, Continuous and In-process Evaluation
1	confirmation and comprehension checks
2	clarification requests
3	repetitions
4	expansions
5	variety of assessment techniques
6	interaction: teacher with student, and/or student with student
	Summative
7	mastery of objective assessed in a variety of ways

1g. The Triad guide:

The Triad Guide



Introduction

The Triad Project is a collaborative partnership between the School of Education at CSU Chico and Chico Unified School District, supported by a grant from the S.D. Bechtel, Jr. Foundation. The Triad Project is named for its three-pronged structure. The "Triads" are made up of one ***cooperating teacher***, one ***science teacher candidate***, and a ***science educator or "content specialist***." Supervisors also play a key role by conducting observations and providing feedback to the candidate, and in some cases, may act as the content specialist as well, or even a fourth member of the Triad.

The Triads work collaboratively over a semester to design, implement, reflect upon, revise and submit a field-tested, integrated, NGSS unit that follows a template designed by science educators at CSU, Chico. Each unit includes a chart of lesson plans, along with support materials all geared toward engaging students deeply in all three dimensions of the NGSS: **science and engineering standards, core ideas, and cross-cutting concepts**. The units are aligned to the Common Core State Standards and include strategies for meeting the needs of all learners, including ELs and special needs students. Units are implemented using a co-teaching model.

The result is a freely downloadable and classroom-ready unit that contains formative and summative assessments, rubrics, and student work samples. In the process, all Triad participants receive valuable professional development that is *longitudinal, collaborative, non-hierarchical, teacher-driven*, and directly related to their teaching practice.

Triad Meetings

To accomplish the goal of publishing a NGSS unit, the Triads typically meet 4-5 times per semester, make progress towards goals during the meetings, and delegate responsibilities for each member of the triad to complete before the next meeting. Meetings should be scheduled in advance when all Triad members can fully participate and should be 1-2 hours in length so that substantial progress can be made at each meeting. All meetings should begin with a reminder of the norms and agreements defined by the Triad Project and by your triad.

The norms and agreements from the Triad Project are as follows.

1. All members bring backgrounds, resources, and ideas which are valued by all members of the triad.
2. All members are significant contributors to the unit from start to finish. All members are also learners. Regardless of years of experience, we can always learn from each other and new experiences.
3. All members share the workload. (In the past, teacher candidates have been burdened with a significant amount of the work in some triads. Prevent this from happening in your triad by knowing your responsibilities outlined below, delegating responsibilities between meetings, and then showing up at the next meeting with your tasks completed.)
4. All members are dedicated to creating an amazing unit that teaches science in ways that allow students to inquire about phenomena, share their ideas with each other, and allow students to take responsibility for their own learning.
5. Have fun and trust the process!

Sample Triad Meeting Agenda:

1. Reminder of Triad norms and agreements. All meetings begin with this important step.
2. Logistics – Share contact information to facilitate communication. Address any issues that have arisen so far. Come to resolution or reach out to a Triad person (Al or Mimi) for guidance.
3. Main task(s) for this meeting. These meetings should be working meetings. See Triad Timeline for this. For example, your first meeting might be choosing your standard, completing Section A of the Planning Tool, and moving onto section B, content research. A good place to start here is watching the Bozeman Science Videos together on each of the 3 dimensions of your standard, and taking notes in section B, so that you are all on the same page about the direction you are going with your unit.
4. Delegate responsibilities to complete individually, or in pairs, before next meeting.
5. Schedule next meeting at a time when all can attend. Place meeting date, time and location on your calendars.

Triad Participant Responsibilities

The primary responsibilities of each member are described below.

Teacher Candidates are the first authors of the units and have the primary responsibility, with the support of the Triad, for completing the NGSS Planning Tool which will eventually be the final, published unit. The teacher candidates are supported in their science methods course (EDTE 532b). The planning, implementation,

presentation of, and publication of the unit is their key assignment for the course. Teacher candidates should be applying practices and approaches learned in their methods classes and PD workshops to their units. Because teacher candidates have many responsibilities outside of Triad, it is important for the Triad to support the teacher candidate with resources, by helping them to complete the planning tool, and by completing their delegated responsibilities in a timely fashion. It is also important to bound the unit around a doable timeframe, which is typically 5- to 10-days.

Cooperating Teachers know their students, school, and community. As a result, they have the primary responsibility for the following: 1) helping the Triad choose a NGSS that fits within the curriculum map for their grade level, 2) identifying available school resources (material, financial, and personnel), 3) providing instructional resources such as existing lesson plans that may work within the unit created, 4) helping the Triad create lesson plans at the developmental level of the students, 5) helping the Triad identify and meet the needs of diverse learners, including ELs and special needs students, and 6) purchasing resources needed for the unit and obtaining reimbursement from the school district leaders associated with the grant. Cooperating teachers also help to create the presentation for the symposium and co-present with their triad.

Content Specialists bring knowledge of science and/or engineering practices and concepts, pedagogies for teaching science, knowledge of the NGSS, and the ability to research and access resources vital to the success of the Triad. Some content specialists will act as consultants, while others may play a more central role, actually taking the lead on designing at least one of the lessons and helping with implementation in the classroom. Content specialists should plan on dedicating anywhere between 8 to 20 hours of work to the Triad.

University Supervisors from the SOE have the primary responsibility of conducting observations of the teacher candidate and providing feedback on teacher candidate progress in regards to meeting the Teacher Performance Expectations (TPEs), teacher dispositions, and goals of the grant. Supervisors should schedule 1 – 2 observations during the instruction of the Triad Unit. They often oversee the collaboration of the triad and support the candidates as they create the science units. Supervisors may assist with the development of the units and ensure that the new standards are being addressed in the creation of the unit plans. Triad supervisors may be required to be trained and calibrated in the use of the Chico CORE Rubric: a new observational tool developed for Common Core classrooms.

NGSS Resources

It is vital that the Triad follow the NGSS Triad Planning Tool to guide the construction of the unit. The planning tool follows backwards design: 1) establish goals which are defined by the NGSS/CCSS standards, 2) decide upon a summative assessment, and 3) plan a series of integrated lessons that will give all students access to the three

dimensions of the NGSS and the related CCSS, and provide students with the knowledge and practices needed to be successful on the summative performance assessment for the unit. Download the NGSS Planning Tool here.

Other Useful Resources: All of these are imbedded in the NGSS Planning Tool, but highlighting them here may help to emphasize their use.

NGSS@NSTA - Go here to help dissect the NGSS.

Bozeman Science NGSS - Go here to watch videos of the three dimensions of your standard.

NGSS@NSTA - Go here to find ideas for lesson plans.

Better Lesson is another place to find ideas for lesson plans.

The Triad Timeline

Making progress throughout the semester is important for creating quality work. Effective triads follow the timeline provided to at least some extent, especially for meeting deadlines, like ordering materials, etc.

Suggested Project Timeline (Fall 2018)

Date	Accomplishment	✓ when completed
8/20 Week 1	University Semester begins	
8/27 Week 2	Triad Kick-Off Meeting (3:30-5:30 PM) Beatnik's Coffee House (located at 1387 East 8th St, Chico)	
9/10 Week 4	**Workshop 1: NGSS: Reading and Interpreting the Standards (3:30 – 5:00 PM) Student Union (MP Room 1001) – Marsh Jr. High School	
By 9/14 Week 5	Triad Unit Planning Meeting #1 *(CT, Candidate, Content Specialist)* Choose NGSS Standard for Triad Unit: Complete Section A of NGSS Planning Tool	
9/17 Week 6	**Workshop 2: Translating NGSS into Practice: Modeling and 5E (3:30 – 5:00 PM) Student Union (MP Room 1001) – Marsh Jr. High School	
9/24 Week 7	**Workshop 3: Translating NGSS into Practice: Argumentation (3:30 – 5:00 PM) Student Union (MP Room 1001) – Marsh Jr. High School	
By 9/28 Week 7	Triad Unit Planning Meeting #2 *(CT, Candidate, Content Specialist)* Choose approach to teach standard: Modeling, 5E, Argumentation, Guided Discovery **Finalize materials order list and CT submit order to Chris Winkle in district office.**	

By 10/5 Week 8	Complete On-Line Co-Teaching Modules/Workshop (3-4 hours total)	
10/1–10/19 Weeks 8-10	1. Triads meet occasionally to plan and refine unit. 2. Complete Sections B - D of the NGSS Planning Tool. a. Section B - **Content Research**: Outline of major concepts & sub-concepts for the unit. b. Section C - **Summative Assessment**: At this point, just a brief description of your summative assessment. You need to know what you want students to produce at the end of the unit, so that you can design instruction accordingly. This is backwards design, and it works. The important part is that the final assessment evaluates student performance for all three dimensions of the NGSS chosen. c. Section D - **The Unit Plan**: For each lesson, you should have a brief description in each box.	
10/22 – 11/30 Weeks 11-15	Teach your Triad Unit (one week) during this time frame. (Thanksgiving Break: 11/19-11/23)	
12/6 Week 16	Triad Unit Presentations. Be prepared for roundtable-style presentation – Use handouts, PowerPoint, demonstration, realia, visuals.	
12/10-12/14 Week 17	1. Finalize Units and submit to AI for uploading to the website. 2. Complete Triad Survey. 3. Submit summative assessment data to AI for your Triad Unit. 4. Conduct exit interviews.	
12/14 Week 17	CUSD Cooperating Teachers: Submit hours to district after unit has been submitted.	

*****Required attendance if you have not previously attended the Science NGSS/Pedagogy Workshops.***

Addressing Issues in Triads or with the Triad Project

The main issue that arises in triads is when one member fails to communicate, attend meetings, or complete their responsibilities. These situations often occur because one member is either very busy and cannot handle the workload, or they feel compelled to do this work and are not engaging in the collaboration voluntarily. These situations place more work and stress on the other two members of the triad which in turn, sours the experience for these members. Historically in these situations, the teacher candidate has to take on a lion's share of the workload, which is neither fair nor acceptable, especially given that they are the only member of the triad not getting paid for their time. Here are ideas for how to address issues if they arise in your triad:

1. Begin all meetings with reminders of the norms and agreements.

2. It is important to establish early in the process that that all members of the triad are doing this work because they want to do it, not because they have to do it.
3. Address any issues in your triad meeting early in the semester, BEFORE they become a larger issue.
4. If for any reason any member of a triad feels that they cannot address the issue with their triad, reach out to Al Schademan or Mimi Miller, one of the Co-Directors of the project. We would be happy to help mediate any issue.

Co-Teaching

The Triad Project incorporates co-teaching as a clinical model. At CSU, Chico co-teaching is defined as two teachers (mentor teacher and credential candidate) working together with groups of students, sharing the planning, organization, delivery and assessment of instruction, as well as the physical space. The *Co-Teaching Online Workshop* at http://mysoe.net is designed to provide new credential candidate/CT pairs with an introduction to co-teaching strategies and activities for developing their partnership. The module is designed for the co-teaching pair to participate together. The suggested timeline below breaks the units down into approximately 1-hour sessions every other week for the first half of the semester. Co-teachers should schedule approximately an hour together for each session at one computer station somewhere where they can hear the audio and be able to talk with each other.

Suggested Timeline for Co-Teaching Online Workshop

Week	Online Unit	Implementation
Weeks 1-3	1. Co-Teaching Overview 2. Co-Teaching Partners: Interview	Try two co-teaching strategies
Weeks 4-5	3. Co-Teaching Partners: Values 4. Importance of Planning 5. Co-Teaching Triad Partnership	Try two different co-teaching strategies
Weeks 6-7	6. Co-Teaching Partners: Strengths 7. Co-Teaching Partners: Communication	Try two different co-teaching strategies
Week 8-9	Continue co-planning	Continue co-teaching
Weeks 10-11	Continue co-planning	Continue co-teaching
Weeks 12-13	Continue co-planning	Continue co-teaching
Weeks 14-15	Continue co-planning	Continue co-teaching

Workshops

The purpose of the three series workshops are to provide information, guidance, and time for hands on use of the NGSS. Each workshop has its own agenda. The first workshop provides information on how to read and interpret the NGSS. The second workshop takes the Triad participants through a hands-on experience on a model-based learning instruction. The third workshop is for the educators to become familiar with #7 of the eight engineering practices from the three dimensions through the same approach as workshop #2.

Workshop 1: Reading and Interpreting the Next Generation Science Standards

Purpose: The purpose of workshop 1 is to to provide the candidates and their cooperating teachers information and time to learn how to read and interpret the NGSS as well as how to use the NGSS technological tools.

Frequency: Once **Duration:** 1.5 Hours

Participants: Candidate, Cooperating Teacher

To Prepare: *=Helpful/Useable attachments provided below

1. *Prepare a slideshow
2. Bring the sign in sheet
3. Shop for food
4. Purchase name tags and pens
5. Gather a computer and projector to be used
6. Set up the space you have been provided with enough chairs and tables for the participants
7. *Set up a table with a sign in sheet, name tags
8. Set up a projector and screen
9. Set up a table with food for the participants

Materials Needed:

- Chairs & tables
- Sign in sheet
- Microphone
- Laptop
- Projector and screen
- Electronic devices for participants (advised to bring with them, but extra ipads on hand)
- Snacks/drinks (optional)

Procedure:

1. Introductions and agenda (Slides 1-4)
2. The Triad Project (Slides 5-6)
3. History of the NGSS (Slides 7-17)
4. Structure of the NGSS (Slides 18-46)
5. How to read the NGSS and Practice (Slides 47-51)
6. Foreshadow for next workshop (Slides 52-54)
7. Survey (Slide 55)

Helpful/Useable Attachment Samples:(Below this list are the visual examples in the order presented~2a-2d)

2a. The Triad Project sign in sheet:
https://docs.google.com/document/d/1Sx4a1IAKFuYyXik4w8wpQMG8rCk86oyKIL3H_ioZOZE/edit?usp=sharing
2b. Workshop 1 sample agenda:
https://docs.google.com/document/d/1DPCXtSTKIQzbCXF0hqrqu6ofqHNSpSOk1ZKEOlWof20/edit?usp=sharing
2c. Workshop 1 slide presentation:
https://docs.google.com/presentation/d/19bw5xmd_qXLbBoHj9rI9cvcmvDSL0MxEaY5Jjy8DCwA/edit?usp=sharing
2d. NGSS planning tool:
https://docs.google.com/document/d/1SMTrtk3Saj2eacLVpabPocyqapW39X4TpT9MNeqL_0A/edit?usp=sharing

2a. The Triad Project sign in sheet:

Triad Next Generation

Triad Teacher Candidate Check In

10/19/2018, 12-1 p.m., Modoc Hall, Room 116

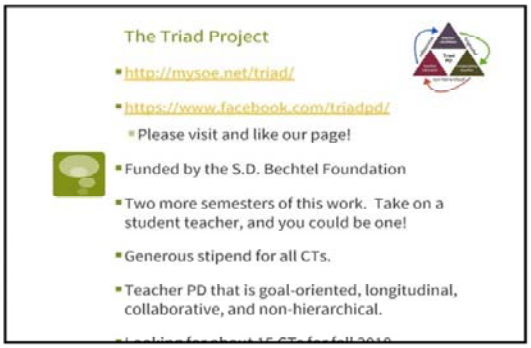
Name	Signature

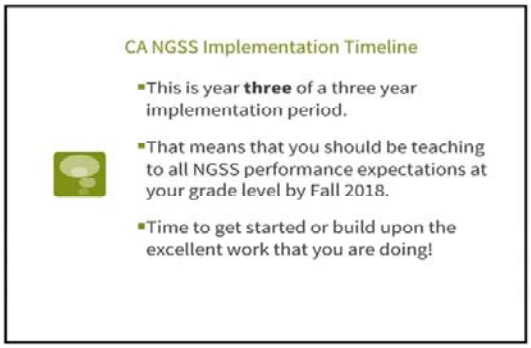
2b. Workshop 1 sample agenda:

The Triad Project Workshop 1 Agenda

- Session One: NGSS
    - The Triad Project Background
    - History of the NGSS
    - Structure of the NGSS
    - How to read the NGSS
    - Practice
    - Survey

2c. Workshop 1 slide presentation:





A Brief History of the NGSS

From Traditional to More Nuanced Views of the Nature of Science and What Scientists Actually Do

Traditional View of Science: *Thee* Scientific Method

- Problem
- Research
- Hypothesis
- Experiment
- Analyze data
- Conclusions

Traditional View of Science: *Thee* Scientific Method

- Where did this come from?
- From studying the products of science:
  - Scientific reports.
  - Reports tend to follow "the scientific method".

Traditional View of Science: *Two Implications*

- Made science appear to be a step-by-step, clean, linear process.
- Placed the experiment as the central scientific practice. (Pickering, 1982)

Traditional View of Science: *Implications for Science Education*

- Teach students:
  - the steps of the scientific method,
  - cookbook labs that follow these steps,
  - products of science (facts, concepts),
  - engage them in experiments.
- Main pedagogies used:
  - Lecture, lecture, lecture followed by cookbook, confirmation labs that reinforce facts and concepts taught in lecture.

The Problem

- But what if that's not how science actually occurs?
- What if this is not an accurate representation of what scientists actually do?
- What if "*Thee Scientific Method*" is not an accurate representation of the nature of science?
- Discuss with a few people around you.

Science as a Social Practice (Pickering, 1982)

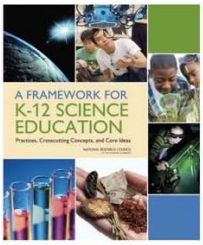
- Sociologists and anthropologists began to study what scientists actually do.
- **Among other things, this research found that scientists:**
- Attempt to *explain natural phenomenon*
- Create *models* of how they think the phenomenon works: the mechanisms behind it, not the rules.
  - These models are much more complex than a "hypothesis".
- *Test* models using scientific methods. *Revise* their models based upon their findings.
- Develop evidence and/or theoretical-based *arguments* to support their models.
- Write and publish reports (one long argument).

Implications for Science Education

- Resulted in 2-3 decades of research on the relationships between experimentation, modeling, inquiry, argumentation, and the big ideas of science.
- Significant effect on our view of the Nature of Science.

A Framework for K-12 Science Education (National Research Council, 2012) - Basis for the NGSS

- Defines Three Dimensions of Science



http://www.nap.edu/catalog.php?record_id=13165#

Three Dimensions of Science (from the NRC Framework)

- Science and Engineering Practices
- Crosscutting Concepts
- Disciplinary Core Ideas

Any Questions?

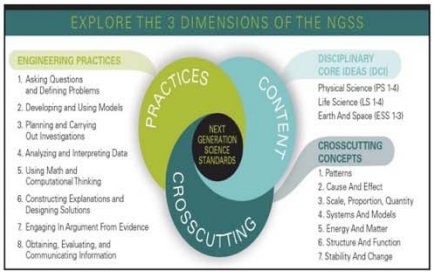
Structure of the NGSS

The Three Dimensions of Science

Three Dimensions of Science

- Science and Engineering Practices
- Crosscutting Concepts
- Disciplinary Core Ideas

FIGURE 2: The Three Dimensions of NGSS



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Science and Engineering Practices

- These are the things that scientists and engineers do
- The processes and practices in which they engage in order to gain insight into how the world works.

Eight Science and Engineering Practices

1. Asking questions and defining problems.
2. Developing and using models
3. Planning and carrying out investigations.
4. Analyzing and interpreting data.
5. Using mathematics and computational thinking.
6. Constructing explanations and designing solutions.
7. Engaging in argument from evidence.
8. Obtaining, evaluating, and communicating information.

Question

- Why is it important (and more fun!) to engage students in these processes and practices as part of "normal" science instruction?
- Discuss at your tables and be ready to share out one reason.

Seven Crosscutting Concepts

- These are big ideas that cut across all disciplines of science: physics, chemistry, earth science, astronomy, & the life sciences.

Seven Crosscutting Concepts

- Patterns
- Cause and Effect – Mechanism and explanation
- Scale, proportion, and quantity.
- Systems and system models.
- Energy and matter: Flows, cycles and conservation.
- Structure and function.
- Stability and change

1. Patterns

Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

2. Cause and Effect

Events have causes, sometimes simple, sometimes multifaceted. Deciphering causal relationships, and the mechanisms by which they are mediated, is a major activity of science and engineering.

3. Scale, Proportion, and Quantity

In considering phenomena, it is critical to recognize what is relevant at different size, time, and energy scales, and to recognize proportional relationships between different quantities as scales change.

4. Systems and System Models

A system is an organized group of related objects or components; models can be used for understanding and predicting the behavior of systems.

5. Energy and Matter

Tracking energy and matter flows, into, out of, and within systems helps one understand their system's behavior.

6. Structure and Function

The way an object is shaped or structured determines many of its properties and functions.

7. Stability and Change

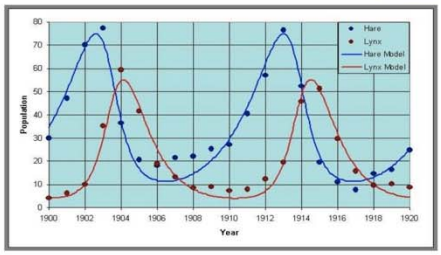
For both designed and natural systems, conditions that affect stability and factors that control rates of change are critical elements to consider and understand.

Crosscutting Concepts: Patterns in Chemistry

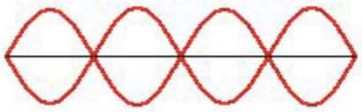
Group→ ↓Period	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1 H																	2 He
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba	* 71 Lu	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra	* 103 Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Uut	114 Fl	115 Uup	116 Lv	117 Uus	118 Uuo

*	57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb
*	89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No

Crosscutting Concepts: Patterns in Biology

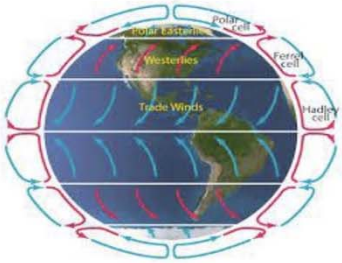


Crosscutting Concepts: Patterns in Physics



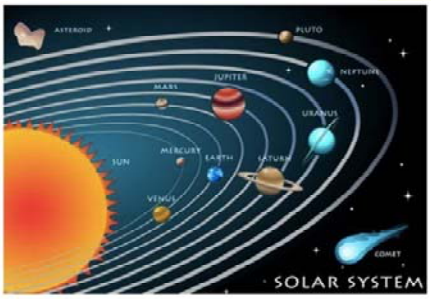
A standing wave pattern for a string

Crosscutting Concepts: Patterns in Earth Science



Crosscutting Concepts: Patterns in Climate Science

Crosscutting Concepts: Patterns in Astronomy



1. Patterns

Observed patterns in nature guide organization and classification and prompt questions about relationships and causes underlying them.

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Cross Cutting Concepts

- Let's go back to the cross cutting concept chart.
- Assign each group one.
- Come up with an example of this in two different science disciplines:
  - Life Science - Biology
  - Physical Science - Physics/Chemistry
  - Earth Science – Geology, Paleontology.

Disciplinary Core Ideas

- The Big Ideas in each discipline of science.

Disciplinary Core Ideas: Physical Sciences

- PS1: Matter and its interactions
- PS2: Motion and stability: Forces and interactions
- PS3: Energy
- PS4: Waves and their applications in technologies for information transfer

Disciplinary Core Ideas: Life Sciences

- LS1: From molecules to organisms: Structures and processes
- LS2: Ecosystems: Interactions, energy, and dynamics
- LS3: Heredity: Inheritance and variation of traits
- LS4: Biological evolution: Unity and diversity

Disciplinary Core Ideas: Earth and Space Sciences

- ESS1: Earth's place in the universe
- ESS2: Earth's systems
- ESS3: Earth and human activity

Disciplinary Core Ideas: Engineering, Technology, and Applications of Science

- ETS1: Engineering design
- ETS2: Links among engineering, technology, science, and society

Three Dimensions of Science: Determined the Structure of the NGSS

- Science and Engineering Practices
- Crosscutting Concepts
- Disciplinary Core Ideas

Questions?

- What are the three dimensions of the NGSS?

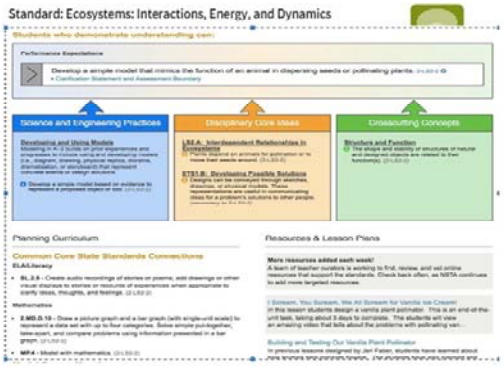
Overall Structure of the NGSS

- Performance – defines what students will be able to do in order to demonstrate that they have met a standard.
- Three Dimensions of Science
  - Science and Engineering Practices
  - Crosscutting Concepts
  - Disciplinary Core Ideas

- Coherence – connections to math and ELA CCSS

Structure of the NGSS

Standard: Ecosystems: Interactions, Energy, and Dynamics



What do the letters and numbers mean?

- **2-LS2-2**
  - **2 – Grade Level**
  - **LS – Life Science**
  - **2 – # of LS topics at this grade level.**
  - **2 – second performance expectation in this topic at this grade level.**

Performance expectations, not knowledge-based standards

- Focus is upon what students can do, not just what they know or understand.
- Example: Elementary
- **2-LS2-2. Develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.**

Your Turn: Dissecting a NGSS Standard

- Access the NGSS Unit Planning Template in the Google Folder.
- Click on this link on page one: http://ngss.nsta.org/Default.aspx
- Find **2-LS2-2**
- Use the tool to dissect all 3 dimensions of the standard.
- Place your cursor each box and notice what happens.

Your Turn: Dissecting a NGSS Standard

- Now go to the *Bozeman Science NGSS* link on the planning tool.
- Find, but do not watch entirely, the videos for the 3 dimensions of this standard.
- Use these two tools to learn all about the standards on your own, with your co-teacher, or with your department. Be a teacher leader.

NGSS Evidence Statements

- Now, go back to the NGSS Planning Tool and click on the Evidence Statements link.
- Do a search for 2-LS2-2.
- Hit submit.
- Click on the correct one – 2-LS2-2.

NGSS Evidence Statements: 2-LS2-2

Observable features of the student performance by the end of the grade:		
1	Components of the model	
	a	Students develop a simple model that mimics the function of an animal in seed dispersal or pollination of plants. Students identify the relevant components of their model, including those components that mimic the natural structure of an animal that helps it disperse seeds (e.g., hair that snares seeds, squirrel cheek pouches that transport seeds) or that mimic the natural structure of an animal that helps it pollinate plants (e.g., bees have fuzzy bodies to which pollen sticks, hummingbirds have bills that transport pollen). The relevant components of the model include:
		i. Relevant structures of the animal.
		ii. Relevant structures of the plant.
		iii. Pollen or seeds from plants.
2	Relationships	
	a	In the model, students describe* relationships between components, including evidence that the developed model mimics how plant and animal structures interact to move pollen or disperse seeds.
		i. Students describe* the relationships between components that allow for movement of pollen or seeds.
		ii. Students describe* the relationships between the parts of the model they are developing and the parts of the animal they are mimicking.
3	Connections	
	a	Students use the model to describe*:
		i. How the structure of the model gives rise to its function.
		ii. Structure-function relationships in the natural world that allow some animals to disperse seeds or pollinate plants.

Helpful Resources

- Go back to NGSS@NSTA
- Find 2-LS2-2 again.
- Isolate it by itself by clicking on the 2-LS2-2 after the text of the PE.
- Go down to **Resources** at bottom right.
- Click on: I Scream, You Scream, We All Scream for Vanilla Ice Cream!
- This activity uses the 5E Approach to guide instruction for the unit.

The Goal of the Triad Project

- Teachers are able to design innovative and engaging units that:
  - Teach to NGSS, CCSS, and ELD standards,
  - Engage students in hands-on activities through science practices, like modeling and argumentation,
  - Engage students in making meaning of natural phenomena,
  - Design multidimensional formative and summative assessments.
- Here's an example:

Start Unit with a Phenomena!

1. Get ideas from this site:

https://www.nessphenomena.com/

2. And keep coming back to this phenomena.

Your Turn!

- Go back to NGSS@NSTA.
- Find any performance expectation (PE) at your grade level.
- Isolate it by itself by clicking on the "2-LS2-2" after the text of the PE.
- Identify the PE, the 3 Dimensions, and the CCSS Connections.
- Find the Evidence Statements for your PE.
- Find the Bozeman Science videos for your 3 dimensions.
- Go down to **Resources** at bottom right and find a cool resource that you could use to teach to your PE.
- Find a phenomena that could serve as an anchor for your standard. https://www.nessphenomena.com/

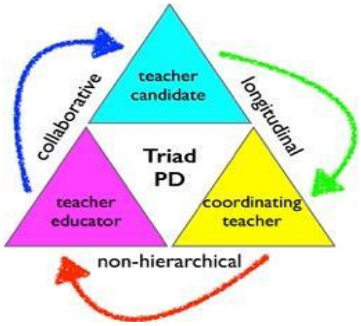
Questions or Comments?

- Please complete the Survey. This session is called:
- ***Reading and Interpreting the NGSS.***

References

- National Research Council (2012), A framework for K-12 Science Education. National Academies Press, Washington D.C.
- Latour, B., & Woolgar, S. (1979). *Laboratory life: The social construction of scientific facts. Beverly Hills: Sage Publications, Inc.*
- Latour, B. (1987). *Science in action: How to follow scientists and engineers through society. Cambridge, MA: Harvard University Press.*
- Pickering, A. (1992). From science as knowledge to science as practice. In A. Pickering (Ed.), *Science as practice and culture* (pp. 1-26). Chicago: University of Chicago Press.

2d. NGSS planning tool:



Triad NGSS Unit Plan Tool

This planning tool is designed to help your Triad create an engaging, effective and enjoyable NGSS Unit that will meet the needs of all of your students. It is based upon Wiggins and McTighe's (1998) backwards design. Hyperlinks are embedded into the text to link you to resources that will define terms and provide explanations of innovative methods in order to support your work. It will also serve as a template for your final unit that will be downloadable for science teachers through our website.

Triad Team Names:
Teacher Candidate:
Science Cooperating Teacher:
Science Educator:
School and District:
Grade Level:
Science Content Area:

A. Grade Level and Standard *(Cut and paste from the standards into the spaces provided below)*

1. California NGSS (To learn more about the NGSS, go to http://ngss.nsta.org/Default.aspx). Go here to access the NGSS Evidence Statements:

   a. Three NGSS Dimensions Contained in the Standard:
      i. Science and Engineering Practice:
      ii. Disciplinary Core Idea:
      iii. Crosscutting Concept:
2. Common Core State Standard Connections:

   a. ELA/Literacy:
   b. Mathematics (if applicable):

3. ELD Standard (Search the ELD Standards using the ELA Standard(s) identified above.)

B. Content Research - Outline of Major Concept and Sub-Concepts in Unit

To begin your research, go to the Bozeman Science NGSS page and watch a short video on each of the three dimensions in your standard. After better understanding the three dimensions, then research your content textbooks and the Internet. ***Do not underestimate this step.*** *Science is complex, and if you do not have a good grasp of the complexities involved in your unit, your assessment and instruction will tend to focus on low-level knowledge rather than higher level reasoning and deep conceptual understandings.*

Using the research that you conducted above, identify the sub-concepts, practices, or ideas that students will need to understand in order to meet the standard and perform successfully on the summative assessment. You could present this either as an outline or as a concept map.

C. Summative Assessment

For your unit, you will need to create an assessment or assessments so that students can demonstrate their performance of all three dimensions of the NGSS that you chose for your unit. After conducting the research above, re-read the standard along with the assessment boundary and determine what assessment(s) would be developmentally appropriate for measuring the extent to which each student at your grade level has met the performance expectation. Blended performance assessments are encouraged. Blended performance assessments contain assessment items that assess student levels of performance on each dimension of an NGSS.

Describe your assessment(s) below. This can be general at this time, something to give you guidance for your lesson sequence.

D. The Unit Plan

Now that you have determined your standard and your summative assessment idea, use the table below to plan an integrated instructional sequence that will give all students access to the content, practices, core ideas, and the cross-cutting concept in preparation for the final assessment. ***Your unit should address ALL standards listed above, including CCSS for ELA and ELD. This assures that your unit contains a literacy piece and supports for ELs. Including the use of technology in at least one lesson is highly recommended. See the PhET Site for some great computer-based simulations.***

The overall approach for this unit could be model-based instruction, argumentation, the 5E Model of Inquiry, or a combination of these approaches. However, with integrated instructional units, you are encouraged to use a variety of instructional strategies to provide diverse learners access to science content, practices, and ideas, including Explicit Direct Instruction. We strongly encourage you to incorporate Universal Design for Learning Principles and Differentiated Instruction into your planning is order to meet the needs of all students, especially those who typically struggle with science content.

Here are two resources to get you started. Although we encourage you to be creative, you do not have to recreate the wheel. Check out the links below for vetted lessons that you could adapt for your own use. First, visit the Triad Project's Website for sample units from previous semesters. You can also visit the Classroom Resources from the NSTA and BetterLesson which include a number of lesson plans arranged by grade level, subject, and each NGSS.

Unit Plan Table*

Lesson	**Standard** (by number) **and Objective(s) for the Lesson**	**Primary Instructional Strategy****	**Summary of Instructional Sequence of Lesson**	**Strategies for Students Who Typically Struggle with Science** (English Learners, Exceptional Students)	**Assessment Summary** (Briefly describe and label as Diagnostic, Formative, or Summative)
1			*For this section, write a 3-4 sentence description of the lesson, followed by a numbered list of the lesson sequence:* *1. Anticipatory Set – Anchoring Event for the first lesson, but each lesson should have one* *2. First…* *3. Second…* *4. Third…* 5. *Closure*		
2					
3					
4					
5					

*Add rows to the table as needed.

**Strategies might include: guided discovery, model-based instruction, argumentation, 5E Model of Inquiry, direct instruction, computer-based or hands-on simulations, interactive video viewing, etc. At least one lesson should involve students collecting, analyzing, and/or interpreting data. You can use existing data sets.

E. Lesson Plans, Support Materials
In this section, include any support materials that you used for each lesson. Including your assessments is also recommended, since they play a central role in your curriculum design.

F. Summative Assessment
In this section, include your summative assessment for your unit. Include any rubrics that accompany your assessment.

Working with English Learners in Science

Three high leverage practices for working with ELs, or Emergent bilinguals, are as follows:

1. Hands-on Activities
2. Cooperative Learning with Strategic Grouping
3. Guarded Vocabulary

Here is a website with more detailed information about working with ELs.
http://www.rohac.com/sdaieinfo.htm

Also, see the list below of other SDAIE Techniques that you can incorporate into your unit as well:

	SDAIE Techniques & Practices
	Input Simplification
1	clear enunciation, slower speech rate; longer pauses; increased redundancy
2	controlled vocabulary; limited use of idiomatic speech; simple verb tenses
3	shorter, less complex sentences and explanations
4	define unusual words and words with double meaning
5	readability level of written materials is low
6	mini lectures
7	use of cognates if possible
	Contextualization and Meaning

1	contextualized teacher delivery: comprehensible input, phrasing, rephrasing
2	Scaffolding; for example, modeling, bridging, contextualizations, schema building, metacognitive development, text representations
3	learners encounter a new topic through a shared, alluring, realistic, direct experience, a common introduction which serves as a foundation for (1) new skills to be acquired, (2) concepts to be learned, or investigated, and/or (3) about which the learners are to read, listen, speak, or write.
4	gestures; facial expressions; act out meaning
5	frequent use of labels
6	props & realia
7	illustrations, pictures, motion pictures, maps, charts, flowcharts, overheads, and graphs
8	bulletin boards with labels whenever appropriate
9	word banks
10	identify key topics organized around main themes
11	extend mental set
12	comprehensible input: provision of information and/or experiences that learners recognize as valuable and meaningful
	Emphasis on Success and Comprehension
1	comprehension is stressed more than form or grammar, semantics more than syntax; utility of ideas, investigations, and skills is the major criterion for success
2	hands-on activities, manipulatives
3	listening and speaking activities precede reading and writing activities
4	reading assignments include pre-reading, during reading, post reading activities
5	writing activities preceded by pre-writing activities
6	cooperative activities
7	adequate time for pupils to complete their work

8	appropriate pacing and difficulty level
9	variety of grouping strategies
10	use of various modalities
11	vocabulary development
12	review of main topics and key vocabulary
	Check Frequently for Attention and Understanding
	Formative, Continuous and In-process Evaluation
1	confirmation and comprehension checks
2	clarification requests
3	repetitions
4	expansions
5	variety of assessment techniques
6	interaction: teacher with student, and/or student with student
	Summative
7	mastery of objective assessed in a variety of ways

Workshop 2: Translating the NGSS into Instruction: Model-based Instruction & Supports for All Students During Inquiry

Purpose: The Purpose of workshop #2 is for educators to become familiar with one of the eight engineering practices from the three dimensions of the NGSS, which is #2 "Developing and using models." If your standards include "modeling," then your performance assessment should include some form of modeling for students.

Frequency: Once **Duration:** 1.5 Hours

Participants: Candidate, Cooperating Teacher

To Prepare: *=Helpful/useable attachments provided below

1. *Prepare a slideshow with necessary information
2. Purchase food for participants
3. Bring sign in sheet
4. Obtain and bring poster board paper and pens for each table set up

Materials Needed:

- Tables and chairs
- Sign in sheet
- Poster board Paper
- Poster markers
- Snacks/drinks
- Computer
- Projector and screen
- Materials to demonstrate
- Phenomenon (aluminum can and train car phenomenon's)
- Prepared slideshow

Procedure:

1. NGSS Planning tool and backwards design (Slide 5)
2. Brief Introduction to Modeling (Slides 6-17)
3. Model-based Instruction Activity & Debrief (Slides 18-26)
4. Supporting ALL Students During Inquiry-based Science (Slide 27)
5. Getting acquainted with the readings and resources in the folder. The teachers see how model-based units are put together (Slides 28-32)

Helpful/Useable Attachment Samples:(Below this list are the visual examples in the order presented~3a-3e)

3a. The Triad Project sign in sheet:
https://docs.google.com/document/d/1CudE8932FGO7az7e0BZ6HA24Abf_uVgewnMO3GZdw44/edit?usp=sharing
3b. Workshop 2 sample agenda:
https://docs.google.com/document/d/1SNB6cZDSX4aaclhJ401JGBijVWbAxfkRFsB1cU9srwI/edit?usp=sharing

3c. Workshop 2 slide presentation:
https://docs.google.com/presentation/d/1cEAgqcvsAyFAeEJ9P4k_yEwsjb86svqDsF9pXtC6ODo/edit?usp=sharing
3d. Workshop 2 crush the can phenomenon(link only):
http://www.metrofamilymagazine.com/July-2013/Simple-Science-Experiments-Crush-a-Can/
3e. Workshop 2 train car phenomenon(link only):
https://www.youtube.com/watch?v=Zz95_VvTxZM

3a. The Triad Project sign in sheet:

Triad Next Generation

Triad Teacher Candidate Check In

10/19/2018, 12-1 p.m., Modoc Hall, Room 116

Name	Signature

3b. Workshop 2 sample agenda:

The Triad Project Workshop #2 Agenda:
Translating the NGSS into Instruction:
Model-based Instruction & Supports for
All Students During Inquiry

- Model-based Instruction Activity & Debrief
- Model & Modeling NGSSs
- Supporting ALL Students During Inquiry-based Science
- Grade Level Groups – Brainstorm modeling activities for modeling standard at your grade level.

3c. Workshop 2 slide presentation:

Translating the NGSS into Instruction: Model-based Instruction & Supports for All Students During Inquiry

Dr. Al Schademan
CSU Chico

Agenda

- Model-based Instruction Activity & Debrief
- Model & Modeling NGSSs
- Supporting ALL Students During Inquiry-based Science
- Grade Level Groups – Brainstorm modeling activities for modeling standard at your grade level.

Objective

- TWABAT:
- 1) apply model-based instruction to appropriate NGSSs as pedagogical approaches to guide instructional unit design.
- 2) provide supports for ALL students, including students with disabilities, during inquiry.

Transitioning to the NGSS

- https://www.teachingchannel.org/videos/transition-to-ngss-achieve
- Give students a chance to explore something first, before you explain anything.
- Students need to be always:
  - Engaging in and explaining phenomena, or
  - Designing a solution to a problem
- What storyline could I develop that, in the end, students had to develop an explanation or design a solution?
- What tools can I provide them that they can use?

NGSS to Instruction: NGSS Planning Tool & Backwards Design (Wiggins & McTighe, 2005)

- Step 1: Choose Performance Expectation(s)
- Step 2: Decide on an assessment. Should follow from the Performance Expectation (backwards design).
- Step 3: Choose an overall approach to guide instruction and plan an activity sequence that would prepare the students for your assessment.
- If your standard includes models or modeling as a SEP, then your approach should include modeling.

NGSS to Instruction: Modeling

- **Model-based Instruction** –
- Anchoring Event,
- Initial Models,
- Instruction and Experimentation,
- Model Revision,
- Model Consensus & Presentation
  - (http://tools4teachingscience.org/).

Model-based Instruction

What is a model?

- Any representation or interpretation of a physical or abstract system or thing.
- Model – Referent
  - Model – what we create.
  - Referent – the thing to which we that we are referring.

Four Types of Models

Lehrer & Schauble, 2000

- Physical
- Representational
- Syntactic
- Hypothetical-Deductive Models

Physical Models

Lehrer & Schauble, 2000

- Physical – volcanoes, solar systems, etc.
  - Physical resemblance to the referent system.

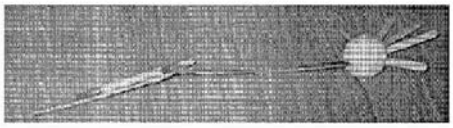
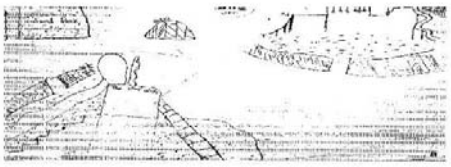


Figure 1. Child's Model of the Elbow.

Representational Models

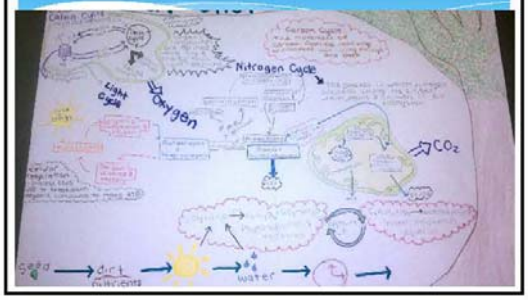
Lehrer & Schauble, 2000

- Representational – maps, diagrams, etc.
  - Resemblance to the referent system through drawing, labeling, etc.



Representational Models

The Triad Project



Syntactic Models

Lehrer & Schauble, 2000

- Syntactic – coin flips or the use of a spinner to model the likelihood of an event occurring in nature.
- Based on Analogy – not trying to resemble the referent in any physical way.
- This is *like* that in some significant way.

Hypothetical-Deductive Models

Lehrer & Schauble, 2000

- Attempt to understand hypothetical entities that result in emergent behaviors.

Hypothetical-Deductive Models

Lehrer & Schauble, 2000

- What guides termite behavior that results in a termite mound?

Hypothetical-Deductive Models

Lehrer & Schauble, 2000

- How do birds to fly in these amazing patterns?
  - https://www.youtube.com/watch?v=Dd2iiVBtja4w

Why Model?

- Because it is a central practice of science.
- To push student thinking about phenomena beyond their current ways of thinking.
- To encourage student-to-student discourse about science and phenomena.
- Because there are 31 K-8 NGSSs that relate to modeling.
- Time to get busy modeling!

Example of Model-based Instruction (MBI)

- Aluminum Can
  - Watch closely.
  - What caused this phenomenon to happen?

Creating Your Model

1. Use the Rubric to guide your modeling.
2. Assign roles.
3. Draw your model on your poster.
4. Each member of the group choose a different colored marker.
5. Write your name at the top in this color. Each student can only write in this color on the model.
6. Show a sequence: Before, During, After (divide paper into 2 or 3 sections).
7. Use arrows, mathematical formulas, captions, a legend (of applicable).
8. Focus on the mechanism that caused the can to crush.
9. Be creative and don't worry about being right: just get your ideas down on paper.
10. You have 20 minutes.

Round Robin

- Choose one person to remain at your poster. Everyone else rotate one table clockwise.
- The person at the table explains your model to the others. Feel free to ask challenging questions like: What exactly is causing this phenomenon to happen? What is your evidence?
- You will have about two minutes before rotating.

Reflective Session

- Return to your original group.
- Discuss what you learned from the other groups' models.
- Using what you learned from the other groups' models, make changes to yours.

Formative Assessment

- Quick Write: Using what you have learned, in one sentence, write what mechanism caused the can to crush?

What did we just do?

- Model-based Instruction
- NGSS Alignment:
- 5-PS1-1. Develop a model to describe that matter is made of particles too small to be seen.
- MS-PS1-4. Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

Three Dimensions

- Science and Engineering Practices
  - Developing and Using Models
- Disciplinary Core Ideas
  - Structure and Properties of Matter
  - Definitions of Energy
- Crosscutting Concepts
  - Cause and Effect

Review of Model-based Instruction

- Begin with an NGSS that involves models or modeling.
- Present a puzzling phenomenon to the students that relates to the core idea.
- Challenge students to explain it in small groups (small group discourse/experimentation).
- Groups share explanations (large group discourse).
- Identify and make public any competing theories. It is good to have disagreement. Gives the class something to argue about.
- Subsequent, integrated instruction helps students gain further knowledge (facts, concepts).
- Explicitly help students tie models and explanations to big ideas and facts/concepts.
- Use formative blended, assessment throughout the unit and end with blended performance assessments.

Reflective Questions

- How did that activity make you feel?
- How did the activity help to make student thinking visible?
- How did the activity encourage student-to-student discourse?

Supports for All Students

- What kind of supports did you need for you to be successful?
- Where might students with disabilities struggle with inquiry-based learning like this?
- How can we be deliberate about where to place supports for our students in the process and in the NGSS Planning Tool?

NGSS & Modeling

- See K-8 Modeling NGSS document in your resources folder.
- Read a modeling standard at or close to your grade level.
- What does it ask a student to be able to do in reference to modeling?
- What happens to modeling as we move from K to 8?

MBI: Integrated Instructional Units

- https://ambitiousscienceteaching.org/
- Engage students in cycles of modeling, reading, activity, experimentation, simulations, and the revision of models.
- Go to Readings Folder – Open Models and Modeling: An Introduction pdf in the Readings folder on your jump drive.
- Elementary Teachers – Go to sound unit on p. 6.
- Secondary Teachers - Go to page 9. Hare-Lynx Phenomenon – Predator-prey population cycles.
- Look at the progression of activities.
- Arrange instruction to provide scaffolds to help students meet the performance expectation.

Anchoring Events & Essential Questions

- These used together guide instruction, make instruction relevant to student lives, increase student engagement, anmd motivate student learning.
- Here are two links:
  - https://www.teachingchannel.org/videos/8th-grade-science-motion
  - https://www.teachingchannel.org/videos/structure-learning-essential-questions

Essential Questions

- Physics Unit - Why should I wear a helmet when I ride my bike or skateboard?
- Astronomy Unit: Are we alone in the universe?
- Genetics Unit - What is a mutant?
- Life Science: Where does the mass of a tree come from?
- Earth Science: What is my house/bike/phone/computer/skateboard made of and where does all that stuff come from?

Anchoring Event Examples

- Triad Website: mysoe.net/triad
- Anchoring Event Examples from Triad:
- What is this object (a tuning fork) and what does it do? (Bailey, Sigler, and Lofgren)
- Dead Zones (Koontz, Dalby, & Siemrod) – 5E Model with modeling and argumentation
- Phases of the Moon: How do they happen? (Wright, Mathews, & Schademan). MBI
- The earth's climate has changed in cycles over the past 400,000 years. What factors contribute to climate change? (Templeton, Tippets, & Schademan). – Modeling and Argumentation.

Questions, Comments, Ideas?

References

- Bybee, R. (2013). Translating the NGSS into Practice. NSTA Press, Arlington, VA.
- Lehrer, R., & Schauble, L. (2000). Developing model-based reasoning in mathematics and science. *Journal of Applied Developmental Psychology, 21(1), 39-48.*
- Sampson, V., & Schleigh, S. (2013). *Scientific argumentation in biology: Thirty classroom activities.* Arlington, VA: NSTA Press.
- Tools for Ambitious Science Teaching. University of Washington. http://toolsateachingscience.org/
- Wiggins, G., & McTighe, J. (2005). *Understanding by design (2nd ed.). Alexandria, VA: ASCD.*

Materials

- Ice Bath – water, ice, small bin.
- Aluminum Cans
- Beaker tongs
- Camp Stove
- Lighter
- Markers, Poster paper

Workshop 3: Translating the NGSS into Instruction: Argumentation

Purpose: The Purpose of workshop #3 is for the educators to become familiar with #7 of the eight engineering practices from the three dimensions of the NGSS. The engineering practice is "Engaging in argument from evidence."

Frequency: Once **Duration:** 1.5 Hours

Participants: Candidate, Cooperating Teacher

To Prepare: *=Helpful/Useable attachments provided below

1. *Prepare a slideshow with information
2. Obtain poster board paper and pens for all tables
3. Set up the space you have been provided with enough chairs and tables for the participants
4. Set up a table with a sign in sheet
5. Set up a table with food for the participants
6. Set up a projector and screen w/computer

Materials Needed:

- Tables & chairs
- Sign in sheet
- Poster board paper
- Poster markers
- Snacks/drinks (optional)
- Computer
- Projector and screen
- Prepared slideshow

Procedure:

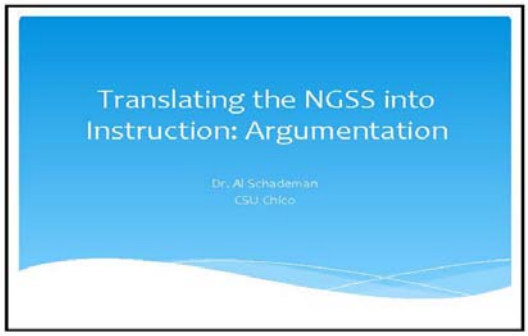
1. 8 Science and engineering pedagogical practices (Slide 3)
2. Today's focus (Slide 4)
3. Arguments (Slides 5-8)
4. Argumentation resources (Slides 9-15)
5. The argumentation process (Slides 16-19)
6. Example unit using argumentation (Slides 20-25)
7. Resources for arguments (26-27)
8. Facilitation of argumentation resource (Slide 28)

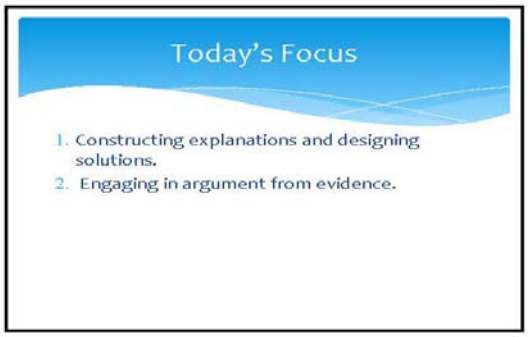
Helpful/Useable Attachment Samples:(Below this list are the visual examples in the order presented~4a-4b)

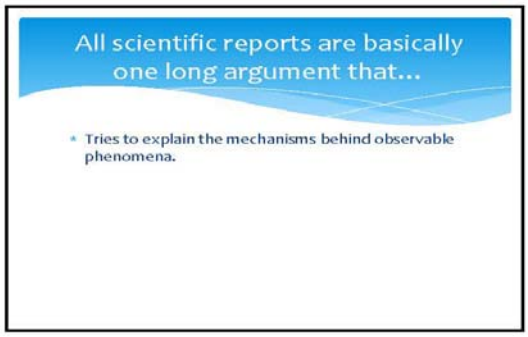
4a. Workshop 3 slide presentation:
https://docs.google.com/presentation/d/1wJZnJAokxRHn-6C65EwBLnWUvUbrPp0ef8SaVpQxh0k/edit?usp=sharing
4b. Workshop 3 argumentation activity handouts (Link Only):
https://documentcloud.adobe.com/link/track?uri=urn%3Aaaid%3Ascds%3AUS%3A0bdc7f8f-a821-460a-89a6-46dd59ffdac5

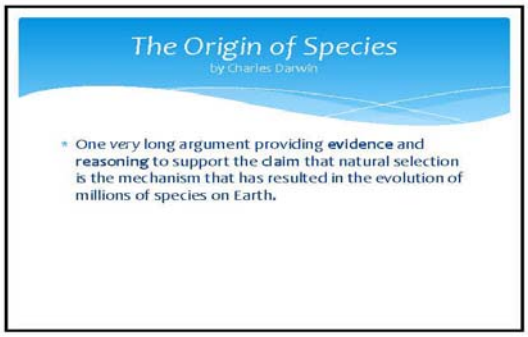
Sampson, V., & Schleigh, S. (2013). *Scientific argumentation in biology: Thirty classroom activities*. Arlington, VA: NSTA Press.

4a. Workshop 3 slide presentation:







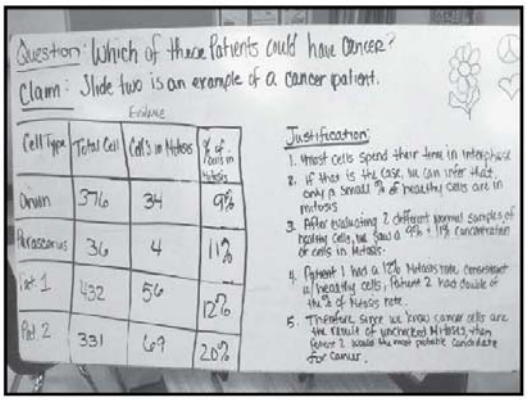


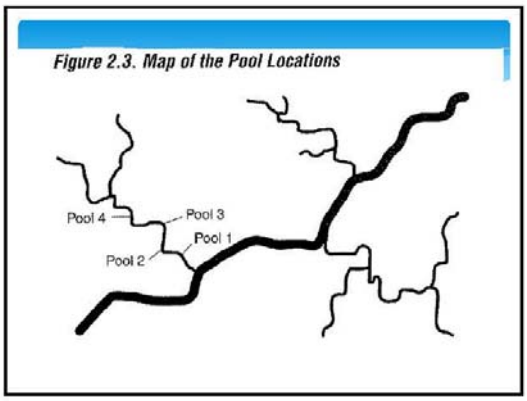
What is an argument?

- **Question:** about a phenomenon:
- **Claim:** statement that attempts to address the question.
- **Evidence:** Data that supports the claim. Can be many forms, both quantitative (numbers) and qualitative (descriptive).
- **Reasoning:** The thought process that ties your evidence to your reasoning.
- See handout.

Classroom Video

- https://www.teachingchannel.org/videos/support-claims-with-evidence-getty





Argumentation Activity

- Color Variation in Venezuelan Guppies - Sampson & Schleigh (2013).
- Study handout of foundational concepts.
- Research Question: **What caused the variation in color in guppy populations?**
- Focus on the data chart.
- Create an evidence-based argument to support your claim.
- Your argument should include: your claim, your evidence, and your reasoning that justifies why the evidence you chose supports your claim. See handouts for guidance.
- Include foundational concepts in your argument: natural selection, adaptation, sexual selection, etc.

Organize Your Argument Like This

The Research Question:	
Your Claim:	
Your Evidence:	Your Justification of the Evidence:

Sentence Starters for Arguments

Detail		Sentence
For example	This shows	As a result
For instance	It seems	Overall
In addition	This suggests	In conclusion
Also	This proves	In summary
Similarly	This demonstrates	Finally
According to	This reveals	Accordingly
Based on	This explains	Thus
The data suggests	This means	Therefore
	This represents	In short

Small Group Share Out: Is their argument convincing?

- How did you analyze your data?
- Why did you do it that way?
- Why does your evidence support your claim?
- Why did you use that evidence?

NGSS

- HS-LS4 Biological Evolution: Unity and Diversity - Students who demonstrate understanding can:
- **HS-LS4-4. Construct an explanation based on evidence for how natural selection leads to adaptation of populations.**

Three Dimensions

- i. Science and Engineering Practices
  - Constructing Explanations and Designing Solutions
- ii. Disciplinary Core Ideas
  - Adaptation
  - Heredity: Inheritance and variation of traits.
- iii. Crosscutting Concepts
  - Cause and Effect

Color Variation in Venezuelan Guppies : Activity Sequence

- Small group work. Create tentative argument.
- Argumentation session – share arguments.
- Reflect on your argument. Revise.
- Final argument.

Generate an Argument Instructional Model (Sampson & Schleigh, 2013, p. xxvii)

- "The teacher identifies the task and question.
  - Students work in small groups to make sense of data or phenomenon and then…
- Generate a tentative argument
  - Share and critique arguments during an…
- Argumentation Session
  - Teacher helps student reflect on their arguments and the nature of science during…
- The Reflective Discussion
  - Students use what they learned to write a…
- Final Written Argument.

Example Unit: Grade 2

- 2-PS1-4. Construct an argument with evidence that some changes caused by heating or cooling can be reversed and some cannot.
- http://mysoe.net/product/grade-2-are-chemical-reactions-reversible-or-irreversible-2-ps1-4/

The Unit in a Nutshell: Day One

Sid the Science Kid- My Ice Pops video. Reveal actual ice pops, one frozen, one melted. Students make a claim about chemical reactions.

QUESTION:
When heating and cooling are all changes reversible?
CLAIM:

_____
_____
_____

Reversible or Irreversible?

The Unit in a Nutshell: Day Two

Stations: Three reversible and three irreversible chemical reactions.

Students create a lab notebook recording their observations and conclusions from each station.

1. **Cooking an Egg**
2. **Heating Paper**
3. **Popcorn**
4. **Melting Butter**
5. **Water Cycle**
6. **Freezing a Leaf**

See Lesson Support Materials of unit for student handouts.

Heating Paper

What did the paper look like **before** heat was added?	What happened to the paper **during** the time heat was added?	What did the paper look like **after** heat was added?
		

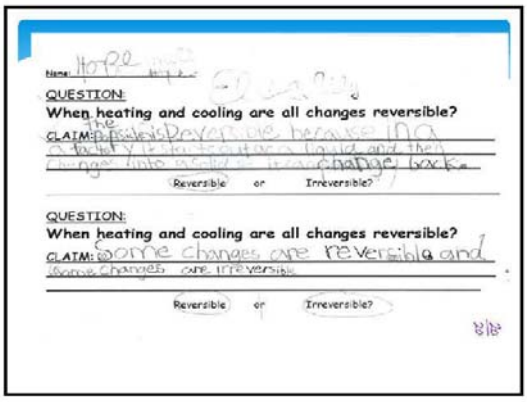
Is this change reversible? Why or why not?

It is irreversible because you can't stick the paper back together.

Melting Butter

Butter **before** heat:	Butter **after** heat:
	

1. What do you predict will happen to the butter when heat is added?
   I think the butter will melt when heat is added.
2. What do you predict will happen after heat is added and the butter cools?
   I think the butter will still be a liquid.
3. What happened? Is this change reversible?
   It melted. It can go back into a solid that means it's reversible.



Constructing Arguments

How do we help students construct explanations?

Sentence Frames

Making a Claim	I claim that _____. I now know that _____.
Providing Evidence	I claim this because _____. I know this because _____. The evidence I can use to support this claim is _____.
Reasoning	I know _____ (claim) because _____ (justification). My evidence supports my claim because _____.

Adapted from Ross, D., Fisher, D., & Frey, N. (2009 November). The art of argumentation. *Science and Children*, 47(3), pages 26–31

Sentence Starters for Arguments

Detail		Sentence
For example	This shows	As a result
For instance	It seems	Overall
In addition	This suggests	In conclusion
Also	This proves	In summary
Similarly	This demonstrates	Finally
According to	This reveals	Accordingly
Based on	This explains	Thus
The data suggests	This means	Therefore
	This represents	In short

From Martens (1999)

Productive Questions

Attention-focusing questions help students fix their attention on significant details.
Have you seen ... ? What have you noticed about ... ? What are they doing? How does it feel/smell/look?

Measuring and counting questions help students become more precise about their observations.
How many ... ? How often ... ? How long ... ? How much ... ?

Comparison questions help students analyze and classify.
How are these the same or different? How do they go together?

Action questions encourage students to explore the properties of unfamiliar materials, living or nonliving, and of small events taking place or to make predictions about phenomena.
What happens if... ? What would happen if... ? What if ... ?

Problem-posing questions help students plan and implement solutions to problems.
Can you find a way to ... ? Can you figure out how to ... ?

Reasoning questions help students think about experiences and construct ideas that make sense to them.
Why do you think ... ? What is your reason for ... ? Can you invent a rule for ...?

Sharing Session: In what ways have/would you used argumentation in your science classes?

- Get into groups around your subject area.
- See argumentation NGSS handout.
- Look at your grade level standard (except for grade one).
- Choose one PE to focus on.
- How might you teach to this standard? What experiences might you provide as evidence for students? How would you support their reasoning? How would you support their literacy skills?

Final Questions or Comments?

- Please fill out the Evaluation Form
- Thanks for your participation in this workshop series.
- Let me know if you have any questions:
- aschademan@csuchico.edu

References

- Bybee, R. (2013). Translating the NGSS into Practice. NSTA Press, Arlington, VA.
- Martens, M. L. (1999). Productive questions: Tools for supporting constructivist learning. Science and Children, NSTA Press, Arlington, VA.
- Sampson, V., & Schleigh, S. (2013). *Scientific argumentation in biology: Thirty classroom activities*. Arlington, VA: NSTA Press.

Grant Team Meetings

Purpose: Grant team meetings involve the Triad Project partners. These meetings are necessary for discussing business associated with the big picture of the Triad Project.

Frequency: 3 per semester **Duration:** 1.5 Hours

Required Participants: All the Triad Project Partners (district and university leadership)

To Prepare: *=Helpful/Useable attachments provided below

1. Secure a meeting place
2. Send Email reminder about meeting date, time and location
3. *Create an agenda for the meeting
4. Print out the agenda
5. Set up the projector

Materials Needed:

- Computer
- Printed Agendas
- Slide Presentation

Procedure:

1. Follow meeting's agenda

Helpful/Useable Attachment Samples:(Below this list are the visual examples in the order presented~5a)

5a. Grant Team Meeting Sample Agenda:
https://docs.google.com/document/d/1Ac6jyYR43XVcvXRNPUvxzXlGWKIncrYgiuDMDKTtqeA/edit?usp=sharing

5a. Grant Team Meeting Sample Agenda:

Grant Team Meeting
Wednesday, October 24, 2018 • 8:30-10am
CUSD Small Conference Room

AGENDA

- **Past Events**
  - NGSS Workshop Series at Marsh Jr. High MPR
  - Fall 2018 NGEI Convening: October 9-11 in Long Beach, CA
    - Email reimbursement form/receipts to NGEI by October 29th
  - NSTA Conference: October 11-13
  - Triad Candidate Check-in/Luncheon: October 19th, 12-1pm in Modoc 116
  - SRI Data Interviews

- **Upcoming Dates & Deadlines**
  - Assistant Vice Chancellor visiting Little Chico Creek at 3:30pm today!
  - STEAM Conference: October 27-29
  - Palermo PD Workshops: October 30th and November 6th at 3:15 – 4:45pm
  - CT Workshop @ CSU, Chico: November 15, 4:30-6:30, Colusa Hall
    - Agenda Items: Cal TPA, CORE rubric training for new and experienced users
  - Triad Team Meeting Schedule for Fall 2018 (Wednesdays, 8:30 – 10am, CUSD Small Conference Rm): November 14th, December 12th
  - Triad Candidate Formatting Mtg/Luncheon: December 7th, 12-1pm in Modoc 116
  - Fall 2018 Triad Symposium: December 10th, 5-7:30pm (Tehama 111, 116 reserved)

- **<u>Current Fall 2018 Triad Updates</u>**
    - Unit Materials Ordering Update, Orders were due September 28th
    - Status of Current Triads

- **<u>Recruitment for Spring Triads</u>**
    - Cooperating Teacher Recruitment: Response email
    - Teacher Candidate Recruitment (Aiming for 20)
        - 35 Multiple Subject Candidates applied, interviews completed
        - Single Subject Candidates?
    - Content Specialists: Recruiting high school and middle school teachers

- **<u>Scaling Up</u>**
    - CUSD Triad Unit Implementation
        - How is this going?
        - Survey of implementation throughout CUSD
          CORE Rubric Use
        - CTs using it for two observations
        - CUSD peer observations: Any data on this?
          Triad Units in science methods courses
          Focus on academic ownership: Making thinking visible

- **<u>Other Items/Updates?</u>**
    - Public Relations: How can we tell others about Triad through PR from both CUSD and CSU Chico?

**** Next Meeting: Wednesday, November 14th ****

Triad Unit Planning Meetings

Purpose: The purpose of the Triad Team Meetings is to carve out time for the Triad to complete and refine their units. Each meeting's agenda is planned and prepared by the participants themselves. In the attachments below is a timeline the participants will use to help stay on time with the completion of their unit.

Required Participants: Candidate, Cooperating Teacher, Content Specialist

Non-Required Participants: University Supervisor

Frequency: Agreed upon by "Triad" **Duration:** 1.5 Hours

To Prepare: *=Helpful/Useable attachments provided below

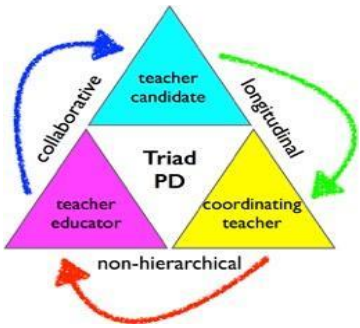
1. Agree on a location to meet
2. Agree on a time to meet
3. Arrive on time and be prepared with all necessary unit materials
4. *Read over The Triad Norms prior to the start of every meeting
5. Collaborate to reach the meetings goals

Materials Needed: Any necessary unit materials the Triad decides they need

Helpful/Useable Attachment Samples: (Below this list are the visual examples in the order presented~6a-6d)

6a. NGSS Standards:(link only)
bit.ly/NGSSWorkshop
6b. Planning tool:
https://docs.google.com/document/d/1vmx961HJJEkggRRGt_OVIQAfG20RPYvh63XHHqcm-q0/edit?usp=sharing
6c. Triad norms and agreements in The Triad guide:
https://docs.google.com/document/d/1xhgEfEOfqq_hkC2cRzlUe4XiyHYPV0ljLBgoXC2ytOg/edit?usp=sharing
6d. Timeline:
https://docs.google.com/document/d/1th0Bshzfh9N22_1qn3qICiJS7h2nJ_gEYQYGu3651aw/edit?usp=sharing

6b. Planning tool:



Triad NGSS Unit Plan Tool

This planning tool is designed to help your Triad create an engaging, effective and enjoyable NGSS Unit that will meet the needs of all of your students. It is based upon Wiggins and McTighe's (1998) backwards design. Hyperlinks are embedded into the text to link you to resources that will define terms and provide explanations of innovative methods in order to support your work. It will also serve as a template for your final unit that will be downloadable for science teachers through our website.

Triad Team Names:
Teacher Candidate:
Science Cooperating Teacher:
Science Educator:
School and District:
Grade Level:
Science Content Area:

A. Grade Level and Standard *(Cut and paste from the standards into the spaces provided below)*

1. California NGSS (To learn more about the NGSS, go to http://ngss.nsta.org/Default.aspx). Go here to access the NGSS Evidence Statements:

   a. Three NGSS Dimensions Contained in the Standard:
      i. Science and Engineering Practice:
      ii. Disciplinary Core Idea:
      iii. Crosscutting Concept:
2. Common Core State Standard Connections:

   a. ELA/Literacy:
   b. Mathematics (if applicable):

3. ELD Standard (Search the ELD Standards using the ELA Standard(s) identified above.)

B. Content Research - Outline of Major Concept and Sub-Concepts in Unit

To begin your research, go to the Bozeman Science NGSS page and watch a short video on each of the three dimensions in your standard. After better understanding the three dimensions, then research your content textbooks and the Internet. ***Do not underestimate this step.*** *Science is complex, and if you do not have a good grasp of the complexities involved in your unit, your assessment and instruction will tend to focus on low-level knowledge rather than higher level reasoning and deep conceptual understandings.*

Using the research that you conducted above, identify the sub-concepts, practices, or ideas that students will need to understand in order to meet the standard and perform successfully on the summative assessment. You could present this either as an outline or as a concept map.

C. Summative Assessment

For your unit, you will need to create an assessment or assessments so that students can demonstrate their performance of all three dimensions of the NGSS that you chose for your unit. After conducting the research above, re-read the standard along with the assessment boundary and determine what assessment(s) would be developmentally appropriate for measuring the extent to which each student at your grade level has met the performance expectation. Blended performance assessments are encouraged. Blended performance assessments contain assessment items that assess student levels of performance on each dimension of an NGSS.

Describe your assessment(s) below. This can be general at this time, something to give you guidance for your lesson sequence.

D. The Unit Plan

Now that you have determined your standard and your summative assessment idea, use the table below to plan an integrated instructional sequence that will give all students access to the content, practices, core ideas, and the cross-cutting concept in preparation for the final assessment. ***Your unit should address ALL standards listed above, including CCSS for ELA and ELD. This assures that your unit contains a literacy piece and supports for ELs. Including the use of technology in at least one lesson is highly recommended. See the PhET Site for some great computer-based simulations.***

The overall approach for this unit could be model-based instruction, argumentation, the 5E Model of Inquiry, or a combination of these approaches. However, with integrated instructional units, you are encouraged to use a variety of instructional strategies to provide diverse learners access to science content, practices, and ideas, including Explicit Direct Instruction. We strongly encourage you to incorporate Universal Design for Learning Principles and Differentiated Instruction into your planning is order to meet the needs of all students, especially those who typically struggle with science content.

Here are two resources to get you started. Although we encourage you to be creative, you do not have to recreate the wheel. Check out the links below for vetted lessons that you could adapt for your own use. First, visit the Triad Project's Website for sample units from previous semesters. You can also visit the Classroom Resources from the NSTA and BetterLesson which include a number of lesson plans arranged by grade level, subject, and each NGSS.

Unit Plan Table*

Lesson	**Standard** (by number) **and Objective(s) for the Lesson**	**Primary Instructional Strategy****	**Summary of Instructional Sequence of Lesson**	**Strategies for Students Who Typically Struggle with Science** (English Learners, Exceptional Students)	**Assessment Summary** (Briefly describe and label as Diagnostic, Formative, or Summative)
1			*For this section, write a 3-4 sentence description of the lesson, followed by a numbered list of the lesson sequence:* *1. Anticipatory Set – Anchoring Event for the first lesson, but each lesson should have one* *2. First…* *3. Second…* *4. Third…* 5. *Closure*		
2					
3					
4					
5					

*Add rows to the table as needed.

**Strategies might include: guided discovery, model-based instruction, argumentation, 5E Model of Inquiry, direct instruction, computer-based or hands-on simulations, interactive video viewing, etc. At least one lesson should involve students collecting, analyzing, and/or interpreting data. You can use existing data sets.

E. Lesson Plans, Support Materials
In this section, include any support materials that you used for each lesson. Including your assessments is also recommended, since they play a central role in your curriculum design.

F. Summative Assessment
In this section, include your summative assessment for your unit. Include any rubrics that accompany your assessment.

Working with English Learners in Science

Three high leverage practices for working with ELs, or Emergent bilinguals, are as follows:

1. Hands-on Activities
2. Cooperative Learning with Strategic Grouping
3. Guarded Vocabulary

Here is a website with more detailed information about working with ELs.
http://www.rohac.com/sdaieinfo.htm

Also, see the list below of other SDAIE Techniques that you can incorporate into your unit as well:

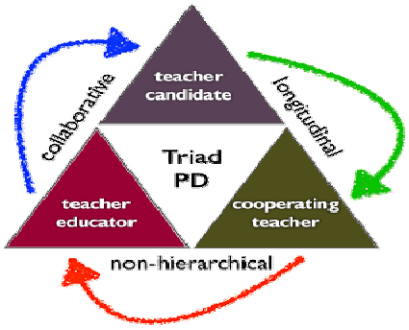
	SDAIE Techniques & Practices
	Input Simplification
1	clear enunciation, slower speech rate; longer pauses; increased redundancy
2	controlled vocabulary; limited use of idiomatic speech; simple verb tenses
3	shorter, less complex sentences and explanations
4	define unusual words and words with double meaning
5	readability level of written materials is low
6	mini lectures
7	use of cognates if possible
	Contextualization and Meaning

1	contextualized teacher delivery: comprehensible input, phrasing, rephrasing
2	Scaffolding; for example, modeling, bridging, contextualizations, schema building, metacognitive development, text representations
3	learners encounter a new topic through a shared, alluring, realistic, direct experience, a common introduction which serves as a foundation for (1) new skills to be acquired, (2) concepts to be learned, or investigated, and/or (3) about which the learners are to read, listen, speak, or write.
4	gestures; facial expressions; act out meaning
5	frequent use of labels
6	props & realia
7	illustrations, pictures, motion pictures, maps, charts, flowcharts, overheads, and graphs
8	bulletin boards with labels whenever appropriate
9	word banks
10	identify key topics organized around main themes
11	extend mental set
12	comprehensible input: provision of information and/or experiences that learners recognize as valuable and meaningful
	Emphasis on Success and Comprehension
1	comprehension is stressed more than form or grammar, semantics more than syntax; utility of ideas, investigations, and skills is the major criterion for success
2	hands-on activities, manipulatives
3	listening and speaking activities precede reading and writing activities
4	reading assignments include pre-reading, during reading, post reading activities
5	writing activities preceded by pre-writing activities
6	cooperative activities
7	adequate time for pupils to complete their work

8	appropriate pacing and difficulty level
9	variety of grouping strategies
10	use of various modalities
11	vocabulary development
12	review of main topics and key vocabulary
	Check Frequently for Attention and Understanding
	Formative, Continuous and In-process Evaluation
1	confirmation and comprehension checks
2	clarification requests
3	repetitions
4	expansions
5	variety of assessment techniques
6	interaction: teacher with student, and/or student with student
	Summative
7	mastery of objective assessed in a variety of ways

6c. Triad norms and agreements in The Triad guide:

The Triad Guide



Introduction

The Triad Project is a collaborative partnership between the School of Education at CSU Chico and Chico Unified School District, supported by a grant from the S.D. Bechtel, Jr. Foundation. The Triad Project is named for its three-pronged structure. The "Triads" are made up of one ***cooperating teacher***, one ***science teacher candidate***, and a ***science educator or "content specialist***." Supervisors also play a key role by conducting observations and providing feedback to the candidate, and in some cases, may act as the content specialist as well, or even a fourth member of the Triad.

The Triads work collaboratively over a semester to design, implement, reflect upon, revise and submit a field-tested, integrated, NGSS unit that follows a template designed by science educators at CSU, Chico. Each unit includes a chart of lesson plans, along with support materials all geared toward engaging students deeply in all three dimensions of the NGSS: **science and engineering standards, core ideas, and cross-cutting concepts**. The units are aligned to the Common Core State Standards and include strategies for meeting the needs of all learners, including ELs and special needs students. Units are implemented using a co-teaching model.

The result is a freely downloadable and classroom-ready unit that contains formative and summative assessments, rubrics, and student work samples. In the process, all Triad participants receive valuable professional development that is *longitudinal, collaborative, non-hierarchical, teacher-driven*, and directly related to their teaching practice.

Triad Meetings

To accomplish the goal of publishing a NGSS unit, the Triads typically meet 4-5 times per semester, make progress towards goals during the meetings, and delegate responsibilities for each member of the triad to complete before the next meeting. Meetings should be scheduled in advance when all Triad members can fully participate and should be 1-2 hours in length so that substantial progress can be made at each meeting. All meetings should begin with a reminder of the norms and agreements defined by the Triad Project and by your triad.

The norms and agreements from the Triad Project are as follows.

1. All members bring backgrounds, resources, and ideas which are valued by all members of the triad.
2. All members are significant contributors to the unit from start to finish. All members are also learners. Regardless of years of experience, we can always learn from each other and new experiences.
3. All members share the workload. (In the past, teacher candidates have been burdened with a significant amount of the work in some triads. Prevent this from happening in your triad by knowing your responsibilities outlined below, delegating responsibilities between meetings, and then showing up at the next meeting with your tasks completed.)
4. All members are dedicated to creating an amazing unit that teaches science in ways that allow students to inquire about phenomena, share their ideas with each other, and allow students to take responsibility for their own learning.
5. Have fun and trust the process!

Sample Triad Meeting Agenda:

1. Reminder of Triad norms and agreements. All meetings begin with this important step.
2. Logistics – Share contact information to facilitate communication. Address any issues that have arisen so far. Come to resolution or reach out to a Triad person (Al or Mimi) for guidance.
3. Main task(s) for this meeting. These meetings should be working meetings. See Triad Timeline for this. For example, your first meeting might be choosing your standard, completing Section A of the Planning Tool, and moving onto section B, content research. A good place to start here is watching the Bozeman Science Videos together on each of the 3 dimensions of your standard, and taking notes in section B, so that you are all on the same page about the direction you are going with your unit.
4. Delegate responsibilities to complete individually, or in pairs, before next meeting.
5. Schedule next meeting at a time when all can attend. Place meeting date, time and location on your calendars.

Triad Participant Responsibilities

The primary responsibilities of each member are described below.

Teacher Candidates are the first authors of the units and have the primary responsibility, with the support of the Triad, for completing the NGSS Planning Tool which will eventually be the final, published unit. The teacher candidates are supported in their science methods course (EDTE 532b). The planning, implementation, presentation of, and publication of the unit is their key assignment for the course.

Teacher candidates should be applying practices and approaches learned in their methods classes and PD workshops to their units. Because teacher candidates have many responsibilities outside of Triad, it is important for the Triad to support the teacher candidate with resources, by helping them to complete the planning tool, and by completing their delegated responsibilities in a timely fashion. It is also important to bound the unit around a doable timeframe, which is typically 5- to 10-days.

Cooperating Teachers know their students, school, and community. As a result, they have the primary responsibility for the following: 1) helping the Triad choose a NGSS that fits within the curriculum map for their grade level, 2) identifying available school resources (material, financial, and personnel), 3) providing instructional resources such as existing lesson plans that may work within the unit created, 4) helping the Triad create lesson plans at the developmental level of the students, 5) helping the Triad identify and meet the needs of diverse learners, including ELs and special needs students, and 6) purchasing resources needed for the unit and obtaining reimbursement from the school district leaders associated with the grant. Cooperating teachers also help to create the presentation for the symposium and co-present with their triad.

Content Specialists bring knowledge of science and/or engineering practices and concepts, pedagogies for teaching science, knowledge of the NGSS, and the ability to research and access resources vital to the success of the Triad. Some content specialists will act as consultants, while others may play a more central role, actually taking the lead on designing at least one of the lessons and helping with implementation in the classroom. Content specialists should plan on dedicating anywhere between 8 to 20 hours of work to the Triad.

University Supervisors from the SOE have the primary responsibility of conducting observations of the teacher candidate and providing feedback on teacher candidate progress in regards to meeting the Teacher Performance Expectations (TPEs), teacher dispositions, and goals of the grant. Supervisors should schedule 1 – 2 observations during the instruction of the Triad Unit. They often oversee the collaboration of the triad and support the candidates as they create the science units. Supervisors may assist with the development of the units and ensure that the new standards are being addressed in the creation of the unit plans. Triad supervisors may be required to be trained and calibrated in the use of the Chico CORE Rubric: a new observational tool developed for Common Core classrooms.

NGSS Resources

It is vital that the Triad follow the NGSS Triad Planning Tool to guide the construction of the unit. The planning tool follows backwards design: 1) establish goals which are defined by the NGSS/CCSS standards, 2) decide upon a summative assessment, and 3) plan a series of integrated lessons that will give all students access to the three dimensions of the NGSS and the related CCSS, and provide students with the knowledge

and practices needed to be successful on the summative performance assessment for the unit. Download the NGSS Planning Tool here.

Other Useful Resources: All of these are imbedded in the NGSS Planning Tool, but highlighting them here may help to emphasize their use.

NGSS@NSTA - Go here to help dissect the NGSS.

Bozeman Science NGSS - Go here to watch videos of the three dimensions of your standard.

NGSS@NSTA - Go here to find ideas for lesson plans.

Better Lesson is another place to find ideas for lesson plans.

The Triad Timeline

Making progress throughout the semester is important for creating quality work. Effective triads follow the timeline provided to at least some extent, especially for meeting deadlines, like ordering materials, etc.

Suggested Project Timeline (Fall 2018)

Date	Accomplishment	✓ when completed
8/20 Week 1	University Semester begins	
8/27 Week 2	Triad Kick-Off Meeting (3:30-5:30 PM) Beatnik's Coffee House (located at 1387 East 8th St, Chico)	
9/10 Week 4	**Workshop 1: NGSS: Reading and Interpreting the Standards (3:30 – 5:00 PM) Student Union (MP Room 1001) – Marsh Jr. High School	
By 9/14 Week 5	Triad Unit Planning Meeting #1 *(CT, Candidate, Content Specialist)* Choose NGSS Standard for Triad Unit: Complete Section A of NGSS Planning Tool	
9/17 Week 6	**Workshop 2: Translating NGSS into Practice: Modeling and 5E (3:30 – 5:00 PM) Student Union (MP Room 1001) – Marsh Jr. High School	
9/24 Week 7	**Workshop 3: Translating NGSS into Practice: Argumentation (3:30 – 5:00 PM) Student Union (MP Room 1001) – Marsh Jr. High School	
By 9/28 Week 7	Triad Unit Planning Meeting #2 *(CT, Candidate, Content Specialist)* Choose approach to teach standard: Modeling, 5E, Argumentation, Guided Discovery **Finalize materials order list and CT submit order to Chris Winkle in district office.**	
By 10/5 Week 8	Complete On-Line Co-Teaching Modules/Workshop (3-4 hours total)	

10/1–10/19 Weeks 8-10	1. Triads meet occasionally to plan and refine unit. 2. Complete Sections B - D of the NGSS Planning Tool. a. Section B - **Content Research**: Outline of major concepts & sub-concepts for the unit. b. Section C - **Summative Assessment**: At this point, just a brief description of your summative assessment. You need to know what you want students to produce at the end of the unit, so that you can design instruction accordingly. This is backwards design, and it works. The important part is that the final assessment evaluates student performance for all three dimensions of the NGSS chosen. c. Section D - **The Unit Plan**: For each lesson, you should have a brief description in each box.	
10/22–11/30 Weeks 11-15	Teach your Triad Unit (one week) during this time frame. (Thanksgiving Break: 11/19-11/23)	
12/6 Week 16	Triad Unit Presentations. Be prepared for roundtable-style presentation – Use handouts, PowerPoint, demonstration, realia, visuals.	
12/10-12/14 Week 17	1. Finalize Units and submit to AI for uploading to the website. 2. Complete Triad Survey. 3. Submit summative assessment data to AI for your Triad Unit. 4. Conduct exit interviews.	
12/14 Week 17	CUSD Cooperating Teachers: Submit hours to district after unit has been submitted.	

*****Required attendance if you have not previously attended the Science NGSS/Pedagogy Workshops.***

Addressing Issues in Triads or with the Triad Project

The main issue that arises in triads is when one member fails to communicate, attend meetings, or complete their responsibilities. These situations often occur because one member is either very busy and cannot handle the workload, or they feel compelled to do this work and are not engaging in the collaboration voluntarily. These situations place more work and stress on the other two members of the triad which in turn, sours the experience for these members. Historically in these situations, the teacher candidate has to take on a lion's share of the workload, which is neither fair nor acceptable, especially given that they are the only member of the triad not getting paid for their time. Here are ideas for how to address issues if they arise in your triad:

1. Begin all meetings with reminders of the norms and agreements.
2. It is important to establish early in the process that that all members of the triad are doing this work because they want to do it, not because they have to do it.
3. Address any issues in your triad meeting early in the semester, BEFORE they become a larger issue.

4. If for any reason any member of a triad feels that they cannot address the issue with their triad, reach out to Al Schademan or Mimi Miller, one of the Co-Directors of the project. We would be happy to help mediate any issue.

Co-Teaching

The Triad Project incorporates co-teaching as a clinical model. At CSU, Chico co-teaching is defined as two teachers (mentor teacher and credential candidate) working together with groups of students, sharing the planning, organization, delivery and assessment of instruction, as well as the physical space. The *Co-Teaching Online Workshop* at http://mysoe.net is designed to provide new credential candidate/CT pairs with an introduction to co-teaching strategies and activities for developing their partnership. The module is designed for the co-teaching pair to participate together. The suggested timeline below breaks the units down into approximately 1-hour sessions every other week for the first half of the semester. Co-teachers should schedule approximately an hour together for each session at one computer station somewhere where they can hear the audio and be able to talk with each other.

Suggested Timeline for Co-Teaching Online Workshop

Week	Online Unit	Implementation
Weeks 1-3	1. Co-Teaching Overview 2. Co-Teaching Partners: Interview	Try two co-teaching strategies
Weeks 4-5	3. Co-Teaching Partners: Values 4. Importance of Planning 5. Co-Teaching Triad Partnership	Try two different co-teaching strategies
Weeks 6-7	6. Co-Teaching Partners: Strengths 7. Co-Teaching Partners: Communication	Try two different co-teaching strategies
Week 8-9	Continue co-planning	Continue co-teaching
Weeks 10-11	Continue co-planning	Continue co-teaching
Weeks 12-13	Continue co-planning	Continue co-teaching
Weeks 14-15	Continue co-planning	Continue co-teaching

6d. Timeline:

Date	Accomplishment	✓ when completed
Mon 1/22 Week 1	Triad Kick-Off Meeting, 4-6 pm, Beatniks Coffee House, 1387 E. 8th St., Chico University semester begins	
Mon 2/5 Week 3	**Workshop 1: *NGSS: Reading and Interpreting the Standards* (3:30 – 5:00 PM) Student Union (MP Room 1001), Marsh Jr. High School	
By Fri 2/9 Week 3	Triad Unit Planning Meeting #1 *(CT, Candidate, Content Specialist)* Choose NGSS Standard for Triad Unit: Complete Section A of NGSS Planning Tool	
Mon 2/12 Week 4	**Workshop 2: *Translating NGSS into Practice: Modeling and 5E* (3:30 – 5:00 PM) Student Union (MP Room 1001), Marsh Jr. High School	
Mon 2/26 Week 6	**Workshop 3: *Translating NGSS into Practice: Argumentation* (3:30 – 5:00 PM) Student Union (MP Room 1001), Marsh Jr. High School	
By Fri 3/2 Week 6	Triad Unit Planning Meeting #2 *(CT, Candidate, Content Specialist)* Choose approach to teach standard: Modeling, 5E, Argumentation, Guided Discovery **Finalize materials order list and CT submit order to district office.**	
By Fri 3/9 Week 7	Complete On-Line Co-Teaching Modules/Workshop (3-4 hours total)	
3/5–3/30 Weeks 7-10 *(Spring Break 3/19-3/23)*	1. Triads meet occasionally to plan and refine unit. 2. Complete Sections B - D of the NGSS Planning Tool. a. Section B - **Content Research**: Outline of major concepts & sub-concepts for the unit. b. Section C - **Summative Assessment**: At this point, just a brief description of your summative assessment. You need to know what you want students to produce at the end of the unit, so that you can design instruction accordingly. This is backwards design, and it works. The important part is that the final assessment evaluates student performance for all three dimensions of the NGSS chosen. c. Section D - **The Unit Plan**: For each lesson, you should have a brief description in each box.	
4/3 - 5/4 Weeks 11-15	Teach your Triad Unit (one week) during this time frame.	
5/7-5/11 Week 16	Unit formatting meeting for candidates, time TBA	

Mon 5/14 Week 17	Triad Unit Presentations. Be prepared for roundtable-style presentation – Use handouts, PowerPoint, demonstration, realia, visuals.	
5/14-5/18 Week 17	1. Finalize Units and submit to Mimi for uploading to the website. 2. Complete Triad Survey. 3. Submit summative assessment data to Mimi for your Triad Unit. 4. Conduct exit interviews.	
5/18 Week 17	CUSD Cooperating Teachers: Submit hours to district after unit has been submitted.	

Symposium

Purpose: The purpose of the symposium is for the Triads to share their units in a seminar form for all Triads to observe and ask questions.

Required Participants: Candidate, Cooperating Teacher, Content Specialist, Staff, Photographer.

Non-Required Participants: University Supervisor, District and School of Education Administration, District School Board

Frequency: Once at the end of the semester **Duration:** 1.5 Hours

To Prepare: *=Helpful/Useable attachments provided below

1. *Create a slide presentation
2. Secure a location, and time for symposium
3. *Create symposium invitation
4. Invite all participants and those interested in participating
5. Create a food menu and order food
6. *Create agenda
7. Set up tables for units to be displayed
8. Display units
9. Set up a projector
10. Set up a microphone
11. Set up food table

Materials Needed:

- Slide Presentation
- Invitation
- Food
- Tables
- Agenda
- Chairs
- Microphone
- Projector
- Computer
- Units
- Table for Food

Procedure:

1. Welcome/Announcements/Introductions (Slides 1-3)
2. Information about The Triad Project (Slides 4-6)
3. Goals and Agenda (Slides 7-8)
4. Begin Round Table Discussions (Slides 9-11)

Helpful/Useable Attachment Samples: (Below this list are the visual examples in the order presented~7a-7c)

7a. Symposium invitation:
https://docs.google.com/document/d/1tUIsZSOHWNhQeq0GxOOxVXwCHiW5fzt69zkP6Dj3GQg/edit?usp=sharing
7b. Symposium sample agenda: https://docs.google.com/document/d/14L-EknJKoWx2fqA3mXGW_79x3jWSfnRZF6n5y_2-vs8/edit?usp=sharing
7c. Symposium slideshow:
https://docs.google.com/presentation/d/1nr8Sf6dAAolkTxq5Ms85C8Lds8JbM7yBWGe9QAMCi7o/edit?usp=sharing

7a. Symposium invitation:

Symposium Invitation

Dear Colleagues and Science Educators,

We hope that this email finds you all well. As we wrap up another semester, we have another successful cohort of Triad Project Participants and their shiny, new NGSS units to showcase at the Spring 2018 Triad Symposium!

You're Invited! Spring 2018 Triad Symposium

Date: Monday, May 14, 2018
Time: 5:00 – 7:30 PM
Location: Tehama 116 (on the CSUC campus – map attached)

We will be serving refreshments and light appetizers, so **RSVP Here** if you plan to attend.

The heart of the Triad Project is to make the Next Generation Science Standards (NGSS) accessible to all. This means cultivating a collaborative, inquiry-based process for ALL teachers and ALL of their students. For this reason, the highlight of the Symposium is a sharing session where current participants of the Triad Project have the opportunity to present their NGSS-aligned unit (including key activities, student work samples, photo/video, etc.), along with any elements that make their unit a hands-on and interactive experience.

Please let us know if you have any questions, and we hope to see you at the Symposium this upcoming Monday, May 14th!

Sent on behalf of:

Al Schademan, PhD
Science Educator
CSU Chico School of Education
Tehama 403
530-898-4534
Office Hours: Thursday 1::00 – 5:00 PM
Triad Project Website: mysoe.net/triad

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Rachael Beyers
Office of Outreach, Research & Grants
Project Assistant/Recruiter
rlbeyers@csuchico.edu
(530)898-5025

7b. Symposium sample agenda:

Triad Next Generation

Spring 2018 Triad Symposium

Agenda

Set-up & Appetizers – 20 minutes (5:00-5:20PM)
Please find your seating with your Triad in Tehama 116, and get your materials prepped before heading to Tehama 111 for a beverage/appetizer.

Welcome & Overview – 10 minutes (5:20-5:30PM)

Roundtable Presentations – 70 minutes (5:30-6:40PM)
Triads at four different roundtables present to one another for 12-15 minutes each. *Focus is on the unit (the table from your unit plan), key activities/lessons during the unit, student work samples, photos and video clip sharing (if applicable), assessment results, etc.*
*Each roundtable may take a 5-10 minute break midway through presentations.

Announcements – 10 minutes (6:40-6:50PM)

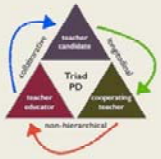
- Triad Meeting Recordings
- Future Research Interviews

Reflection and Discussion – 10 minutes (6:50-7:00PM)

Completion of Digital Survey – 10 minutes (7:00-7:10PM)
Use your own device or ask if you need to borrow a device for a brief digital survey:
https://www.surveymonkey.com/r/TriadSpring2018

Connections and Closing – 20 minutes (7:10-7:30PM)
An opportunity to network with CUSD Leadership who support and value the work of the Triad Grant.

7c. Symposium slideshow:



The Triad Project

A Partnership Between the SOE and CUSD

Welcome!

Announcements
- Food – Tehama 111 – to the left, on the right.
- Restrooms –
  - Men's to the left
  - Women's – to the right.
- Set Up:
  - Group One: Begins with "Three Little Pigs"
  - Group Two: Begins with "Five Little Pumpkins"
  - Access your electronic files now at your stations.

Introductions

- Triads members
- District & SOE Admin
- School Board
- Photographer
- Staff

The Triad Project

- http://mysoe.net/triad/
- https://www.facebook.com/triadpd/
  - Please visit and like our page!

The Triad Project

- Part of the Next Generation of Educator's Initiative (NGEI)
- A unique collaboration between the CSU and the Bechtel Foundation

The Triad Project

- Pilot Project: 2015-16
  - 13 Triads; 11 published units
- Fall 2016 - 6 Triads
- Spring 2017 – 10 Triads.
- Fall 2017 – 10 Triads
- Total Triads: 39
- 26 Published Units.

Goals for Tonight

- Share the wonderful units that we have all created.
- Share our experiences with the Triad Project.
- Provide feedback for the project for continuous improvement.
- Thank you all for your amazing work! We are creating the Next Generation of Amazing Science Teachers!

Agenda

Spring 2018 Triad Symposium

Agenda

Set-up & Appetizers - 20 minutes (5:00-5:20PM)
Please find your seating with your Triad in Tehama 116, and get your materials prepped before heading to Tehama 111 for a beverage/appetizer.
Welcome & Overview - 10 minutes (5:20-5:30PM)
Roundtable Presentations - 70 minutes (5:30-6:40PM)
Triads at four different roundtables present to one another for 12-15 minutes each. *Focus is on the unit (the table from your unit plan), key activities/lessons during the unit, student work samples, photos and video clip sharing (if applicable), assessment results, etc.*
*Each roundtable may take a 5-10 minute break midway through presentations.
Announcements - 10 minutes (6:40-6:50PM)

- Triad Meeting Recordings
- Future Research Interviews

Reflection and Discussion - 10 minutes (6:50-7:00PM)
Completion of Digital Survey - 10 minutes (7:00-7:10PM)
Use your own device or ask if you need to borrow a device for a brief digital survey:
https://www.surveymonkey.com/r/TriadSpring2018
Connections and Closing - 20 minutes (7:10-7:30PM)
An opportunity to network with CUSD Leadership who support and value the work of the Triad Grant.

Round Table Discussions

To Guiding Your Observations:

What is one significant thing you just learned about how to effectively teach an integrated, NGSS/CCSS unit to meet the needs of all students?

Open Floor Discussion 1

Guiding Question for Discussion:

What is one significant thing you just learned about how to effectively teach an integrated, NGSS/CCSS unit to meet the needs of all students?

Announcements

- CUSD Announcement for payment for CTs.
- Interviews – 30 minutes - Content Specialists conduct interview. Voluntary but highly recommended.
- Triad Meeting Recordings – Content Specialists. Send recordings to AI.

Triad Survey

https://www.surveymonkey.com/r/TriadFall2017

Happy Holidays!