

Theory to Process to Practice: A Collaborative, Reflective, Practical Strategy Supporting Inservice Teacher Growth

by [Martha Inouye](#), University of Wyoming; & Ana Houseal, University of Wyoming

Abstract

To successfully implement the Next Generation Science Standards (NGSS), more than 3.4 million in-service educators in the United States will have to understand the instructional shifts needed to adopt these new standards. Here, based on our recent experiences with teachers, we introduce a professional learning (PL) strategy that employs collaborative video analysis to help teachers adjust their instruction to promote the vision and learning objectives of the Standards. Building on effective professional development characteristics, we created and piloted it with teachers who were working on making student thinking visible. In our setting, it has been effective in providing relevant, sustainable changes to in-service teachers' classroom instruction.

Introduction

Science and engineering influence and are, in turn, influenced by much of modern life, and as such, it is important that students possess sufficient knowledge in these fields to be successful in their daily lives and in the workforce. Yet, many people lack basic knowledge in these fields upon graduating from K-12 schools (NRC, 2012). The National Research Council (NRC) and the National Academies Press (NAP) each developed documents to improve K-12 science education, *A Framework for K-12 Science Education* (NRC, 2012) and the *Next Generation Science Standards* (NGSS Lead States, 2013), respectively. The vision set forth by the *Framework* is “to help realize a vision for education in the sciences and engineering in which students, over multiple years of school, actively engage in scientific and engineering practices and apply crosscutting concepts to deepen their understanding of the core ideas in these fields” (NRC, 2012, p.10). This vision “takes into account two major goals for K-12 science education: (1) educating all students in science and engineering and (2) providing the foundational knowledge for those who will become the scientists, engineers, technologists, and technicians of the future.” (NRC, 2012, p.10).

The Next Generation Science Standards (NGSS) are based on this vision, representing the most recent effort to improve science education and a “significant departure from past approaches to science education” (Bybee, 2014, p. 213). The NGSS necessitate that teachers integrate a three-dimensional approach to learning, such that students use science and engineering practices to gain a deeper understanding of core science ideas as they apply overarching big ideas to and between content.

Some instructional implications of this shift can be found in the first two columns of Table 1 (NRC, 2015), which juxtaposes current classroom practices with the shifts needed to support the standards. As indicated, content knowledge acquisition should involve less direct transfer of information from teachers to students. Rather, this learning should involve more connected and contextualized experiences facilitated by teachers. These changes will require many in-service teachers to modify how they teach science (refer to column three in Table 1) and challenge some of the ways in which students have come to learn. Teachers will need to shift their instruction from “front-loading” disciplinary vocabulary and explaining concepts to providing information and experiences that students can use to make sense of natural phenomena and solve problems of human importance. The role of the teacher within the classroom becomes one that focuses more on asking questions and prompting students to make evidence-supported claims than for the teachers to do the heavy lifting *for* students by explaining the connections *to* them. For some, this will require a dramatic shift in their overall approach to teaching (National Academies of Science, Engineering, and Medicine (NASEM), 2015). Although making such a shift will be a challenge, it is also an opportunity for the nation to address gaps in scientific and engineering literacy and change the direction of teaching and learning in science.

Table 1 (Click on image to enlarge)

Implications of the Vision of the Framework and the NGSS

Science Education Will Involve Less	Science Education Will Involve More	To achieve this, teachers will need to:
Rote memorization of facts and terminology	Facts and terminology learned as needed while developing explanations and designing solutions supported by evidence-based arguments and reasoning	Facilitate learning using techniques such as “activity before content” and promote evidence-based claims; introduce vocabulary in context
Learning of ideas disconnected from questions about phenomena	Systems thinking and modeling to explain phenomena and to give a context for the ideas to be learned	View concepts as interconnected and identify relevant between concepts and real-world application
Teachers providing information to the whole class	Students conducting investigations, solving problems, and engaging in discussions with teachers’ guidance	Contextualize the concepts and provide opportunities for students to discover concepts thru engaging in common experiences, investigations, and drawing conclusions
Teachers posing questions with only one right answer	Students discussing open-ended questions that focus on the strength of the evidence used to generate claims	Re-frame questions to be more open-ended, which requires a deep understanding of content
Students reading textbooks and answering questions at the end of the chapter	Students reading multiple sources, including science-related magazines, journal articles, and web-based resources; Students developing summaries of information	Find a variety of resources and evaluate them for relevance; facilitate capacity building skills of students in interpretation across multiple sources
Preplanned outcomes for “cookbook” laboratories or hands-on activities	Multiple investigations driven by students’ questions with a range of possible outcomes that collectively lead to a deep understanding of established core scientific ideas	Connect concepts to larger real-world issues; guide students through questioning and well-placed investigations
Worksheets	Students writing journals, reports, posters, media presentations that explain and argue	Consider multiple and varied ways of asking students to relay information and make their thinking visible
Oversimplification of activities for students who are perceived to be less able to do science and engineering	Providing supports so that all students can engage in sophisticated science and engineering practices	Believe that all students can learn and, thus, develop skeletons, such as sentence starters, outlines or graphic organizers to assist students in conveying their thinking and growth

Note: Adapted from the Guide to Implementing the Next Generation Science Standards (NRC, 2015, pp. 8-9).

Success in meeting this challenge, and opportunity, is largely dependent upon teachers, since they are the most direct link between students and their exposure to the standards (Borko, 2004; Fullan, Hill, & Crevola, 2006; NASEM, 2015). Despite what is known about effective professional learning (PL), a multi-year research initiative examining the state of PL in the United States found that by 2008, teachers had fewer opportunities to participate in sustained, collegial workshops (those that lasted longer than eight hours). In addition, the U.S. invested more funds for teacher learning that focused increasingly on short-term

workshops — the least effective models of professional learning (Wei, Darling-Hammond, Adamson, 2010). Additionally, few teachers received more than 35 hours of PL over a three-year period (Banilower, et al., 2013). Moreover, collaborative planning among teachers was found to be limited (about 2.7 hours per week) and ineffective at creating a cooperative school climate for instructional growth and increased student achievement (Wei et al., 2010). As such, it is imperative that the format of continuing professional learning for in-service teachers be re-thought if they are to adopt practices that support integration of the NGSS, or any other K-12 reform effort.

In addition to a shift toward less effective teacher learning experience formats, Schools and Staffing Survey (SASS) data from 2008 reveal that secondary and rural teachers specifically, receive inequitable access to PL opportunities, as compared to their elementary and urban or suburban school counterparts. In contrast, Banilower et al. (2013) found that elementary, rather than secondary teachers, were less likely to have participated in recent professional learning opportunities and far less likely to have received feedback on their instruction. Thus, it appears there is a need for expanding professional learning for all of these educators and identifying what methods are effective in these settings and for these populations. This article presents an alternative and seeks to address the following question: What support is effective in helping improve teacher instruction for all teachers, but especially for those who receive inequitable access (i.e., secondary, rural teachers)?

Contextualizing the Strategy

The NGSS outline what students should know and be able to do in science after having completed their K-12 education. They formulate science as three dimensional, delineating the (a) practices, (science and engineering practices), (b) core content (disciplinary core ideas), and (c) big ideas (crosscutting concepts) and thus, imply that science should be taught in this manner. In past decades, the main emphasis in K-12 science education has focused on only one of these dimensions – the disciplinary core ideas – while the science and engineering practices and crosscutting concepts have been absent from, decontextualized, or isolated in many classrooms. As such, classroom strategies designed for targeting these other two dimensions of science may be new for many current in-service teachers. Additionally, making these connections explicit is important for increasing efficacy of teacher instruction.

With a need to incorporate all three dimensions into the classroom, which is referred to in the literature as three-dimensional science learning or 3D learning (e.g. Krajcik, 2015), teachers will need to gain new knowledge of science practices and ideas, a better understanding of instructional strategies consistent with NGSS, and the skills to implement these strategies (NASSEM, 2015). It is also important to consider that, according to Guskey (2002), the biggest struggle for integrating an innovation is not in understanding but in implementing it. Thus,

supports are needed not only to help teachers understand NGSS and appropriate instructional strategies, but also to become comfortable with strategies that will promote 3D learning.

While recognizing that teachers will need support to understand and implement the NGSS vision, there are a variety of ways in which this support may be provided. *Science Teacher's Learning: Enhancing Opportunities, Creating Supportive Contexts* (NASEM, 2015) indicates the importance of building collective capacity within schools and districts for science teaching and providing opportunities that support cumulative learning over time and target teachers' specific needs. Despite their potential benefits, these types of PL have received little attention (NASEM, 2015). Therefore, this article provides one professional learning strategy for supporting teachers in changing instructional practices to support the NGSS that involved developing collective capacity while attending to teachers' specific needs over time.

The PL strategy (Pick-Do-Share-Repeat) comes from a multi-year, district-wide professional development grant conducted with 7-12th grade science teachers from a small, rural district in the intermountain West. The state in which the district resides was in the process of adopting standards based on and closely aligned with the NGSS. Specifically, this strategy was employed with its secondary teachers in earth science, biology, chemistry, and physics who voluntarily elected to participate in the grant. Approximately 15 of the secondary teachers in the district (grades 7-12), ranging in experience from a second-year teacher to veteran teachers with decades of experience, met for a full day every six weeks during the academic year to gain a deeper understanding of the NGSS and its implications for classroom instruction. A goal of the grant, set forth by the district, was for teachers to identify ways in which students' thinking could be made visible. In an attempt to align our PL with the district-wide initiative, we connected the notion of making student thinking visible to strategies that were consistent with the NGSS vision.

Given the complexity of these standards, we recognized the importance of supporting teachers through structured workshops with clear goals and opportunities for both understanding the standards as well as identifying ways to integrate them. Thus, the workshops followed a basic format of building understanding, exploring examples, selecting a new strategy to implement, giving teacher time to implementing it, and debriefing the experience in a subsequent workshop. Throughout the planning process, we referenced the effective PL characteristics listed above in order to ensure the workshops aligned.

What is “Effective” Professional Learning?

A growing body of research has identified characteristics that lead to high-quality, effective professional learning for K-12 science educators. In 2007, Cormas and Barufaldi (2011) conducted a comparative analysis of over 20 works published between 1995 and 2006, in which they identified 16 effective research-based characteristics of PL (refer to Table 2). Additionally, more recent studies have found importance in teacher collaboration, the

presentation of material via active learning and modeling of content/strategies/activities, and integrated or interdisciplinary approaches to teaching (Beaudoin et al., 2013; Hestness et al., 2014; Houseal, A. K., Abd El Khalick, F., & Destefano, L., 2014; Miller et al., 2014; Nagle, 2013; NASEM, 2015; Reiser, 2013).

In a secondary level (7-12) professional learning program supported by a district-wide grant, the authors as facilitators, used a video analysis strategy that incorporates the characteristics identified by Cormas and Barufaldi (2011) and more recent studies mentioned above. Table 2 provides descriptions of how the video analysis strategy we employed aligns with Cormas and Barufaldi's (2011) characteristics. Our strategy involved teachers iteratively exploring instructional strategies through vignettes, case studies, or other examples in the context of their classrooms and reflecting upon attempts to implement a strategy. Additionally, we incorporated into our PL, through modeling, the three identified effective characteristics described in more recent studies by bringing teachers together to collaboratively explore new strategies, learn actively, and debrief the experience through video analysis with colleagues. This PL strategy has been coined Pick-Do-Share-Repeat and was used by rural, secondary, in-service teachers as they worked toward full implementation of the NGSS.

Table 2 (Click on image to enlarge)

Alignment of Effective PD Characteristics with Video Analysis Strategy

Effective research-based characteristics	Pick-Do-Share-Repeat targets and how characteristics are addressed
1. Teachers' discipline-specific knowledge is increased	✗ Content knowledge is not explicitly addressed with video analysis, although question/discussion may arise organically. It is addressed in other areas of this PD.
2. Teachers understand how students learn and what are effective teaching strategies within a specific discipline	✓ The strategies introduced in the video analysis are based on the literature; discussions and modeling of how students learn and effective strategies are used.
3. Teachers understand how students learn and what are effective teaching strategies	✓ Same as above
4. Teacher effectiveness and student achievement outcomes are used to determine whether professional development has worked	✓ Teacher discussions and reflections are used by facilitators to determine how to refine activities for effectiveness.
5. Requires resources (money and time)	✓ Teachers are supplied with substitutes; the workshops are held during school hours.
6. Professional development is on-going	✓ The workshop facilitators have worked with the district for five years with six workshops per year. Video analysis has been conducted at every session over the last year.
7. Professional development occurs in day-to-day contexts of teachers	✓ The workshops are held during school hours and the video analysis is of colleagues and students in the district.
8. Uses effective teaching strategies	✓ Strategies used by facilitators are based on research examining best practice. The video analysis includes sustained, on-going, relevant, and effective practices.
9. Collaborational/guided with school/districtwide goals	✓ The workshops are part of a collaborative Grant proposed by the district; goals are set by the district; facilitators collaborate with their science coordinator and align with the state's goals of implementing newly adopted science standards.
10. Teachers provide input into professional development design; professional development is engaging and relevant	✓ Teachers complete a survey before and after each workshop, which includes queries on their needs/interests. The video analysis uses teacher's own videos with their students; teachers' survey responses and discussions suggest the analysis is engaging.
11. Involves collaboration between teachers and others	✓ The video analysis structure requires collaboration between teachers as well as between teachers and the science coordinator/facilitators.
12. Generates further collaboration or projects	✓ The structure of the video analysis has been established such that teachers and the district coordinator can proceed independently.
13. Treats teachers as professionals	✓ By using teachers' videos and valuing their input to drive reflection, facilitators are treating them as professionals in their field.
14. Promotes teacher self-reflection	✓ The video analysis creates a structure for teachers to reflect on their practice as they watch themselves teach and to verbalize their reflections, and how others' input.
15. Uses inquiry as a teaching style	✓ Inquiry is used while teachers are piloting effective strategies in their classrooms. This may take the form of an essential question about student thinking that is investigated through modeling, discussion, or "gallery walk."
16. Increases teacher ability to meet needs of diverse learners	✓ By having teachers explore multiple teaching strategies, the video analysis helps teachers identify multiple modalities to reach diverse learners.

Pick-Do-Share-Repeat: Changing Practice while Making Student Thinking Visible

The implementation struggle that Guskey (2002) noted has an effect on the number of teachers who actually implement a new strategies after they learn it. This is further complicated by evidence that teachers only change their beliefs after seeing success with students and that they tend to abandon the practice of a new skill if they do not see immediate success (e.g., Guskey, 1984). Thus, a pivotal component of our in-service teacher

professional learning was to have teachers incorporate the use of a new strategy into classroom instruction iteratively throughout the year with the added accountability to share their implementation with others via a video at a subsequent workshop.

Even with structural supports, the decision to redefine one's pedagogical role in the classroom can be a daunting task; it often requires changes in beliefs and current practice. Thus, without space for posing questions and resolving dissonance, teachers are unlikely to abandon current teaching practices for new strategies that often appear uncomfortable or at odds with their beliefs (Guskey, 2002). Critical reflection can assist in this redefinition (Mezirow, 1990). In this PL, we sought to help teachers incorporate classroom strategies that support the NGSS by giving them time to read about, discuss, and participate in model examples of new teaching strategies before they attempted their own implementation, and to further reflect upon their experience after they tried it.

The specific format of Pick-Do-Share-Repeat was facilitated as follows:

- Teachers were exposed to a number of teaching strategies
- They selected one strategy to incorporate into their instruction
- Teachers video-recorded their attempt, and then
- They reflected upon that attempt both independently and collaboratively.

Teachers had been exposed to many of the strategies through modeling. For example, facilitators elicited prior knowledge and strategies already used by these teachers in their classrooms. We approach PL with the stance that teachers are professionals in their fields and bring expertise to the table; therefore, it is important to value their ideas and successes. Here, we present one possible format for introducing strategies for the purposes of video analysis. After identifying the strategies, teachers might be given time to explore several resources and note which strategies they thought would align with their classroom setting or target various dimensions of the NGSS. A silent conversation on butcher paper followed by a group discussion might be used to share their findings and discuss the effectiveness of each strategy. A session might end with teachers considering their current classes, identifying a strategy, and planning out how to implement that strategy.

As stated earlier, the shifts required of teachers to successfully implement NGSS are large (Bybee, 2014) and include content knowledge, instructional strategies, and the skills to implement those strategies (NASEM, 2015). Further, these are often new ideas for early career teachers who may have limited exposure as a student or a teacher (Inouye & Houseal, 2018). Thus, PL opportunities should attempt to support teachers on all fronts through the use of modeling good science teaching while helping them to understanding what is good science teaching. Other formats besides that listed above could be used, as long as they were supportive of the NGSS and helped to model the strategies with which we hope to instill in teachers' repertoire of instruction.

Since the video analysis protocol and the NGSS were new for the teachers, we decided to focus primarily on the science and engineering practice of engaging in argumentation with evidence-based claims, as it tied to the district initiative of making thinking visible. In addition, other formative assessment strategies (e.g., Harvard's Project Zero's (2016) *thinking routines*, Formative Assessment Classroom Techniques (Keeley, 2008) such as, "*I used to think..., but now I know...*" with an added explanation of "*because...*") and more traditional and well-known instructional strategies including *think-pair-share* and *gallery walks* were also used.

Following the introduction of several instructional strategies, teachers were given time to select a strategy and discuss how they would implement it (Pick-). After the workshop, they returned to their classrooms and video-recorded the strategy before the next workshop (-Do-). We left the selection of the clip to the discretion of the teachers and what they thought most adequately demonstrated their implementation attempt. During each subsequent workshop, all teachers showed a 5-minute segment of their instruction, reflected upon their experience, and received feedback from their peers on the effectiveness of their chosen strategy (-Share-) before repeating the process (-Repeat).

The frequent meetings allowed teachers to cyclically identify new needs and repeat the process multiple times. The use of video analysis was especially important during reflection and teacher discourse because it provided a common reference point (Ball & Cohen, 1999) and challenged teachers to use evidence from the videos to support their claims (Roth, Garnier, Chen, Lemmens, Schwille, & Wickler, 2011). Thus, it served a dual purpose by encouraging teachers to use some of the skills they were asking of their students while building a catalog of common visual examples of each strategy.

Embedded in this particular video analysis debrief was a discussion of how the lesson aligned with three-dimensional learning (described above) and how it elicited student thinking; however, the debrief format can be customized to teacher need, content, and goals. In our case, we chose to provide an opportunity for teachers to (a) reflect on the strategy itself (execution and effectiveness), (b) practice identifying which NGSS dimensions were present, (c) analyze evidence of student learning, (d) receive peer feedback, and (e) ask and respond to questions. Refer to Appendix A for the debrief form that guided the discussions. The format of the debrief followed a structure similar to the critical friends reflection protocol (refer to Table 3), which was first developed by the Annenberg Institute for School Reform (Appleby, 1998). During the presentation, one teacher would frame his/her video clip by describing the lesson, its goals, and why he/she chose the strategy. Colleagues were provided an opportunity to ask any clarifying questions before the video was played. The quiet response occurred as colleagues watched the video and wrote down notes on the debrief form (refer to Appendix A). After watching the video, colleagues would provide suggestions after sharing what they noticed and liked about the teacher's facilitation of their chosen instructional strategy. Questions on the second side of the debrief form guided this section of the protocol. PL facilitators ensured that colleagues used evidence from the clip to

provide feedback based on each section of the debrief form. The debrief ended with the presenter (and colleagues) concluding what was useful and what he/she would take away from the experience.

Table 3 (Click on image to enlarge)

Critical Friends Protocol

PRESENTATION
Presenter explains their project; audience listens
CLARIFICATION
Audience asks short clarifying questions; presenter responds
QUIET RESPONSE (OPTIONAL)
Each audience member quietly writes down likes and wonders on paper
"I LIKE..."
Audience shares with each other what they like; presenter listens
"I WONDER..."
Audience shares with each other what they like; presenter listens
RESPONSE
Presenter reflects on useful feedback; audience listens or enters dialogue focusing on useful ideas or resources
DEBRIEF
Presenter (and others) may share key learning

Case study of Brent A

As an example, we will look at a second-year middle school teacher whose instructional practice changed during his participation in the program. In October of 2017, during the second workshop session of the year, Brent showed his peers a video in which his students were to brainstorm scientific questions related to a video on water quality. He stated that he was attempting to have students make their thinking visible and build critical thinking skills. The classroom was arranged as single tables, facing forward with one or two students at each table.

TEACHER: "What I want you to do is pay attention to the video that you're about to see. These are the creatures inside pond water."

[Class watches video.]

TEACHER: "...Based on what you have seen, what kinds of questions do you think scientists would have that they could test?"

STUDENTS: [Quietly writing. No discussion. One student raises hand, and teacher responds by saying "Answer on a piece of paper."]

TEACHER: "Everyone needs to have at least two answers on their paper."

STUDENTS: [Silent. Some writing on papers.]

TEACHER: "Now that you have something written down, I want you to brainstorm at least one more with your partner."

STUDENTS: [Students quietly talk in pairs. Conversations are short.]

[The lesson proceeds with the teacher asking each group to share a question with the entire class, which he writes on the board. Teacher writes all questions on board; does not ask why they would want to know the answer or how an answer to a question might help scientists.]

TEACHER: “Now, let’s look to see if they are testable questions. (Reads the first). Can we determine this today?”

STUDENTS B&C: “No”

TEACHER: “Why?”

STUDENTS B&C: [Respond; teacher evaluates their response.]

In Brent’s first engagement with video analysis, he tried to use a think-pair-share strategy to help students critically think about feasible scientific questions. However, students did not respond to or critique each other’s ideas, nor did he, their questions. There was no discussion or building on one another’s ideas during the *share* portion of the strategy. Another strategy used by Brent was first identified by Meham (1979) and termed Initiate-Respond-Evaluate (I-R-E) and was very teacher-centered. Brent had students come up with their own questions, but rarely pushed them to think about why they want to know the answer to their questions or what observation resulted in that question. In the debrief, Brent was able to articulate to an audience of peers how he had tried to make student thinking visible. He also received feedback from his colleagues about successful intentions (e.g., getting students to ask questions) and suggestions for improvement (e.g., asking students why they want to know that question or how that would help the scientific enterprise). During this discussion, another colleague also shared a video in which students were developing questions for further study based on a reading. Here, she invited students to engage in discussion about the students’ thinking that led them to their questions, which provided an example of how Brent might further refine the think-pair-share strategy.

In February 2018, Brent brought a video in which he tried to capture his most recent attempts to make student thinking visible and build their critical thinking skills. The video showed a classroom with pods of tables with three to five students sitting at each pod. It began with the teacher having students think individually, similar to the first video. From there, the implementation of the strategy diverges significantly.

TEACHER: “You all just finished a writing prompt on: What is the worst natural disaster that there could be? In groups, share your response and decide what is the worst and why.”

[Students sharing ideas – lots of talk among all groups, students are arguing, engaged, smiling; Some students reference statistics; some students only use opinions]

TEACHER: [brings students back together to share their claims]

STUDENTS: [Student groups share their claims and evidence with the entire class.]

TEACHER: “We have two tables that think hurricanes are worst, one tornado, and one earthquake. Discuss why [your claim is better supported].”

[After another round of argumentation in small groups, students share reasoning of “the worst natural disaster” to the entire class. There are several instances in which student groups respond to each other.]

From the set-up of the room to the framing of the lesson and the teacher’s role as a facilitator, it was a different classroom. The pod arrangement of the tables promoted group work and student-to-student interaction. Interactions within the classroom were mostly student-to-student with the teacher occasionally helping to direct rather than engaging in teacher-led I-R-E. The enthusiasm and noise level present during student discussions was also testament to the increase in students sharing their thinking and reasoning with each other compared to quiet classroom in the first video. Lastly, in terms of making student thinking visible, Brent posed a larger question (“Which natural disaster is the worst and why?”) to small groups of students and explicitly reminded (e.g., “Remember to use your resources to support your answer”) and prompted (e.g., “What is your evidence?”) them that they needed empirical evidence to support their claims. After being given time to independently collect their thoughts, these students used their resources to create an evidence-supported claim (e.g., “Earthquakes killed almost 750,000 people between 1994 and 2013, and this was more than all other disasters put together.”; “Droughts are the worst because they were only 5% of the events but hurt more than one billion people. This is like 25% of the total.”). This was very different from his first attempt to get students thinking by independently brainstorming and sharing their questions aloud with little interaction between students, few resources from which to draw, and infrequent opportunities to explain their observations or thoughts. In the second attempt, Brent still used I-R-E, but students shared their claims and evidence and then returned to their groups to discuss their claims in light of the other groups’ claims.

During the debrief, Brent’s colleagues and facilitators were able to direct his attention to how his lesson facilitation allowed for more complex and engaging student discourse that promoted the use of data to support their claims. Using the debrief form mentioned above, colleagues watched Brent’s video through the lens of evidence of 3D learning, his use of his selected strategy, and evidence of student learning. After Brent was given five minutes to describe his planning and how he thought the lesson went, his colleagues gave feedback. To help teachers provide objective and meaningful feedback, facilitators prompted them to support their claims with specific evidence from the video or to ask a question that would provide evidence for their claims.

Through this process, Brent received positive feedback from veteran teachers as they helped to support his growth. One of his colleagues made the connection between his and others’ videos to his own instruction:

The...examples of others' classes and our discussions make me realize that what we have been learning in [these workshops] is very doable for me and all other science teachers that put in a bit of effort.

Brent selected both of those videos, in an attempt to demonstrate his integration of strategies to elicit student thinking and build critical thinking skills. Initially, he struggled with both the idea of making student thinking visible and the selection of an example from his practice that exemplified the process. Given the difference in his selections between workshop #2 and #4, and the debrief conversations, Brent demonstrated that he had shifted his mindset and practice to some extent. This suggests that there were influential factors during this time that contributed to his change in conception of what it means for (a) students to show their thinking and (b) build critical thinking skills. Although we cannot definitively say that the debrief discussions, viewing of their own and others' videos, and the workshops themselves resulted in Brent's shift in instruction, the changes seen through this teacher's videos occurred during the time frame in which this PL occurred.

Benefits of this PL Strategy

To obtain a measure of efficacy for this PL strategy, teacher participants completed a short questionnaire asking them to rate and comment on their self-perceived concerns, confidence, and commitment to the materials and activities presented. These parameters were measured with a 10-point Likert scale and open-ended responses. Quantitative analysis from the Likert-scale questions (Cronbach's alpha of 0.74) suggested an increase in confidence and commitment and a decrease in teachers' levels of concern associated with strategy implementation and change in classroom instruction. Results from teachers' open-response comments revealed that teachers experienced several key benefits from this collaborative, observational, and reflective strategy. Primarily, the video analysis allowed teachers to identify more successes in their implementation, realize the potential of these changes in practice, and gain the confidence and collective commitment needed to continue such practices. Below are several quotes that exemplify these benefits and are indicative of the group's sentiments:

- "Watching the video's this last session increased my confidence." – *10th grade teacher*
- "I am not feeling as badly about my teaching after our meeting today. It is so nice to have other teachers' feedback on my teaching habits and their support." – *9th grade teacher*
- "I can see a difference in my students' engagement and overall learning with greater incorporation of the strategies." – *9th grade teacher*

Through this process, teachers built a learning community with common goals among peers as they met to explore new strategies, returned to the classroom to implement a strategy, and reconvened to share the classroom experience. By watching each other's videos, teachers were able to provide supportive feedback and identify successes missed by

independent reflection but celebrated through collective reflection. Thus, another benefit of collaborative reflection is that questions or actions unnoticed by the instructing teacher may be identified by his/her peers and boost that teacher's confidence as their effective instruction is recognized.

Additionally, we found that teachers not only reflected on their own practice by analyzing their own videos, but they also reflected on their practice through the analysis of other's videos. By watching their peers try a new strategy, which resulted in high student engagement or teacher excitement, they could envision that scenario in their own classroom and noted increased desires to try new strategies.

Brent is one example of many that occurred during this time period. We have found that this versatile PL strategy was useful in our context at many levels of educational support and across a wide range of content areas and instructional strategies to help change teacher practice in sustainable ways. Therefore, we suggest that the use of video analysis is helpful in changing teacher practice. We found this to be true in specific areas, such as in Brent's case and more broadly, in terms of promoting three-dimensional learning within classrooms.

One limitation that emerged throughout the PL series was the extent to which teacher could provide feedback on strategies or content with which they had varying levels of expertise and exposure. To provide meaningful feedback, one must understand that which they are observing. As teachers gained deeper understanding of the NGSS and supportive strategies, their feedback got more targeted. Facilitators assisted with this by modeling feedback, asking clarifying questions, and support teachers personal growth on the standards and the strategies involved in the workshop series.

Given the potential vulnerability that a teacher might feel with colleagues critiquing their teaching, it was important that a strong culture be established with clear expectations around the goals and purpose of the workshop series. Unclear goals and/or a lack of trust could be a limitation of this type of PL, but this particular workshops series did not experience difficulties because of these factors.

Final Thoughts

The journey toward full implementation of the NGSS will take time, support, and continuous reflection. Thus, identifying strategies that move teacher instruction toward this vision are worthwhile. Here, we have identified one PL strategy for supporting best practice in the classroom and shifting teacher instruction to mirror it. The Pick-Do-Share-Repeat video analysis strategy served the dual purpose of having teachers use skills they were promoting among their students (e.g., evidence-based claims, reflection, common experience from which to discuss and draw) while building a catalog of enacted strategy examples (their video library).

This paper is intended to offer guidance for professional learning facilitators and school administrators and we believe that the ideas presented can be incorporated at many levels (PLCs, school initiatives, district-wide professional learning, etc.) in an authentic and instructionally relevant manner. Though the process takes time and iteration, the resulting teacher growth proved meaningful and worth the time investment. One 7th grade teacher supported this supposition stating that “practice and analysis of effectiveness, followed by more practice and analysis of effectiveness” (in reference to Pick-Do-Share-Repeat) would continue to build his confidence and incorporation of the strategies. Thus, the collaborative, reflective, and skill-based emphasis of this strategy provided benefits for teachers through growth in practice, increased confidence, improved instruction, and a network of peer support. We note that this strategy, like any educational strategy or innovation, will never serve as a panacea. Nevertheless, it can provide teachers with instructional support in some very important ways.

Supplemental Files

[Appendix-A.jpg](#)

References

- Appleby, J. (1998). *Becoming critical friends: Reflections of an NSRF coach*. Providence, RI: Annenberg Institute for School Reform at Brown University
- Ball, D.L., & Cohen, D.K. (1999). Developing practice, developing practitioners: Toward a practice-based theory of professional education. In G. Sykes & L. Darling-Hammond (Ed.), *Teaching as the learning profession: Handbook of policy and practice* (pp. 3–32). San Francisco, CA: Jossey Bass.
- Banilower, E. R., Smith, S. P., Weiss, I. R., Malzahn, K. A., Campbell, K. M., & Weis, A. M. (2013). *Report of the 2012 National Survey of Science and Mathematics Education*. Chapel Hill, NC: Horizon Research, Inc.
- Beaudoin, C., Johnston, P., Jones, L., & Waggett, R. (2013). University support of secondary stem teachers through professional development. *Education*, 133, 330-339.
- Borko, H. (2004). Professional development and teacher learning: Mapping the terrain. *Educational Researcher*, 33(8), 3–15.
- Bybee, R (2014). NGSS and the next generation of science teachers. *Journal for Science Teacher Education*, 25, 211-221.
- Cormas, P. C., & Barufaldi, J. P. (2011). The effective research-based characteristics of professional development of the national science foundation’s GK-12 program. *Journal of Science Teacher Education*, 22, 255-272.

- Fullan, M., Hill, P., & Crevola, C. (2006). *Breakthrough*. Thousand Oaks, CA: Corwin Press.
- Guskey, T. R. (1984). The influence of change in instructional effectiveness upon the affective characteristics of teachers. *American Educational Research Journal*, 21, 245-259.
- Guskey, T. R. (2002). Professional development and teacher change. *Teachers and Teaching: Theory and Practice*, 8, 381–391.
- Hestness, E., McDonald, R. C., Breslyn, W., McGinnis, J. R., & Mouza, C. (2014). Science teacher professional development in climate change education informed by the Next Generation Science Standards. *Journal of Geoscience Education*, 62, 319-329.
- Houseal, A. K., Abd El Khalick, F., & Destefano, L. (2014). Impact of a Student-Teacher-Scientist Partnership on students' and teachers' content knowledge, attitudes toward science, and pedagogical practices. *Journal of Research in Science Teaching*. 51, 84-115.
- Keeley, Page. (2008). *Science formative assessment: 75 practical strategies for linking assessment, instruction, and learning*. Thousand Oaks, CA: Corwin Press.
- Krajcik, J. (2015). Three-dimensional instruction: Using a new type of teaching in the science classroom. *The Science Teacher*, 83(8), 50–52.
- Mehan, H. (1979). *Learning lessons: social organization in the classroom*. Cambridge, MA: Harvard University Press.
- Mezirow, J. (1990). *Fostering critical reflection in adulthood: A guide to transformative and emancipatory learning*. San Francisco: Jossey-Bass.
- Miller, R. G., Curwen, M. S., White-Smith, K. A., & Calfee, R. C. (2014). Cultivating primary students' scientific thinking through sustained teacher professional development. *Early Childhood Education Journal*, 43, 317-326.
- Nagle, B. (2013). Preparing high school students for the interdisciplinary nature of modern biology. *CBE-Life Sciences Education*, 12, 144-147.
- National Academies of Sciences, Engineering, and Medicine. (2015). *Science Teachers Learning: Enhancing Opportunities, Creating Supportive Contexts*. Washington, DC: The National Academies Press.
- National Research Council. [NRC]. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas*. Washington, DC: National Academies Press.

NRC. (2015). *Guide to Implementing the Next Generation Science Standards*. Washington, DC: National Academies Press. Available at <http://www.nap.edu/catalog/18802/guide-to-implementing-the-next-generation-science-standards>

NGSS Lead States. (2013). *Next Generation Science Standards: For states, by states*. Washington, DC: National Academies Press.

Reiser, B.J. (2013). *What Professional Development Strategies Are Needed for Successful Implementation of the Next Generation Science Standards?* Paper written for the Invitational Research Symposium on Science Assessment, September 24-25, Educational Testing Service, Washington, DC. Available at <http://www.k12center.org/rsc/pdf/reiser.pdf>.

Roth, K., Garnier, H., Chen, C., Lemmens, M., Schwille, K., & Wickler, N. (2011). Videobased lesson analysis: Effective science PD for teacher and student learning. *Journal of Research in Science Teaching*, 48, 117-148.

U.S. Department of Education, National Center for Education Statistics, Schools and Staffing Survey (SASS), "Public School Teacher Data File," 2011–12.

Project Zero. (2016). *Visible Thinking*. Retrieved from <http://www.pz.harvard.edu/research/Vislhink.htm>

Wei, R. C., Darling-Hammond, L., and Adamson, F. (2010). *Professional development in the United States: Trends and challenges*. Dallas, TX: National Staff Development Council.