The Framework for Analyzing Video in Science Teacher Education and Examples of its Broad Applicability

by Anna Arias, Kennesaw State University; Brett Criswell, West Chester University; Josh A. Ellis, Florida International University; Lawrence Escalada, University of Northern Iowa; Michelle Forsythe, Texas State University; Heather Johnson, Vanderbilt University; Donna Mahar, SUNY Empire State College; Amy Palmeri, Vanderbilt University; Margaret Parker, Illinois State University; & Jessica Riccio, Columbia University

Abstract

There appears to be consensus that the use of video in science teacher education can support the pedagogical development of science teacher candidates. However, in a comprehensive review, Gaudin and Chaliès (2015) identified critical questions about video use that remain unanswered and need to be explored through research in teacher education. A critical question they ask is, “How can teaching teachers to identify and interpret relevant classroom events on video clips improve their capacity to perform the same activities in the classroom?” (p. 57). This paper shares the efforts of a collaborative of science teacher educators from nine teacher preparation programs working to answer this question. In particular, we provide an overview of a theoretically-constructed video analysis framework and demonstrate how that framework has guided the design of pedagogical tools and video-based learning experiences both within and across a variety of contexts. These contexts include both undergraduate and graduate science teacher preparation programs, as well as elementary and secondary science methods and content courses. Readers will be provided a window into the planning and enactment of video analyses in these different contexts, as well as insights from the assessment and research efforts that are exploring the impact of the integration of video analysis in each context.

Identification of the Challenge Within Science Teacher Education

There appears to be consensus that the use of video in science teacher education (either of a teacher’s own practice or of the practice of others) can support the pedagogical development of science teachers (Abell & Cennamo, 2003; Barth-Cohen, Little & Abrahamson, 2018; Kearney, Pressick-Kilborn & Aubusson, 2015; Martin & Siry, 2012). Despite this consensus, and despite the significant amount of research that has been devoted to the use of video in science teacher education from both a theoretical and empirical standpoint, significant questions remain unanswered. For instance, in a comprehensive review of the use of video in teacher education across contexts, Gaudin and Chaliès (2015) identify critical questions that still need to be systematically explored through future research. One of these questions has been the core concern of the science teacher educators collaborating on this article: “How can teaching teachers to identify and interpret relevant classroom events on video clips improve their capacity to perform the same activities in the classroom?” (p. 57).

Our collaborative’s efforts to answer this question in a manner that is simultaneously *holistic* and *practical* have been the driving force behind the development of the Framework for Analyzing Video in Science Teacher Education [FAVSTE]. In its essence, FAVSTE focuses on what can be considered a key skillset that science teacher candidates must develop: the capacity to analyze and articulate pedagogical practice. This skillset integrates at least two critical abilities that have been identified within the science teacher education literature: *noticing* (Barnhart & van Es, 2015; Benedict-Chambers, 2016) and *reflecting* (Abell & Bryan, 1997; Hawkins & Park Rogers, 2016). A tremendous challenge faced by science teacher educators is how to progressively build such a skillset in teacher candidates across experiences within their teacher preparation programs (Martin & Siry, 2012). Specifically, as our group developed FAVSTE, we were interested in how such a framework might support a continuum of use in teacher candidate coursework and field experiences. Additionally, there was a desire to create a tool that was flexible enough to use across various teacher demographics (e.g. elementary through secondary science methods students; undergraduates and graduates in teacher preparation programs) and that, while developed for science teacher training, could potentially be implemented within other subject areas as well. In this paper, we demonstrate how FAVSTE, as well as other pedagogical tools developed and/or utilized by the collaborative, supports science teacher educators’ work with preservice and early-career teachers across a variety of contexts.

ATLAS and the Video Analysis Framework Group

In 2016, a geographically-distributed group of science teacher educators from across the U.S. was brought together through a project spearheaded by the National Board for Professional Teaching Standards (NBPTS). The overarching goal of this collaborative was to identify best practices for using the NBPTS Accomplished Teaching, Learning And Schools™ (ATLAS) video library to support the preparation of science teachers. ATLAS (http://www.nbpts.org/atlas) provides a collection of authentic video cases that feature National Board Certified Teachers. ATLAS is available as a subscription service, and the cost for this service is based on the size of the subscribing organization and the length of the subscription. Each case within ATLAS includes an uninterrupted video clip from real classroom teaching, instructional materials that supported that teaching, and a commentary written by the teacher about their instructional context, planning process, analysis of the video, and reflection on the instruction. At present, ATLAS includes over 1300 video cases, including 334 cases around science instruction (91 at the elementary level and 243 at the secondary level). The collaborative formed through the NBPTS project sought to identify or develop a viable framework for guiding the use of the ATLAS video library in science teacher education and professional development.

An initial review of the literature highlighted multiple frameworks associated with the use of video analysis for teacher preparation and professional development. For instance, Chan and Harris (2005) developed a framework that outlined the *cognitive activities* used by teachers as they engaged in video ethnography. Van Es and Sherin's (2002) framework provided ideas for scaffolding pre- and in-service teachers in "learning to notice" — a skill they argue is central to being able to analyze video. Van Es, Tunney, Goldsmith, and Seago (2014) and Gelfuso (2016) both devised frameworks that focused on the facilitation of video tasks, with the former emphasizing video *analysis* and its use with *in-service* teachers and the latter concentrating on video *reflection* and its use with *pre-service* teachers. Finally, Kang and van Es (2018) created a framework for addressing design principles for the use of video, including such elements as articulating broad learning goals, selecting a clip, and designing a task.

All of the above frameworks have value in relation to different aspects of using video in teacher preparation and/or professional development and are supported by research. Our collaborative believed, however, that none of these frameworks presented a holistic representation of the most critical elements that science teacher educators need to consider in order to achieve a set of specific outcomes with the use of video. These outcomes include supporting teacher candidates in developing (1) knowledge for teaching (i.e. PCK), (2) professional vision / noticing of teaching practices, (3) reflective and responsive teaching, and (4) capacity to engage in professional conversations around practice. Designing such a framework became a driving force for our collaborative.

Framework for Analyzing Video in Science Teacher Education (FAVSTE)

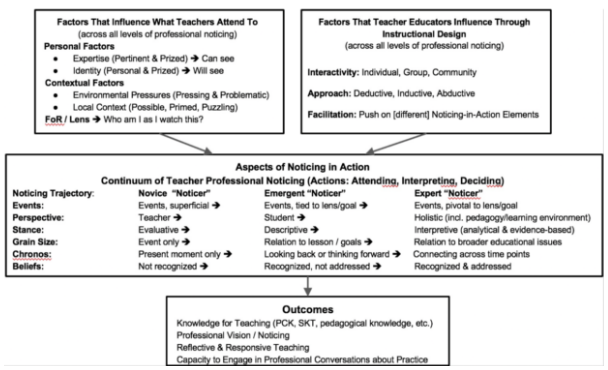
Our development of FAVSTE drew on existing literature on video analysis (e.g., van Es and Sherin, 2002; Jacobs, Lamb, & Philipp, 2010) as well as a consideration of our collective experiences and expertise as teacher educators. Figure 1 represents our current instantiation of the framework; for the purposes of this paper, we will highlight key aspects of it. FAVSTE has three major segments that can be identified by moving from the top to the bottom of Figure 1. The top segment has two boxes ("Factors That Influence What Teachers Attend To" and "Factors That Teacher Educators Influence Through Instructional Design") and represents the *preparation* components of conducting a video analysis / reflection task with candidates. These are the factors that science teacher educators must consider as they lay the foundation for and frame the experience. These factors support the "Aspects of Noticing in Action" — captured in the middle box in Figure 1 — which denote the core set of skills to be developed in teacher candidates. These "Aspects" represent things that, in some explicit manner, need to be scaffolded and facilitated by the science teacher educator during the *enactment* of the task to promote effective video analysis / reflection. It is not reasonable that all FAVSTE aspects would be given attention in the same video analysis task, so the science teacher educator has to consider which one(s) will be emphasized. We have tried to describe these "Aspects" in terms of very tentative progressions from *Novice* to *Emergent* to

Expert “Noticer” so that the science teacher educator can look for evidence of candidates’ progress in their capacity to analyze and articulate practice. Finally, the bottom box delineates the desired “Outcomes” if FAVSTE is used holistically and methodically across numerous video-based learning experiences – preferably across an entire teacher preparation program – so that the factors (top two boxes) and the skills (middle box) that enable these outcomes can be meaningfully developed.

(It is critical that the reader understand that the sequence represented by the vertical segments and the linear structure indicated by the arrows connecting the boxes in those different segments *are not* intended to convey that the relationships between the factors, skills and outcomes is one-directional or that the entire process of planning, enacting, and assessing video analysis / reflection tasks can only proceed from top to bottom. Even in our hypothetical example in the next section, we start by describing intended ‘Outcomes’, go up to the ‘Factors’ boxes to select which ones to emphasis, then move into the ‘Aspects’ (skills) box to think about how to support those during the task. The representation (Figure 1) and the description of it were just presented in this way to simplify our discussion of FAVSTE.)

Figure 1

FAVSTE Video Analysis Framework



Using FAVSTE: A Hypothetical Example

In order to help the reader better understand the framework, we offer the following hypothetical example of how FAVSTE might be used, picking a limited number of elements from the figure to feature. Consider a science teacher educator who, aligned with the professional noticing approach (Gibson & Ross, 2016; Jacobs, Lamb, & Philipp, 2010), is interested in helping her teacher candidates gain a stronger sense of how to interpret student ideas in order to decide what kinds of questions to ask in conversations around scientific phenomena. The hypothetical context for this scenario is a secondary science methods course populated by candidates from different disciplinary backgrounds; we imagine this science teacher educator determining that photosynthesis would be a good content focus from which to draw examples. She locates two ATLAS videos that provide examples of teaching related to this content: Case 2533 — Clarifying Misconceptions About Photosynthesis and Respiration and Case 2540 — Thinking Critically about Photosynthesis and the Transfer of Energy in a System. Then, using FAVSTE as a reference, the science teacher educator considers how to structure the task in which these videos will be used. She decides that, given her desired outcome of improving how candidates interpret student thinking, the *Frame of Reference (For) / Lens* is an important factor as candidates will need to think about the events in the video through the lens of the secondary students. She makes a note to explicitly include and activate this lens when she introduces the video analysis task. The science teacher educator has selected two cases from ATLAS as this will allow candidates to compare and analyze across cases — i.e. to engage in an *Abductive Reasoning* approach. In order to better support this form of reasoning, the science teacher educator contemplates *Interactivity*, and she decides it would be best to split her teacher candidates into two groups and have each group analyze a single case, then present the results of their analysis to the other group to allow comparisons to be made. In order to support candidates in participating more productively making decisions about questions, the science teacher educator chooses to focus on the *Perspective* aspect of noticing and in her introduction tells candidates to pay attention to not just what the teacher does or what the students say, but to how the interactions between the teacher and the student impinge on student learning. Finally, to push the candidates to articulate their insights from the analysis effectively in their presentations, she scaffolds them to adopt an *Interpretive Stance* in which they support their assertions about teacher actions and student thinking with observational evidence from the videos.

Using FAVSTE: Real Examples from the ATLAS Science Teacher Collaborative

The previous sections have presented a brief overview of FAVSTE and its application. Here, we want to provide examples of the diverse ways in which the framework has guided our own use of video in science teacher preparation. Table 1 summarizes the broad set of contexts to which we have applied FAVSTE. Included in the table are the names and email addresses of the authors describing each context in case readers want to contact them for additional information. After the table, we present five detailed, real world examples of FAVSTE use to illustrate the potential of this framework for structuring experiences with elementary and secondary science teacher candidates and to show how we have coupled it with other pedagogical tools. The specific cases from Table 1 highlighted in the five examples have the context marked in bold.

Table 1 (Click on image to enlarge)

Examples of the Breadth of Use across Science Teacher Educator Collaborative

Table 1. Examples of the Breadth of Use across Science Teacher Educator Collaborative

Certification Level / Time in Program (Author and contact info)	Learning Goals	Foci from the Framework	Instructional Choices (e.g. type of video)	Example Tools and Pedagogy
Elementary science methods course (Author 1)	Designing 5E lessons that position students as authors of scientific discovery	Aspects of Noticing in Action: events, perspective, grain size, and themes	ATLAS videos identified by instructor that align to phases of the 5E model	3-Step Video Analysis Instructional Sequence
Elementary science content course (Author 2)	Noticing students' abilities to connect and make sense of content	Aspects of Noticing in Action: perspective and stance	ATLAS videos identified by the instructor that are related to the investigations conducted in the course	In-class video analysis discussions aligned with homework assignment using basic noticing of student thinking.
Elementary science content course (Author 3)	To build content knowledge for teaching by noticing and analyzing how the thinking and teaching of particular big ideas or core concepts in science change over the span of the elementary school curriculum	Aspects of Noticing in Action: events, perspective, stance, grain size, and themes	ATLAS videos are selected to align with an anchor event TC engage with.	In-class video analysis of one ATLAS video that aligns closely to the anchor event. Then small groups analyze different ATLAS cases that address similar across a range of grade levels. Emphasis on content knowledge for teaching.
Secondary science methods course with intensive field experience (Author 4)	Learning to attend to student thinking and make connections to effective teaching practices in alignment with NGSS	Aspects of Noticing in Action (all)	ATLAS videos → transitioning to teacher candidate's own videos	Modular Format; Learning cycle pedagogy
Secondary science methods course (Author 5)	Noticing and responding to student thinking	Personal Factors and PoR Lens; Aspects of Noticing in Action (all)	ATLAS videos → transitioning to teacher candidate's own videos	Rapid Survey of Student Thinking (tool from www.ambitiousscienceteaching.org)
Secondary science student teaching seminar (Author 2)	Transferring skills of analyzing others' videos to reflecting on one's own video	PoR / Lens → helping candidates develop their professional identity; Stance → getting them to objectively and critically analyze their own practice; Beliefs → how do candidates personal / professional beliefs impinge on decision-making	Candidates self-select video, with caveat that the episode must involve NGSS-aligned teaching & learning; candidates determine length of segment and pre-identify critical incidents for discussion; candidates lead discussion	Critical Incident Reflection (CIR) protocol (see Appendix B) that is designed to build bridges between noticing and reflecting, as well as surface candidates' beliefs
Secondary science MAT program without student teaching (Author 7)	Use ATLAS cases as models of instruction to learn to focus attention on important events during classroom activity	Aspects of Noticing in Action (all) with an emphasis on building from emergent to expert noticing in the three years of the program	Candidates examine multiple ATLAS cases as part of their coursework before they get into the field; candidates reflect on two ATLAS cases and their own practice focusing on an evidence-based analysis	Professional, state, and MAT program standards

Context 1: Elementary Science Methods Course

One of the contexts in which FAVSTE was implemented was multiple sections of an undergraduate elementary science methods course at a large Hispanic-serving public university in the southwest. This course primarily serves teacher candidates seeking their EC-6 generalist certification and ESL endorsement. However, a few K-12 SPED candidates and a few EC-6 generalist candidates with a bilingual endorsement also typically co-enroll. The course is a “floater” class in all three of these programs: for some teacher candidates, this course is the first education course that they complete, while for others, it is the last course that they take before student teaching. The course covers common reform-oriented approaches to inquiry-based elementary science teaching and learning, with an emphasis on the 5E instructional model (Bybee, 2014). Most of the teacher candidates self-report that their prior experiences as science students emphasized direct-instruction models of teaching and led to negative perceptions of their capabilities both as students of science and as teachers of science.

The Task Used to Support Key Learning Outcomes

For this methods course, one major challenge is helping teacher candidates develop a new vision for what elementary science can look and sound like. Most of these candidates have not had previous experiences in classrooms that actively position elementary students as the authors of scientific knowledge. In addition, most also eventually teach in school districts that use the 5E cycle to structure elementary lessons. Consequently, we structure our video analysis sessions around video clips that exemplify transformational teaching practices across the 5E cycle: using anchoring events to engage students’ funds of knowledge, structuring student-led explorations and data collection, supporting small-group construction of evidence-based explanations, and guiding whole-class discussion and revision of explanations.

These video analysis sessions follow a general instructional sequence that we have refined over years of working with different populations of teacher candidates. The five activities within this sequence are described in Figure 2, and each of these activities offers candidates a different entry point into making sense of science teaching and learning. However, we have found that the full 5-step instructional sequence is not essential for every video analysis session. Instead, we use this instructional sequence flexibly to respond to the specific needs of the teacher candidates. For example, when there are significant gaps in the candidate's science content knowledge, we take time to engage them as "students" in a similar science activity to help address their own preconceptions before we move on to analyzing video. However, when candidates come in with significant prior knowledge about the science content in the video, we often skip this step.

Figure 2

Instructional Sequence for Elementary Methods Course

Full 5-Step Video Analysis Instructional Sequence

1. Engage as "students" in a science investigation similar to that in the video clip.
2. Analyze a transcribed excerpt of student talk from the video clip.
3. Watch the video clip and take individual "noticing notes".
4. Watch (or re-watch) the video clip as a group, pausing to analyze our "noticings".
5. Explore the master teacher's commentary about the video clip to answer pedagogical questions that emerged from the previous activities and uncover new perspectives.

Use of FAVSTE in Designing the Task

FAVSTE provides a tool for focusing our video analysis sessions with the elementary teacher candidates. We have chosen to emphasize four specific aspects of Noticing in Action in this task: events, perspective, grain size, and chronos. This decision has helped us communicate to our teacher candidates how video analysis sessions support them in identifying and making sense of instructionally pivotal moments from a holistic perspective that is connected to educational themes such as equity and students' trajectories of learning. In addition, we have used the section of FAVSTE detailing the "Factors that Influence what Teachers Attend To" to better anticipate the experiences and perspectives that our teacher candidates might bring into a video analysis session and adapt our instruction as needed. This section has also helped us reflect on moments when candidates seemed to regress in their noticing trajectory. In many cases, we could connect these moments to broader systems at work, such as how the environmental pressures in their language arts practicum or the local context of other courses they were taking primed candidates to attend to specific aspects of the video clip that we as science instructors considered to be less critical.

Evidence of Impact

In this context, we use FAVSTE “behind the scenes” to guide pedagogical decisions about video analysis sessions and do not directly provide it to teacher candidates. As will be seen repeatedly throughout the following examples, one powerful application of FAVSTE is as a communicative tool to support teacher educators in making intentional choices about the design of instruction. For us, the “trickle-down” impact of FAVSTE has been consistently observed in candidates’ self-reflection assignments and course evaluations, where they report on the positive impacts of the video analysis sessions. For example, one candidate reflected:

I also learned that a teacher can learn a lot by listening to student’s ideas and their prior knowledge. When watching case #1845… the teacher presented an opening question and the students discussed with one another of what they knew and what they agreed or disagreed about from their peers. This was a great way for the teacher to see what students know and to tailor the rest of the lesson to developing the aspects of a standard that is missing.

Context 2: Secondary Science Methods Course with Intensive Field Experiences

This example took place in an undergraduate secondary science teaching program at a Midwest liberal arts university with a university-wide teacher education program. The secondary science teaching program serves majors in various science departments as well as those in science education by faculty in both Colleges of Education and Humanities, Arts and Sciences. The program integrates professional education courses and methods courses with intensive classroom field experiences prior to student teaching. This includes a 2-3 semester sequence with a general science methods course and an upper-level physical and/or life science methods course depending on the major. A module approach to video analysis has been used with teacher candidates in the upper-level methods course for the physical sciences.

The Task Used to Support Key Learning Outcomes

In the methods for teaching physical science course, students complete a number of modules in which they analyze teaching videos from ATLAS and their own teaching videos from their classroom field experiences to provide evidence for effective science teaching practices in alignment with the 5E Learning Cycle (Bybee, 2014) and the Next Generation Science Standards (NGSS). A set of five modules were developed that incorporated FAVSTE and the pedagogical approach of the course and applied these to instructional strategies introduced within the context of video analysis. These modules were spread out across the semester with the first four modules focused on teaching videos of secondary science teachers from the ATLAS resources and the last module focused on candidates’ own teaching videos from their classroom field experiences. A summary of the module approach implemented is provided in Table 2.

Table 2

Summary of Module Approach to Video Analysis

Table 2: Summary of Module Approach to Video Analysis

Module	Objectives	Video Case Selection	FAVSTE Focus
Module 1: Introduction to ATLAS	Look for evidence within the case resources (video, commentary, instructional materials) for alignment with NGSS	Analyze one common chemistry case from ATLAS	Attending, Interpreting, and Deciding
Module 2: Alignment with Learning Cycle	Look for evidence in the teaching video of alignment with the BSCS 5E Learning Cycle Instructional Model.	Analyze one common physics case from ATLAS	Attending, Interpreting, and Deciding
Module 3: Effective Questioning Part A	Focus on effective questioning strategies used in ATLAS classrooms to develop criteria for effective questioning in their own classrooms	Analyze two earth science cases from ATLAS	Attending, Interpreting, and Deciding
Module 4: Effective Questioning Part B	Apply criteria of effective questioning strategies	Analyze one chemistry case from ATLAS	Attending, Interpreting, and Deciding
Module 5: Classroom Teaching	Look for evidence of BSCS 5E Learning Cycle Instructional Model and alignment with NGSS	Analyze own video	Attending, Interpreting, and Deciding to move beyond Evaluation

Use of FAVSTE in Designing the Task

The first module served as an introduction and exploration to the ATLAS resources and video analysis, with an emphasis on looking for evidence within a video case of teaching in alignment with the NGSS. Candidates first explored the various video cases, frameworks, and collections available. They then examined the commentary, background, and instructional materials for an ATLAS video case that focused on building the ability to observe periodic trends in a high school chemistry course. The candidates were asked questions that supported them in being able to *attend*, *interpret*, and *decide* in relation to critical events within the video. In this context, a critical incident is a moment during teaching that either significantly impacted the way that classroom events unfolded or revealed insights about the skills of the teacher. After individually completing this first module, the candidates discussed their ideas in small groups and shared their results from these discussions in class. The second module utilized a similar template but with a different focus (see Table 2). The third and fourth modules focused on effective questioning and used a slightly different format. In the third modules, candidates developed individual, group, and class lists of criteria for effective questioning strategies from the video cases they analyzed. In the fourth, candidates used the effective questioning list to identify the effective questioning strategies employed in a video case. For the fifth (and final) module, students transitioned from the ATLAS videos to their own teaching video.

Evidence of Impact

Although the candidates had been engaged in intensive field experiences since the beginning of their teacher education program, the analysis of the ATLAS videos provided them with opportunities to observe effective science teaching practices that they have yet to witness in their field experience classrooms. Candidates commented that the teaching videos modeled how the science teacher could facilitate discussions involving both teacher-student and peer-peer interactions. The focus on FAVSTE in analyzing the teaching videos in a modular format provides students with a number of opportunities to help develop proficiency in professional noticing to gain insights on the effective science practices being modeled.

The transition for candidates from analyzing the ATLAS videos to analyzing their own classroom teaching videos using the FAVSTE framework is essential for students to go beyond just evaluating their teaching based on what they have done well and what they need to work on. Future activities could support candidates' capacity to incorporate the attending, interpreting, and deciding aspects of the FAVSTE into their reflections on their own teaching outside the use of these modules.

Incorporating video analysis in a module format provides an example of how video analysis can be embedded in a course with alignment to the pedagogical approach of the course. The module format can be applied to any instructional strategy that is being introduced and reinforced in a methods course — and the FAVSTE can help to structure the module design.

Context 3: Secondary Science Student Teaching Seminar

This example took place in a MAT in Secondary STEM Education program at a large Midwest university. The program is designed to last three semesters, with a general STEM methods course in the summer semester, a discipline-specific methods course in the fall semester and a STEM student teaching seminar in the spring. The author for this example (Author 2) had taught the candidates in both the fall and spring methods courses, using FAVSTE to design and implement the video analysis tasks used in each (~6 per course) and the Professional Noticing Template (See Supplemental Material A) to scaffold the skills addressed by the tasks. Author 2 also was the instructor for the spring student teaching seminar, where one of the key outcomes was for candidates to transfer the professional noticing skills they had developed when analyzing others' videos in the methods courses to reflections on videos of their own teaching in the student teaching seminar.

The Task Used to Support Key Learning Outcomes

In the spring student teaching seminar, candidates regularly video recorded themselves when teaching and selected two videos (one in each half of the student teaching semester) for more formal reflection. The assignment description clarified that the video should be of a learning experience in which students were exploring a scientific phenomenon and that the candidates had the opportunity to facilitate conversation around making sense of a phenomenon. The candidates were to identify a critical incident (Tripp, 2011) in the video, then complete a formal reflection on that event using the Critical Incident Reflection (CIR) form (see Supplemental Material B). Although the CIR form had been used for several years prior to its use in this course, it was modified to better align with the Professional Noticing Template; those modifications were guided by FAVSTE.

Use of FAVSTE in Designing the Task

The Critical Incident Reflection (CIR) form was developed by a group of education researchers at Georgia State University (Calandra, Brantley-Dias, Lee & Fox, 2009). While it can be a powerful scaffold for deeper reflection (Jay & Johnson, 2002), the connections between the *reflecting* that it supported and the *noticing* supported by the Professional Noticing Template were not necessarily obvious to the teacher candidates. Thus, the CIR form was revised to make the connections more apparent; FAVSTE was consulted in developing these revisions. For instance, the *Position* section was re-written to highlight the need to surface candidate's beliefs that "might be influencing this interpretation [of the critical incident]." This revision was designed to highlight the *Stance* and *Beliefs* elements of the 'Aspects of Noticing' component of FAVSTE, as well as their inter-relationship.

Evidence of Impact

The candidates in the student teaching seminar struggled initially in transferring their noticing skills to reflecting on their own and each other's videos. It seems apparent that this was largely a function of the emotional connection to their own practice and the concern with being critical of their peers (Bopardikar, Borowiec, Castle, Doubler, Win, & Crissman, 2019). By the time the second set of CIR discussions took place during the seminar, candidates had overcome these issues and their conversations – and reflections – were more meaningful. As an example of where the candidates were at this point, a statement from Michael during the discussion of his CIR is provided; it came after one of his peers pointed out a flaw in a student's thinking to which he had not attended in the moment of teaching:

Uh, and I noticed, watching it back, it's like, man, right after I start talking again … nobody's quite as engaged as they were before that. And I think it's probably somewhat due to the fact that there's a lot being said there, and I don't really try to digest any of it. [Laughs] I just kind of push forward with my own kind of driving, uh, driving ideas of where I want the conversation to go, rather than letting it play out with what they've said and evaluating what's being brought up.

Michael recognized that he had not attended to a student idea that could have been a useful starting point for a more engaging class discussion. Just as importantly, in the written CIR form submitted after the seminar conversation took place, Michael translated that into beliefs that could better guide his response to and interpretation of students' ideas in the future:

Science, at its core, deals with answering questions and making sense of the world around us. For students, the notion that science can be questioned, evaluated, and improved is usually something that must be encouraged and developed over a period of time. The competing ideas (as well as the numerous conceptions present in student statements) presented during this incident was something I did not notice in the moment during the lesson. I was simply trying to “keep the ship afloat” as the class conversation progressed. Because of this mindset, I overlooked a real opportunity for a meaningful moment for the entire class to evaluate important ideas from their classmates.

Noticing is a critical part of the professional practice of being a science teacher. A teacher’s beliefs about teaching and learning can either undermine or support the application of skills such as noticing. Michael’s reflection shows that he made that connection and could restructure his beliefs about attending to student ideas as needed.

Context 4: Secondary Science MAT Program

In this example, FAVSTE provided a framework for faculty and external school partners to reconceptualize candidate preparation and graduation expectations in a MAT program for career changers. During the first year of this three-year program leading to 7-12 certification, teacher candidates take courses on adolescent development and subject-area pedagogy. The first year includes 50 observation hours as well as a cross-curricular methods class where teacher candidates present short lessons to faculty and their class colleagues. Years two and three require the candidate to be a classroom teacher of record with college faculty providing onsite mentoring four times each semester; once each semester the candidates video record a lesson they are teaching to be evaluated by faculty proficient in the candidates’ content area.

The Task Used to Support Key Learning Outcomes

Initially, the ATLAS videos were incorporated into the first-year science methods course. The videos served as a model of what to look (i.e. *attending*) for when completing the 50 classroom observation hours. Without a student teaching component prior to having their own classroom, models of best practice in the content area are critical to candidates’ understanding of how pedagogy informs practice. When the initial cohort of ATLAS users moved to their second year in the MAT program, ATLAS videos became part of the second content methods class. Here the focus became more analytical as candidates became teachers of record responsible for analyzing videos of their own classroom teaching. The ATLAS videos also play a role in the MAT capstone course. The culminating assignment requires candidates to compare teachers in two ATLAS videos to each other as well as to the candidate’s own practice. The reflection must be evidence-based, analytical, connected to issues of pedagogy and practice beyond what is observed in the videos, and be grounded in professional, state, and MAT program standards.

Use of FAVSTE in Designing the Task

Becoming familiar with FAVSTE allowed MAT faculty to use the noticing trajectory to frame candidate expectations for video use across the program. The first-year methods class now focuses on the novice trajectory, the second year focuses on the emergent trajectory, and the capstone experience incorporates the expert trajectory traits with specific emphasis on evidenced-based analysis and relations to broader educational issues.

Evidence of Impact

FAVSTE provides faculty and students, both within the science courses and across disciplines, vocabulary and benchmarks for clear and consistent analysis of candidate progress. Noticing connotes awareness and awareness becomes more astute with the knowledge and perspective candidates gain as they move through the program. FAVSTE allows analysis of candidates' pedagogical awareness and praxis within a developmental trajectory. Although currently used in content methods classes and the capstone course, faculty are discussing how FAVSTE can inform clinical courses. By clarifying language and expectations, FAVSTE is a useful tool in meeting program outcomes across secondary certification areas.

Context 5: Secondary Science Student Teaching in a MA and EDD Program

This example took place concurrently in a Masters' Program which leads to state licensure in Secondary Science Education and a Doctoral Program which leads to preparation in Science Teacher Education at a large east coast university. The program is designed to cover the middle school to high school continuum across two semesters, with disciplinary science coursework and corresponding methods course and fieldwork focusing on middle school in the fall and a parallel coursework focus on high school in the spring along with an intensive student teaching seminar. The Program Director co-taught and mentored the doctoral students in all of the MA courses in this sequence. The doctoral students functioned as master teachers, mentors, and University Supervisors in the student teaching seminar. We approach our work with the assumptions that teacher education is on-going and continuous throughout a teacher's career. We see our collaborative team effort among supervisors, faculty, student teachers, and doctoral candidates as one of the first steps in providing positive professional development which is necessary for developing efficacy, identity, and agency in the process of learning to teach (Feiman-Nemser, 2001; Luft, Roehrig, & Patterson, 2003). Our examination of our roles in the professional learning continuum empowers us to address the lack of cohesion among the stages between and including preservice through inservice teacher learning (Knight et al., 2015; Luft et. al., 2003; Luft, 2007; Luft & Hewson, 2014).

The Task Used to Support Key Learning Outcomes

In the spring student teaching seminar, candidates utilized the video tool Vialogues in tandem with the ATLAS library, as a medium to annotate and reflect on practice as well as prepare for the high stakes edTPA (2013) assessment. In groups facilitated by the doctoral supervisor mentors and the lead faculty member, the student teachers created five video Vialogues, each with a different theme: content knowledge, planning, learning environment, instruction, and professional dispositions. The goal was to find 5 minutes of footage of their own teaching that candidates felt showed some evidence of that theme. Supervisor mentors watched their group's video and provided annotated feedback in the video tool. After review, the supervisor mentors would collaborate with the faculty lead to discuss themes in the teacher candidates' work. The faculty lead would then search ATLAS to identify specific cases in that fit as an exemplar to share with the candidates on the areas that needed further development, i.e. collaboration, inquiry, cooperative learning, board work, to name a few examples.

Use of FAVSTE in Designing the Task

One of the critical components of FAVSTE in the design of this activity was to provide teacher candidates a collaborative way to *notice* and *reflect* concurrently on one's own and peers' work. As we wanted the *noticing* to be "in the moment", we felt the Vialogue tool was a necessary adjuvant component to ATLAS to facilitate the process of *reflecting.* We also wanted to cultivate an online community of practice that could potentially outlive the candidacy period and serve as a platform during induction for continual communication and support with the colleagues and mentors with whom they first developed these skills and trust.

Evidence of Impact

The candidates in the student teaching seminar worked in four groups to document noticing and reflecting on their own and each other's video in five Vialogues with the themes of content knowledge, planning, learning environment, instruction, and professional development. Table 3 details the incidence of noticing, defined as number comments annotated in the video tool, across each group and theme. It is interesting to see that the area that the student teachers found most comfortable to notice and reflect upon was instruction (mean 16.25) and content knowledge (mean 16.25), followed by learning environment (mean 16.00) and then planning (mean 14.5). Upon reflection, we noted that during the formative stages of this learning activity, the concurrent access to the ATLAS master videos helped the student teachers to *see themselves* in a way that we were never able to fully explain to them using traditional pedagogy. We found this multi-modal approach useful and look forward to implementing it with our second cohort of student teachers this spring.

Table 3

Incidence of Noticing across each Group and Theme

Table 3: Incidence of Noticing across each Group and Theme

	Content Knowledge	Planning	Learning Environment	Instruction	Professional Dispositions
Group 1	8	9	10	17	5
Group 2	19	13	17	17	11
Group 3	16	16	17	18	16
Group 4	22	20	20	13	4
Mean	16.25	14.50	16.00	16.25	9.00

Conclusion

As the collaborative considers our individual and collective use of FAVSTE, we have found the following: (1) FAVSTE could be applied effectively across a variety of settings, demographics, courses, and goals; (2) when used as an instructional design tool, FAVSTE provided a meaningful scaffold for teacher candidate learning; (3) the use of FAVSTE spurred innovative and varied teacher educational practices; and (4) our use of FAVSTE allowed us to test and refine conjectures regarding teacher candidates' learning trajectories.

First, as evident in the cases presented, members of the science collaborative conduct their work in a variety of settings (e.g. large state universities and small private universities across the U. S.), work in a variety of different programs (e.g. undergraduate and graduate level programs at the elementary and secondary levels), and are housed in various colleges and departments within the university (e.g. Department of Physics, Department of Teaching and Learning, etc.). Our examples provide evidence of the flexibility of FAVSTE in the continuum of teacher professional learning and the many different contexts of teacher education. The broad utility of FAVSTE across these varied contexts suggest that it is a tool that would be useful for other teacher educators interested in using video analysis to support teacher education.

Second, by bringing together both existing literature on video analysis research (e.g., van Es and Sherin, 2002, Abell & Cennamo, 2003) and the experiences and knowledge of a team of science teacher educators with diverse perspectives and expertise, the design of FAVSTE was grounded in both research and practice. The principled use of FAVSTE allows the teacher educator to focus teacher candidates' attention to particular elements of teaching (as exemplified by and filtered through different aspects of noticing delineated in the framework), thus breaking down the complexity of teaching into smaller, more manageable pieces that are accessible to the teacher candidate. This targeted focus supports teacher candidates' ability to develop ways of seeing and talking about teaching practices, thus guiding their learning and development along a structured trajectory. We argue that over time this foundation has the potential to help the teacher candidate build more comprehensive knowledge and skill in relation to specific elements of practice that also simultaneously considers and coordinates the various elements of the framework into a seamless whole.

Third, given the range of instructional purposes and pedagogical structures characterizing FAVSTE use in the cases presented, the framework has been shown to be a versatile tool for structuring and scaffolding teacher candidate learning through video analysis. In addition, FAVSTE use spurred the design and implementation of innovative pedagogical structures (e.g. modules) and strategies (e.g. the explicit building over time) for supporting a teacher candidate's ability to apply what they are learning through video analysis to their own practice (e.g. as they move from analyzing someone else's video to analyzing their own). Through consideration of FAVSTE, the teacher educator designed meaningful tasks for teacher learning as suggested by the voices of the teacher candidates in Context 1 and Context 3. We attribute the articulation of the varied facets of noticing (e.g. perspective, stance, grain size, etc.) as being critical to spurring this innovation. As we ascertained and named the various aspects of noticing in action, we were positioned as teacher educators to break down this complex skill into constituent parts that could be more easily learned and applied by the novice. The use of FAVSTE and associated innovations spread through teacher educator programs as seen in Context 2 as well as across the institutions of our group, allowing us to build on each other's innovations. Our intention is that other teacher educators may also be able to use and build on this work.

Finally, as teacher educators, we make intentional choices regarding which elements of the framework and/or practice to focus on. These choices are shaped by our varied contexts of use and more specifically as our consideration of details of the structure and sequence of our individual programs and where our particular courses are situated in these sequences. Our decisions therefore are implicitly, if not explicitly informed by our own conjectures regarding trajectories of teacher candidate learning (Hundley et al., 2018). As we continue to use FAVSTE as a framework, we could begin exploring which, if any, of the elements of the framework are foundational and might need to be developed by the teacher candidate prior to other elements of the framework that might require more sophisticated, nuanced, and/or contingent thinking and analysis on the part of the teacher candidate. Thus, not only was the design of FAVSTE grounded in research and practice, but the principled use of FAVSTE by teacher educators has the potential to contribute to the generation and refinement of theory and practice related to teacher candidate learning and development.

Supplemental Files

Supplemental-Material-A.docx

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