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Examining the Quality of Preservice Science Teachers' Written Reflections When Using Video Recordings, Audio Recordings, and Memories of a Teaching Event

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A group of preservice science teachers edited video footage of their practice teaching to identify and isolate critical incidents. They then wrote guided reflection papers on those critical incidents using different forms of media prompts while they wrote. The authors used a counterbalanced research design to compare the quality of writing that participants produced when they had access to either their edited video clip of the incident, audio from the clip only, or their memory of the incident alone while writing. All reflection papers were evaluated using a rubric developed by Ward and McCotter (2004). An analysis of variance among paper scores showed that participants wrote significantly higher quality papers on several indicators when prompted by video than when prompted by audio. There was also a difference in means between their reflections when prompted by video and when they worked from memory alone.

A recent review of the literature has shown that digital video is being used as a major component of teacher education and professional development worldwide and across disciplines (Gaudin & Chaliès, 2015). A growing body of scholarly work has indicated that some attributes of digital video may be particularly well-suited for preservice teachers' (PSTs') reflective practice (Brophy, 2004; Calandra & Rich, 2014; Gaudin & Chaliès, 2015).

Digital video provides PSTs with the ability to capture, edit, annotate, review, and share evidence of personal teaching practice in a tangible and authentic format. In other words, with digital video, a PST can capture the "richness and complexity of classroom activity" (Gaudin & Chalies, 2015, p. 43) then learn from it through analyzing, discussing, deconstructing, and reconstructing the captured events, which is similar to how reflective teacher learning has been described in the past (Shulman, 1987). The affordances provided by digital video can provide PSTs with opportunities for learning that are situated in practice, something supported in teacher education in general (Putnam & Borko, 2000; Shulman, 1987; Yost, Sentner, & Forlenza-Bailey, 2000), and science teacher education more specifically (Rosaen, Lundeberg, Cooper, Fritzen, & Terpstra, 2008; Yerrick, Ross, & Molebash, 2005). In addition, many researchers have found digital video to be an effective tool for helping teachers to learn from and link to *their own* teaching practice (Calandra, 2014; Gaudin & Chaliès, 2015; Rich, & Hannafin, 2008; Seidel, Blomberg, & Renkel, 2013; Seidel, Sturmer, Blomberg, Kobarg, & Schwindt, 2011; Sun & Van Es, 2015; Van Es & Sherin, 2010).

As part of this body of work, some researchers have been examining a process of teacher reflection that includes editing digital video of one's own teaching for critical teaching incidents and then writing guided reflection papers (Calandra, 2014). In one of these critical incident reflection studies, the researchers compared the quality of guided reflection papers written either with or without video support (Calandra, Brantley-Dias, Lee & Fox, 2009). In the 2009 paper, it was reported that participants who edited video of their own teaching and then later wrote guided reflection papers, wrote longer, more meaningful, and more pedagogically connected papers than did their counterparts who engaged in the same guided reflection, but without capturing or editing video. Although the Calandra et al. (2009) study found evidence that participants were capturing and editing video of their own teaching at some point before writing reflection papers, the PSTs were allowed to write their reflection papers at home, meaning that there was no reliable evidence of whether or when they referred to the video clips during their reflective writing.

Less can be found in the academic literature about the use of audio recordings for PSTs' reflective practice. Accordingly, the impact of audio recording "on preservice teachers is relatively unknown compared to previous studies and extensive applications of video-recording" (Bergman, 2015, p. 129). Audio recordings of both teaching episodes and reflective discussions have been utilized successfully in some studies as a method to stimulate PSTs thinking about their instructional strategies and pedagogical content knowledge (Hofer & Grandgenet, 2012; Jong, Van Driel, & Verloop, 2005). One question that is not addressed in these studies, however, is whether and why audio rather than video recordings may be more or less likely to support PSTs' reflective practice. This is an important question to ask, because there is a large body of literature that supports the use of video for PSTs' reflective practice, and because digital video recording is nowadays easier to support in teacher education contexts than in the past (Calandra, 2014).

Bergman (2015) compared how the use of audio recordings and video recordings of PST's own teaching affected their reflective writing. Part of Bergman's rational for trying audio was that video recording their own teaching may cause increased participant anxiety, privacy issues, and technical challenges. In addition, Bergman claimed that audio may be a less demanding and more user-friendly medium for teachers to use while writing reflections or multitasking in other ways. Bergman found that, generally, there was no large difference in reflections across media groups, but the video group paid significantly more attention in written reflections to teacher movement and nonverbal behaviors than the audio group did.

Bergman (2015) also suggested that the few students from the audio group who referred to movement and gestures in their reflections may have been doing it from memory rather than from what they heard in the recording; thus, he suggested, "it would be insightful to use a similar study design to learn if preservice teachers using audio-recordings score closer to those using video-recordings or to those basing their reflections on memory alone" (p. 136).

The purpose of the current study was to examine what happened when a group of PSTs used video prompts, audio prompts, or memory alone during a guided reflective writing exercise. This exploratory study used the following research question: Is there a difference in the type of guided written reflections PSTs produce when immediately prompted by either video recordings of a critical teaching incident, audio recordings of a critical teaching incident, or memory of the critical teaching incident alone?

Method

In this study, the researchers examined a group of 28 PSTs who first videorecorded their practice teaching, edited the video footage to identify and isolate critical incidents, and then wrote guided reflection papers in a proctored classroom setting. Participants wrote their papers while having access to either the edited video clips, audio only from the video clips, or memory alone of the teaching incidents. Twenty-three out of 28 participants completed all three treatments, and the data from those 23 participants were used in this study.

A counterbalanced design was used to compare the quality of reflective writing the participants produced. This design ensured that all 23 participants worked through all three versions of the treatment and that all potential sequences for treatments were accounted for. In this way, the researchers hoped to account for time, sequence of treatments, and participants' prior knowledge (see Table 1).

Table 1
Counterbalanced Design

Group	Treatment Sequence			Participants
G1	M	A	V	5
G2	M	V	A	3
G3	A	V	M	3
G4	A	M	V	4
G5	V	M	A	5
G6	V	A	M	3
Note: M stands for memory only; A stands for Audio; and V stands for video.				

Context and Participants

This study was conducted in an Introduction to Secondary Science Teaching course. Of the 31 students enrolled in the course, 28 were graduate students and three were undergraduate students. The 28 graduate students who were asked to participate in the study were enrolled in a Master of Arts in Teaching (MAT) secondary science program housed in a Department of Middle and Secondary Education at a research-intensive university in the southeastern U.S. The graduate students did not have professional teaching experience. See Table 2 for graduate student participants' demographic information.

Table 2
Demographic Information of Graduate Students Enrolled in the Course

	MAT Science Education Graduate Track	
Ethnicity	**Male**	**Female**
White	2	9
Black	3	10
Asian	1	2
Latino		1
Total	6	22

Science Education is one of seven MAT degree programs in the department designed for students who hold a bachelor's degree outside of education (science in this case) from a regionally accredited college or university and who wish to obtain an initial teaching certification in their chosen field. The MAT provides individuals who have interest in teaching science with initial teacher certification.

The MAT students in this study could choose to concentrate on broad field science, biology, chemistry, earth science, and physics. As a part of the program, students were placed in student teaching assignments at a middle and high school in a metropolitan area near the university. Each student was assigned a mentor teacher from the teaching staff at their practicum school, and each was supervised by a faculty member from the Middle and Secondary Education department.

Introduction to Secondary Science Teaching. The secondary science methods course that provided the context for this study was the first course in a sequence of three science methods courses offered to MAT degree students. The course combined essential components for secondary science teacher preparation. It provided a context for the exploration of instructional materials, different teaching strategies, educational technology, and developing an understanding of effective science teaching for students in grades 6-12. This course provided a variety of experiences in science education that were characterized as experiential, inquiry-oriented, and reflective. The nature of the course was open and informal in order to create an interactive and supportive environment for PST collaboration. Various teaching strategies were used to model effective teaching and practice, including microteaching.

Microteachings. The microteaching activities that became the context for this study were part of a performance-based assessment. The goal was to give the PSTs a chance to practice some of the basic skills of teaching in a safe, comfortable environment while still experiencing some of the realities of teaching. There were three microteaching activities, limited to 15 minutes each, which took place during the activity in question.

Before each microteaching, the PSTs were given a minilesson prompt, for example, "Explain the science behind a commercially available product to high school students," or "Introduce the students to a piece of cutting-edge science/technology that can be connected to a given set of educational standards." In each of the microteachings, PSTs worked in small groups of four to five peers and three to four high school students who had an interest in pursuing a future career in teaching and who were invited from local area high schools.

The PSTs were expected to help their audience come to an understanding of certain content, and they were evaluated on the way they met this expectation relative to their level of experience within the course and to teaching, in general. Course evaluation of microteachings focused on the mechanical aspects of PSTs' performance, with the overall expectations increasing from microteaching to microteaching.

For example, when they performed the first microteaching with high school students, the PSTs simply focused on their ability to speak clearly, present a coherent message, and make some attempt to engage their audience. With each microteaching that followed, the set of expectations increased, shifting from focus on self to focus on students. Although the PSTs were not expected to create a formal lesson plan for the microteaching activities, they were advised to make use of some form of notes or scripts.

Each PST prepared and presented a microteaching individually, although they could do preparation as a group. During the microteaching activities, the high school students rotated from group to group after each PST from the same group presented the lesson. Each microteaching was video-recorded on a mobile device. Videos were recorded by PST peers.

Video-Aided Teacher Reflection. The video reflection exercise described in this section was repeated three times over a 7-week semester as one part of the PST's microteaching activities. On Wednesday of the first week, each participant was assigned a mobile device and ear buds. Mobile devices were chosen for this exercise because they allowed participants to record, trim, and share video footage of their teaching with peers and mentors easily, anytime, anywhere and using only a singular device. In addition, the mobile devices were small and portable enough to be less intrusive during participants' in-class recording.

We have found that using mobile devices is an effective alternative to bulkier and more complicated professional video kits that include video cameras, tripods, and microphones, and that have been used for this purpose in the past (Calandra, 2014). We gave participants a training session on how to record and edit video using the mobile devices, which included an in-person demonstration, a printed handout, and a link to a YouTube video tutorial.

Next, participants were asked to choose a partner from among their classmates to assist them with video recording while they did their microteaching. Participants in the study each had a partner record their practice teaching. Having a partner record the teaching allowed the participants to interact naturally with their students, without the additional task of controlling a camera before, during, or after teaching. Once footage of their practice teaching had been recorded, participants were asked to review the recordings on their own and to look for critical incidents. A critical incident was described to them in this way:

A Critical Incident is a moment during a teaching episode that you recognize as significant, either in terms of the impact that moment had on the way the episode unfolded, or in terms of what that moment showed you in relation to your developing skills as a teacher.

Participants were then instructed to isolate three separate critical incidents from the entire recording of their teaching and save those clips as separate files on their mobile devices using a function called "trimming." Students were asked to keep their clips between 1 and 3 minutes long. During the in-class treatment, all participants were given 30 minutes at the end of their regular course time to write a guided reflection paper on what happened during their critical incidents using varied multimedia prompts based on treatment group. Participants' reflective writing was completed and submitted to their instructor as an electronic document. The researchers were later provided access to these documents.

This cycle of recording, editing, and reflecting from Wednesday teaching practice to Monday reflective writing exercise was repeated in three equally spaced intervals over 3 weeks. During each of the treatment cycles, participants were randomly assigned to refer to either the 3-minute, edited critical incident video clip, audio only extracted from their edited critical incident video, or their memory of the teaching event alone while writing their guided reflection papers. Participants using mobile devices could play, pause, and rewind the audio or video as many times as they chose to.

All sessions were proctored to ensure that participants could successfully complete their tasks during the allotted time. Participants assigned to the audio and video treatment groups used headphones. Participants assigned to the memory treatment were not allowed to view their mobile device before or during their 30-minute reflective writing session.

Writing Guide

Some prior research has shown that PSTs can have trouble writing high-quality reflection papers due to a variety of factors, including (a) lack of prior knowledge about teaching, (b) under developed writing and expressive skills, and (c) not fully understanding what it means to reflect and to write reflectively (Lai, Calandra, & Ma, 2008; Calandra, Sun, & Puvirajah, 2014). To address this concern, participants in the current study wrote their reflection papers guided by a protocol called the Critical Incident Reflection form (CIR) (Brantley-Dias, Calandra, & Fox, 2007; Griffin, 2003). (See Appendix A.)

In this study, the CIR first asked participants to provide an in-depth description of the critical incident that they had identified and trimmed the previous week, but without using judgment, interpretation, or point of view. Second, the CIR asked participants to describe the feelings they experienced during the incident. Third, the CIR asked participants to explain the incident again, but this time to take on the perspective of each actor who participated in the incident, such as the as teacher [self], the student, and so forth. The CIR then asked participants to discuss the incident in terms of culturally relevant teaching as well as teacher beliefs.

These topics were drawn in part from Griffin's (2003) work on critical incidents, but also from topics that were being discussed in the science teacher education program in question. Finally, participants were prompted by the CIR to describe what they felt that they might have done differently during each incident after having had a chance to reflect. Data analysis was based on reviewing participants' responses to sections of this reflection guide.

Reflection Paper Scoring Procedure

The first and third authors rated each reflection paper using Ward and McCotter's (2004) reflection rubric for guidance. The rubric includes three dimensions of reflection (focus, inquiry, and change) and four qualitative levels of reflection (routine, technical, dialogic, and transformative).

Seminal works by Dewey (1933) and Schön (1983) were utilized in developing the dimensions and levels. In a review of reflection rubrics, Lee (2005) found that teacher educators tend to use terms *practical/technical*, *contextual/deliberative/conceptual*, and *critical/dialectical/transformative* to identify different levels of reflective thinking in teachers' reflective practice. These are also similar to van Manen's (1977) three stages of reflective thinking. Indeed, we have used similar frameworks to evaluate reflective papers in the past and found the Ward and McCotter (2004) rubric to be both an appropriate and validated measure that was amenable to quantitative scoring of reflection papers (Lai & Calandra, 2010; Lai et al., 2008).

For the purposes of this study, we assigned the following numbers to each of the four levels: routine-1, technical-2, dialogic-3, and transformative-4. Each rater underwent training on how to use the rubric to minimize any measurement error. Raters then scored each section of participants' written reflections. Sections were based on the format of the CIR. After Round 1 of ratings, some small differences in rater scores were found, although interrater reliability produced an intraclass correlation coefficient (absolute) of .815, which was above the acceptable 0.70 coefficient (Shrout & Fleiss, 1979).

Even though the intraclass correlation did not show a serious measurement error, the raters decided that a second round of ratings using a third rater would be appropriate. For Round 2, the second author randomly rated 20 (26%) of the 77 total ratings used in the study. The third rater's CIR scores were consistent with each of the previous raters, but the reliability index was still at .815. There was no evident pattern, however to indicate that one rater was higher or lower than the other. Finally, and to further remove chances of measurement error, the first two authors met for a third time to review all ratings, discuss differences, and come to complete agreement on each score. While there were 77 total reflection papers produced from 28 students in the course, five of the PSTs did not complete all three treatments. Although their reflections had been rated, these reflections were later discarded, leaving a total of 69 total reflections produced by 23 participants that were used for the final round of data analysis.

Analysis and Results

To answer our research question, we compared reflection paper scores between treatments (video, audio, and memory) on each of multiple dependent variables. The first variables were based on scores given to each section of the CIR form: *what, perspectives, emotions, diverse learner, position, and actions* (see Appendix A). An average score of all CIR sections, called "overall CIR score," was also used. We conducted a repeated measures ANOVA and, where applicable, LSD post hoc analyses. The LSD post hoc analyses allowed us to determine which differences existed amongst the dependent variables when a statistically significant main effect was determined. Those results are reported in the next sections.

Overall CIR Scores

Using repeated measure ANOVA, we found a significant main effect on overall CIR scores, F (1,22) = 5.2, p = .014. Partial ETA squared (effect size) was .33, and power was .78. An LSD post hoc analysis was then run on the data in order to determine the degree of difference between treatment groups. CIR papers written while using video footage of the critical incident earned significantly higher scores on average, $p < .05$, than those written by participants when using audio. For examples of CIRs, see appendices B and C. See Table 3 for descriptive data.

Table 3
Descriptive Statistics for CIR scores by treatment

Treatment	Mean	*SD*	*N*
Video	2.4491	.44764	23
Audio	2.1383	.40411	23
Memory	2.2096	.50518	23

Significant main effects were also found on mean scores from three of the six CIR sections: *what*, *emotions*, and *perspectives*. For those means only, LSD post hoc analysis was used in order to determine the degree of difference between means of each set of treatment scores. CIR data excerpts for these sections are provided as scoring examples in order to further illustrate the findings.

What (Descriptions)

A significant main effect was found for scores on the *what* section of the CIR: F(1,22) = 3.60, p = .046. Partial ETA squared (effect size) was .26 and power was .60. Participants' descriptions of their critical incidents when referring to video were scored significantly higher on average $p < .05$ than those written by participants when using audio. See Table 4 for descriptive data.

Table 4
Descriptive Statistics for CIR Scores on the What Section

Treatment	Mean	*SD*	*N*
Video	2.3478	.64728	23
Audio	1.9565	.63806	23
Memory	2.0000	.67420	23

The *what* section of the CIR guides the participants' focus on the event that occurred. The highest score for this section was a score of 3 (Dialogic) with the lowest being a 1

(Routine). To receive a score of 3, the reflective writing had to contain a focus on students, informal or formal assessments, and interactions that would help the teacher to interpret if and how students were learning about the content (Ward & McCotter, 2004). The following is an example of a Dialogic reflection from a participant in the video treatment:

Students are learning about gene splicing and using paper DNA to splice together firefly and plant DNA to make a glowing plant. At this part, students are identifying cut points, isolating the "glowing" gene, and inserting it into the plant DNA. Of the three students, one has done this before and is moving quickly, one has not but is familiar with the concept and is moving at the pace I expected, and one is not familiar or for whatever reason moving a little slower. As they isolate and cut, the third student starts falling a little behind, partly because it takes her longer to find the cut points on the firefly DNA and partly because she doesn't seem as interested in doing it. Because of time, I begin giving the next instructions before she finishes cutting. Then the students use the same enzyme to cut open the plant DNA. At this point, the third student is struggling to find the location and does not show that she understands the concept. I demonstrate using another student's DNA and that student leans over to help her. As they finish, I ask a few extension questions about why this technique is expensive and why some people object to it. Students 1 and 2 volunteer answers but Student 3 tunes out. (Participant 23; Reflection 2; Video Treatment)

Rather than focusing on the outcome of the learning, the participant reflects on the learning process, particularly for the struggling student. She pays attention to the students' level of participation and understandings of the concepts.

In this section, reflections again received a score of 2 (Technical) when the participant focused on teaching tasks such as asking questions, as in the following example:

At the beginning of my microteaching lecture, I provided pictures of cars and asked my students what made the cars operate, to which they replied "gasoline." I said, "Correct, and we use oil to make gasoline." I then asked them if they knew of another word to describe oil, to which they replied, "fossil fuel." I asked them if fossil fuels were good or bad for the environment, to which they replied bad, and I asked them why. The students told me that fossil fuels pollute the air and the environment. (Participant 14; Reflection 1; Memory Treatment)

Typical of a Technical reflection, Participant 14 did not extend the reflection to include the quality of students' responses, nor did she try to make connections between the specific instructional strategy and student learning.

A score of 1 (Routine) indicated that the participant was focusing on self or analyzing practice without a personal response. This type of lower level reflection does not focus on a particular problem or the complexity of the situation. The following is an example of a Routine reflection from a participant in the audio treatment:

During the beginning of my presentation, one of the students was using the restroom and did not join the presentation before 3 minutes in. When she came in she was somewhat disruptive while moving her chair around when she sat down and the other students were paying attention to her instead of me. (Participant 61; Reflection 2, Audio Treatment)

Rather than taking responsibility for the incident or questioning what role he might play in changing the situation, the participant places blame on the student who enters late. This was typical of a Routine reflection in the *what* section.

Emotions

A significant main effect was found for scores on the *emotions* section of the CIR: $F(1,22) = 4.97$, $p = .017$. Partial ETA squared (effect size) was .32 and power was .75. In other words, participants' descriptions of the feelings they had during the critical incident experience when referring to video were scored significantly higher on average $p < .05$ than those written by participants when using audio. See Table 5 for descriptive data.

Table 5
Descriptive Statistics for CIR Scores on the Emotions Section

Treatment	Mean	*SD*	*N*
Video	2.3478	.57277	23
Audio	1.8696	.81488	23
Memory	2.2174	.73587	23

Like the previous section, the highest level for the *emotions* section was 3 (Dialogic) and the lowest was 1 (Routine). Using the reflective process to gain new insights into teaching is another dimension of the Dialogic exemplar (Ward & McCotter, 2004). Through inquiry, participants engage in ongoing questions about their practice to facilitate changes in their beliefs or professional practice. The following example represents such a Dialogic score:

> I felt much more confident and relaxed with this particular incident than any of the previous Micro-teachings. I also tried to hold back and give the students the opportunity to answer my questions and respond to each other which was difficult/frustrating at times (especially because of time constraints); however, I realize that giving students the time to answer questions is extremely important. Holding back and giving the students time to answer was especially difficult because I could tell one student was struggling more with the concept and examples of adaptation than the other. (Participant 15; Reflection 3; Video Treatment)

The focus on students leads the participant to change how she approaches classroom discourse. She pays particular attention to the struggling student.

A score of 2 (Technical) was assigned when participants illustrated concern about a specific teaching task rather than examining their emotions or insights into improving practice or questioning their instructional solutions. The following is an example:

> Although my glass lesson was not nearly as exciting as the previous week's lesson on water, I was glad that my group of students was able to gain something from the lesson. Also, I only used 11 of my allotted 15 minutes, and really wish I had planned more to utilize that time. (Participant 35; Reflection 2; Memory Treatment)

A score of 1 (Routine) generally illustrated a lack of analysis. For example, in the passage below, the PST used "snack ingredients" in order to help students conceptualize the parts

of a cell: "I was excited to teach this lesson. I wanted to make the students feel comfortable with exploring the cell in an interactive way" (Participant 54; Reflection 3; Audio Treatment).

Due in part to a lack of detail, the PST is unable to make any connections between her emotions, what she pays attention to during her teaching, or any changes in her approach that might be necessary.

Perspectives

A significant main effect was found for scores on the *perspectives* section of the CIR: $F(1,22) = 4.40$, $p = .025$. Partial ETA squared (effect size) was .30 and power was .70. In other words, participants' descriptions of their critical incidents written from the perspective of each actor who participated in the incident (done when referring to video) were scored significantly higher on average $p < .05$ than those written by participants when using audio. See Table 6 for descriptive data.

Table 6
Descriptive Statistics for CIR Scores on the Perspectives Section

Treatment	Mean	*SD*	*N*
Video	2.0870	.79275	23
Audio	1.4783	.66535	23
Memory	1.9130	.73318	23

The highest score in this section was 3 (Dialogic) with the lowest being a 1 (Routine). As the term implies, an aspect of a Dialogic reflection is a dialogue with others or with self in which the participant considers the views of *others*. The *perspectives* section of the CIR renders the internal dialogue explicit. The following is a typical Dialogic example from the video treatment group. In this example, the PST reflected on an incident that occurred after a minilecture on waves and light, in which a student posed a question about dreaming in color. The PST focuses on what multiple students may be thinking as he facilitated the discussion:

> Jazmin (student): This is kind of interesting, I've heard this thing about dreams before. I wonder if it's true. The purpose of this experience is for us to learn new scientific information.
>
> Spencer (student): I always dream in black and white. That matches up with my life experience. It reminds me of this one dream that I had, which was crazy!
>
> Matt (teacher): I'm happy to answer questions and give you guys some new scientific insights; we're starting to get off track here, and I feel like the balance of our time is swinging away from topical learning into relaxed, social time. I need to bring things back under control if I'm going get anything done... (Participant 53; Reflection 1; Video Treatment)

Reflections receiving a score of 2 (Technical) often had a narrow focus on a teaching task, but did not demonstrate thinking about the situation from multiple perspectives. In the following example, Participant 54 conducted a microteaching about cells and focused her critical incident on an instructional method used during the lesson:

> I choose to be very interactive with students because I wanted to engage them in during the lesson. In addition, I wanted to keep their attention. The students seemed to be very receptive. The students commented that they wanted to come over because they were interested in knowing what the activity would be (Participant 54; Reflection 3; Audio Treatment)

A score of 1 or a Routine reflection was typically short and written as if the PST completed the analysis for its own sake (Ward & McCotter, 2004). For example, after listening to the audio recording of the lesson, this PST reflected on what a student thought about the lesson on why ice floats: "From a student's perspective: The lesson went well. You were able to make water interesting" (Participant 35; Reflection 1; Audio Treatment).

As illustrated in these examples, these reflections lacked insights into students' thinking as well as the participant's own thinking. Thus, the PST has negated any problem solving or insights that might occur if she had considered *all* participants' perspectives.

Limitations

Participants wrote their reflections while together in a large classroom. Thus, even though they used headsets to listen to recordings of their critical incidents, they may have experienced some distraction. All participants video-recorded themselves teaching and edited the video for critical incidents before writing their reflection papers. This may have influenced their reflective writing in different ways. For example, a small number of the participants who were in the memory only treatment group still seemed to reference video in their guided reflection papers. All three raters in this study were authors of this paper, which is why multiple procedures were put in place to reduce researcher bias as much as possible, even though initial rating was done blind. As mentioned earlier in the paper, not all participants completed all three treatments, which is why the *N* reported in the results section is 23 rather than 28. In addition, the sample size was small and power was adversely affected. Future studies will include a larger sample.

Finally, the Ward and McCotter rubric has a specific focus on student learning and teacher practice. The CIR was not designed specifically for that, but rather to help the PSTs focus on the *meaning* of any incident that made them take notice of their practice rather than on only the *experience* of it (Griffin, 2003). Thus, if the focus of participants' written reflection papers did not align with the intent of the Ward and McCotter instrument, it could have resulted in a lower score. Although this may be viewed as a limitation, we were interested in fostering the kind of reflective practice promoted by Ward and McCotter (2004) and their rubric.

Discussion

With regard to individual sections of the CIR, it is noteworthy that the significant differences found on individual sections of the paper were on the first three sections of the CIR, which were developed to help PSTs describe, focus on, and recall the incidents. This result may have been due to the fact that video provides a richer and more accurate recording of a teaching incident from which to reflect than audio.

Also of note was that the Emotions and Perspectives sections of the CIR were specifically designed to elicit participants' emotions and shift participants' focus away from themselves, which is consistent with studies that have uncovered how working with video of one's own teaching can elicit a combination of cognitive as well as emotional processes that may influence teacher learning (Seidel et al., 2011). They have also found that viewing video of one's own teaching can help PSTs shift focus from themselves to others Calandra, Gurvitch, & Lund, 2008; Santagata, 2009; Sherin & van Es, 2009; van Es & Sherin, 2008).

No significant difference was found on the last three individual sections of the CIR between treatments. This occurrence may have been a result of small sample size or because the medium (video, audio, none) had less of an influence when writing about Cultural Relevance, (Teacher) Position, or (Future) Actions. Similar studies have also reported varying levels of reflection resulting from media conditions, but dependent on the type of question asked in the reflection instrument (Bergman, 2015; Welsch & Devlin, 2007).

Media in and of itself made less of a difference in this study; rather certain attributes of media may have been more or less supportive for different types of learning from PSTs' own teaching (Clark, 1983; Kozma, 1994). Regardless of where one stands on the importance of media for learning, these results are important, because video is currently being used on such a large scale in teacher education.

Finally, while the literature contains many reports that support the use of digital video for PST development, some in the past have warned that the process can feel difficult, cumbersome, and intrusive for participants and their students, which in turn, adversely affects levels of participation in video-aided teacher reflection exercises. To a large extent, this effect has been a result of the seemingly large amount of effort required to record footage of classroom teaching and, in some cases, a rather high learning curve for video editing software. We have found that using mobile devices for teacher education purposes has made the process easier because (a) using a mobile device to capture video is now rather a commonplace activity, (b) mobile devices are comparably more familiar and less obtrusive in classroom contexts than professional cameras or recorders, and (c) users can capture, edit, and share video footage with relative ease all on the same mobile device.

The purpose of this study was to examine what happened when a group of PSTs used video prompts, audio prompts, or memory alone during a guided reflective writing exercise. In conclusion, we found that that reflection papers written while referencing video of critical teaching incidents were of significantly higher quality than those written while referencing audio.

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Appendix A
Critical Incident Reflection Form

What are Critical Incidents?

Critical Incidents are the "oops," "ouch," "aha...," or "oh..." moments that you experience during a teaching episode or as you watch your videotaped lesson. The incident may be something that "amused" or "annoyed," was "typical" or "atypical," or a "felt difficulty" or "felt success."

Why use Critical Incidents?

One goal of using critical incidents is to help you look beyond the experience of the incident to the *meaning* of the incident. This is a form of *reflection-on-action*. Another goal is to help you develop your ability to reflect on these incidents as they happen, or *reflection-in-action*. Finally, using critical incidents can help you adjust your lesson and strategies for future teaching cycles, or *reflection-for-action*.

How do I reflect on the Critical Incidents that I select?

Remember, there is no "right" or "wrong" way to select an incident. It should be something useful and meaningful to you. After watching and editing your videotaped lesson for critical incidents, use the statements and questions below to guide you as you reflect about the two-three critical incidents that you selected.

What

Provide an in-depth description of the event. Try to write this without judgment or interpretation.

Emotions

Describe the feelings you had as you "experienced" the incident.

Perspectives

Explain the incident from the perspective of each participant (student, teacher, etc.). Use "I" for each participant's explanation.

Cultural Relevance

In what ways did you employ culturally relevant teaching? (For example, communicating high expectations for all students; using cultural referents for imparting knowledge, skills, and attitudes; creating a learning environment that honors and promotes cultural diversity; helping students challenge the status quo.) You might begin with "As an educator, I was/was not able to. ..."

Position

What are some of your personal beliefs related to teaching and learning that you identified when reflecting on this incident and the portfolio standards that you addressed. You might begin with "As an educator, I believe/value. ..."

Actions

After considering this incident, what will you do differently in the next lesson in light of your new understandings? You might begin with "As an educator, I will...

Appendix B
Participant 23: CIR #2, Video Treatment

Overall CIR Score: 3.0

Incident:

What—Score 3

I was teaching a lesson on the Kepler Mission, when I finished with the lesson. I asked the students whether or not they were interested in astronomy. One of the students responded that she liked to read about her horoscopes. I had to explain that that was not astronomy, but astrology. I should have asked this question to begin with to address misconceptions.

Emotions—Score 3

I felt bad that I had not addressed the misconceptions between astronomy and astrology. I was not aware that the students did not have much experience with astronomy. I was also worried when the rest of the students laughed when I tried to explain that astrology was not science. I'm sure there are so many different views on what is and what is not science.

Perspective—Score 3

Student #1 (with astrology response): I was trying to pick an astronomy topic to relate with the teacher and I thought that horoscopes had to do with the science of the stars, astronomy.

Other students: We found it funny when the teacher, told student #1 that astrology is not astronomy. We all laughed.

Teacher: I was trying to relate with the students, but their misconceptions proved to cause a misunderstanding of astronomy. I should have cleared any misconceptions before the lesson. I did not want to make the student feel bad for not knowing the difference between astronomy and astrology.

Reflection on Incident:

Addressing Diverse Learners—Score 3

I did not take into account the needs and backgrounds of the audience before starting. I addressed it at the end which makes no sense now. I should have asked if they had a science background at the beginning or what their thoughts on astronomy was before a started the lesson.

Position—Score 3

As an educator, I will be sure to try and address the misconceptions about the topic before talking about it. I also believe that it is important to relate to your students. I felt that the students weren't interested and engaged in the topic. This could be because they don't have much background in astronomy.

Actions—Score 3

As an educator, I will begin my lessons with questions related to the topic instead of waiting until the end. I will also be sure to pick topics that the students should have previous background in and use the GPS to get a better understanding of what previous knowledge the students have. I'm sure, though, that not all students will not be on the same level in regards to previous knowledge. I will have to tailor my lessons to reach all levels of students.

Appendix C
Participant 23: CIR #3, Audio Treatment

Overall CIR Score: 2.0

Incident:

What- Score-2

For this microteaching session I was talking about the general properties of matter. I had the students categorize different pictures of matter into solid, liquid, and gas states. One of my pictures was lightening. One of the students mentioned that lightening was in a fourth state of plasma. I did originally explain that lightening was energy, not matter.

Emotions-Score 2

I thought that I should have talked about plasma. I don't believe that lightening is plasma, but a form of energy. I felt that I should have went more in depth to clarify the students thinking.

Perspective-Score 1

I, the teacher, wanted to just touch on the 3 states of matter. I felt this was too easy for the students and should have talked about the 4th state of plasma.

Student: The teacher didn't touch on the fourth state or whether or not matter is really energy or matter.

Reflection on Incident:

Addressing Diverse Learners- Score 2

As an educator, I did not really consider the backgrounds of the students besides that fact that they were going to be highschoolers. It may have helped to look at the GPS to see what the students may have already known.

Position- Score 2

As an educator, I believe that we must be prepared for any questions that come are way and be prepared to talk about things that were not originally on our lesson plans. Students will have other ideas then what the teacher will.

Actions- Score 2

As an educator, I will have to have a very broad understanding of the topics I will be talking about.