

THE EFFECT OF FLIPPED CLASSROOM VIDEOS FILMED AT FIELD  
LOCATIONS

by

Matthew Clay

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Matthew Clay

July 2014

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**ABSTRACT**

In this project, videos filmed at field locations were used in place of narrated slideshows in a classroom using the flipped model. Surveys were used to determine if this change had an effect on student engagement and students' views of the nature of science as well as recording behavior logs as the students viewed the videos. Data showed an increase in test scores after students viewed the field location videos, but not after students viewed the narrated slideshow videos. Additionally, there was a significant difference in survey responses for questions such as "I space out while watching the videos" and "I find the videos entertaining."

## INTRODUCTION AND BACKGROUND

My research question is “How effective are flipped classroom videos filmed at field locations in increasing student engagement?” This topic has taken on a very personal meaning for me as student engagement has become one of my main goals as a teacher. In pursuit of this goal I have implemented a flipped classroom model as have many other teachers. Although there are numerous benefits to the flipped classroom model as a whole, for this project I isolated and focused specifically the video component to make it as effective possible. In contrast to the flipped classroom model, videos will be viewed in class to reduce the number of variables such as students’ outside of school schedules. I am in my third year teaching at College Heights Christian School in Joplin, Missouri. I am the only middle school science teacher, and as a result I have a lot of flexibility when it comes to curriculum and teaching technique.

Through my experience I have noticed a decrease in student engagement. In my time teaching middle school I have come to the conclusion that with the vast availability of scientific content through the internet, engaging and motivating students is my most important job as an educator. I feel that if students were properly engaged and motivated, teaching science content and scientific thinking skills would be much more effective. For the purposes of this study I will focus on engagement as being voluntarily attentive and often this carries with it a positive view of the class experience. Engagement does not necessarily mean improved student achievement, however there is a precedent for this association in the literature.

A second observation I have noticed is a decreasing desire in my students to explore. I often receive negative responses from students when we discuss new

exploration such as the Mars Rovers, geologic expeditions, or the attempt to drill to the mantle. Students often state that they believe such projects are too expensive or not worth the effort. Although it is possible that students still foster an innate desire to explore, a large number often respond negatively when I present them with stories of exploration going on in the world today. This is perhaps a result of social or societal influences or could arise from having a relatively narrow demographic of students. These observations have led me to a two part problem: “How do I increase student engagement and students’ desire to explore?”

The primary purpose of this research is to determine if using videos filmed at field locations in place of narrated slideshows increases student engagement. Videos are often used in the flipped classroom to move direct instruction home and allow class time to be used for activities or assignments. The purpose of the model is to allow the teacher more opportunities to help students as they complete their work. In addition to addressing this primary question I will address the following subsidiary questions:

- How do flipped classroom videos filmed at field locations affect students’ views of scientific exploration?
- How do flipped classroom videos filmed at field locations affect students’ views of the nature of science?
- What are the effects of flipped classroom videos filmed at field locations on the teacher?
- Is there a benefit for students in having videos created by their own teacher?
- What effect do flipped classroom videos filmed at field locations have on student achievement?



### Hypothesis

In this study it was expected that the field location videos would increase student engagement and cause students to have a more favorable view of exploration. Moreover, I expected changes in the students' views of the nature of science. Finally, I did not expect field location videos to affect student achievement.

### CONCEPTUAL FRAMEWORK

In framing this project there are three main points of focus. First, the flipped classroom model is a model that has become very popular and will continue to gain popularity in education. A second point of focus is that research surrounding the use of media in flipped classrooms is lacking. Finally, videos filmed at field locations could offer an effective tool in the current educational climate.

In the year 2000, a model of teaching was introduced that for many teachers has dramatically altered the way they approach their classroom. Lage, Platt, and Treglia saw what they believed was a mismatch between students' learning style and instructors' teaching style leading to a decrease in student achievement and engagement (2000). In an effort to address this disconnect, they introduced the inverted classroom model, which would later become known as the flipped classroom. In this model activities that traditionally took place at home, now occurred at school and activities that normally took place at school (direct instruction) would occur at home (Lage, Platt, and Treglia, 2000). The original inverted classroom used video cassettes as the media for students, but in 2007 two science teachers in Woodland Park, Colorado began to use screencasting software to record and narrate slideshows, which were then viewable by students at home online (Bergmann and Sams, 2012). The popular use of screencasting continues in

flipped classrooms today. The flipped classroom model has continued to grow in popularity. The Flipped Learning Network, a social network centered around flipped learning, grew from around 2,500 members in 2011 to over 17,000 by early 2014 (Godwin and Miller, 2013). This popularity is hardly a surprise as the Flipped Learning Network reports that 88% of teachers report increased job satisfaction and 99% of teachers claim they will use the model again in future years (“Flipped learning network homepage”).

As a philosophy, there have been numerous benefits demonstrated in the flipped classroom model. One of the great benefits to the instructional video is that students are able to personalize their learning by choosing what order and what pace they watch segments of a lecture (Bull, Ferster, and Kjellstorm, 2012). This demonstration of personalization also relates the model back to its original purpose of matching students’ learning and instructors’ teaching styles. Although personalization can be beneficial for students, most of the benefits discussed have dealt with what now occurs inside the classroom.

In 1977 Joseph Novak proposed that science education should consist of laboratory, library, and field experience (Novak, 2011). The first two of these can be accomplished fairly easily in a classroom and the flipped classroom model allows even more class time to address these two goals. Of Novak’s three components of science education, the one that is obviously the most challenging in many classroom settings is field study. The opportunity for field study is often limited by the physical location of the school, ability to travel with students, and create further difficulties when students are split into multiple sections of the same course. Flipped classroom videos filmed at field locations could

offer a possible solution for addressing this goal in a manner that works easily into most classrooms.

Teachers have reported nearly doubling the amount of class they have been able to devote to hands-on and small group activities (Brunsnell and Horejsi, 2013). This affords teachers the opportunity to implement more problem solving activities, which the students can complete in the presence of the teacher. The flipped classroom is often referenced as blended learning. Although typically, the ‘blended’ aspect refers to the media for teaching, the flipped classroom could be viewed as blended in terms of educational philosophy. In the flipped classroom, direct instruction has moved home, which can allow the use of constructivism in the classroom.

The connection between flipped learning and constructivism is probably best demonstrated by this quote from Cooperstein and Kocevar-Weidinger “Essentially, in constructive learning, the standard classroom procedure is turned upside down – no lectures, no demonstrations, no presentations. From the beginning, students engage in activities through which they develop skills and acquire concepts” (2004, p. 141).

The reliance on activity, and lack of in class instruction both coordinate very well with the flipped classroom model. To establish the merit of further researching best practices in the flipped classroom, it is probably beneficial to establish the constructivist approach as beneficial. If constructivism were ineffective, there would be little benefit in blending educational philosophies and the flipped classroom is simply become a model of increased efficiency.

Over seventy years before the flipped classroom model began to be popularized, Dewey argued for a shifting of the teacher from the imparter of information to more of a guiding

role (Dewey, 1897). Additionally, in 1938 in *Experience & Education* Dewey argued for a sound philosophy of experience in which students create knowledge through experiences. Moreover, Dewey emphasizes the importance of student engagement in *My Pedagogical Creed* by saying “I believe that the child should be stimulated and controlled in his work through the life of the community” (p. 9).

There has been research critical of constructivism. Kirschner, Sweller, and Clark claimed that constructivist, discovery, experiential, and inquiry-based teaching were all ultimately ineffective (2006). This criticism carries extreme implications for users of the flipped classroom, because these teaching methods often represent how class time is used in the flipped classroom. The study claimed that there is no research supporting the use of these minimal guidance models and that student test scores in their study showed no improvement over direct instruction. However, there are two potential short-comings in this study.

Firstly, an absence of proof is not a proof of absence. More importantly, however, their study employed multiple-choice questions to assess students. As noted by the University of Oregon, by definition, multiple choice questions cannot be used to assess the synthesis level of Bloom’s taxonomy, and likely struggle to assess other upper levels of the taxonomy (“Bloom’s”). This can be extrapolated by Bloom’s own definition of the synthesis level which he described as “the ability to combine extant elements into new forms and patterns” (Bloom, 1956 p.18). One cannot combine elements into new forms when choosing from a list of already existing choices. This is of particular interest, as the Next Generation Science Standards for middle school earth science are centered at the synthesis level. The verbs for the standards include develop, construct, analyze, and

interpret (“The Next Generation Science Standards”). All of these verbs are listed in the upper three tiers of Bloom’s taxonomy. In short, this criticism of minimal-guidance methods failed to assess whether these methods are more effective than direct instruction at improving higher-level thinking, and more importantly failed to assess their effectiveness at the cognitive levels at which the Next Generation Science Standards are written.

Despite the popularity of the flipped classroom model, and the potential benefits it offers students and teachers, there has been little research into the effectiveness of the media used. The importance of this research is made clear by a 1994 article by Richard Clark, in which he claims that media will never influence learning (Clark, 1994). He makes a clear distinction between media and method and states that “media not only fail to influence learning, they are also not directly responsible for motivating learning” (p. 23). This belief has been supported by other research (Mayer, 1997). In light of this concept, the door to exploring effective methods in media is left wide open as currently the contribution of technology to pedagogic innovation is low (Mayer, 1997). Richard Mayer summarized his article on the topic by stating, “In short, this review demonstrates that progress in multimedia research depends partly on searching for the right kinds of questions” (p. 17).

In his doctoral dissertation, Derek Muller called into question the effectiveness of lecture-style videos (2008). In his research, after viewing a lecture-style video, despite having confidence that they had learned, students’ post test scores did not improve significantly. However, after viewing a video in which two characters discussed a concept and the alternative explanations test scores did improve significantly, despite having less

confidence in their learning (Muller, 2008). These findings seem to contradict the advocacy of others for direct, strong instructional guidance (Kirschner, Sweller, and Clark, 2006).

Recent trends in education tend to support the notion that videos filmed at field locations for a flipped classroom are a worthwhile pursuit. Studies have shown that when speech in a video is presented in a personal, conversational style students perform better than when it is presented in a more formal tone (Moreno and Mayer, 2000). In fact, studies have shown that it takes as little as replacing the word “the” with “your” in videos about physiological principles to gain the significantly higher test scores associated with personalization (Mayer, Fennell, Farmer, and Campbell, 2004). Additionally, removing on-screen text and simply having narration can reduce cognitive loading (Mayer, Fennell, Farmer, and Campbell, 2004).

Redesigned videos for flipped classrooms could also promote student learning through increased student engagement. Student engagement has a benefit beyond simply increasing students’ interests in science; student engagement is essential to achievement (Reyes, 2012). Prior research has established both direct and indirect connections between classroom and environment and student achievement (Reyes, 2012). Moreover, the same research established that students who are engaged also exhibit less problem behaviors in the classroom. The sense of belonging, engagement, and positive behavior can lead to a positive classroom climate. A 2004 study showed that middle school students who are engaged are seventy-five percent more likely to do well in the areas of achievement and attendance (Klem, 2004).

A reoccurring problem in science classes is the alienation of the student, due mainly to difficult content (Kruckeberg, 2006). This alienation is furthered by the fact that the objective body of knowledge in science is inherently impersonal. This alienation creates a continuum in science education with the individuality of the student on one end and the curriculum on the other (Kruckeberg, 2006). In light of this dichotomy, Dewey emphasized the importance of designing instruction and curriculum around the prior experiences of students (Kruckeberg, 2006). These experiences are often very diverse, but field location videos could create shared experiences for students, which could allow for a more fluid design of curriculum.

## METHODOLOGY

### Treatment

A flipped classroom involves students watching videos at home in place of lecture while doing activities and assignments during class time. This approach is designed to get the most benefit out of student contact time as well as to offer students the best chance to be successful in activities and assignments by having the teacher there as a resource. The videos I typically use are narrated slideshows of text and images, placed on YouTube or Vimeo, over which the students complete fill-in-the blank notes. For the purpose of this project both comparison and treatment videos were derived from the existing notes outline for an introduction to meteorology chapter. In a strictly practical sense, the only change made in instruction was to record myself presenting a lecture in a field location instead of using a slideshow that I narrated and appeared in a small window in the corner of the screen. As previously mentioned, this project focused strictly on the video component of the flipped classroom.

Although typically flipped classroom videos are viewed at home (which is the basis of the flipped model), the videos for this study were viewed during class time. I observed that often whether or not a student watches a video at home has more to do with the day of the week and students' schedules. To ensure that this study tested only the effect of the video and not the effect of scheduling the videos, they were shown in class. The videos ranged in length from one and a half to two and a half minutes. The videos were shown over a period of three days. Activities followed the class periods of watching the videos such as weather map tracking, article reactions, and graphic organizers. However, the activities were completed after the post-test for this study to allow the post-test to assess only knowledge gained from watching the videos. The topics for the three treatment videos were solar radiation, the water cycle, and clouds. One to two videos were shown in each class period as part of this study.

Assignment of comparison or treatment was done in an alternating fashion. The first and third lessons were comparison videos that consisted of traditional narrated slideshow videos. The second, fourth, and fifth lessons were treatment videos. The second and fifth lessons were 'talking head' videos filmed in a field location, in which I appeared and explained the existing notes outline. The fourth lesson was a video, filmed in the field, showing a drawing and explanation of the water cycle. All treatment videos were filmed in King Jack Park in Webb City, Missouri during a winter storm. The treatment videos did not have printed text on the screen. The videos were recorded and posted on Vimeo and shown to the students in class. In class viewing was chosen as earlier surveys indicated that factors outside the quality of the video, such as students' schedules, often determined if students watched an assigned video at home.



### Sample and Demographics

This treatment was applied in two eighth grade earth and space science classes at a private Christian school in Joplin, Missouri. These two class periods represent the entire eighth grade population for the school. Total there are twenty-one males and twenty-three females. Of the forty-four students, 93% are Caucasian. There are no recognized special education or English language learner students. Free and reduced lunch is not offered at the school, so there is not a record of how many students would be considered low socioeconomic status, however the number would be kept fairly low due to the cost of tuition. For the students, this course was their first experience with a flipped classroom. I chose my eighth grade classes because the content of the eighth curriculum in the first semester of the year is much better suited for field location videos than the seventh grade curriculum. The sixth grade curriculum is designed to help students adjust from elementary to middle school, and I did not want to jeopardize this transition for the students.

Of the forty-four students, thirty-five attended the school and completed the Stanford Ten Achievement test during seventh grade. As a class, thirty-two percent of students scored above average, fifty-nine percent of students scored average, and ten percent of students scored below average. Assessment scores for the students eighth grade year were not available during the timeline of this project.

### Instrumentation

A Likert-scale survey is the primary data collection tool for this project (Appendix A). However, an open-ended survey was used to address students' views of the nature of science (Appendix B). The Likert-scale survey was designed to address different aspects

of student engagement as well as students' desire to explore. On the page of the survey there are open-ended questions to allow students to express views and opinions that they were not able to share in the Likert-scale survey. Student interviews were used to help insure the validity and reliability of the survey. A lack of clarity in survey questions can lead to unrepresentative data and student surveys offer an opportunity to identify these issues. Moreover, student interviews allow me to identify effects of the treatment on students that extend beyond the scope of the survey questions. To delineate between student engagement from field location videos and engagement from the flipped model in general, I had students complete a survey early in the school year over their opinions of the flipped classroom approach (Appendix C).

The survey for the views of the nature of science is adapted from a standardized survey reviewed by a team of experts for validity (Lederman, 2002). Questions dealing with content not addressed by the eighth grade scope and sequence of the school were removed. Additionally, a question that referred to the age of the extinction of the dinosaurs as sixty-five million years was modified to remove the age as a majority of my students believe the earth is less than ten thousand years old. I made the change to keep students from not fully considering the question based on their religious beliefs.

Together these two surveys offered me large scale pattern changes in my classes. In the creation of the survey it was noted that changes are often subtle (Lederman, 2002).

Behavior logs were recorded as the students watch the videos in class. Each behavior log consisted of two positive behaviors (taking notes and nodding in agreement) and two negative behaviors (talking out of turn and messing with other objects). Random groups of five students were created for each of the videos using a random number generator and

a numbered alphabetical class roster. The data was collected as the students watched the videos.

Student achievement was assessed using a pre and post-test. The test was created with five multiple choice questions from each of the five videos that the students watched. Most of the questions were taken from unit tests from previous years. In addition, there were four short answer questions written to coincide with the nature of the Next Generation Science Standards. Students completed the Pre-Test before watching the first video and completed the Post-Test after watching the final video. They were not given time to study at home and the test was not recorded as a grade.

With a topic as complex as students' attitudes, it is impossible for me to identify, let alone control, all of the variables. Student interviews allowed me to qualitatively identify changes in students' attitudes in areas that extend beyond my surveys or behavior log. Moreover, this allowed me to uncover potential issues in my other data collection such as misunderstood survey questions. Students that were interviewed were chosen from an after school extended care program for students who parents cannot pick them up from school before 3:30PM. There is no academic factor to which students attend the program. Participation in the research was voluntary and participation or non-participation did not affect a student's grades or class standing in any way. This study was exempt from the Institutional Review Board (Appendix D).

Table 1  
*Triangulation of Data Sources.*

Research Question	Data Source		
	Source 1	Source 2	Source 3
How effective are flipped classroom videos filmed at field locations in increasing student engagement?	Likert Survey	Behavior talley sheets	Student interviews
How do flipped classroom videos filmed at field locations affect students' views of scientific exploration?	Likert Survey	Student interviews	Student free response survey
How do flipped classroom videos filmed at field locations affect students' views of the nature of science?	Views of nature of science probe	Student interviews	Student free response survey
What are the effects of flipped classroom videos filmed at field locations on the teacher?	Reflective Journal	Time tally sheet	Student free response survey
What effect do flipped classroom videos filmed at field locations have on student achievement?	Unit Test Scores	Likert Survey	Student interviews

## DATA AND ANALYSIS

Analysis of the data was carried out for each of the three main data instruments. Although specific research questions rely more heavily on particular instruments, there was a high degree of overlap in each of the instruments.

### Survey Responses

Likert scale surveys were used to determine what effect the field location videos had on student engagement and students' views of scientific exploration as well as to help indicate if there is a benefit for teachers in creating their own videos. A Chi square test was used to compare the combined totals for each of the Likert scale survey questions for the narrative slideshows and the combined total of videos filmed at field locations. The Chi square test was chosen because the survey responses are categorical data, and it is impossible to determine if the categories are equidistant. Since it is impossible to determine that the categories are equidistant, they were not assigned a numerical value. The combined ratio of the surveys given after narrative slideshow videos was used as the predicted ratio for responses for the videos filmed at field locations. Questions eight and ten were treated as four categories, as strongly disagree was never marked on any of the surveys. All questions were tested to a ninety-five percent confidence interval (N=40-42). Except for questions eight and ten, all questions were tested to four degrees of freedom. Questions eight and ten were tested with three degrees of freedom.

Several of the questions that did not return a significant difference were not expected to. The questions "I would rather read the textbook than watch the videos" and "The length of the videos is about right" were consistent across the surveys. From narrated slideshow videos 81.4 percent of students disagreed or strongly disagreed when asked if they would rather read the textbook than watch the video. For field location videos, 79.8 percent of students responded with disagree or strongly disagree for the same question. When asked about the length of the video, 69.1 percent of responses were agree or strongly agree after students watched the narrated slideshows. After viewing

field location videos, 72.0 percent of responses were agree or strongly agree. A lack of significance is expected, however, because all videos were close to the same length.

Other questions that did not return a significant difference were: The topic we are studying is something I would like to know more about, I look forward to watching the videos, I enjoy having videos to watch, I feel like I am learning as well with the videos as I would with lectures, and I think it is important for scientists to travel to explore areas with this topic. A lack of significance for these questions simply indicates that the treatment did not have a noticeable effect on the overall views of students. This could indicate that these questions could address differences between the flipped classroom model itself and other teaching models, rather than delineate effects between the two approaches within the flipped model.

Five questions did have a significant difference between the narrative slideshow videos and the videos filmed at field locations. The questions with significant differences were as follows: I spaced out while watching this video ( $p=0.0087$ ), I find the videos entertaining ( $p=0.00024$ ), I would watch more videos on this topic if they were available ( $p=0.0066$ ), I would rather have videos Mr. Clay made than videos made by someone else ( $p=0.026$ ), and I think exploring this topic is important ( $p=0.031$ ). Although the associations for most of the questions were positive, the question of exploring the topic had a negative association. Since the viewing and classroom context was consistent with all the videos, significance in these questions indicates an effect associated with the different types of videos. These findings support the hypothesis that field location videos will increase student engagement.

A juxtaposition that could indicate an interesting difference is that there was not a significant difference when students were asked if they felt it was important for scientists to study to explore this topic, but there was when students were asked if they felt exploring the topic was important. When asked about scientists travelling to explore, 49.0 percent of responses were agree or strongly agree after viewing narrated slideshows and that number only rose to 50.8 percent after viewing field location videos. When asked if they felt exploring the topic was important, 50.0 percent of students marked agree or strongly agree after viewing narrated slideshows. This number fell to 46.4 percent of responses after viewing field location videos. This could indicate that students' views of exploration are not connected to their level of engagement, which is in contrast to the hypothesis that field location videos would provide a more favorable view of exploration. Although the Likert scale survey responses did not indicate an increase in students desires to explore, one student did say during his interview, "I would really like to go outside to study weather."

Some questions that did not show a significant difference did show positive responses. Nearly sixty percent of students agreed or strongly agreed that they enjoyed having videos to watch. Also, on both surveys sixty-three percent agreed or strongly agreed that they were learning as well with videos as they would with lectures. When asked if they felt it was important for scientists to travel to explore this topic, less than four percent of responses were disagree or strongly disagree.

There was variation in the four questions that asked students of their opinion on the topic of the videos. There was not a significant difference for "the topic we are studying is something I would like to know more about" and "I think it is important for scientists to

travel to explore areas with this topic”. This could easily be attributed to the fact that all the videos that the students viewed deal with the same basic topic of weather. However, “I would watch more videos on this topic if they were available” and “I think exploring this topic is important” did show a significant difference. For the first of these two questions the primary shift occurred in the fraction of responses moving from strongly disagree to disagree. Similarly, for the second video, the shift in opinions appears to occur between disagree and strongly disagree.

The two questions most directly relevant to student engagement, “I spaced out watching video” and “I find the videos entertaining” did have a significant difference. For the first question, the portion of responses that were agree or strongly agree decreased from 28.05 percent to 17.75 percent. The second question had the portion of responses that were strongly disagree or disagree decrease from 21.7 percent to 8.1 percent. Similarly there was an increase from 39.8 to 51.2 percent for agree and strongly agree responses comparing narrative slides to field videos for the question “I would rather have videos Mr. Clay made than videos made by someone else”.

One interesting transition happened between the pre-test and post-test in an individual student. The student earned an A first semester and is very consistent in her work. On the pre-test when asked “What in your view is science? What makes science different from other disciplines of inquiry?” she responded, “It is good if people don’t go too far and forget that God created it. I think it is good to do research but not on everything and spending a ton of money on it.” After the viewing the videos, her response for the same question was “Science asks questions and try (sic) to answer them. You use answers and research.” In teaching at a religious school, I often encounter religion-based preconceived



notions about science. However, the change in response is very interesting. None of the videos dealt specifically with the nature of science; however, the change in response appears to show that the student viewed science as more of a process after viewing the videos.

The shift cannot be empirically tied to the field location videos, because the student viewed both narrated slideshow and field location videos in between the pre-test and post-test. However, the student had viewed narrated slideshows prior to the pre-test, yet did not describe science as clearly as a process the first time she answered the question. Also, of interest is that the first time she answered the question she did so in third person and the second time it was in second person, which could indicate a greater personal connection to the subject.

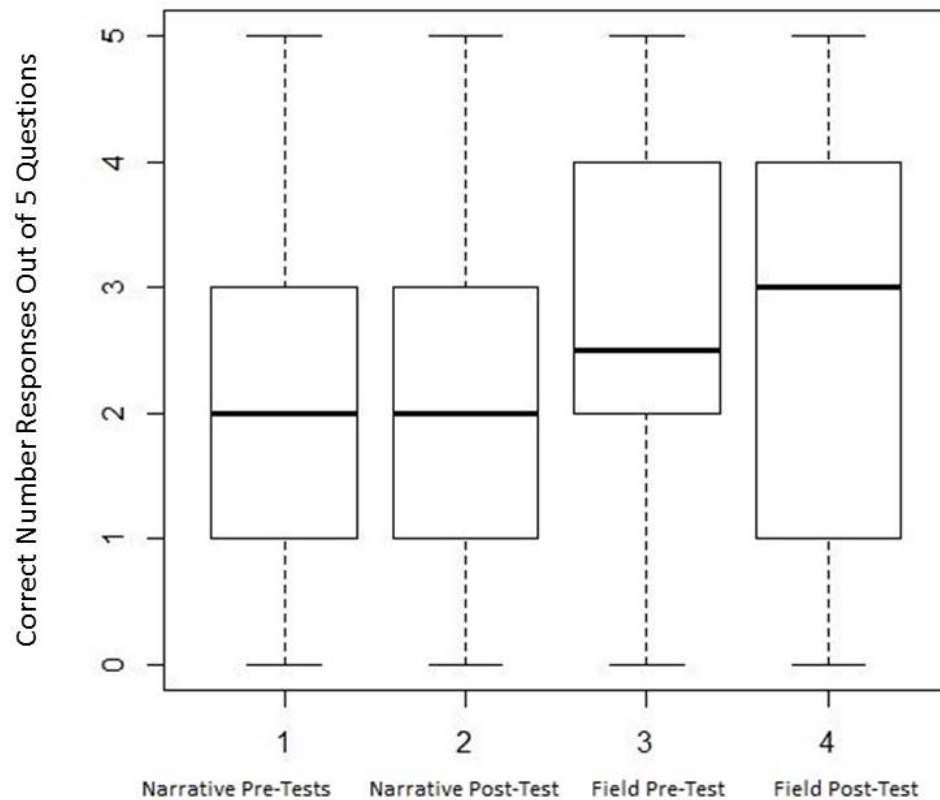
Similar to this student, a second student had a shift in responses to the part of the question that asks how science is different from lines of inquiry. This student earned a B in the course. On the pre-test she described science as being different because “there are many different ways things could turn out.” On the post-test she described science as being different because “it has lots of methods and loops.” Prior to viewing the videos she focused on variation in results, but after the videos this shifted to variation in methods. This could again indicate a more personal connection to the subject. The previous emphasis on results could show that the student viewed science as something to be completed by others from which she could view the various results. However, this shifted to describing variation in methods, possibly indicating that she viewed science as something in which she could participate.

This student had a related change in her responses to the question “What is an experiment?” On the pre-test she described an experiment as “Taking something and trying new results” which again emphasizes results. On the post-test this response changed to “when you try something new”. Again, the post-test response includes more participatory wording and moves from describing science as something where results are given, but rather a process. Although, the vast majority of students did not change their responses to questions about their views of the nature of science, these two students indicate that there were shifts for some individuals. Although the hypothesis of pattern changes in students’ views of the nature of science was not supported, however the hypothesis was supported in the case of these few individual students.

#### Pre-Test and Post-Test Scores

Pre-test and post-test scores were used to determine the effect of field location videos on student achievement. It is easy to tell from viewing the distributions that the pre and post test data are not normally distributed (Appendix E). As a result, the non-parametric Wilcoxon signed rank test was used to compare test scores. Neither post-test was significantly different from the pre-test. The two pre-tests were not significantly different to a ninety-nine percent confidence interval ( $p=0.01187$ ), however the two post-tests were significantly different to a ninety-nine percent confidence interval ( $p=0.004714$ ). Although there was not a significant difference between the pre and post-tests ( $p=0.3409$ ,  $p=0.8448$ ), the test scores over the videos filmed at field locations increased from 50.63 percent to 54.33 percent which is much higher than the increase of 41.43 percent to 41.50 percent (table 2). This improvement was not hypothesized, but came as a surprise associated benefit to field location videos.

Box plots confirm that pre-test and post-test scores for narrated slideshows indicate no improvement (figure 1). The pre-test and post-test scores from the field location videos do indicate a couple interesting patterns. First, the pre-test scores between the two tests are obviously different. Scores in the second and third quartile for the narrated slideshows are evenly concentrated, in contrast to the field location videos pretests.



*Figure 1.* Box Plots of Pre-test and Post-test Scores, ( $N=40-42$ ).

The transition from the pre-test to post-test for the field location videos does indicate a couple of interesting changes. The median (indicated by the thick bar) increased moving from the pre-test to post-test. Additionally, scores in the third quartile

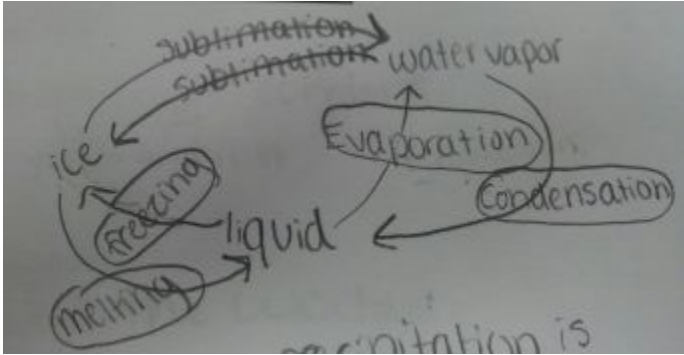
became more concentrated and scores in the second quartile became more scattered. Moreover, there was a drastic decrease in the concentration of the frequency of scores in the first quartile. This plot visual demonstrates that narrated slideshows had no effect on student achievement. Additionally, it shows improvement in subjects covered by field location videos, in particular in the top fifty percent of students. This opens the possibility that this technique is more effective for higher achieving students than students who are struggling, which reinforces the importance for me as a teacher in monitoring students who are struggling.

Table 2  
*Pre and Post-test Percentages (N=40-42)*

Pre-Test Percent Narrated Slides	Post-Test Percent Narrated Slides	Pre-Test Percent Field Location	Post-Test Percent Field Location
41.43%	41.50%	50.63%	54.33%

On the short answer questions designed to correspond to Next Generation Science Standards, zero students correctly drew the water cycle on the pre-test, however nine students (22.5 percent) accurately drew the water cycle after watching a minute and a half long video. Similarly, although the sample size decrease from the forty-two to forty (due to absences) going from the pre-test to the post-test, the number of students that accurately described the role of the sun in causing evaporation increased from twenty-one to twenty-three. One interesting student response was the student who drew a factually accurate diagram of the water cycle, in an order different from that presented in the video (figure 2). This indicates that the student did not simply quickly memorize the image

presented, but rather had an understanding of the association between the phases of matter and the transitions in between them.



*Figure 2.* Student Drawing of Water cycle from Post-test.

During her interview, one student stated, "I think I did a lot better on the regular (narrated slideshow) video questions." She acted quite surprised to learn that the overall pattern was no increase in scores for the narrated slideshow videos and an increase in the questions associated with the field location videos. This could indicate a disconnect between student confidence and student achievement, which was also observed by Muller (2008).

### Behavior Log

The behavior log was used as a secondary data source for determining the effect of field location videos on student engagement. The ratio of positive to negative behaviors from the narrative slideshow as compared to the videos filmed at field locations. Behaviors were scored by number of observed occurrences. A Chi square test was used to determine significance. The scores were tested to a ninety-five percent confidence interval with one degree of freedom. During narrative slideshows there were two positive and fourteen

negative behaviors recorded among the random sample. During the field location videos nineteen positive and eleven negative behaviors were recorded among the random student groups. This represents a 24 percent decrease in negative behaviors moving from the narrated slideshows to the field videos and a 950 percent increase in positive behaviors. This drastic change, in correlation with the significant difference in the questions “I spaced out while watching this video” and “I find this video entertaining” provides strong support that students were more engaged during field location videos than narrated slideshows. The results of the behavior log confirm the association that students who are more engaged behave better in class, which again supports the hypothesis that field location videos increase student engagement.

Table 3.

*Total Positive and Negative Behaviors from Behavior Logs*

	Positive Behaviors	Negative Behaviors
Narrated Slides	2	14
Field Location	19	11

Teaching Impact

In creating the videos I found that I was more excited to create the field location videos than the narrated slideshows. Total, I spent an hour and fifteen minutes creating the two narrated slideshows and forty-five minutes creating the three field location videos. I was fortunate to be able to film the field location videos near my home, as well as to have a related weather event (winter storm) in which to film them. Also, the field location videos had to be created outside of my teaching contract day, where the narrated slideshows were created during my planning period.

Similar to the changes observed in some students' responses, I felt like more of a participant in science while filming the field location videos than creating the narrated slideshows. Psychologically, I felt as though being outside increased my legitimacy as a teacher. After I created the field location videos I felt more motivated to enter the school week than I usually do after weekends of doing more traditional lesson planning.

Although creating field location videos was very enjoyable, it was uncomfortable to watch myself on screen without being able to hide behind text or images. In a narrated slideshow video I assumed that students were focusing on the text or images on the screen, however with field location videos I know that the students are focusing on me. In my teacher reflective journal on March 1, 2014 when I recorded the field location videos I wrote, "I felt a lot more like a real scientist and actually looked forward to creating the videos. Creating the videos went fairly quickly and was a lot of fun despite the cold."

#### INTERPRETATION AND CONCLUSION

As a teacher, I feel it is critical to turn the results of this study into practical classroom practices. In response to the primary question of the effect of field videos on student engagement, there are several indications in the data to show that student engagement increased.. The survey questions "I spaced out during this video" and "I find the videos entertaining" both had significant differences. Additionally, there was a significant improvement in the results of the behavior log. In reference to the Introduction to Meteorology video, which was a narrated slideshow, one student commented, "It is really boring. It doesn't get me excited about learning." However, after viewing the video on solar radiation, which was filmed in nature, one student commented, "I'm learning things without being totally bored."

Perhaps the more interesting implication comes from the significant difference in responses to the question “I would rather videos made by Mr. Clay than someone else”. Prior to this project, I had operated under the assumption that if I was creating my own videos, it would benefit my students. Literature has indicated that students need to feel that teachers are involved in their education, and in creating my own videos I had hoped to create this feeling. However, if students were simply interested in videos created by their teacher regardless of engagement, this question would not have had a significant difference.

With the wealth of videos available online, this finding indicates that as a teacher, if I am going to invest time in creating my own videos, I should make them engaging. There is likely little benefit gained in creating my own video that is not engaging. Pre-test and post-test scores showed no improvement from narrated slideshow videos in which students indicated that they were not engaged. This indicates that there is no benefit in showing an unengaging video to students and moreover it is a poor use of a teacher’s time to create an unengaging video. If a teacher lacks the time or resources to create an engaging video, it could very well be advantageous to find an already existing video on the topic that is engaging.

Although some teachers might be adverse to using videos created by others in feeling that they are no longer teaching their classes, in many ways this is akin to teachers using textbooks written by others. The art of teaching still comes in choosing quality videos and accompanying activities and guiding students through the learning process.

Determining if students will find a video engaging can be very difficult, but a more personal, informal approach in an interesting context appears to be a good starting point.



This is supported by the differences in survey responses in the two types of videos. All of the videos' content was sections of an existing note outline, however when the text on the screen was removed in favor of the more interesting background of nature students became more engaged and furthermore showed more improvement in test scores. Criticism of less direct instruction, such as the removal of text in the field location video, has claimed that it leads to less student achievement. However, test scores were significantly higher for questions dealing with topics in the field location videos (3.7% increase). Moreover, the questions over topics discussed in the narrated slideshows showed essentially no improvement between pre and post-tests (0.07% increase). Although the post-test scores for questions dealing with topics in the field location videos were not significantly higher, there was an improvement in scores. This finding was not hypothesized, but came as a fortunate surprise. In all fairness, the resulting improvement may not be as a result of the changed technique, or even the reduced cognitive loading, but directly from increased student engagement. In interviews, students expressed they felt more confident in what they learned in the narrative slideshows than the field location videos and were surprised that the test scores indicated otherwise. One student stated, "I think I know the introduction stuff (Introduction to Meteorology video) a lot better." This is similar to the findings that Derek Muller presented in his dissertation.

The greatest implication, however, that this project has produced for me thus far is the realization and desire to pursue student engagement as a primary goal in my teaching. This goal, laid out decades ago by John Dewey, has still not been fully realized. In an era where there is a lot of emphasis on student achievement, I feel the literature clearly demonstrates the need and benefits of student engagement. Moreover, prior

research reaffirms what was demonstrated in this project, that pursuing student engagement and student achievement are not contrasting goals, but in fact are correlated pursuits.

For teachers who are considering implementing the flipped classroom model there are hurdles that must be overcome. One hurdle, which this project has not addressed is the technology available to students, however this project was carried out in a school that is not one to one with tablets or laptops. I was able to use the approach by offering showings of videos before and after school. Many students also made arrangements to watch videos with each before or after school on a phone or tablet. In addition to student or parent resistance, which in my case has been minimal, perhaps the two greatest hurdles are the time requirement and familiarity with technology.

This project demonstrated a couple principles that could very likely help teachers overcome this hurdle. Where teachers may be concerned with their ability to create narrated slideshows, or the unfamiliarity with screencasting software, videos filmed in field locations require little more technical ability than operating a camcorder. Even simpler, these videos could be created using a smartphone or tablet. Moreover, this project indicates that time invested in creating narrated slideshows may not be time well spent, as demonstrated by the 0.07% increase in test scores. This time invested essentially created no measurable gain in student achievement.

In reference to the question about students' views of exploration, survey responses did not provide support for field location videos affecting students' views of exploration. In fact there was a decrease of 3.6 percent in the number of responses that were agree or strongly agree going from the narrated slideshows to the field location videos. This could

indicate that in a flipped classroom it is more effective to try to encourage student exploration through the activities completed in class rather than relying solely on the media. Although this study focuses specifically on media, in class activities and assignments compose a large portion of what occurs in flipped classrooms and cannot be neglected. This finding did not support the hypothesis that field location videos would cause a more favorable view of exploration.

In terms of students' views of the nature of science, there were not any large scale changes. This was not overly surprising because views of the nature of science can be very slow changing and this study was completed over the course of a few class periods. However, there were changes in individual student responses. Two students in particular shifted from writing in the third person on their pre-test to expressing their views in second person on the post-test. This shift could indicate a greater feeling of the ability to participate in science. John Dewey described experience as being essential to how students create knowledge (1938). Moreover, field experience is also a beneficial component of education (Novak, 2011). This shift in language, although there were not large pattern shifts, could indicate that for some individuals field location videos can create an experience on which knowledge can be constructed. Moreover, this shift could indicate a connection between students' views of the nature of science and engagement, which could be an interesting future area of research.

#### VALUES

In utilizing these findings, a teacher who is implementing the flipped classroom model might use engaging videos created by others. They could then incorporate a few of their own videos over specific topics that they feel most comfortable in creating engaging

videos over. This project, as has been shown in the literature, reaffirms the fact that a lesson that would not be engaging when presented in person, will not be engaging when presented in the form of a video. Although this study was completed with the focus on flipped classrooms, the findings likely carry over to videos shown in class time. As previously mentioned, some teachers might express concern that using videos created by others might be equivalent to them not teaching their own classes, however nearly all teachers use textbooks written by others without similar concerns. Moreover, if teachers re-envision their role in the mindset of the constructivist approach presented by Dewey this could help them redefine their place in the classroom to be that of guide that provides the resources and support for students to build their knowledge.

As I transition to a new teaching position next school year, I will continue to use the flipped classroom model. However, I will not invest countless hours in creating narrated slideshow videos that students will not find engaging, simply for the sake of having them view videos I created. Moreover, my new position will have me teaching five to six different courses, which will require me to be incredibly efficient in my preparation time, especially using the flipped model. I have redefined my role as a teacher to be a provider of the resources to build knowledge and then to act as a guide for students through the process of building knowledge. This is emphasized by the findings about students' views of exploration. In creating an effective flipped classroom, I will work to not neglect the media or the activities and assignments. Fostering a desire for exploration is still an important goal for me, and the results of this study show that this goal should be addressed in my classroom outside of the media used.

I think the topic of what makes a video engaging is one that still has much left unanswered, particularly for the individual student. I am interested if the context of the video (filmed outside) alone is responsible for the increase in student engagement and achievement, or if the relevance of the context to the content is key. Also, I think the effect of videos that are presented in a more informal tone as well as those the present discourse instead of direct instruction present to very interesting avenues of future study. The body of knowledge on effective media in the flipped classroom still has many gaps. Work has shown that discourse in videos is effective in physics courses at the post-secondary level, but are they equally effective in other sciences and with other students? Traditional thought has been that the more formats a student encounters the information (visually in text and audibly) will increase the chance of retention, but in this study students improved when the visual text was removed.

I feel that science educational media, as a field, is ready to undergo the thorough development of best practices as seen in traditional in-person teaching. In addition to questions about the media, the potential connection between student engagement and views of the nature of science provides an interesting opportunity. Additionally, potential variation in views of the nature of science amongst students possibly by age, ability level, or socioeconomic status could a good opportunity to more clearly define what determines views of the nature of science.

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APPENDICES



APPENDIX A

LIKERT SCALE SURVEY FOR VIDEOS

## LIKERT SCALE SURVEY FOR VIDEOS

**Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.**

Name \_\_\_\_\_ Class \_\_\_\_\_ Video Watched \_\_\_\_\_

1. I spaced out watching the video  
Strongly Disagree      Disagree      Neutral      Agree      Strongly Agree
2. I would rather read the textbook than watch the videos  
Strongly Disagree      Disagree      Neutral      Agree      Strongly Agree
3. I find the videos entertaining  
Strongly Disagree      Disagree      Neutral      Agree      Strongly Agree
4. I would watch more videos on this topic if they were available  
Strongly Disagree      Disagree      Neutral      Agree      Strongly Agree
5. The topic we are studying is something I would like to know more about  
Strongly Disagree      Disagree      Neutral      Agree      Strongly Agree
6. I look forward to watching the videos  
Strongly Disagree      Disagree      Neutral      Agree      Strongly Agree
7. I enjoy having videos to watch:  
Strongly Disagree      Disagree      Neutral      Agree      Strongly Agree
8. The length of the videos is about right:  
Strongly Disagree      Disagree      Neutral      Agree      Strongly Agree
9. I feel like I am learning as well with the videos as I would with lectures:  
Strongly Disagree      Disagree      Neutral      Agree      Strongly Agree
10. I would rather have videos that were filmed in nature than powerpoint slides:  
Strongly Disagree      Disagree      Neutral      Agree      Strongly Agree
11. I would rather have videos Mr. Clay made than videos made by someone else:  
Strongly Disagree      Disagree      Neutral      Agree      Strongly Agree
12. I think exploring this topic is important.  
Strongly Disagree      Disagree      Neutral      Agree      Strongly Agree
13. I think it is important for scientist to travel to explore areas with this topic.  
Strongly Disagree      Disagree      Neutral      Agree      Strongly Agree
14. What I like least about this video is:

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15. What I like most about this video is:

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16. Something Mr. Clay could do to improve this video is:

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APPENDIX B

SURVEY FOR STUDENTS' VIEWS OF THE NATURE OF SCIENCE

**S Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.**

1. What in your view is science? What makes science (or a scientific discipline such as geology or biology) different from other disciplines of inquiry (religion or philosophy)?
  
  
  
  
  
  
  
  
  
  
2. What is an experiment?
  
  
  
  
  
  
  
  
  
  
3. Does the development of scientific knowledge require experiments?
  
  
  
  
  
  
  
  
  
  
4. Explain your answer to number 3 and give an example.
  
  
  
  
  
  
  
  
  
  
5. Scientists perform experiments/investigations when trying to find answers to the questions they put forth. Do scientists use their creativity and imagination during the investigations? If yes please explain at what point of the process and give examples. If no, please explain why and give an example.

APPENDIX C

SURVEY OVER STUDENTS' OPINIONS OF FLIPPED CLASSROOM

### SURVEY OVER STUDENTS' OPINION OF FLIPPED CLASSROOM

Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.

Grade \_\_\_\_\_ Hour \_\_\_\_\_

**1. I enjoy having videos to watch before class:**

Strongly Disagree      Disagree      Neutral      Agree      Strongly Agree

**2. The length of the videos is about right:**

Strongly Disagree      Disagree      Neutral      Agree      Strongly Agree

**3. It is easy to know what video to watch and when:**

Strongly Disagree      Disagree      Neutral      Agree      Strongly Agree

**4. Even if there were not notes, I would still watch videos that were assigned:**

Strongly Disagree      Disagree      Neutral      Agree      Strongly Agree

**5. The number of videos to watch each week is about right:**

Strongly Disagree      Disagree      Neutral      Agree      Strongly Agree

**6. I feel like I am learning as well with the videos as I would with lectures:**

Strongly Disagree      Disagree      Neutral      Agree      Strongly Agree

**7. I feel I am learning better by watching videos at home and doing activities in class than I would with lecture:**

Strongly Disagree      Disagree      Neutral      Agree      Strongly Agree

**8. I would rather have videos that were filmed in nature than powerpoint slides:**

Strongly Disagree      Disagree      Neutral      Agree      Strongly Agree

**9. I would rather have videos Mr. Clay made than videos made by someone else:**

Strongly Disagree      Disagree      Neutral      Agree      Strongly Agree

APPENDIX D

INSTITUTIONAL REVIEW BOARD EXEMPTION

## INSTITUTIONAL REVIEW BOARD EXEMPTION



**INSTITUTIONAL REVIEW BOARD**  
**For the Protection of Human Subjects**  
**FWA 00000165**

960 Technology Blvd. Room 127  
 c/o Immunology & Infectious Diseases  
 Montana State University  
 Bozeman, MT 59718  
 Telephone: 406-994-6783  
 FAX: 406-994-4303  
 E-mail: cherylj@montana.edu

*Chair:* Mark Quinn  
 406-994-5721  
 mquinn@montana.edu

*Administrator:*  
 Cheryl Johnson  
 406-994-6783  
 cherylj@montana.edu

**MEMORANDUM**

**TO:** Matthew Clay and Walt Woolbaugh  
**FROM:** Mark Quinn, Chair *Mark Quinn CH*  
**DATE:** December 23, 2013  
**RE:** "What is the Effect of Flipped Classroom Videos Filmed at Field Locations on Student Engagement?"  
 [MC12-2313-EX]

The above research, described in your submission of December 23, 2013, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal regulations, Part 46, section 101. The specific paragraph which applies to your research is:

- (b) (1) Research conducted in established or commonly accepted educational settings, involving normal educational practices such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.
- (b) (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.
- (b) (3) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if: (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.
- (b) (4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available, or if the information is recorded by the investigator in such a manner that the subjects cannot be identified, directly or through identifiers linked to the subjects.
- (b) (5) Research and demonstration projects, which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (i) public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.
- (b) (6) Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed, or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the FDA, or approved by the EPA, or the Food Safety and Inspection Service of the USDA.

Although review by the Institutional Review Board is not required for the above research, the Committee will be glad to review it. If you wish a review and committee approval, please submit 3 copies of the usual application form and it will be processed by expedited review.



APPENDIX E

PRE-TEST AND POST-TEST SCORES

## PRE-TEST AND POST-TEST SCORES

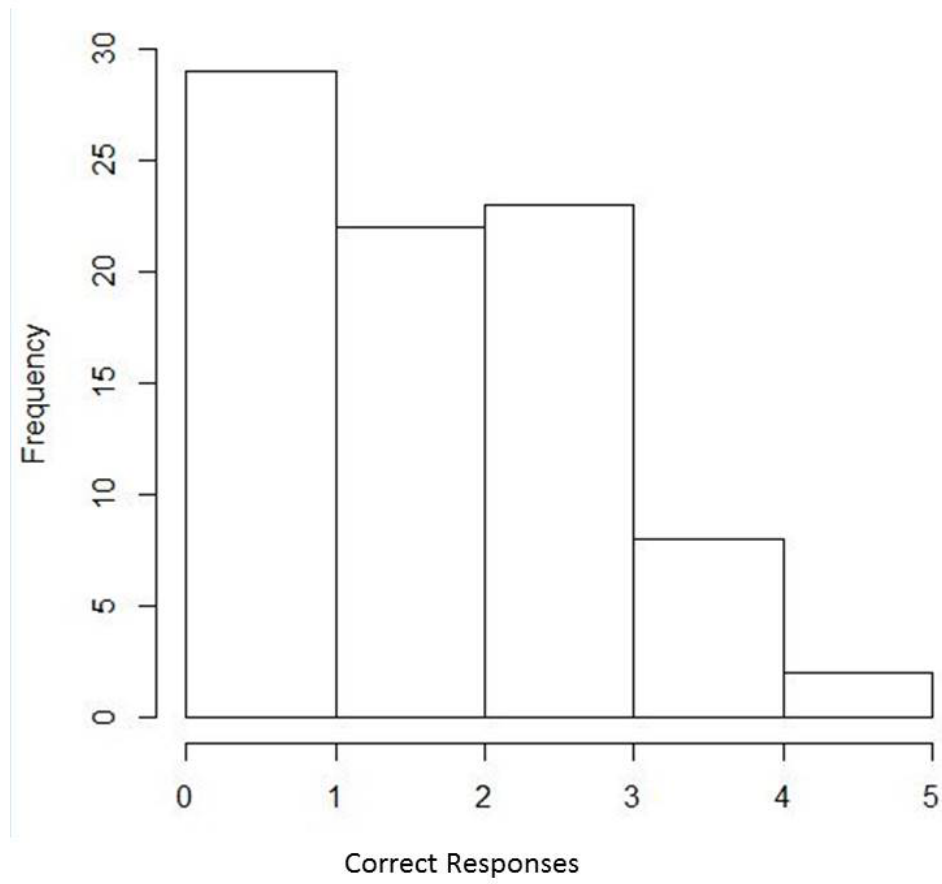


Figure E1. *Histogram of pre-test scores for narrative slideshows.*

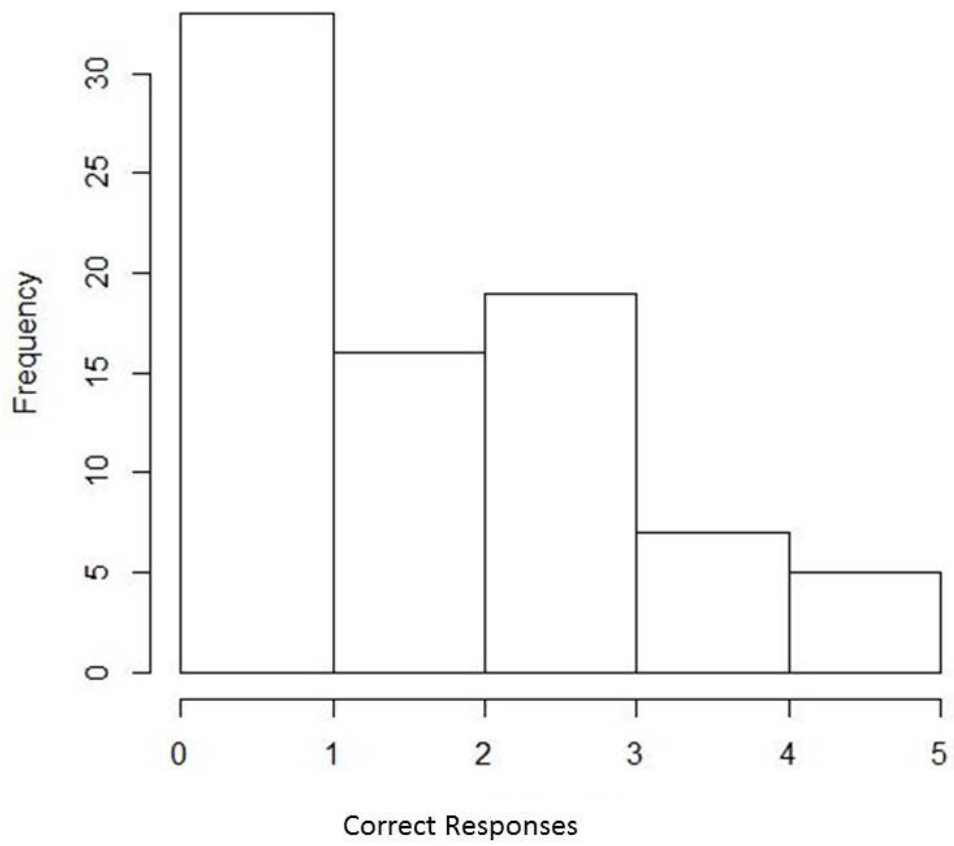


Figure E2. *Histogram of post-test scores for narrative slideshows.*

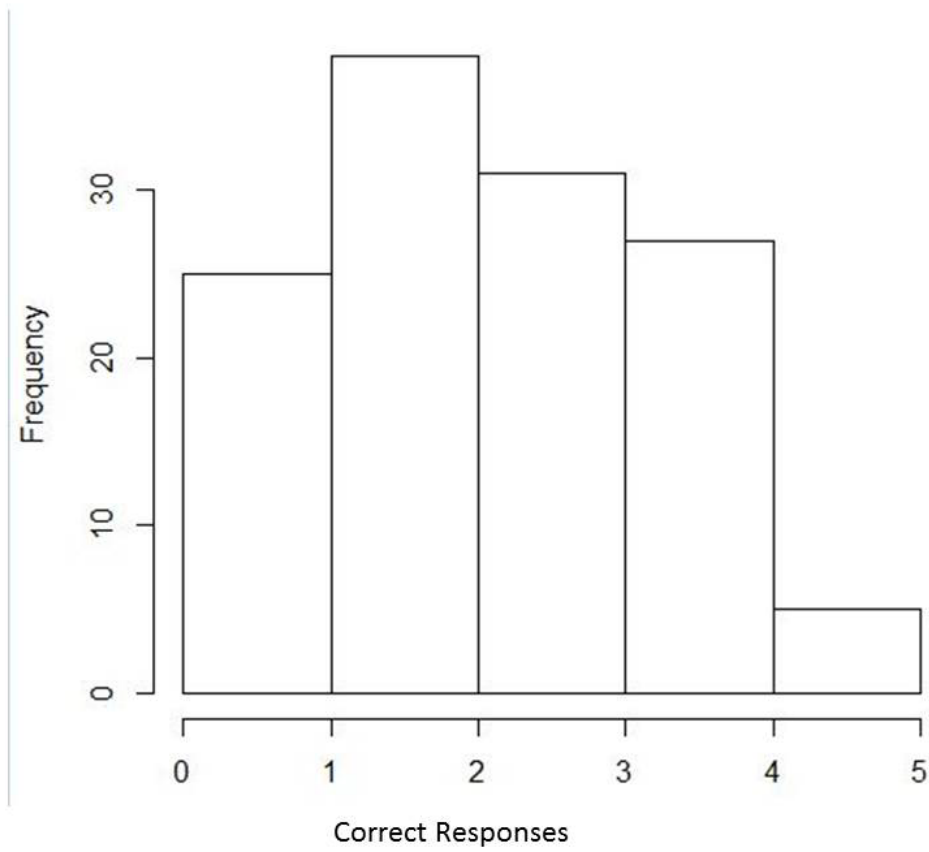


Figure E3. *Histogram of pre-test scores for field location videos.*

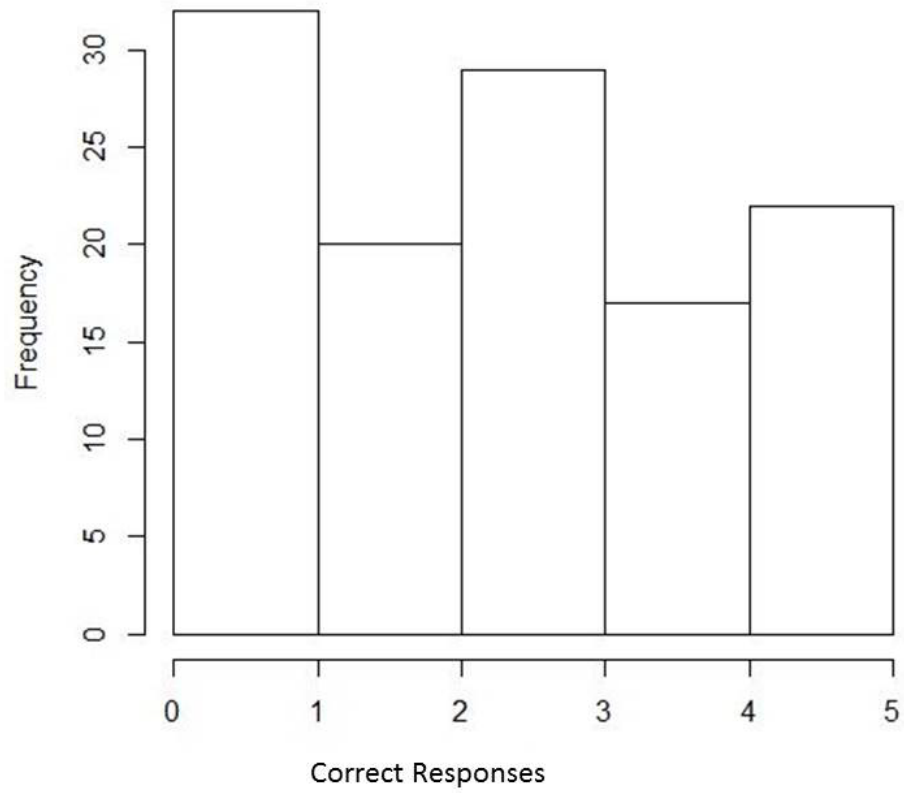


Figure E4. *Histogram of post-test scores for field location videos.*

APPENDIX F

PRE-TEST AND POST-TEST FOR NARRATED SLIDESHOW AND FIELD VIDEOS

## PRE-TEST AND POST-TEST FOR NARRATED SLIDESHOW AND FIELD VIDEOS

**Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.**

## PART 1

1. With what layer of the atmosphere are we most concerned in terms of weather?
  - a. Mesosphere
  - b. Exosphere
  - c. Troposphere
  - d. Stratosphere
2. What special layer of the atmosphere absorbs UV-B radiation?
  - a. Ionosphere
  - b. Magnetosphere
  - c. Exosphere
  - d. Ozone layer
3. What percent of the atmosphere is Nitrogen?
  - a. 65%
  - b. 40%
  - c. 21%
  - d. 78%
4. What percent of the atmosphere is Oxygen?
  - a. 78%
  - b. <1%
  - c. 98%
  - d. 21%
5. If the cloud extends past the lowest layer of the atmosphere, into what layer would it reach?
  - a. Magnetosphere
  - b. Troposphere
  - c. Stratosphere
  - d. Mesosphere

**Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.**

Part 2

1. What is heat transfer through direct contact?
  - a. Convection
  - b. Conduction
  - c. Condensation
  - d. Sublimation
2. What is heat transfer through differences in density?
  - a. Condensation
  - b. Conduction
  - c. Convection
  - d. Precipitation
3. Which TWO are greenhouse gases?
  - a. Water
  - b. Oxygen
  - c. Nitrogen
  - d. Carbon Dioxide
4. About what percentage of solar radiation is reflected?
  - a. 64%
  - b. 15%
  - c. 32%
  - d. 97%
5. On average what percent of solar radiation reaches the earth's surface?
  - a. 60-75%
  - b. 5-10%
  - c. 85-90%
  - d. 20-25%



**Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.**

PART 3

1. Precipitation would be likely with a dew point temperature that is \_\_\_\_\_.
  - a. Negative
  - b. Low
  - c. High
  - d. Dew point doesn't affect precipitation
2. Which of the following decrease with elevation? (You may mark more than one)
  - a. Humidity
  - b. Temperature
  - c. Air Pressure
  - d. Dew Point
3. What is the ratio of the amount of water vapor in the air to what it can hold
  - a. Dew point
  - b. Absolute humidity
  - c. Relative humidity
  - d. Wind chill
4. Wind moves from \_\_\_\_\_ to \_\_\_\_\_ always.
  - a. East to West
  - b. High humidity to low humidity
  - c. South to North
  - d. High pressure to low pressure
5. How is a wind chill created?
  - a. Wind brings cold air closer
  - b. Wind causes your nerves to retreat
  - c. Wind causes increased evaporation
  - d. Wind causes the illusion of cold

**Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.**

PART 4

1. What process is the transformation of liquid water to water vapor?
  - a. Evaporation
  - b. Sublimation
  - c. Condensation
  - d. Melting
2. What process is the transformation of ice to water vapor?
  - a. Sublimation
  - b. Condensation
  - c. Evaporation
  - d. Melting
3. What process is the transformation of water vapor to ice?
  - a. Evaporation
  - b. Condensation
  - c. Sublimation
  - d. Freezing
4. What process is the transformation of water vapor to liquid water?
  - a. Evaporation
  - b. Condensation
  - c. Sublimation
  - d. Freezing
5. What process is the transformation of ice to liquid water?
  - a. Melting
  - b. Freezing
  - c. Condensation
  - d. Evaporation

**Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.**

PART 5

1. What type of clouds produce severe thunderstorms?
  - a. Cirrus
  - b. Cumulus
  - c. Cumulonimbus
  - d. Stratus
2. What type of cooling does water undergo as it rises?
  - a. Orographic
  - b. Adiabatic
  - c. Geometeorological
  - d. Tectonic
3. What best describes the temperature of supercooled water?
  - a. Below 0 degrees Celsius and liquid
  - b. Between 0 and 20 degrees Celsius and liquid
  - c. Between 20 and 40 degrees Celsius and solid
  - d. Below 0 degrees Celsius and solid
4. To what do water droplets condense?
  - a. Nothing
  - b. Condensation nuclei
  - c. Only other water droplets
  - d. Organic particles
5. High humidity and low temperatures would produce clouds with \_\_\_\_\_.
  - a. Low base
  - b. High base
  - c. Clouds wouldn't form with these conditions
  - d. At low temperature the water would freeze on the ground instead of forming clouds

APPENDIX G

NEXT GENERATION SCIENCE STANDARDS PRE-TEST AND POST-TEST

## NEXT GENERATION SCIENCE STANDARDS PRE-TEST AND POST-TEST

**Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.**

Name \_\_\_\_\_

Class \_\_\_\_\_

## PRETEST

1. Draw or describe how water cycles through the atmosphere.
2. How does sun affect water cycling through the atmosphere.
3. How could uneven heating of the earth affect weather?
4. Summarize the process of solar radiation reaching the earth's surface.

APPENDIX H  
BEHAVIOR LOG

BEHAVIOR LOG

Date \_\_\_\_\_ Class \_\_\_\_\_ Video \_\_\_\_\_

Student	Positive Behaviors			Negative Behaviors		
	Taking notes	Nodding in acknowledgement	TOTAL	Talking out of turn	Fiddling with other objects	TOTAL
TOTALS						

APPENDIX I

OUTLINE OF UNIT TOPICS



## OUTLINE OF UNIT TOPICS

1. Introduction to Meteorology
  - a. The atmosphere
    - i. Composition
      1. Joseph Priestly and Karl Scheele discovered oxygen in the atmosphere
      2. Rutherford discovered Nitrogen
      3. 78% N<sub>2</sub>
      4. 21% O<sub>2</sub>
      5. 1% H<sub>2</sub>O, H<sub>2</sub>, CO<sub>2</sub>, CH<sub>4</sub>
    - ii. Composition layers
      1. Homosphere
        - a. Where air constantly mixes
        - b. Extends to an altitude of about 50miles
      2. Heterosphere
        - a. Gases separated by density
    - iii. Temperature layers
      1. Troposphere
        - a. Lowest layer
        - b. Upper boundary is tropopause
        - c. Where most weather occurs
        - d. Goes to about 11km
      2. Stratosphere
        - a. Goes from troposphere to about 50km
        - b. Free of clouds
        - c. Where jet stream is located
      3. Mesosphere
        - a. Extends to mesopause at
      4. Thermosphere
        - a. Uppermost layer extends to 300km
        - b. Upper boundary is tropopause
      5. Exosphere
        - a. Transition between atmosphere and outer space
    - iv. Special layers
      1. Ozone layer
        - a. Extends from 20km to 50km
        - b. Made of O<sub>3</sub>
        - c. Blocks harmful radiation
      2. Ionosphere
        - a. Contains charged particles called ions



1. Wind is movement of air at the ground
2. Moves from high to low pressure
3. Can create a wind chill which is an apparent drop in temperature because of increased evaporation
- vii. Precipitation
  1. Moisture falling from the sky
  2. Rain, snow, hail, sleet, freezing rain
- viii. Dew point
  1. Temperature at which air would be saturated
  2. If it is high precipitation is likely if it is low it is not
  2. Atmospheric Water
    - a. Water cycle
  - i. Drawing
  - b. Clouds
    - i. Clouds are masses of water droplets or ice crystals suspended in the air
    - ii. Formation
      1. As warm moist air rises it cools in a process called adiabatic cooling
      2. Cooling lowers the temperature, increase the RH
      3. Condensation nuclei are dust particle which water condense on to
      4. A quiet atmosphere can lead to supercooled water below freezing temperature that will sublimate
  - iii. Cloud types
    1. Stratus-thin layers
    2. Cumulus-billowy
    3. Cirrus-wispy
  - iv. Elevation of clouds is caused by the elevation of lower temperatures
    1. High water, low temps=low clouds
    2. Low water=high clouds
    3. Low level clouds often produce precipitation
  - v. Cumulonimbus
    1. Large clouds that produce severe thunderstorms
    2. Fueled by a strong in flow
    3. Need high levels of energy

APPENDIX J

LIKERT SCALE SURVEY RESPONSES

## LIKERT SCALE SURVEY RESPONSES

Table J1. Responses to Likert scale survey for Introduction to Meteorology video.

Question	SD	D	N	A	SA	TOTAL
1	9	11	13	5	4	42
2	23	13	5	1	0	42
3	3	8	18	10	3	42
4	6	4	15	12	4	41
5	4	8	14	12	5	43
6	4	3	19	11	5	42
7	2	2	11	17	6	38
8	0	3	10	20	9	42
9	0	9	7	17	9	42
10	0	5	13	13	11	42
11	0	3	22	8	9	42
12	1	2	18	19	2	42
13	1	0	20	14	7	42

Table J2. Responses to Likert scale survey for Elements of Weather video.

Question	Combined					TOTAL
	SD	D	N	A	SA	
1	6	11	9	14	0	40
2	16	14	3	5	1	39
3	1	6	20	13	1	41
4	3	4	20	10	4	41
5	2	5	17	13	2	39
6	1	6	17	11	5	40
7	1	4	12	18	5	40
8	0	4	8	21	6	39
9	1	4	9	14	13	41
10	0	6	9	14	9	38
11	2	2	21	11	5	41
12	0	4	16	17	3	40
13	0	2	18	15	4	39

Table J3. *Combined responses to Likert scale survey for narrated slideshow videos.*

Question	SD	D	N	A	SA	TOTAL
1	15	22	22	19	4	82
2	39	27	8	6	1	81
3	4	14	38	23	4	83
4	9	8	35	22	8	82
5	6	13	31	25	7	82
6	5	9	36	22	10	82
7	3	6	23	35	11	78
8	0	7	18	41	15	81
9	1	13	16	31	22	83
10	0	11	22	27	20	80
11	2	5	43	19	14	83
12	1	6	34	36	5	82
13	1	2	38	29	11	81

Table J4. *Responses to Likert scale survey for Radiation video.*

Question	SD	D	N	A	SA	TOTAL
1	4	18	13	5	1	41
2	21	13	6	1	0	41
3	1	2	21	11	5	40
4	2	10	19	8	2	41
5	4	6	17	12	2	41
6	2	3	16	13	7	41
7	1	2	13	15	10	41
8	0	5	7	19	10	41
9	1	5	11	10	14	41
10	1	5	10	13	12	41
11	0	4	19	11	8	42
12	3	1	18	17	1	40
13	0	0	20	18	3	41

Table J5. *Responses to Likert scale survey for Water Cycle video.*

Question	SD	D	N	A	SA	TOTAL
1	14	17	8	4	0	43
2	19	16	6	2	0	43

3	1	2	17	19	4	43
4	5	9	16	14	3	47
5	2	6	20	10	5	43
6	1	3	17	16	7	44
7	1	1	8	25	8	43
8	2	2	10	24	7	45
9	2	2	9	19	10	42
10	1	1	15	13	12	42
11	0	3	14	16	8	41
12	1	1	22	17	3	44
13	0	1	19	22	1	43

Table J6. Responses to Likert scale survey for Clouds video.

Question	SD	D	N	A	SA	TOTAL
1	7	13	8	12	0	40
2	14	16	3	5	2	40
3	1	3	15	19	2	40
4	3	5	18	12	2	40
5	2	6	17	12	3	40
6	1	2	17	14	6	40
7	1	2	10	22	6	41
8	2	2	5	25	5	39
9	1	4	10	17	9	41
10	1	3	10	14	11	39
11	0	2	18	13	7	40
12	1	3	17	17	3	41
13	0	0	21	14	5	40

Table J7. Combined responses to Likert scale survey for field location videos.

Question	SD	D	N	A	SA	TOTAL
1	25	48	29	21	1	124
2	54	45	15	8	2	124
3	3	7	53	49	11	123
4	10	24	53	34	7	128
5	8	18	54	34	10	124

6	4	8	50	43	20	125
7	3	5	31	62	24	125
8	4	9	22	68	22	125
9	4	11	30	46	33	124
10	3	9	35	40	35	122
11	0	9	51	40	23	123
12	5	5	57	51	7	125
13	0	1	60	54	9	124

Table J8. *Chi square values for Likert scale survey responses*

Question	SD	D	N	A	SA	TOTAL	Significant Difference
1	0.24	6.52	0.55	2.08	4.21	13.60	Yes
2	0.54	0.33	0.62	0.15	0.14	1.79	No
3	1.45	9.11	0.19	6.53	4.34	21.62	Yes
4	1.17	10.61	0.05	0.00	2.41	14.24	Yes
5	0.13	0.14	1.08	0.38	0.03	1.76	No
6	1.72	2.38	0.43	2.67	1.48	8.69	No
7	0.68	2.22	0.93	0.62	2.30	6.75	No
8		0.30	1.20	0.35	0.06	1.91	No
9	4.20	3.65	1.55	0.00	0.00	9.41	No
10		3.60	0.06	0.03	0.66	4.36	No
11	2.96	0.34	2.54	4.98	0.24	11.07	Yes
12	7.92	1.88	0.52	0.27	0.05	10.64	Yes
13	1.53	1.39	0.06	2.08	3.65	8.70	No



APPENDIX K

WEB ADDRESSES OF VIDEOS USED

## WEB ADDRESSES OF VIDEOS USED

Video	Address
Introduction to Meteorology	<a href="https://vimeo.com/88085533">https://vimeo.com/88085533</a>
Solar Radiation	<a href="https://vimeo.com/88085539">https://vimeo.com/88085539</a>
Elements of Weather	<a href="https://vimeo.com/88085530">https://vimeo.com/88085530</a>
Water Cycle	<a href="https://vimeo.com/88085537">https://vimeo.com/88085537</a>
Clouds	<a href="https://vimeo.com/88085529">https://vimeo.com/88085529</a>