

WHAT MAKES A SCIENCE VIDEO ENGAGING IN TODAY'S AMERICAN
CLASSROOM?

by

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DEDICATION

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ABSTRACT

This thesis investigates the fundamental question: “What makes a science film for the classroom effective in helping educators achieve their goals for the largest number of students?” I argue here that effective films take students on a journey. The best films are experiential, taking students on a journey as opposed to telling them what to think. I have also compiled a list of several key ingredients that effective films tend to share: they are generally short, they employ elements of humor and action, they avoid heavy narration, they are accessible using the latest and most widespread technologies, and they are associated with supplemental information and activities for teachers to maximize use of the material. To discuss what makes a film effective, I make the distinction between levels of effectiveness in the classroom. Science films that tend to be more effective are defined here as *student ignition points*. Those that fall toward the other end of the spectrum, those that are least effective, I define as *student snoozers*.

This thesis is a compilation of almost a decade of thought and application regarding the creation of effective science videos for use in the classroom. The culmination of this work has resulted in the Untamed Science video series that is included in the Miller and Levine high school biology book, the Pearson middle grades science books, the Pearson high school chemistry book, the Pearson elementary science books, and the Untamedscience.com web portal. While the techniques for creating classroom science videos vary due to the intended target age ranges (from kindergarten to 12th grade), there are filmmaking “key ingredients” effectively employed over the entire age range. This discussion focuses on the high school and upper middle grades demographic.

INTRODUCTION

A cursory examination of many science videos currently distributed throughout the American educational system demonstrates a consistent failure to meet the goals of science educators. Science educators want their interactions with students to create not only a platform for delivering facts and theories about a subject, but also to produce a more fundamental goal to spark a desire by students to learn independently more about the subject; i.e. helping the students reach the ignition point at which a more meaningful learning process begins.

If filmmakers are to create effective films for the science classroom, they should have many of the same goals in mind. Science films for use in the high school classroom should not simply deliver facts and visuals about subject matter - they should engage the students and ignite a desire for further study. In fact, I argue that this is the most important part of a science classroom film. Creating a film like this requires not only engaging the students, but igniting a desire for further study.

In this research, I found that, or I will show that, there are several key ingredients that make science videos in the classroom engaging. To compare and contrast videos that fall on opposite ends of a spectrum of engagement in the classroom, I use the terms *student igniter* and *student snoozer*. The defining characteristic between these two types of science video is the degree to which they hold student interest in a high school or middle grades science classroom. *Student igniters* engage students, keeping their interest in the science film at hand. *Snoozers* exert less hold on a student's attention – students fall asleep, either literally or figuratively. Although *igniters* and *snoozers* have existed in

the science classroom since the earliest films were available for classroom use (in the 1950's), noone has produced a guide to aid filmmakers in producing *student igniters*. Using the knowledge gained from over ten years of creating more than three hundred videos for each grade level in the science classroom, I present a guide to distinguishing between *snoozers* and *igniters* and a set of guidelines that make science videos created for the high school and middle grades classroom more engaging.

STUDENT SNOOZERS AND STUDENT IGNITERS

This study is not the first to analyze the qualities of effective educational films. In fact it builds on great deals of research conducted by formative and summative resarchers. The first major attempt to conduct this research on educational videos began in the late 1960's when an ingenious kids show designed to teach underprivaledged children and get them ready for school was thought up – *Sesame Street*. The Children's Television Workshop (CTW) formed a collaboration in 1968 with the production team of *Sesame Street* to test learning in kids that watched the show.

Testing of students was done in two broad categories: students in individual settings and students in group settings. In both categories, distraction and attentiveness were indicators used to gauge a film's effectiveness. One child at a time would sit alone to watch segments of *Sesame Street* programs. In a corner of the same room, a slide show of other interesting images would be also visible to the student. The researchers recorded and timed the student's visual attentiveness on the two sets of images every 7.5 seconds. If segments of *Sesame Street* tested too low on this "distraction test," that segment would not be aired (Fisch and Truglio14). While researchers at CTW did not classify segments into *snoozers* and *igniters*, I would classify an episode that tested low on their "distraction test" as a *snoozer*. The students "snoozed" by looking away from the primary test video. Segments that scored high on these individual tests can be viewed as *student igniters* because they were able to hold the attention of the individual students.

In a later series of tests, the same researchers placed students in group settings that more closely approximated classroom conditions. While the researchers were

concerned that this group-testing might bias results because of random influences of individuals in that group, they found that in this setting, very engaging *Sesame Street* segments scored even better and less engaging segments scored even worse. The researchers assumed this was because if an individual segment was not engaging, some students would get distracted, which would thus distract the rest of the group (Fisch and Bernstein 50).

CTW Researchers linked a low level of student engagement to making a *student snoozer*, where students do not retain as much information from the video. Researchers with *Seasame Street* found that there was a strong correlation between the results of both test approaches (group or individual) when looking at student engagement (Anderson *et al.* 446). *Sesame Street* researchers were concerned with examining student engagement because they found a direct correlation between student interest in a video segment and retention of information (Fisch and Truglio 15). In other words, if a student liked the video they retained more information. Thus, to be a *student igniter*, a film must be highly engaging and enjoyable.

While both of these tests may be broad indicators of the overall effectiveness of the videos in generating and maintaining student interest and retaining information, these particular tests don't identify the elements that cause them to excel or fall short in that effort.

Additional research at *Seasame Street* did attempt to identify the overall film segment length, the tone of voice of the narrator, and the nature or lack of video action as key elements that affect student attention, engagement, and knowledge retention.

However, few have attempted to study this for science films for older students. The examination of these points compose the second half of this paper.

Student snoozers are not necessarily “bad films”; in fact, they can be some of the most interesting and beautiful science videos currently being made. *Snoozers* range from high budget blue chip films to low-budget films made for the classroom. For example, the one-hour long Blue Planet videos are a joy to watch on Sunday nights with the family, but in the classroom long films that lack an overarching storyline do little to intrigue students for the length of the film. The sonorous, omniscient “voice of god” narration that accompanies amazing shots through the world’s oceans may bore the pants off middle and high school students. In this case, it’s likely a combination of the length of these long segments and the fact that they are not experiential that give them a *snoozer* rating. Students don’t always like narrators to tell them what to think, they enjoy hosts that can take them along for a ride, giving them a sense of immersion.

Students have short attention spans. Middendorf and Kalish studied the attention span of students at an Israeli University in two undergraduate psychology classes. They found that students were only able to significantly absorb information in the first ten minutes of a lecture if it wasn’t broken up in some way (1). Documentaries can act just like a typical classroom lecture. If they’re not broken up, or shorter than about ten minutes, the students won’t retain as much. Thus, long format films, such as, Blue Planet (2001), Planet Earth (2006), *March of the Penguins* (2005), and *Earth* (2007) may not be the best use of class time for a teacher. Instead of being a tool to boost learning, this type of science video becomes a monkey wrench thrown into a class period - slowing down

what could be otherwise an exciting, engaging learning process. Science videos and documentaries over ten minutes are not made for the demographic of the student watching them: students with short attention spans sitting in a classroom as a teacher presents a topic.

However, even videos made specifically for the classroom can still be *snoozers*. A great example of this is the highly acclaimed, widely used The World of Chemistry video series (Annenberg/CPB). In 1989, the Annenberg/CPB foundation provided money to produce a series of twenty-six chemistry videos intended to help increase student learning of chemistry topics. The videos were produced for high school classrooms and adult learners. Each video was a half hour long and consisted of a female narrator, and a male Nobel laureate (Roald Hoffmann) who would bridge the gap between segments of scientists describing topics such as molecules, electrons, polymers, and inert gases. The series also took visits to industrial venues and conducted experiments that teachers often can not perform in the classroom. With videos chock-full of experts, facts, visual diagrams, animations, experiments and field trips, this series had a lot going for it. It could easily have been engaging, but this series still gets a *snoozer* grade. Harwood and McMahon interviewed high school students and asked them what they liked and didn't like about the videos (627). Students described them as slow, which may be attributed to the narrator's long monologues that could be viewed as boring (626), and to the fact that the videos were too long (thirty minutes) for student attention spans. This required teachers to stop and start at several points to increase learning (Harwood and McMahon 625). The study summarized the parts that the students enjoyed, particularly noting the

experiments, animations and the field trips (627). Even though this series is a snoozer, it is constantly cited as proof that science videos are effective in the classroom. The overall conclusion by Harwood and MacMahon was that integrating science videos into the classroom did have a significant effect on both student achievement and student attitudes. They based this conclusion on the fact that students from the test group who watched the videos scored better on standardized tests and expressed a greater interest in the subject of chemistry. That being said, it is important to note that this study showed that student attitudes toward chemistry only rose from 69.0 percent to 69.7 percent. Thus, although being exposed to these videos did not turn students away from science, I argue that their interest in chemistry did not significantly improve. Imagine what a series that truly ignited interest in chemistry through a host lead immersive journey might have done to reinforce a positive attitude towards chemistry.

Student igniters on the other hand are videos that hold the attention of the student better than *snoozers*. They are on the opposite end of a spectrum of engagement. While there are many types of videos that a student might enjoy watching in the classroom, I'm restricting my definition to videos a teacher would show in the science classroom. Many videos that have science focus are not *student igniters* because they fail in one or many categories that make them appropriate for classroom use. For example, the Blue Planet series videos are not *student igniters* because they are too long and lack a cohesive story tying the short bits together. They simply explain topics rather than taking students on an experiential journey. The World of Chemistry videos are not *student engagers* because they are utterly dorky, somewhat dull and humorless. Yet, the successful programs like

Discovery Channel's *Man vs. Wild* and Animal Planet's *River Monster's* that have enthusiastic and knowledgeable hosts, quick editing, and grungy graphics tend to be very engaging to students. Add to that the fact that these shows immerse the host in the midst of a journey. They put the hosts in awkward situations, forcing them to overcome obstacles. This is extremely important and key to making a good, attention-grabbing video. So is there a list of attributes that one can use to make engaging videos?

Good *student igniters* have a number of factors that make them engaging for students. The first and most important factor is that they show, rather than tell the students what to believe. They are immersive journeys. In addition, they often share many important filmmaking "ingredients": they are short, humorous, science-topic focused, rich with engaging hosts, use some form of repetition, are produced to appeal to the student demographic, and are also tagged with supplemental material so teachers can use them effectively in class. For example, the Brainpop videos, a series of humorous animated shorts (1999-2011), are great *student igniters*. They are found on the Internet and are often accompanied by interactive post-show quizzes. Shows like *Bill Nye the Science Guy* (1993-1998), which feature an entertaining host, Bill Nye, are also *student igniters* because of the way Nye appeals to young students. The show seems to attract students because of the antics of the presenter and the quirky style of editing. Personal communication with teachers reveals great value in the Bill Nye videos because of their extreme science topic focus. Topics from *Bill Nye the Science Guy Season one* (1993) include: Animal Locomotion, Digestion, Evolution, Flowers, Food Web, the Heart, Plants and Populations. They are ideal for teachers because they follow the subjects that a

science teacher would teach in a middle school classroom. *Discovery* channel videos such as *Man vs Wild* episodes, while engaging, are not focused on a science topic taught in the classroom, and thus can't be used in this setting. The factors that make a video a *student igniter* will be discussed in-depth in the next section. Before I delve into that, it's important to understand why *student igniters* are useful in a science classroom.

Student igniters are great to show in the classroom because they not only help educators teach science topics, but they also improve students' perception of science. As mentioned previously, studies such as Harwood and McMahon's evaluation of The World of Chemistry series have shown that even relatively non-engaging "*snoozer*" videos are useful in the classroom (617). Even though they did show a small degree of change in student's adoration to chemistry, imagine what greater effect a highly immersive *student igniter* might have? While there are no studies that compare the effectiveness of different videos to each other, Yigal evaluated the effectiveness of Brainpop, an online video series that presents science via an animated boy host and his mute robot (451). Yigal conducted his study at private schools in Israel, where he studied 418 fifth and seventh grade students. A control group did not watch the videos, while the experimental group used the videos as a learning tool. Yigal found that students who watched the videos showed a significant increase in their understanding of the material. Yigal continued his study to examine student's perception of science. By watching the Brainpop videos, he found that students who were able to watch the videos did have a higher appreciation of science after the course than those who did not (452). This study represents one of the few studies that clearly show that engaging videos, like Brainpop,

are useful for a teacher in the science classroom because they help students perform better on tests and leave the class with a better perception of science.

Student igniters are one of the best tools for a science teacher to introduce a science topic. While *student igniters* work well to diversify a lecture at any point in the class period, these *igniters* are most effective as a ‘hook’ to get students interested in the lecture topic. Because videos can take students places they might never have gone and show science concepts foreign in nature (such as space travel, distant rain forests, or the deep sea), the videos act to engage the mind of the student before the lesson begins. Randy Olsen, in *Don’t be Such a Scientist (2009)*, argues that science videos should first engage and then explain topics. Failure to do so risks losing the interest of the students early in a lecture.

A great example of how science videos can be used in the classroom to introduce a subject is through the personal communication with a Montessori school teacher in Minneapolis, Haley Chamberlain. She uses Untamed Science podcasts as a tool as she teaches her students. This series, a production of the authors here, are short (three to five minute) science videos that end up being very similar to the Bill Nye series - except they star a series of young, back-packing “ecogeeks” with a tendency to present concepts from an ecological or biological perspective. Chamberlain notes that she uses the Untamed Science Halloween episode about pumpkins, squash and other gourds to help her students grasp important biological concepts around this holiday (Ecogeek video podcast #24). In this episode, the hosts explain that all of the gourds are in the family Cucurbitaceae. They go on to show that pumpkins and zucchini are, in fact, the same species – only having

different characteristics because of selective breeding. This video acts as a springboard for her lesson about the rudiments of classification. To add another dimension to the lesson, she brings many different types of squash used as examples in the video. Chamberlain explained that she tries to use a lesson-specific science video early in teaching a topic - to give students visuals they can refer to as they discuss the topic further. She feels that having real examples is the best scenario, but video is very important (often necessary) for showing things you cannot bring into the classroom. In addition, Chamberlain notes that her students often refer to the video examples then raise their own questions about particular topics: “It gives them concrete examples to think about as we head into a new subject with all new vocabulary and concepts. It makes a huge difference to have an entertaining topic video at the beginning of a lesson.” Chamberlain claims the immersive and experiential style of the Untamed Science podcasts greatly ignites her students’ enthusiasm to learn more about each topic, and she feels it is one of the key ingredients that makes students look forward to science class (personal communication - interviewed May 2008).

Another example of how the videos can be used in the classroom comes from Chris Borgatti, a high school biology teacher at an all boys school in Boston. Borgatti uses a different Untamed Science BioAdventures video once a week to start off a particular unit or chapter. He explains that the students began looking forward to the videos as part of their class lectures, and that much of the class discussions that follow (even after further lecture) centered around the information and examples in the videos. In fact, Borgatti reveals that his students very often use examples from the

BioAdventures videos when asked to give specific case study examples on tests. Another effect of this initial video springboard was his students' growing interest in the biology of Panama, due to the fact that many videos were set in Panama. Borgatti then set out to organize a class field trip to Coiba, an island just off the coast of Panama, giving them the chance to have "bio-adventures" of their own. While most teachers wouldn't be able to take this springboard effect this far, one can clearly see the power videos can wield to get students excited about science.

Igniters inspire students by taking them places they can't normally go. Just like showing chemistry experiments, videos can show students processes that are outside the scope of a normal in-class lesson. For example, in a lesson about forces in which students need to understand that wind friction is a force that pushes against the force of gravity, Untamed Science produced a highly experiential *student igniter* about Terminal Velocity (see Ecogeek podcast #66 – *Terminal velocity*). The concept of terminal velocity is fairly easy to understand: it's when the force of wind friction is equal (and opposite) to the force of gravity. Yet, how many students would ever be able to see the process first hand. The video starts with a shot of skydiving, an action sports sequence that students always seem to love watching. However, because it's difficult to see that a static skydiver falling toward Earth has actually stopped accelerating after the first ten seconds, the episode moves into a simulated free-fall wind tunnel. We feel it is extremely important to immerse the hosts in the explanatory examples. In this case, the hosts do a walkthrough of the facility, showing the fans that will create a constant 110 mph in the tunnel. As the host jumps into the wind-tunnel they do not move up or down because

wind friction against the sky diver's body equals gravity. The video continues to show dramatic action as the hosts change their body shape, shooting them up into the air. The change in body shape, changes the wind friction and thus, changes the forces acting on the sky diver. The video wraps with the expert fliers doing tricks in the tunnel. Because few students are old enough to skydive, and few wind tunnels exist in the world, this video is able to show a concept in a fun way to students visually. But maybe more importantly it inspires an interest in students to want to learn more. We've provided the student's ideal examples of what a scientist should do. Our hosts are living the process of discovery - asking a simple question about Terminal velocity and then exploring it with kid-like enthusiasm.

In another video, Untamed Science explains a different topic that's difficult to show in the classroom: how different wavelengths of light diminish with depth (12.4: *Why is the Ocean Blue*). To do this, our host took six colored SCUBA tank toppers down to a depth of 110 feet. The video of the underwater descent is sped up - so the viewer can easily see how the colored toppers appear to change with depth. These visuals compliment the narration, helping make the associations (Yelland 108). In only three minutes of video, Untamed Science introduces the topic and takes students to make the conceptual discovery themselves. Again, this process of immersive discovery is one of the key elements of the Untamed Science videos. In this case, the SCUBA and skydiving episodes are good examples of *student igniters* that allow students to understand the complex concepts outside the framework of the classroom.

KEY INGREDIENTS FOR CREATING *STUDENT IGNITERS*

Filmmakers will have a greater opportunity to create *student igniters* for the science classroom by employing a combination of “key ingredients” laid out below. The key ingredients chosen here are a collection of concrete elements (compiled through personal research and the research of others) that contribute to creating engaging science videos specifically used by teachers in the classroom. These key ingredients are guidelines to keep in mind while creating a science video, rather than strict rules or a checklist of items that should all be included in every video.

Because making video is an evolving creative process, filmmakers must employ many non-concrete elements such as creative adaptation to the humor of the present time and modifications based on artistic style. These combined elements ultimately lead to a synergy that cannot be broken down into a simple list. The whole video is more than the sum of its parts, and these key ingredients give filmmakers concrete choices to think about in their own creative process.

Key Ingredient #1: Length

In the same way that studies suggest classroom lectures should accommodate student attention spans, the length of *student igniters* should be tailored to accommodate the average attention span of the students for which it is being created. Many high school teachers show the fifty-minute Blue Planet episodes in class. It’s doubtful that these teachers take into account the fact that a high school student’s average attention span is less than the fifty-minute video... and neither do the filmmakers. One reason a video like

this is a *snoozer* in this setting is that it is too long for use in the classroom. Studies have found undergraduate student attention spans during classroom lectures to be approximately ten to eighteen minutes long. In one study, Johnstone and Percival observed students in ninety lectures, with twelve different lecturers, and recorded breaks in student attention throughout the lectures (49). They detected a general pattern that was, after three to five minutes of “settling down” at the start of class, the next lapse of attention occurred around ten to eighteen minutes later. In another study of undergraduate attention spans, Burns had students write summaries of the lecture after it concluded. He organized the information reported by the students into the time it was presented within the lecture. He reported the information given for each half-minute segment of the lecture, and he found that most information given by the students was reported from the first five minutes of the presentation. In addition, the information recall was the lowest at the fifteen to twenty minute level. With both of these studies suggesting a fifteen to twenty minute attention span during lecture and Burns’ study suggesting the most recall may be in the first five minutes of the lecture, Burns recommends “building a ‘change-up’” into classes to “restart the attention clock.” The “change-ups” are any “deliberate break . . . usually commanded a better attention span from the class, and these deliberate variations had the effect of postponing or even eliminating the occurrence of an attention break.” (2)

While these studies focused on lectures from teachers, filmmakers can use this idea of restarting the attention clock and the waning ability of students to absorb information over time to their advantage. Simply put, filmmakers have a better chance of

making a *student igniter* if they craft shorter videos than the attention span of the targeted students and introduce the main ideas early in the video.

Producing videos longer than the attention span of a student can still be effective in the classroom if filmmakers designed them for viewing in smaller segments. A filmmaker may desire to make a longer video for the classroom with more depth and/or information, and filmmakers must still find a way to accommodate student attention spans. By further applying the studies of Burns and Johnstone, the filmmaker can create longer videos designed to incorporate “change-ups” that can “restart the attention clock” every few minutes. For example, The World of Chemistry videos studied by Harwood and McMahon are thirty minutes long. For the test group that used the videos, they informed teachers to break up the video into short sections, stopping occasionally to ask students questions (617). If students didn’t understand a concept, they were instructed to rewind the video and play it again. The results of this study showed a significant increase in students’ positive attitude toward chemistry using this method. By breaking up the video, students have the opportunity to evaluate the material already seen, re-engage in the subject at hand and, perhaps, avoid an attention break.

In designing the length of videos for the recent Untamed Science BioAdventure series, I incorporated this information about attention span. Each video in the series fell into a time span of six to nine minutes, with the average run time around seven minutes. I chose this length based on the research of Burns and Johnstone, product testing conducted by Pearson Publishing, and email feedback from teachers utilizing Untamed Science videos in their classrooms. Teachers tended to agree that videos around eight

minutes are the most helpful as they left enough time for a short introduction, held the students' attention, and created a springboard for discussion of the rest of the lecture, and activities. On the other end of the spectrum, Pearson's product testing revealed that videos shorter than three minutes tended to leave the students and teachers wanting more (personal communication - email with Mary Ellen Leahy). Untamed Science also agreed it is more difficult to explain complex high school science topics with an adventure story in videos shorter than five minutes (personal observation). For example, it is difficult to discuss the topic of Boyle's Law through a SCUBA diving story in less than five minutes. We use one minute to open and wrap the video, while we use about three minutes to wrap student's heads around the gas law. For all of these reasons, Untamed Science planned videos that were over five minutes and under ten minutes. The resulting series, containing videos ranging from six to nine minutes, tests well among high school classrooms (personal communication - email Walter Rodriguez).

Key Ingredient #2: Repetition

Repetition in science videos helps students stay engaged in a video because of the way the human brain works. Middelndorf and Kalish noted that the human brain does not record information the way a videocassette does (1). Students deal with information by breaking it down into meaningful chunks, known as categories. Students learn as they fit the information they gather from the world into pre-existing categories. As they learn new concepts, they create new categories. Categorization determines how people acquire a concept and how they retrieve it from memory (Tobin, Tippins, & Gallard 45). As

students process information from a video, their learning potential increases when they reinforce concepts from categories. In other words, if a topic is introduced early in a video, a student's brain will process that information by creating a category for it. If we repeat the concept within the video, we force a student's brain to pull from the same category that it first created, thus strengthening the perception of that concept. In a summary of teaching studies Eitington notes that teachers have used this technique since the earliest studies of teaching in the late 1800s (13).

The Untamed Science series employs the use of repetition in each video by stating what we want to say, giving an example, and then repeating why that example demonstrates the topic. For instance, repetition is used throughout the Untamed Science middle grades *The Water Cycle* video to drive home the cyclical nature of water in a system. The video begins with a short animation showing the steps of water cycle. Examples of the steps of the water cycle follow in the same order as the hosts raft and kayak down the Colorado River. Finally, we summarize the process again (in the same order) with a cartoon version of the examples on the Colorado River. This structure for repetition, advocated by Untamed Science, follows Middendorf and Kalish's study suggesting the way students learn. In this case, the brain's new "category" is a newly introduced science concept or process, and the episode revisits the "category" in several ways for reinforcement.

A specific variation of repetition used in educational media is known as the "James Earl Jones Effect." This form of repetition involves pauses in the delivery of information, giving viewers the opportunity to process what was just spoken or to be

thinking about what is about to be spoken. The “James Earl Jones Effect” got its name because James Earl Jones used it in his appearance on a segment of *Sesame Street*, during which he speaks the alphabet in his deep, rich voice. His delivery is slow, and he leaves long, pregnant pauses after each letter, while the next letter appears visually onscreen. Formative researchers noticed that students would repeat the letter just spoken in their first viewing. With successive viewings of the segment within the show, students would begin shouting out the next letter before Mr. Jones said it. The benefit of the pauses seems two-fold. The pauses give the student time to process information when it is presented for the first time, and (with repeated viewing) pauses allowed students the opportunity to participate and essentially quiz themselves about what they are learning. *Sesame Street* stumbled upon this technique almost by accident and, due to its success in engaging students, became widely used throughout the *Sesame Street* program (Lesser 4).

This type of repetition can also be found in language learning videos for adults and children, wherein words or phrases are spoken slowly with pauses between translations. This allows the viewer to repeat the information aloud. In this way, the “James Earl Jones Effect” gives language learners time to process and practice foreign words at their first introduction. Over multiple viewings, the adults and children test and gauge their progress.

Untamed Science adapts repetition techniques for use within many videos in the BioAdventures, Middle Grades, and Chemistry series. This often takes shape as a brief, planned pause just before the delivery of information, each time it is revisited. For example, in a video about oxidation-reduction reactions, the conditions for the formation

of rust are given 3 times. The first time it is mentioned briefly with an animation, with a pause between each ingredient. The second time it is explained in a specific context, slowly listing the conditions with visual examples. The last time the conditions are repeated the host says, “So what do these things give us ... ? (Pause) That’s right, rust.” This deliberate repetition combines Middendorf and Kalish’s idea of reinforcing “categories” in the brain and *Sesame Street*’s “James Earl Jones Effect” by repeating information several times after its introduction and using pauses in the delivery of information. By building these techniques into the videos, Untamed Science hopes to give students the opportunity to be actively engaged, to feel like they are able to keep up with the pace of the video, and to learn the main concepts from the video.

Key Ingredient #3: Humor

Humor is one of the historically least used, but arguably most effective tools for a science filmmaker. Several studies have shown that using humor in a classroom setting can help students pay more attention, ease tension, and increase learning (Bobek, 2002; Friedman, Halpern, & Salb, 1999; McLaughlin, 2001). One study by Fisch and Truglio even showed the benefit of humor directly in video. They conducted their research as part of the formative research of *Sesame Street* to determine which *Sesame Street* segments work to keep children engaged. While this study focused on very young children, work on attention spans with middle grades students (Brooks and Tees 2), college students (Olmsted 525) and military radar workers (Mackworth 1) all seem to show similar patterns of attention, allowing me to conclude that a study like this also

translates well to older children. The *Sesame Street* researchers concluded that the best method to help engage and entertain students is through the use of humor (2). Other studies on the use of humor have directed research into the broader application of humor in a classroom, rather than within a video. For example, in one study Garner showed that college teachers who used humor while teaching in class increased the performance of students on end-of-year tests (177). Ziv, in an Israeli study, found similar results when testing the use of humor by teachers for students in both psychology courses and a statistics course (5). These studies show evidence that humor increases student test scores, likely because it increases interest in the subject. For this reason, humor is a useful tool for any filmmaker, including science filmmakers, to wield and increase interest in their subject.

Key Ingredient #4: Fast-Paced Editing Style

Videos in the science classroom can become more engaging - become more of a *student igniter* - if filmmakers use a fast-paced editing style. Fast-paced editing helps to focus the video on the target demographic. In this case, students in middle school and high school. There are no studies that show that student's benefit from fast-paced videos in school. However, one can examine the shows on TV that have successfully reached older students and draw parallels to the classroom. Of particular interest is the work of Robert Pitmann, founder of MTV. Pitmann started MTV in 1980, creating the original programing. The program had a fast paced audio and visual style combined into music videos. Teenagers were quickly attracted to the program, making the program a success.

Yet, MTV rarely gets into classrooms. *Bill Nye the Science Guy*, picked up on this fast-paced style. Videos are quick, punchy and MTV-esque. The *Bill Nye* series does a good job hitting a middle school demographic, part of which has to do with the editing style.

Series that use a slower paced editing style risk boring students. Blue Planet (2001) and Planet Earth (2006) have long shots between edits. *Home* (2009), a documentary composed entirely of aerial footage is notorious for its long shots. The classic science film The World of Chemistry video series, is a great example of a student film series edited for an older demographic. This series consists almost entirely of a monotone narrator explaining the science concept over poorly shot clips. Clips are often pulled from a stock library to explain the topic and edited in a rather slow manner. Occasionally an older, dry, and fairly monotone scientist appears to explain the chemistry. These elements make the video a *student snoozer*. Videos of this sort do little to reach the high school demographic. If the teacher wasn't there to stop and start the video, the students would likely fall asleep. Video intended for middle grades and high school students must be produced with that age group in mind, and the editing style altered.

Key Ingredient #5: Engaging Hosts

Another method the Untamed Science series found to work well for the high school demographic is the use of engaging hosts that take students on an experiential journey. Fitzgibbons did a survey of the most viewed shows on *Animal Planet* in 2006 and found that one element they all had in common was the use of hosts that would

immerse themselves in the action - rather than the use of omniscient narration (25). Untamed Science found (through student/teacher feedback and Pearson Publishing product testing) that elements of video considered successful in the eighteen to thirty year old range (the range studied by Fitzgibbons) tend to be received well by high school students. Teacher feedback of the Untamed Science videos also indicates that the languid, calm voice of a third person omniscient narrator tends to allow students the opportunity for an attention break, while the use of a host that is in the action tends to keep students more attentive and engaged. Pearson Publishing felt so strongly about these tendencies that they discontinued working with other vendors (who were providing them with omnisciently narrated science material) and sought the hosted format of the Untamed Science team to accompany the best-selling science book, the Miller and Levine high school biology textbook. Students and teachers interviewed overwhelmingly agree that watching a video piece with an engaging host is preferable in the classroom setting (email communication Walter Rodriguez).

Untamed Science is assembling an ongoing list of typical shared elements of engaging hosts for the high school and middle school demographic. The hosts from the Fitzgibbons study tend to be physically attractive, humorous and tend to have a conversational delivery when speaking on camera. They also tend to immerse themselves in the physical action as opposed to simply narrating segments. Current examples include Bear Grylls in *Man vs Wild*, Jeremy Ward in *River Monsters*, Mike Roe in *Dirty Jobs*, and Pat Spain in *Beast Hunter*.

Humor is a great tool for general use within science videos, and a humorous host can be successful for many of the same reasons. Just as Fisch and Truglio's study shows that students are entertained and engaged by humor in general, having a host who is perceived as funny can work the same way. For example, in a high school student survey question asking, "Which Untamed Science host is your favorite and why?" the most popular reason for choosing a favorite is based on humor. Students tend to want to watch a host they consider funny, rather than any other quality. The second most popular answer is related to physical attractiveness, and no student ever chose a favorite host based solely on the perception of the host's intelligence. If a science filmmaker is choosing a host for a high school audience, they must be aware that a host that can be funny may powerfully resonate with students.

Key Ingredient #6: Create Videos Featuring a Classroom Science Concept

Filmmakers that intend to create science videos for the classroom should focus on science concepts or topics that most teachers will teach in the classroom. The reason for this is that kids have a harder time seeing a video in class if there is no relevance to the subject at hand. This might seem obvious, but it's extremely important to review the reasons why. With programs in America like *No Child Left Behind*, teachers are, more than ever, teaching only topics and concepts that appear on standardized tests (Broder 1). Because of this, novelty lessons, especially in science, are often kept to a minimum (Cloud 41). Relevant science classroom topics can be found on public state science standards lists or in the table of contents of a science textbook. The topics can range from

a large, overarching concept to a specific process. A few examples of science classroom concepts or topics include photosynthesis, cell biology, natural selection, mitosis, classification, and human biology. By creating a video that is focused around a concept or topic like this, it has a better chance of actually being used in the classroom.

Key Ingredient #7: Create Supplemental Material

Science videos that include supplemental material are more likely to be used by teachers than those that have no supplemental material. Teachers have a limited amount of time to come up with lessons, find material and conduct class. Berger *et al* argued it was not enough to simply have technology in the classroom (466). Teachers must do something with it. Many popular nature shows have figured this out and give teachers the tools to use the video in the classroom. The Strange Days on Planet Earth series stands out. The producers created an entire campaign around the series to get teachers to use the video. Even a series like Blue Planet have made it a priority to create short lessons for students. The Untamed Science textbook series presents another example of ways to integrate video with factual content. In the BioAdventures series, the videos do more than have lesson plans, they go hand in hand with the *Miller and Levine High School Biology* textbook by Pearson Publishing (Miller and Levine). For example, the beginning of each chapter in the book includes a short science mystery. To compliment this, the Untamed Science videos highlight this mystery at the beginning of every video. These mysteries are then tied into the topic of each of the Untamed Science features. Students

try to solve these mysteries as they go through the textbooks. This ties the videos well with the existing chapter lessons and makes the whole product more effective.

Key Ingredient #8: Make it accessible on the web

Putting science videos on the web is important because it is the easiest way for teachers to search and find topics relevant to the lessons. Putting a science video on the Internet gives it maximum exposure with minimal cost. Before the Internet, a copy of a science video had to be physically present in the classroom in order for a teacher to show it. Today science filmmakers can get instantaneous global distribution as soon as they upload a film on the web. Uploading to YouTube, blip.tv and vimeo is free. While any one of the Untamed Science podcasts might take from a week to an afternoon to produce, within a couple hours of finishing a podcast we can distribute them to the world. A few hours after that, it may have several thousand downloads. Within days, it may have almost 20,000 viewer downloads. On average, Untamed Science gets about 7,000 views a day on our web uploads. This is something few would have thought possible a decade ago.

Even without distribution via podcasts, having a film online will allow people to find and use it. Teachers often find what they are looking for with web searches. This basically opens up one more potential viewer base. Finally, putting a video on the Internet without charge means that teachers, who often have very little extra money for teaching materials, can utilize the work for the betterment of student learning. It's a gift filmmakers can give teachers and one I hope more filmmakers will realize.

Having science videos online also serves the purpose of creating a unique learning tool for students using computer technology. While this paper focuses primarily on the use of video by teachers in the science classroom, students can easily use videos while alone or in small groups around a computer. In fact, Kearney notes that the computer environment encourages small group interactions and permits a more intimate engagement with tasks. This environment offers students control of the tasks and allows teachers more time to interact with students (3). Kearny studied tenth and eleventh grade physics classes to see how effective interactive computer-based media was at disseminating information and keeping student attention. Through post-lesson interviews with students, he found that students enjoyed this type of learning. They enjoyed the ability to manipulate and control the actual demonstration because it was presented on the web. However, one thing students kept saying was that the quality of the video clips were very important. Some videos worked well because they used good examples, while others were not shot well and couldn't explain the concept they were trying to learn (22). Their description of these videos is key to my argument - videos must be quality *student igniters* for the classroom for students to get the most out of them.

CONCLUSION

Over the last ten years, I've worked to find better and better ways to incorporate video into the science classroom. Most of my decisions have come from personal observations working directly with students and teachers. I'm delighted that a great deal of study has gone into certain areas of educational films, particularly the work done by the CTW on *Sesame Street*. Most of this research is based on the ability of a video to engage and thus educate a student. The studies of Harwood and McMahon on The World of Chemistry series likewise concentrated mostly on the ability of the films to teach. While teaching is a great goal for science educators, I think that the goal of future films should be simply to inspire. I believe that most kids just need a reason to take up a passion in a subject. Films are the perfect venue to inspire life-long learners in middle grades and high school students.

Filmmakers have a huge amount of responsibility on their shoulders. Given the importance of films in learning, it's now up to the filmmaker to make those films. I dare to say that today there are few *student igniters* on the market. It's the job of filmmakers to make those films. Filmmakers must be able to learn how to make an engaging film for the students sitting in a science classroom. It's a different type of film from what most are trained to make. Besides taking into account the key ingredients I have outlined above, I feel one of the most important avenues is to take students with you on a journey. Don't just tell them about the rainforest; take them with you. Don't just tell them about the deep sea; take them there. Don't just tell them about terminal velocity; let them vicariously

experience it on skydiving from 13,000 feet. Students live in a time when experiential documentaries are the key to engaging them.

Researchers and filmmakers should also find a way to unite to help our understanding of educational science films for older children. Like the CTW did with early childhood filmmaking, we need similar collaborations with films for older students. Researchers have already learned that films are useful in the classroom and thus, the research should focus on other aspects of the films. They should focus on learning more about how to make films that inspire an interest in science. I know that I'm doing what I'm doing today because of the Jacques Cousteau films I saw as a kid. Students will likely never see a Jacques Cousteau video and thus, they need modern inspirational videos produced to ignite their imagination and drive them to become life-long learners.

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