Instructional scientific humor in the secondary classroom

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INSTRUCTIONAL SCIENTIFIC HUMOR IN THE SECONDARY CLASSROOM

Abstract

This study is an examination of the manner in which educators employ scientific content humor and how that humor is perceived by their students. Content humor is a useful strategy in drawing the attention of students and improving their receptivity toward scientific information. It is also a useful tool in combating the growing distractions of the electronic classroom. Previous studies have found that humor has a positive effect on knowledge, memory, and understanding. However, few studies have been conducted below the undergraduate level and mainly quantitative measures of student recall have been used to measure learning. This study employed multiple data sources to determine how two secondary biology teachers used humor in order to explain scientific concepts and how their students perceived their teachers' use of scientific instructional humor. Evidence of student humor reception was collected from four students in each of the two classes. All of the scientific instructional humor used in the studied classrooms was cognitive in nature, varying among factual, procedural, conceptual, and metacognitive knowledge. Teachers tended to use dialogic forms of humor. Their scientific humor reflected everyday experiences, presented queries, poked fun at authority, and asked students to search out new perspectives and perform thought experiments. Teachers were the primary actors in performing the humorous events. The events were sometimes physical exaggerations of words or drawings, and they occurred for the purpose of establishing rapport or having students make connections between scientific concepts and prior knowledge. Student perceptions were that teachers did employ humor toward instructional objectives that helped their learning. Helping students become critical thinkers is a trademark of science teachers. Science teachers who take the risk of
adopting some attributes of comedians may earn the reward of imparting behaviors on their students like critical thinking skills, the ability to explore questions in a detached manner, and the ability to search out new perspectives. The results of this research may encourage additional study on how secondary science teachers use humor to explain scientific concepts and may also encourage science teachers to investigate novel ways that instructional humor can be used in their classrooms.

*Keywords:* Scientific Humor, Instructional Humor, Secondary, Biology
Dedication

This work is dedicated to Guillermo Ripoll-Brenot. He is the man who, first and foremost, taught me to keep my eye on the ball.
Acknowledgments

I would like to thank the teachers who participated in this study. They shared their time, their views, and their classrooms. This study could not have been completed without their enthusiastic participation. I hope they found this as valuable an experience as I did.

Thank you also to the students and their parents for giving consent and participating in this research. Without their cooperation this would not have been possible.

I am grateful to the other school personnel who helped me to obtain the necessary permission and materials. Their actions smoothed this process for me immeasurably.

My dissertation committee was very supportive of me throughout the duration of this study and I am indebted to them. Professor Kristen Wilcox gave me valuable questions to consider as I navigated through my methods of data collection. Professor Roberta Johnson gave me invaluable access to surveyed research subjects and was very supportive of this research. Most especially, my advisor and dissertation chair, Professor Alandeom Oliveira, gave me concise feedback and was a great advocate. I admire him and look forward to our continued association and work together.
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Chapter I

Introduction

In an ethnographic example of content-embedded scientific humor, a genetics professor described the semiconservative quality of DNA replication as being conducted by Rush Limbaugh (Wizner & Oliveira, 2012). This tongue-in-cheek reference by the instructor was a humorous construction of an analogy in which biological conservatism was unexpectedly compared to political conservatism. The classroom in which this reference was made contained 50 undergraduate students in a Wi-Fi enabled room. Most students were sitting erect and apparently attentive to the lecture, some acknowledged the reference and, perhaps, their amusement, with a nod or a smile. Three students were lying prone with their torsos leaning against desks, several students were wearing ear buds, and some were using other electronic devices. The use of humor in this instance was the professor’s attempt to allow a brief mental departure from the earnest, complex nature of a discussion about DNA replication as well as to provide students with a mental image or mnemonic for recalling and comprehending the process of DNA replication. This example illustrates the use of instructional scientific humor intended to help students better remember and understand a scientific concept, as well as inattention on the part of some students.

According to Uekawa, Borman, and Lee (2007), engaged students pay close attention to class activities, are interested in the content of lessons, and may have heightened performance. Students are more engaged when they perceive that a topic is easy, relevant, cooperative strategies are used, class conversations are content driven, and delivery is fun. In the DNA replication example above, most students appeared attentive due to the inclination of their bodies and their facial expressions. Likewise, some students
appeared inattentive due to their body language or their manipulation of objects unrelated to the class. Although students may withdraw their attention from instruction in favor of daydreaming or doodling, technology, though beneficial in many learning situations, also represents a distraction when misused (Adams, 2006; Bugeja, 2007; Fink, 2010; Gilroy, 2004; Nworie & Haughton, 2008).

For the purpose of this study, it is appropriate to differentiate among several terms:

1. **Humor** is defined as a quality which is seen as comic, absurd or incongruous (Merriam-Webster Online).

2. **Scientific (content) humor** is the incongruous or comedic presentation or reception of science related topics.

3. **Amusement** is the emotion of enjoyment or entertainment (Merriam-Webster Online).

4. **Engagement** has been discussed extensively in literature (Bunce, Flens, & Niele, 2010; Christenson & Thurlow, 2004; Johnstone & Percival, 1976; Mann & Robinson, 2009; Stuart & Rutherford, 1978; Uekawa et al., 2007; Young, Robinson, & Alberts, 2011). However, Lawson and Lawson (2013) presented the most thorough description of engagement, calling it the “conceptual glue that connects student agency . . . and its ecological influences . . . to the organizational structures and cultures of school (p. 433). With these definitions in mind, I will discuss the use of scientific humor and student engagement as informed by the existing literature.

This chapter discusses the problem of maintaining student interest during class time and the confounding variable of growing Wi-Fi use in schools. Although student inattention has been the subject of some research at the college level, the need for a
secondary focus has been advanced. The use of humor for the maintenance of student interest was noted in the research, but the lack of content-related humor set the stage for this study.

**Statement of the Problem**

Test-score performance in the areas of math, science, and reading has improved annually at a rate of about 1.6% of a standard deviation in the United States. However, student test scores for 10- and 15-year-olds in 24 other countries are improving at a faster rate. Latvia, Chile, and Brazil improved at an annual rate of 4.0% of a standard deviation, and Portugal, Hong Kong, Germany, Poland, Liechtenstein, Slovenia, Columbia, and Lithuania made gains at twice the rate of the United States (Hanushek, Peterson, & Woessman, 2012). Simply put, the United States is losing the competition in the world community for academic achievement. Students need to redouble their learning efforts, and educators must do all that they can to assist student learning.

Although it is likely that there are several factors that impact student achievement, not least among them are students’ socioeconomic status, cultural environment, and family background. One important contributing reason for lack of student achievement at all levels is lack of classroom engagement by students. Engagement includes academic, behavioral, cognitive, and psychological dimensions. Academic and behavioral engagement are necessary for sustained attention to and completion of school work and classroom participation. Cognitive and psychological engagement are necessary for internal processing of academic information, thinking about how to learn, and self-monitoring progress toward task completion, as well as a sense of belonging and connection with the school (Christenson & Thurlow, 2004). Moore, Armstrong, and Pearson (2008) found that 230 undergraduates cited reasons such as boredom, length of
class, or involvement with a computer game for their nonattendance at a scheduled lecture. Clearly, the reasons cited in Moore et al. are examples of disengagement as described in Christenson and Thurlow (2004). Student boredom in class, as mentioned in Moore et al., has been a topic of study over the course of nearly 40 years of educational research (Bunce et al., 2010; Johnstone & Percival, 1976; Mann & Robinson, 2009; Stuart & Rutherford, 1978; Young et al., 2011).

The lack of student attention in class can be thought of as analogous to vigilance decrement as found in human monitoring of equipment (Grier et al., 2003). In fact, student disengagement or inattention to class activities does not necessarily have to be due to lack of student motivation, as cited in Moore et al. (2008). Grier et al. (2003) found that vigilance tasks like those required in a science classroom impose a substantial mental burden that must be mediated. This mediation may be achieved through variations in pedagogical technique and a focus on student-directed activities. In keeping with the focus of this paper, a positive mental effect has been demonstrated with the application of humor in instruction, which may likewise mediate the mental burden of vigilance tasks such as attending to classroom lectures (Berk et al., 1989; Gruner, 1970; Watson, Matthews, & Allman, 2007). Whether the root cause of lack of classroom engagement is an absence of student motivation or the mental burden that higher order scientific thinking entails, both of those are contributing factors that may be correlated with lower science achievement in the United States on the National Assessment of Educational Progress, the Programme for International Student Assessment, and the Trends in International Mathematics and Science Study (Hanushek et al., 2012).

**Student Boredom**

Disengagement with the classroom community is a multidimensional
phenomenon in which student boredom is one element (Christenson & Thurlow, 2004; Moore et al., 2008). Although lack of student motivation may play a role in a pervasive withdrawal from the school community as described in Moore et al., there is also a fairly typical decrease in attention that occurs during times of physical passivity or repetitive action (Bunce et al., 2010; Johnstone & Percival, 1976; Young et al., 2011). The following groups of studies rely on either student reporting or observation to record student boredom and inattentiveness to class activities. As noted earlier, this lack of engagement is one contributing factor that has the direct, negative consequence of lower science achievement among American students.

Johnstone and Percival (1976), Mann and Robinson (2009), Bunce et al. (2010), Young et al. (2011), and Stuart and Rutherford (1978) all researched the well-known phenomenon of student boredom. Johnstone and Percival (1976) observed breaks in attention involving a majority of students in over 90 chemistry lectures. Stuart and Rutherford (1978) discovered similar findings through student self-reporting questionnaires. Student concentration was reported at its maximum of 10-15 minutes, but thereafter it dropped steadily. A more recent investigation conducted by Bunce et al. (2010) employed the use of individual response devices (clickers) for student self-reporting in regard to their lack of attentiveness during class. The researchers analyzed attentiveness in relation to different pedagogies. They found that students cycle through attention and inattention throughout class, and they tended to be more attentive during and immediately after more student-centered pedagogies. In fact, Young et al. (2011) compared the passive nature of a standard lecture to be similar to the phenomenon found in ergonomics known as vigilance decrement. The results of the study indicated that “concentration decays in the same way during a passive lecture as does that of a human
operator monitoring automated equipment, with serious implications for learning and performance” (Young et al., 2011, p. 52).

Student boredom, whether caused by lack of motivation or vigilance decrement, may be mediated by variations in pedagogical technique such as the use of instructional humor (Berk et al., 1989; Gruner, 1970; Watson et al., 2007). As students are less attentive to class activities, their science achievement will be lower on international measures of excellence. Educators, to the highest degree possible, must help students manage their vigilance decrement and encourage motivation by varying techniques and using an engaging manner in their presentation.

The Wireless Classroom

Compounding the problem of student inattention after several minutes of passive instruction, easy Internet access has, for some students, become an attractive nuisance. Nworie and Haughton (2008) and Adams (2006) cited the new technology-supported distraction as including Internet-assisted cheating opportunities, student communication through e-mail and instant messaging, gaming, web surfing, personal projects, and use of social media.

Classroom wireless Internet access is the norm on college campuses, and according to a U.S. News Education Online (2013) report on high school education, “the proliferation of social media and technology has changed the way educators teach, how students learn, and the way teachers and students communicate” [para. 1]. Even without Wi-Fi, students may surreptitiously use their cell phones to text, play solitaire, or check sports scores during class (Adams, 2006; Gilroy, 2004; Nworie & Haughton, 2008). These technological distractions have merely supplanted passing notes, daydreaming, and doodling as detractors of attending to class activities. This is not a new problem. In 1972,
Eda LeShan coined the term *Sesame Street syndrome* to describe students who prefer to be passively entertained rather than participate in more active, stimulating learning. If one accepts the premise that access to the Internet in the classroom is a useful tool that responsible students must choose to harness for learning rather than abuse, we as educators must still use methods that are interesting, active, engaging, and fun in order to help students stay focused on the work of the classroom.

**The Need for a Secondary Focus**

Certainly, the problem of student inattention does not exclusively exist within college lectures, yet this was the focus of studies by Johnstone and Percival (1976), Mann and Robinson (2009), Bunce et al. (2010), Young et al. (2011), and Stuart and Rutherford (1978). Similarly, the attention of younger students may be drawn to their Wi-Fi-enabled devices during class time. Both of these realities should raise a red flag of concern with regard to high school science students. It is precisely during secondary education when most students decide if they will advance their academic careers, and if so, what their course of study will be. Without doubt, science knowledge is necessary for the growing technological economy. Therefore, educators would do well to interest secondary students in science at a time when students are determining their future studies.

Depending on the nature of the content and the abilities and receptivity of the students, building student knowledge may be either straightforward and uncomplicated or challenging and perplexing. Beyond student vigilance, ability, and receptivity, there are the growing electronic distractions. Some educators have noted shortened attention spans of students, and in some instances, have moved to limit student access to electronic devices in an effort to refocus students toward their studies (Adams, 2006; Bugeja, 2007; Carr, 2008; Fink, 2010; Ulrich, 2008). In an effort partly motivated to make content more
interesting to students, some teachers have inserted humor into their instruction, though humorous comments may have little to do with the scientific content. Few studies have been conducted where humor was considered to be an instructional strategy that could aid student learning (Bryant & Zillman, 1988; Conkell, Imwold, & Ratliffe, 1999; Hackathorn, Garczynski, Blankmeyer, Tennial, & Solomon, 2011; Rule & Auge, 2005; Wanzer & Frymier, 1999; Wanzer, Frymier, & Irwin, 2010; Wizner & Oliveira, 2012; Zillman, Williams, Bryant, Boynton, & Wolf, 1980; Ziv, 1988). This study was intended for exactly that purpose: it is an examination of the manner in which educators employ scientific content humor and how that humor is perceived by their students.

**Research Questions**

The guiding research question and secondary, related research question are listed below:

1. How do teachers use humor in order to explain scientific concepts?

2. How do students perceive their teachers' use of scientific instructional humor?
Chapter II

Literature Review

Overview

The purpose of this study was to understand how teachers' use of instructional humor impacts student learning. This chapter is a review of the scholarly literature related to the study. The review is organized into the following sectional themes: (a) Humor: A Comprehensive Positive Effect on Learning, (b) Humor: A Positive Effect on Knowledge and Remembering, (c) Humor: A Positive Effect on Comprehension or Understanding, (d) Humor: A Positive Effect on Analysis, (e) Humor: A Positive Effect on Evaluation, and (f) Humor: No Effect on Learning. This chapter concludes with the theoretical framework that was used to investigate the research questions in this study.

To find literature for this review, I first searched the Albany University Libraries databases for the use of humor in education. In addition, I conducted searches within the science education journals: Journal of Research in Science Teaching, Science Education, and the International Journal of Science Education looking for humor and science education. Along with my literature review, I conducted a pilot study of how higher education instructors inserted humor into their science classes in the spring, summer, and fall of 2011. That research was refined in a manuscript authored with Dr. Alandeom Oliveira entitled Scientific Humor in University Lectures. In this study, I am further refining my focus to include only humor instruction as it relates to learning. The themes that follow guide the following review of literature and will also inform this research study.

Humor: A Comprehensive Positive Effect on Learning

Quite a few studies have determined that the use of humor positively affects
learning. Some have not delineated what learning objectives have been achieved. Those that have, have identified learning objectives found among Bloom’s Taxonomy of Learning Objectives (Anderson et al., 2001) and will be discussed later in sections (b) through (e) identified above. The underlying theme in the literature found in this section is that humor has a general, comprehensive, positive relationship with learning. The nine studies below span 33 years of research demonstrating that humor supports student learning.

For example, in 1988, Gorham found that there was a positive relationship between teacher immediacy behaviors and students' perceptions of learning. Verbal immediacy behaviors are stylistic differences in expression such as addressing students by name, smiling at the class, moving around while teaching, and referring to the class as “our” rather than “my.” Verbal immediacy behaviors also include using humor in class, from which like-dislike is inferred. Undergraduate subjects completed 387 questionnaires in nonrequired communication courses. This nearly 25-year-old university study examined humor only as a part of teacher immediacy. It did not differentiate humor from other student-friendly behaviors such as remembering students' names and soliciting students' opinions. In a later study, humor was examined more specifically (Gorham & Christophel, 1990).

Gorham and Christophel (1990) found that the relationship between teachers’ use of humor in the classroom and student learning might best be understood when that use of humor is examined in conjunction with teacher immediacy. The total number of humorous incidents recorded for each teacher was positively correlated with the frequency of his or her use of other verbal and nonverbal immediacy behaviors, and the overall use of verbal and nonverbal immediacy behaviors was highly correlated with
learning outcomes. Undergraduate communications students completed 206 sets of data. These data included questionnaires about teacher immediacy and observations of the teachers they had referred to in their questionnaires and recorded data about that teacher’s use of humor over five class meetings. A possible limiting factor that the authors of the university study noted was that the student observers who recorded teachers’ classroom behavior observed fewer incidents of humor than had been indicated in previous research. There are several conceivable explanations for this, among them that “effective classroom humor may be so embedded in the instructional message that it does not draw attention to itself” (Gorham & Christophel, 1990, p. 58).

Although Gorham and Christophel (1990) considered the use of humor in conjunction with teacher immediacy, Wanzer and Frymier (1999) considered humor in conjunction with communicative style and its effect on learning. Teacher immediacy behaviors as found in Gorham (1988) and Gorham and Christophel (1990) bear some resemblance to a high humor orientation style as found in Wanzer and Frymier’s (1999) study. Humor orientation is a scale that measures individual differences in the predisposition to enact humorous messages. Those scoring with high humor orientation were perceived as funnier by objective judges when telling jokes (Booth-Butterfield & Booth-Butterfield, 1991).

Wanzer and Frymier (1999) surveyed 314 communications undergraduates to determine their previous professor’s humor and communicative style and students’ perceptions of the effect on their learning. Instructors with higher humor orientation were more positively associated with student learning. An author-identified limitation of this study was the inability to know exactly how many different instructors were reported in the sample. It was a large sample size. Students reported on 37 different departments, so
it is likely that a large number of instructors were evaluated in this college-level study.

What was striking about this study was the number of research instruments that were used with participants. To measure humor orientation, a 17-item Likert measure was used twice: once for students to rate themselves and a second time to rate their instructor. A 14-item, five-point scale was used to measure nonverbal immediacy. Sociocommunicative style was measured with a 20-item Likert scale. Learning was measured with four subscales, each with seven-step bipolar adjectives, and with a second, eight-item Likert measure. In total, this represents 104 items to which participants were requested to respond. Although participants in the Wanzer and Frymier (1999) study were participating as part of their communications course, one might still conclude that responding to so many items, repetitively designed, in a 1-week timeframe could result in some participant apathy or at the very least, carelessness in responses. Galesic and Bosnjak (2009) investigated questionnaire length in relation to participation and response quality and found that with longer online questionnaires, fewer respondents started and completed the survey. Further, questions positioned later in the questionnaire were answered faster and with less variability if the items were arranged in grids as with Likert scales. Even though the Wanzer and Frymier (1999) study was done by participants enrolled in a course and was administered traditionally, its validity is flawed due to excessive instrument length.

Wanzer et al. (2010) proposed the instructional humor processing theory (IHPT) and demonstrated that humor related to instruction was positively associated with student learning, but other disparaging and offensive humor did not correlate with student learning. Undergraduate communication subjects \((N = 378)\) completed an online survey requesting information about an instructor that preceded the communication class in
which they were enrolled. The author-acknowledged limitation of this study was that
self-reporting of student perceptions may differ from instructors’ self-reported behaviors.
This limitation is common in most studies that measure perceptions. The focus of the
study was the undergraduate, rather than the secondary level. This study was
contemporary research with a fairly large sample size that used, as a part of its
methodology, 41 humor behaviors deemed either appropriate or inappropriate in Wanzer,
Frymier, Wojtaszczyk, and Smith (2006). Among the categories of inappropriate teacher
humor is humor that is offensive. Examples offered are sexual comments, vulgarity,
drinking, personal stories, illegal activities, or sarcasm. Yet Wizner and Oliveira (2012)
found that although some humor may be potentially offensive to some students, the
humor may be directed toward the instructional aims of the course. Furthermore,
Frymier, Wanzer, and Wojtaszczyk (2008) later qualified students’ perceptions of
inappropriate and appropriate teacher humor to be dependent on students’ and teachers’
communication orientations. According to Frymier et al. (2008), “Highly humor-oriented
individuals tend to be more aware of others’ reactions to humor attempts and may make
subtle distinctions in both how and when it is appropriate to use these types of humor” (p.
284). Further, Frymier et al. (2008) found that teachers who tended to use aggressive
messages in the classroom were also expected to use humor that was aggressive in nature,
and students perceived the use of that humor as appropriate. Finally, Martin (2007) noted
that it is possible to find a joke about a particular set of people with a given characteristic
funny without believing in a stereotype. He explained that those who are genuinely
hostile toward a particular group will likely manifest their feelings in other ways, as well.

Garner (2006) did not concern himself with types of humor, as did Wanzer et al.
(2010). Instead, his focus was the use of humor, in general, on learning. His method of
data collection also differed from the three earlier mentioned studies. Garner measured learning not by student perceptions, but through a content assessment of students. Garner found that subjects in the humor group recalled and retained more information regarding research methods and statistics than the control group. Ninety-four undergraduates participated in the series of three 40-minute taped lectures. Lectures were delivered via three 1-hour videos to students in an asynchronous distance education format.

A content assessment was performed after the final video lecture. The final sample size in Garner's (2006) study was under 100, and therefore may not provide generalizability of the research conclusions. The author noted that students viewed videos during a 2-week time period. The short timeframe between videos prohibited the use of multiple assessments, which might have introduced bias. The fact that there was only one assessment for all three videos is apparently the reason for Garner’s claim of greater retention in addition to recall of content. Although a reasonable finding of increased recall seems appropriate for this small sample, it would be difficult to conclude that information had been retained for an extended time period as the content exam was given immediately following the third video. Furthermore, the author stated that humorous material was assessed by a group of academic judges to ensure that the video additions could be considered reasonably humorous and were related to the content covered. The study is flawed in that the author failed to elaborate on how inter-rater reliability was established among the academic judges.

Like Garner (2006), Kaplan and Pasco (1977) employed a content test to assess learning, but they combined that with a survey to determine student impressions of the lectures. Kaplan and Pascoe found that an interesting effect of concept humor was that although immediate comprehension was not facilitated, retention improved after 6 weeks.
A sample of 508 university psychology students viewed either a 20-minute serious lecture or one of three humorous versions of the lecture (concept humor, nonconcept humor, or mixed humor). Students then completed a rating sheet to determine student assessments of the degree of humor or interest and a brief content quiz. Six weeks later, the same quiz was readministered to subjects. The students who viewed the concept humor lecture did better on quiz items dealing with humorous examples; however, their overall performance was not much different from those viewing the serious lecture. However, the students viewing the concept humor lecture did significantly better than all other students on the quiz administered six weeks after the lecture. This 35-year-old university study employed a multiversioned (variable humor/nonhumor), black and white, videotaped lecture about Freudian personality theory. Given the obsolete nature of the delivery mechanism, the study may bear repeating to see if results can be replicated.

Just as Garner (2006) relied solely on content test results to demonstrate learning, so too did authors of the following two studies. Garner’s (2006) study method employed videotaped lectures before testing; Worner, Romero, and Bustamante (2010) used pre- and posttests given during an entire semester course; and Ziv (1988) employed posttesting after a semester-long course. All studies involved undergraduate students.

Worner et al. (2010) found that average scores rose from a mean of 2.2 (unsatisfactory) on a pretest to 3.0 (partially satisfactory) on a posttest in an introductory physics course intended for nonspecialists that employed humor as a vehicle for instruction. The total number of undergraduates tested was 568, with a mean population per lecture of 28.4. The sample population was approximately evenly divided between males and females, all of whom had completed at least one year of college. This study did not employ a control group for a means of comparison. The only comparative data were
the pretest versus posttest scores. Therefore, it is not possible to know whether undergraduates would have improved their content knowledge as much, less, or more than the assessed (humor treatment) group.

In 1988, Ziv published a self-replicated experiment in which humor was used to instruct first, a statistics course and second, a psychology course, both at the undergraduate level. In the first instance, 161 students participated, evenly divided between males and females. In the second instance, 132 females were sampled. Course-relevant humor was used in both instances. In both the statistics and psychology courses, the experimental (humor) groups performed better on 50-question final exams. One limitation of the second experiment was the use of only females. In addition, although generally well-designed, this study is nearly 25 years old and focuses on higher education only.

Although all studies in this section relate to humor having a general, comprehensive, positive relationship with learning, all eight of the prior studies have focused on the effect of humor on the learning of undergraduate students. The following study examined the general, comprehensive, positive relationship of humor on the learning of very young elementary children. Zillman et al. (1980) found that unrelated humor inserted into educational programming increased the attentiveness and therefore, information acquisition, among 70 kindergarten and first-grade students. Experimental treatments included inserts into programming that were variably humorous or nonhumorous and slow or fast paced. Researchers found that subjects not exposed to humor took their eyes off the screen more frequently than those exposed to humor treatments. Subsequent to viewing, 10 content-related questions were orally administered to subjects. The subjects exposed to humor outperformed other research subjects. Despite
the positive affirmation of the effect of humor on the learning of research subjects, this 30-year-old study featured the use of unrelated humor with very young students. The present research deals with the effect of content-related scientific humor on secondary students.

Dating back as early as Kaplan and Pascoe (1977), research can be found showing that humor has a general, comprehensive, positive relationship to learning. Research has focused predominantly on the undergraduate level (Garner, 2006; Gorham, 1988; Gorham & Christophel, 1990; Kaplan & Pasco, 1977; Wanzer et al., 2010; Worner et al., 2010; Zillman et al., 1980; Ziv, 1988), with the exception of Wanzer and Frymier (1999), whose study focused on very young students. In three studies, data were collected only through survey instruments (Garner, 1988; Wanzer et al., 2010; Wanzer & Frymier, 1999); three used only content tests as data sources (Garner, 2006; Worner et al., 2010; Ziv, 1988); one used a survey and student observations of teachers (Gorham & Christophel, 1990); one used an orally administered content test and student observations (Zillman et al., 1980); and one used both a survey and a content test (Kaplan & Pascoe, 1977). Overall, the body of literature in the area of humor’s general, comprehensive, positive relationship with learning is well-represented in higher education. Conversely, there is a dearth of research in the primary, middle, or secondary levels of education.

**Humor: A Positive Effect on Knowledge and Remembering**

Three studies have determined that the use of humor positively affects knowledge and remembering. The studies that share this theme have identified a learning objective that is found at the lowest level of Bloom’s Taxonomy of Learning Objectives (Anderson et al., 2001). The literature found in this section is supportive of the notion that humor positively affects knowledge and remembering, which can include students’ ability to...
White (2001) surveyed 128 university instructors as to how they used humor in their classrooms and 206 students as to their perceptions of their professors’ use of humor in the classroom. Research subjects included university instructors from public and private colleges in Arkansas and students from one Arkansas University who combined had attended over 50 other institutions. It was determined that 56% of students agreed that professors used humor to provoke thinking and 45% of students agreed that professors used humor to reinforce knowledge. Seventy-nine percent of professors agreed that they used humor to provoke thinking and 77% said that they used humor to reinforce knowledge. The greater number of student responses in this study may be due to the sampling method used. Faculty questionnaires were mailed to surrounding universities and received a 35% response rate. Only students from Arkansas University were queried, and the study does not elaborate on how they were chosen to participate, how they obtained the questionnaire, or the student response rate. Aside from the lack of clarity regarding specifically how students became part of this study’s sample, there is also ambiguity regarding survey construction. According to White, professors from two universities developed the survey and a screening sample group “refined” it in order to determine the positive and negative items. Additional clarification of this process would be welcome. White also stated that there was a random listing of items “after purification of the original list” (p. 339). There is no elaboration of what is meant by purification.

Dorion (2009) studied cases of drama activities in local secondary science classes in the United Kingdom where the drama was intended to convey topics like the history of the atom, bioaccumulation, wavelengths, and medical ethics. Data sources included pre- and postactivity interviews of teachers, postactivity interviews with students, and
videotapes of drama lessons. Among the dramatic activities were those with humor, which included innuendo, self-deprecation, sarcasm, religious humor, black humor, and physical humor. Teachers stated objectives that included students' expression of scientific knowledge and acquisition of abstract concepts. The learning environments used in this study may have been particularly conducive to positive research results in that they did not object to the use of drama in the instruction of science.

Hackathorn et al. (2011) found that humor was a pedagogical tool in a social psychology course of approximately 50 students. Humorous attempts by the instructor included puns, jokes, riddles, personal anecdotes, and multimedia. Approximately 40% of the constructs in the course where taught with humor. A total of 24 concepts were taught over the semester and each was measured on the knowledge, comprehension, and application levels of Bloom’s taxonomy. Overall, students scored higher on constructs taught with humor. Test items on the knowledge and comprehension levels of Bloom’s taxonomy resulted in higher student scores when taught with humor. Application level items resulted in slightly lower student scores when taught with humor. This was a contemporary quantitative study of the effect of humor on undergraduate knowledge, comprehension, and application of concepts taught.

Only three studies in this review specifically demonstrated that students increased their knowledge and memory of a subject as a result of humor used during instruction (Dorion, 2009; Hackathorn et al., 2011; White, 2001). In White’s (2001) study, knowledge was assessed through both instructor and student surveys. Dorion’s (2009) research tapped both teacher and student interviews and observations of taped lessons, and Hackathorn et al. (2011) relied upon variable-item quizzes. Bryant and Zillman (1988) noted in their earlier examination of the existing literature that despite the various
ways in which learning might be understood and assessed, most studies examining the
effects of humor on learning have involved traditional measures such as acquisition of
information, item recognition, recall, and retention rather than alternate modalities
involving experimentation, questioning, illustration, or designing.

White's (2001) study and Hackathorn et al.'s (2011) study mimicked the previous
trend, using content tests. Dorion (2009), however, did conduct some interviews and
student observations. The three studies contained in this section are relatively
contemporary, with the oldest being White (2001). Both White (2001) and Hackathorn et
al. (2011) focused on university students. Only Dorion’s (2009) study focused on
students at the middle school level. Bryant and Zillman (1988) noted that “Increasingly
abundant evidence indicates that when children’s initial attention and motivation to learn
is low, the use of humor in teaching can be expected to help them learn and retain
educational information” (p. 66). Though nearly 25 years old, Bryant and Zillman’s
(1988) observations are founded in much of the existing literature.

Humor: A Positive Effect on Comprehension and Understanding

Comprehension, or more recently termed understanding in Bloom’s Taxonomy of
Learning Objectives (Anderson et al., 2001), is a demonstration of a grasp of the facts.
Four studies spanning 25 years have identified increased comprehension as a benefit of
instruction with humor. Comprehension is a second-level objective, after knowledge, on
Bloom’s taxonomy. Learners may demonstrate their comprehension of content by
discussing it, summarizing it, or giving examples of it.

In Tapper’s (1999) study of talk in undergraduate microbiology practical
laboratories, transcripts were analyzed for recurring themes. The occurrence of laughter
and humor was an important aspect of the manner of lab talk. In an example of this,
Tapper cited a discussion between an instructor and a student in which they discussed the enzyme reaction of catalase in horse erythrocytes. The instructor laughed when describing the reaction and the student, in participating in the discussion, comprehended the description. In this case, humor built solidarity but also demonstrated student understanding. This example, much like the earlier mention of Hackathorn et al.’s (2011) study, showed a specific and higher order level of cognition. Participants in Tapper’s study were undergraduates and instructors and were either part of the teaching staff or demonstrators (working microbiologists in the field). Therefore the quality of discourse may not be seen at less mature academic levels. In Hackathorn et al.’s study, specific test items were coded for the taxons knowledge, comprehension, and application. At the level of comprehension, students who were taught constructs using humor scored a mean of 13 points higher than they did when taught constructs without humor. In Hackathorn et al.’s study as with Tapper’s, participants were undergraduates, capable of high-quality academic discourse.

Roth, Ritchie, Hudson, and Mergard (2011) examined the effects of humor in science lessons. They found that humor simultaneously reinforced the idea of science as serious business while establishing levels of intimacy, complicity, and solidarity between teacher and students. Again, similar to Tapper’s (1999) study, students exhibited knowledge and comprehension when they and their teacher humorously discussed the job of engineers in response to the changing population in Australia. The examples found in this study are focused on one first-year teacher and her instruction of a seventh-grade science class that met two to three times a week. Results may not be generalizable across populations of other teachers with varying levels of experience, students at differing academic levels or situations, or other geographic areas.
Downs, Javidi, and Nussbaum (1988) conducted a two-part study in which they first obtained audiotapes of 57 college instructors across several disciplines and classified their humorous attempts during classroom verbal behavior as either relevant to course content or not. They found that 70% of humorous attempts by instructors were relevant to course material and were used to clarify concepts. The second part of the study involved the analysis of instructional videotapes of nine winners of their university’s award for teaching. The instructors taught a variety of disciplines and were videotaped during a 50-minute lecture before either a traditionally sized classroom or a lecture room. The researchers found that 66% of those nine instructors’ humorous attempts were relevant to course material and were used to clarify concepts. Clarification, it can be surmised, will assist student comprehension. Although the average use of the type of humor varied in the two different parts of the study (self-disclosure or narratives), the instructor’s purpose in using humor was similar. Dramatic instructors seek to clarify by emphasizing “course content that can help students organize their ideas, focus their thoughts, and sort the trivial information from that which is relevant to course content” (Downs et al., 1988, p. 138). This comprehensive study is nearly 25 years old at this writing. Its research subjects included college instructors from the fields of English, philosophy, education, business, communication, sociology, psychology, biology, and mathematics. No information was provided about the number or percentages represented by each department, but if there was equal representation, biology would account for nine individuals or 6%, a small population.

Torok, McMorris, and Lin (2004) surveyed 123 undergraduate students and three instructors in biology, educational psychology, and theater on their beliefs about the use of humor during instruction. Although there is some lack of clarity in this study as to how
the instructors' survey and responses differed from that of their students, results indicated that 50% of subjects believed that an outcome of using humor in instruction is to facilitate understanding. Subjects (presumably just the students) were asked if they would use humor in class if they were college teachers, to which 96% responded affirmatively. Interestingly, 72% of those who responded indicated that they would use humor as a college teacher because humor facilitates learning. Considering that the number of instructors surveyed represented only 2% of respondents (126), one could only consider student responses and infer that students in these classes believed that humor positively impacted their comprehension of content material.

Research that addressed the effect of humor on student comprehension and understanding first appeared in Downs et al. (1988). Downs et al. found that 66% to 70% of instructor’s humorous attempts were relevant to course material and were used for clarification, which assists student comprehension. Tapper (1999) showed evidence of humorous discussions in a microbiology lab between instructors and students. Students able to participate in the humorous discussion showed evidence of comprehension. Furthermore, Torok et al. (2004) found that 50% of the undergraduate students and instructors surveyed believed that an outcome of using humor in instruction is to facilitate understanding. All of these studies (Downs et al., 1988; Tapper, 1999; Torok et al., 2004) occurred at the undergraduate level. Downs et al. (1988) used observations of audio and video tapes for data collection; Tapper used observations and audio tapes of laboratory work to collect data, and Torok et al. surveyed over 100 undergraduates and several instructors to obtain their data set.

Only one study in this group considered a teacher who used humor in a science discussion at the middle school level (Roth et al., 2011). The students exhibited
knowledge and comprehension when they and their teacher humorously discussed the job of engineers in response to the changing population in Australia. It is remarkable that 75% of the studies exemplifying the theme of comprehension and understanding did so without surveying as a data-collection technique. Only Torok et al. (2004) employed a survey to ask whether the purpose of humor in instruction was to facilitate understanding. Downs et al. (1988), Tapper (1999), and Roth et al. (2011) all employed observation as a data-collection technique and determined that humorous conversations with students demonstrated understanding of content.

**Humor: A Positive Effect on Analysis**

Seven studies comprised the literature theme of humor having a positive effect on analysis, making it the second largest grouping overall. The first is humor having a comprehensive, though nonspecific, effect on learning. Previous themes that were less well-represented in the literature included instructional humor’s positive effect on knowledge (remembering) and comprehension (understanding). No instances of instructional humor’s positive effect on application were found. Application is the next category in Bloom’s taxonomy and includes students’ ability to predict, produce, employ, and write. The studies that follow are concerned with instructional humor’s positive effect on analysis, which includes students’ ability to compare, contrast, experiment, and infer.

Breaking down objects or ideas into simpler parts and finding evidence to support generalizations is a higher order taxon within Bloom’s taxonomy of learning objectives. Dorion’s (2009) previously mentioned work investigating cases of drama activities in secondary classes where the drama was intended to convey science topics was offered as an instance where humor was used to help students acquire knowledge. Through dramatic
activities using innuendo, self-deprecation, or other humor, students would be better equipped to remember previously learned information. Dorion’s research is further offered as an instance where instructional (scientific) humor assists students in dramatic modeling of abstract physical phenomena not otherwise observable in a science classroom. This dramatic modeling helps students illustrate and further analyze concepts and is a goal overtly stated by the teacher objectives, which included that students express scientific knowledge and acquire abstract concepts. As noted earlier, Dorion’s study focused on a convenience sample in learning environments that did not object to the use of drama in the instruction of science, which may have made the location particularly conducive to positive research results.

Another way in which scientific content is illustrated humorously is through the use of cartoons and comics. This is evident in the work of Sadowski, Gulgos, and LoBello (1994); Keogh and Naylor (1999); Rule and Auge (2005); and da Silva, Correia, and Infante-Malachias (2009). This is an eclectic group of research studies spanning elementary through college level, utilizing qualitative and quantitative approaches, and demonstrating all the while that the learning objective of analysis can be achieved through student instruction using cartoon illustration.

Sadowski et al. (1994) evaluated the use of content-relevant cartoons as a teaching device by examining the results of a content-specific test administered to 41 social psychology undergraduates (half of whom were exposed to a humor treatment) and surveying 16 of the students exposed to cartoon examples chosen from newspapers and magazines. Though a small sample size and nonequivalent comparison groups confound this study, results are consistent with Ziv (1988) and thus are reported here: 55% of the students in the humor group passed the multiple choice test covering the material
addressed compared with 33% not exposed to the humor treatment. Surveyed students responded that humorous examples helped to illustrate concepts, show applications of the material, and increase understanding of the material.

Keogh and Naylor (1999) used multiple data sources (questionnaires completed by college, secondary, and primary teachers and student-teachers; teacher interviews; student interviews; and classroom case studies) to ascertain the effect of concept cartoons on teaching and learning science. Keogh and Naylor noted the “high quality and prolonged nature” (p. 443) of discussions about the cartoons and that learners participated with a “desire to explore their understandings through investigation and research” (p. 442). In discussions about concept cartoons “learners appear to experience cognitive conflict by being presented with conflicting but apparently plausible ideas” (Keogh & Naylor, 1999, p. 442). In this way, participants would be questioning their own understandings and differentiating their own conceptions that deviate from scientific phenomena in favor of those that are evident of scientific phenomena. Keogh and Naylor expressed concern about the use of concept cartoons with regard to the dominance of individuals’ ideas with group work and the lack of motivation of some learners.

da Silva et al. (2009) described a case where 36 upper elementary students participated in a series of lessons where instructors used cartoons depicting the life and history of Charles Darwin to bridge the gap between the natural science and literacy disciplines. Darwin’s scientific contributions were framed in a historical and human context through the use of cartoons. Brazilian students, the subjects of this study, noted that their school (located in Sao Paulo, Brazil) had been part of the Atlantic Forest (a stop on Darwin’s journey) and that only 10% of the original forest now exists, a connection to both history and the concept of ecological change. That and other connections between
Darwin’s voyage and the students’ own geographic experience were made through the use of cartoons. daSilva et al. (2009) stated that the instruction of scientific history supported the development of skills related to critical thinking. The ability of the students to identify the Atlantic Forest as close to their school and differentiate its present-day condition compared to its historical condition is an example of analysis. This case description was conducted by a student teacher who was also the first author of the study. There was no attempt to triangulate any data except the lead author’s perceptions of student learning.

Rule and Auge (2005) described a study in which sixth-grade (middle school) students’ learning about rocks and minerals increased when the students were instructed using cartoons as opposed to the learning of students instructed using more traditional methods. Thirty students experienced experimental (humor) conditions (versus 33 in the control group) during the study of minerals. Thirty-three students experienced experimental (humor) conditions (versus 30 in the control group) during the study of rocks. The control groups (mineral and rocks combined) earned a 5.2 point increase between pre- and posttest scores, for an increase of 12.3%. The experimental groups (mineral and rocks combined) earned a 9.9 point increase between pre- and posttest scores, for an increase of 23.5%. In addition to viewing scientific cartoons, students involved with this study also analyzed, critiqued, improved, and created their own cartoons. Author-cited limitations of this study include a technology-related problem in displaying cartoons to students and difficulty in obtaining contemporary humor appropriate for study subjects. Both of these issues serve to depress the actual gains that the experimental groups might have made.

Finally, two additional studies mention the use of humor as assisting students in
achieving the learning objective of analysis. Students who analyze are able to break down, categorize, compare, diagram, illustrate, and model in order to find evidence to support larger generalizations. Berk (1996) conducted a 3-year study to evaluate the effectiveness of 10 systematic strategies for using humor as a teaching tool. He relied on student ratings at the end of undergraduate and graduate statistics courses to assess how well the strategies reduced anxiety, made optimal student performance possible, and improved student’s ability to learn. Berk found that students viewed humor as an effective teaching tool to facilitate their learning. Berk stated, “Humor is most effective for application, analysis, synthesis, and evaluation questions. In other words, it fits well with items that measure cognitively complex and higher order thinking skills” (p. 82).

Similarly, Neuliep (1991) surveyed 388 high school teachers to determine the frequency of humor use in the classroom, their perceptions of appropriateness of different kinds of classroom humor, and their reasons for using humor in the classroom. He found that high school teachers used humor less frequently than college teachers, perceived their humor as appropriate, and used humor as a facilitator for learning. In fact, two objectives of Bloom’s taxonomy are listed among the top 10 reasons for using humor in the classroom: helps students remember a point (Number 9) and helps illustrate a point (Number 7). Berk’s (1996) study assessed college students' statistics and Neuliep’s (1991) study assessed high school teachers, of which only 16% taught natural sciences.

The preceding seven studies comprise the literature theme of humor having a positive effect on analysis. These studies have been concerned with students’ ability to compare, contrast, experiment, and infer. Dorion’s (2009) research provided an instance where instructional (scientific) humor assisted students in dramatic modeling of abstract physical phenomena not otherwise observable in a science classroom. Sadowski et al.
(1994), Keogh and Naylor (1999), Rule and Auge (2005), and da Silva et al. (2009) all studied the way scientific content is illustrated humorously through the use of cartoons and comics. Sadowski et al. reported that learners were better able to see applications of the material. Keogh and Naylor observed that learners exposed to concept cartoons differentiated their own conceptions as deviating from scientific phenomena in favor of those that were evident of scientific phenomena. Rule and Auge described a study in which students exposed to humorous cartoons had increased scores over students instructed using more traditional methods. da Silva et al. described a case where students exposed to cartoons about Charles Darwin’s historical journey were able to identify a geographic area close to their school and differentiate its present-day condition compared to its historical condition. Berk (1996) found that humor is most effective for application, analysis, synthesis, and evaluation questions. Similarly, Neuliep (1991) found that teachers’ use humor was a facilitator for learning to remember or illustrate points. These seven studies span approximately 20 years, with Neuliep’s work being the oldest.

Students’ maturity levels ranged from upper elementary (da Silva et al., 2009), middle (Rule & Auge, 2005), secondary (Dorion, 2009; Keogh & Naylor, 1999; Neuliep, 1991), and college (Berk, 1996; Sadowski et al., 1994). Data collection methods included interviews (Dorion, 2009; Keogh & Naylor, 1999), observations (Dorion, 2009), surveys (Berk, 1996; Keogh & Naylor, 1999; Neuliep, 1991; Rule & Auge, 2005; Sadowski et al., 1994), content tests (Rule & Auge, 2005; Sadowski et al., 1994), and case studies (Keogh & Naylor, 1999; da Silva et al., 2009). This great variety of research is joined by the common theme that instructional humor can have a positive effect on analysis.
Humor: A Positive Effect on Evaluation

Only two studies comprise the literature theme of humor having a positive effect on evaluation. Evaluation is a higher order learning outcome of Bloom’s Revised Taxonomy (Anderson et al., 2001). Learners who can evaluate can make and defend judgments based on internal evidence or external criteria. Activities involving evaluation may include justifying, interpreting, or comparing. A common form that humor takes is that of comparisons in the form of analogies. Tobin and Tippins’ (1996) exposition on the use of metaphors in the teaching and learning of science shows that metaphors always have some element of surprise. Metaphors are comparisons of one thing to another without the use of like or as and tend to convey less information than analogies (Gilbert & Ireton, 2003). Analogies are more complex. Analogies are comparisons where one thing is inferred to be similar to another thing in a certain respect on the basis of the known similarity between the things in other respects. They help students visualize science concepts in terms of familiar objects and processes and therefore provide a framework for constructing new ideas (Harrison & Coll, 2008). Analogies can be a logical argument: if two things are alike in some ways, they are alike in some other ways as well. The element of surprise in metaphors and analogies is a technique often employed with humor. Humor using a metaphorical or analogous premise that students perceive achieves the objective of students’ performance of evaluation. Both of the following studies included research involving the humorous use of analogies that assists the learning objective of evaluation.

Jarman (1996) described a study in which 55 preservice science teachers were surveyed to determine their use of analogies to explain scientific concepts. Besides showing relationships between pairs of things, analogies are often used to help provide
insight by comparing an unknown subject to one that is more familiar. According to Jarman, great care was taken to select contexts for the analogies that would relate to students' everyday lives. In using these analogies, many student teachers surveyed employed humor as a tool to compare students' general knowledge to scientific concepts in order for students to learn to evaluate the content of the lesson. The source domains of analogies (e.g., boyfriends and girlfriends, pop concerts, hares and tortoises, boxing, Snow White and the Seven Dwarfs, Legos, and cars, among many others) and target scientific concepts like gravity, blood circulation, the water cycle, sound, and fair scientific investigation contain many opportunities for scientific humor. In one humorous analogical example, the functioning of the circulatory system was compared to the video game Super Mario Bros. Jarman noted that an area of concern within her study is that preservice teachers overwhelmingly did not express concerns about student perceptions relative to their use of analogies.

Zillman et al. (1984) conducted a study that tested the effects of humorous distortions on learning in 64 children between kindergarten and fourth-grade age. Educational television programs that contained either distortion-free (analogous) humor or humorous distortions (exaggeration, irony, or irony that was later corrected) were shown to sets of kindergarten through fourth-grade students. Students were interviewed independently and orally assessed regarding the funniness of programming and information acquisition. Although the thrust of the study was that researchers found that humorous distortions, particularly irony, led to misconceptions among all students, an important sidebar was that humorous analogies (without distortions) resulted in clearer student perceptions about content. Students were assessed about the properties of exotic fruits shown in the educational program. The distortion-free version of the program
demonstrated fruit characteristics like weight and texture with humorous analogies. Those analogies resulted in students being better able to evaluate response choices on the assessment and reach more correct conclusions than students subjected to humorous exaggeration or irony.

In this 25-year-old study, Zillman et al. (1984) used a relatively small sample size, but a positive aspect of its design was that the television program produced for the study was of professional quality and was meant to model Sesame Street. The properties of the exotic fruits were “taught” by actors portraying a store keeper and customer. The educational topic and the humor were presented in an age-appropriate manner. The research subjects, small children, were not assessed as to their cognitive skill, and that is the major flaw in this work. Masten (1986) found that humor production, comprehension, and mirth were associated with academic and social competence. There was no measure in the Zillman et al. (1984) study of students’ academic or social competence with which we may correlate the possible reasons (or lack thereof) for their misunderstanding the age-appropriate humor presented to them.

Both Jarman (1996) and Zillman et al. (1984) provided examples of how the use of humorous analogies can convey knowledge about how learners can evaluate content. Jarman surveyed preservice teachers regarding their employment of analogies. Many, but not all analogies had humorous associations. Furthermore, Jarman did not provide specific excerpts of the analogies being taught; therefore, there can be no determination of how instruction of student evaluation was achieved. Zillman et al. (1984) noted that humorous distortions lead to misconceptions. The controlled group, students exposed to distortion-free analogous humor, learned the content without misconceptions. Although she did not conduct an empirical study, Fulton (1985) described ways in which humor
could be used to teach library skills in academic libraries. She offered a method for teaching students how to evaluate sources for authority, validity, thoroughness, and correctness, so it is appropriate to mention her manuscript in this section. She explained that one aspect of evaluating a source is understanding the author’s use of statistics. Fulton offered several quotations that obviously violated statistical logic in an effort to show how students might learn to assess other statistics presented in source materials they might find in their own research. Fulton’s essay drew on the research to discuss the motivational and pedagogical value of humor in education.

**Humor: No Effect on Learning**

Although some studies have examined the use of inappropriate humor (Frymier et al., 2008; Wanzer et al., 2006), neither identified a causal link between instructional humor and a negative effect on learning. Only one study by Zillman et al. (1984) investigated the use of humorous irony and exaggeration and found that perceptual distortions in kindergarten through fourth graders resulted. Here Zillman et al. (1984) is considered an outlier for several reasons:

1. It is the only study that specifically identifies humor as the cause for student perceptual distortion.

2. The study subjects were very young children who may not have comprehended the humor employed.

3. No control group was used in the study.

4. The study is nearly 30 years old and has not been replicated.

A few studies have determined that scientific humor does not aid in learning. These studies do not make any distinctions with regard to Bloom’s taxonomy (knowledge and remembering, comprehension and understanding, application, analysis, synthesis and
evaluation, or evaluation or creating). Quantitative techniques to measure learning through content assessments were used in all of the following studies. This likely represents the lower order learning objectives of knowledge and comprehension. The research spans back nearly 50 years from Gruner (1967) to slightly over a decade old (Conkell et al., 1999).

Conkell et al. (1999) tested the effects of humor in communicating fitness concepts to high school students. A video on body composition and weight control (approximately 20 minutes long) was shown to 543 ninth-grade students. Roughly half of the students were shown a version of the video that contained humor related to the topic and the other half were shown the video presentation devoid of humor. Although results indicated that students were more receptive toward the instructor and more motivated to improve their fitness levels after watching the video with humor, there was no difference in content understanding between the two groups of ninth graders.

Conkell et al. (1999) devised a well-designed study that used a large sample size appropriately distributed by gender. In this case, the humor was delivered by video, not during live classroom instruction, which may have affected student responses. Furthermore, here, as in many studies, learning was measured with a content test that assessed recall or knowledge of facts. Students were also given a perception questionnaire in which they were asked to rate the statement that, as a result of watching the video they planned to improve their present fitness levels. The response was that 61.2% of those watching the humor treatment (compared with 49.4% of those not watching the humor treatment) agreed with the statement. If those students actually did improve their fitness levels as a result of watching the humorous fitness video, then they will have applied the concepts taught, a cognitive objective higher than simple
knowledge of facts.

Fisher (1997) conducted a study at a planetarium with 495 adult subjects who were shown one of two versions of a 15-minute taped general astronomy show. One version of the show had content-related humorous inserts and the other had the humorous segments covered with silence. In the experimental set-up, humor was inserted every 90 seconds in the middle of each concept being explained. There were 20 concepts, 10 of which had humorous inserts. Both groups of subjects were given one of two different fill-in-the-blank tests. The research progressed until approximately 250 of each of the two versions of the fill-in-the-blank tests were collected. Fisher reported that “visitors who saw a humorous show had less retention of the instructional material and scored lower on the test than visitors who saw a non-humorous show” (p. 703).

Data reported by Fisher (1997) indicated that the nonhumor mean was 13.640 with $n = 250$ tests and the humor mean was 12.861 with $n = 245$ tests. This appears to be a negligible difference (0.779; humor $SD = 3.797$; nonhumor $SD = 3.706$) by which one could conclude that humor had no effect on retention, rather than resulting in less retention. The limitations of Fisher's study included the research location and manner of assessment. The research location was not an institution of formal learning, and as such, visitors would not normally have the expectation that their knowledge would be assessed. Participants in this study were members of the general public, presumably out for a day of relaxation at the planetarium. It is entirely likely that they would not have put forth their best effort on an assessment because they neither expected to be nor wanted to be quizzed on their recall of astronomical facts.

Bryant, Brown, Silberberg, and Elliot (1981) similarly found that humor had no effect on learning when they conducted a study to determine the effects of humorous
illustrations in college textbooks. Research subjects were 180 communication undergraduates. Subjects were asked to read a draft chapter on interpersonal communication and evaluate it according to motivation, appeal, and persuasibility. Subjects were broken into treatment groups that received either an easier or more difficult version of the text or a version of the text that contained no humor, moderate humor, or extensive humor. After subjects read and evaluated the chapter, they were given an unannounced 12-item test in which half of the items were related to the humor. Bryant et al. (1981) found that although humor made the chapter more appealing to students, humor negatively affected persuasibility and had no effect on motivation and information acquisition. Although this study is over 30 years old, it was well-designed and used a fairly large sample size. Its stated purpose was to investigate humorous illustrations on textbook teaching effectiveness. The human element was missing in that information exchange, which makes it much different from humor presented during class time by an instructor to students, which is the purpose of this research.

Finally, Gruner (1967) studied the effects of humor on speaker ethos and audience information gain among male undergraduates enrolled in a business and professional speaking course. Treatment groups consisted of two each of humor and nonhumor, with eight subjects in each group, for a total of 32 subjects. The same speaker was audiorecorded for each speech. The topic was “the process of listening.” Topic-relevant humor was inserted into the humor treatment speech. A negligible difference was found between the two treatments in the areas of authoritativeness of the speaker, interest, or information retention. This study is nearly 50 years old, so the attitudes, sensibilities, and behaviors among undergraduates and society as a whole might result in a different experimental outcome today. Further, a group of 32 male subjects, as employed in this
study, is not the typical composition of most classrooms.

This review of the literature found four studies that determined that scientific humor does not assist in learning. Quantitative techniques were used to measure learning, so it is likely that the lower order learning objectives of knowledge and comprehension were assessed. The oldest research (Gruner, 1967) employed 32 male subjects and is flawed due to an uncharacteristic research sample. The stated purpose of Bryant et al.’s (1981) study was to investigate humorous illustrations on textbook teaching effectiveness. The human element was missing in that information exchange, which makes it very different from humor presented during class time by an instructor to students.

Fisher (1997) investigated the use of humor by using an instructional video at a planetarium. As the research location was not an institution of formal learning, the participants would not normally expect that their knowledge would be assessed. Therefore, it is likely that they would not have put forth their best effort on an assessment. Conkell et al. (1999) provided the information that a greater number of students planned to improve their fitness after watching a humorous video versus a nonhumorous video. If those students actually did improve their fitness levels as a result of watching the humorous fitness video, then they applied the concepts that were taught, a cognitive objective higher than simple knowledge of facts. These four studies do not offer a compelling argument against the positive effect of content-related humor on learning in general or on any learning objective on Bloom’s taxonomy.

**Theoretical Framework**

I began my study of scientific humor in the Spring 2011 semester at the University at Albany. As I continue to teach biology at the secondary and college level, I
find theoretical concepts even more valuable when I am able to make practical use of them in instruction. I consider the use of humor a powerful technique in teaching science concepts. Not only does humor put students in a positive frame of mind, but it can entail cognitive processes for instruction of scientific concepts. At the conclusion of my study of how university professors used humor in the instruction of their science courses (a pilot for this research), Dr. Oliveira and I wrote a manuscript (Wizner & Oliveira, 2012) where we found that, although some humor may be potentially offensive to some students, the humor may be directed toward the instructional aims of the course. In that study, we drew upon Lemke’s (1990) work to construct thematic patterns from the instructor’s lectures and conduct a microethography of the implied social alignments within their discourse.

Since that time, we have revised the manuscript as a result of suggestions made by professional journals. I have used this time as a reflective period to consider how I might examine scientific humor among teachers at the secondary level through a lens deeply grounded in educational theory, yet familiar to practitioners in their daily instruction. Because I use humor in my own secondary and college-level instruction, I have begun to consider specific humorous attempts that I perform and how they might be analyzed to explain my intended scientific learning objectives for my students. Drawing upon my personal teaching experiences as well as my earlier pilot study, I believe that Bloom’s Taxonomy of Educational Objectives (Anderson et al., 2001) represents a deeply grounded educational theory that is dually familiar and practical for both theoreticians and practitioners.

Furthermore, it is equally important to consider humorous attempts by instructors from a philosophical perspective of humor. Morreall (2009) proposed that the
contemporary form of humor, stand-up comedy, has similarities with philosophy. For example, both stand-up comedy and philosophy are conversational, ask questions, and perform critical thinking. I propose that science teachers share those same similarities, and for this reason, consider Morreall’s model of observable behaviors an appropriate frame that can be quantified and qualitatively examined to determine how they assist students with their learning objectives.

The primary theoretical framework for this study was based on the work of Benjamin Bloom (Bloom, Englehart, Furst, Hill, & Krathwohl, 1956). It was later revised by Anderson et al. (2001) and others who established a classification of different learning objectives for students. Bloom's taxonomy divides educational objectives into three domains: cognitive, affective, and psychomotor (sometimes loosely described as knowing/head, feeling/heart and doing/hands, respectively). Bloom's taxonomy is intended to motivate educators to focus on all three domains, creating a more holistic form of education. For the purposes of this study, my focus was on the cognitive (knowing/head) domain.

When Bloom’s taxonomy was updated to be more relevant to 21st-century students and teachers, *A Revision of Bloom’s Taxonomy of Educational Objectives* (Anderson et al., 2001) included several significant changes related to three categories: terminology, structure, and emphasis. The original version of the taxonomy used nouns to describe levels of thinking and is one dimensional, whereas the revised version uses verbs to describe thinking and is two dimensional in order to depict how knowledge interacts with the cognitive process. The present emphasis of the taxonomy is its authentic use for curriculum planning, instruction, and assessment. Throughout this paper, I will strive to include both updated and original terminology, as many educational sources still refer to
Bloom’s original taxonomy.

There are six levels in the cognitive domain of Bloom’s taxonomy, moving through the lowest order processes to the highest: knowledge (now called remembering); comprehension (now called understanding); application (now called applying); analysis (now called analyzing); synthesis (replaced with creating); and evaluation (replaced with evaluating). Learning at the higher levels is dependent on having attained prerequisite knowledge and skills at lower levels. This can be illustrated graphically as shown below in Figure 1. Anderson et al. (2001) defined these cognitive process terms as follows:

1. Remembering: Retrieving, recognizing, and recalling relevant knowledge from long-term memory.

2. Understanding: Constructing meaning from oral, written, and graphic messages through interpreting, exemplifying, classifying, summarizing, inferring, comparing, and explaining.

3. Applying: Carrying out or using a procedure through executing, or implementing.

4. Analyzing: Breaking material into constituent parts, determining how the parts relate to one another and to an overall structure or purpose through differentiating, organizing, and attributing.

5. Evaluating: Making judgments based on criteria and standards through checking and critiquing.

6. Creating: Putting elements together to form a coherent or functional whole; reorganizing elements into a new pattern or structure through generating, planning, or producing. (This was referred to as synthesis in Bloom et al., 1956.)
Figure 1. Hierarchical and parallel framework of Bloom’s revised taxonomy.

The revised form of Bloom’s taxonomy can take the form of a two-dimensional table (see Table 1). Read vertically, the four types of knowledge to be achieved are listed: factual, conceptual, procedural, and metacognitive. Factual knowledge includes the basic elements students must know to be acquainted with a discipline or solve problems in it; Conceptual knowledge is knowing classifications within a larger structure and how they function; Procedural knowledge is an understanding of subject-specific skills; and Metacognitive knowledge is a general awareness of one’s own knowledge level. Read horizontally, the six cognitive processes for achieving the types of knowledge are listed and described briefly in Table 1 and are defined more fully above. The intersections of the knowledge and process categories form 24 separate cells that identify various behaviors that exemplify a given learning objective.
Humorous attempts in the science classroom will be most instructionally successful when due consideration is given to the learning objectives to be achieved within Bloom’s taxonomy and the academic and social competence of the learners, as described by Masten (1986). Masten found that humor comprehension and production in children was positively correlated with classroom behavior, peer reputation, and academic achievement. Teachers' instructional humor production must be directed toward intended learning objectives and with consideration of students’ academic competence. Students at lower academic and social competencies would better understand and find amusement in humor that dealt with listing characteristics, predicting outcomes, or classifying items. At the upper end of academic and social competencies students could understand and be amused by differences between constructs, conclusions about data, or making unique combinations.
Table 1

Learning Behaviors Evident in Bloom’s Revised Taxonomy

<table>
<thead>
<tr>
<th>Type of knowledge to be achieved</th>
<th>Cognitive process through which various types of knowledge may be achieved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remember:</td>
<td>Retrieve knowledge from long-term memory</td>
</tr>
<tr>
<td>Understand:</td>
<td>Interpret; paraphrase</td>
</tr>
<tr>
<td>Apply:</td>
<td>Implement a procedure</td>
</tr>
<tr>
<td>Analyze:</td>
<td>Break into parts and determine how parts relate to one another &amp; to overall structure</td>
</tr>
<tr>
<td>Evaluate:</td>
<td>Make judgments based on criteria</td>
</tr>
<tr>
<td>Create:</td>
<td>Organize elements into new pattern or structure</td>
</tr>
<tr>
<td>Factual:</td>
<td>List</td>
</tr>
<tr>
<td>Conceptual:</td>
<td>Decipher</td>
</tr>
<tr>
<td>Procedural:</td>
<td>Tabulate</td>
</tr>
<tr>
<td>Metacognitive:</td>
<td>Execute</td>
</tr>
<tr>
<td></td>
<td>Appropriate use of terminology.</td>
</tr>
</tbody>
</table>

The secondary theoretical framework for this study is based on the work of Morreall (2009). Morreall (2009) proposed that the contemporary form of humor, stand-up comedy, has eight similarities to philosophy. Both stand-up comedy and philosophy
1. Are conversational.

2. Reflect everyday experience.

3. Ask questions.

4. Explore questions in a detached manner.

5. Search out new perspectives.

6. Are critical thinkers.

7. Do not defer to authority or tradition.

8. Perform “thought experiments” to mentally manipulate possibilities.

I propose that science teachers share those similarities. These are observable behaviors that can be quantified and qualitatively examined to determine how they assist students with their learning objectives. For example, science teachers are critical thinkers and encourage their students to be, as well. Classroom events may establish incongruity, which, according to Morreall (1987), may be reacted to through uneasiness, feelings of loss of control, motivation to change the incongruous situation, or amusement. If students found the classroom events amusing, one might conclude that they found humor in them.

This literature review examined the scholarly literature on humor instruction as it related to learning. The following themes were found within the research: (a) Humor: A Comprehensive Positive Effect on Learning, (b) Humor: A Positive Effect on Knowledge/Remembering, (c) Humor: A Positive Effect on Comprehension/Understanding, (d) Humor: A Positive Effect on Analysis, (e) Humor: A Positive Effect on Evaluation, and (f) Humor: No Effect on Learning.

As early as 1977, Kaplan and Pascoe performed research in support of humor having a general, comprehensive, positive relationship with learning. Research has focused predominantly on the undergraduate level (Garner, 2006; Gorham, 1988;
Gorham & Christophel, 1990; Kaplan & Pasco, 1977; Wanzer et al., 2010; Warner et al., 2010; Zillman, 1980; Ziv 1988). Overall, the body of literature in the area of humor’s general, comprehensive, positive relationship with learning is well-represented in higher education. Conversely, there is a dearth of research in the primary, middle, or secondary levels of education. Two of the three studies in this review that demonstrated increasing students’ knowledge and remembering as a result of humor used during instruction were also focused on university students (Hackathorn et al., 2011; White, 2001). Bryant and Zillman (1988) noted in their earlier examination of the existing literature that despite the various ways in which learning might be understood and assessed, most studies examining the effects of humor on learning have involved traditional measures such as acquisition of information, item recognition, recall, and retention rather than alternate modalities involving experimentation, questioning, illustration, or designing. Four studies addressed the effect of humor on student comprehension and understanding. Three of the studies (Downs et al., 1988; Tapper, 1999; Torok et al., 2004) occurred at the undergraduate level.

It is remarkable that 75% of the studies exemplifying the theme of comprehension/understanding did so without surveying as a data-collection technique. Only Torok et al. (2004) employed a survey to ask if the purpose of humor in instruction was to facilitate understanding. Downs et al. (1988), Tapper (1999), and Roth et al. (2011) employed observation as a data-collection technique and determined that humorous conversations with students demonstrated understanding of content. Seven studies found that humor had a positive effect on analysis.

The studies spanned approximately 20 years and students’ maturity levels ranged from upper elementary (da Silva et al., 2009), middle (Rule & Auge, 2005), secondary
(Dorion, 2009; Keogh & Naylor, 1999; Neuliep, 1991), and college (Berk, 1996; Sadowski et al., 1994). Data collection methods included interviews (Dorion, 2009; Keogh & Naylor, 1999), observations (Dorion, 2009), surveys (Berk, 1996; Keogh & Naylor, 1999; Neuliep, 1991; Rule & Auge, 2005; Sadowski et al., 1994) content tests (Rule & Auge, 2005; Sadowski et al., 1994), and case studies (da Silva et al., 2009; Keogh & Naylor, 1999). This great variety of research is joined by the common theme that instructional humor can have a positive effect on analysis.

Only two studies (Jarman, 1996; Zillman et al., 1984) provided examples of how the use of humorous analogies can convey knowledge about how learners can evaluate content. Jarman (1996) surveyed preservice teachers about their employment of analogies but did not provide specific excerpts of the analogies being taught; therefore, there can be no determination of how instruction of student evaluation was achieved. Zillman (1984) noted that humorous distortions lead to misconceptions but students exposed to distortion-free analogous humor learned the content without misconceptions.

Contrary to the preceding body of research, four studies determined that scientific humor does not assist in learning. As quantitative techniques were used to measure learning, it is likely that the lower order learning objectives of knowledge and comprehension were assessed. Gruner’s (1967) study employed 32 male subjects and is flawed due to an uncharacteristic research sample. Bryant et al. (1981) investigated the effect of humorous illustrations on textbook teaching effectiveness. The human element is missing in that information exchange, which makes it much different from humor presented during class time by an instructor to students. Fisher’s (1997) investigation was conducted at a planetarium, which is not an institution of formal learning where participants would typically expect assessment. Therefore, it is likely that participants
would not have put forth their best effort on an assessment. Conkell et al.'s (1999) study provided the possibility that students watching a humorous fitness video might apply concepts taught and therefore reach a higher learning objective than those taught without humor. These four studies do not offer a compelling argument against the positive effect of content-related humor on learning in general, or any learning objective on Bloom’s taxonomy.

The glaring gap in the literature related to the effect of humor on learning is that there are few studies conducted below the undergraduate level. Furthermore, many studies employed quantitative measures of student recall rather than alternate modalities involving experimentation, questioning, illustration, or designing. Few studies employed multiple data sources because many studies conducted were quantitative in nature. With the exception of Hackathorn et al. (2011), no other studies overtly examined instructional humor in terms of specific learning objectives identified by Bloom’s taxonomy.

Humor has been shown to directly impact learning objectives articulated in Bloom et al.’s (1956) taxonomy and Bloom’s revised taxonomy (Anderson et al., 2000). For this reason, this study will be framed with consideration given to Bloom’s taxonomy of learning objectives. It is appropriate to also consider prevailing theoretical underpinnings with regard to humor research. Morreall is a noted contemporary philosopher and aspects of his framework were borrowed for this analysis. Both Bloom’s Taxonomy and Morreall’s framework have implications on the research methodology that follows.
Chapter III

Methodology

The literature reviewed in Chapter II drew attention to the research available on the use of humor exclusively for instruction. By far, the majority of research regarding the use of humor in education relates to enhancing course or instructor appeal (Bryant et al., 1980), student engagement (Weitkamp & Burnet, 2007), managing conflict or other behavioral issues (Fovet, 2009; Norrick & Spitz, 2008) or testing concerns (Berk & Nanda, 2006; McMorris, Boothroyd, & Pietrangelo, 1997; McMorris, Urback, & Connor, 1985). Relatively little is known about the use of humor as an instructional tool. The aim of this study was to examine the way that science teachers used humor in their teaching to affect students’ perception of learning. The guiding question was, How do teachers use humor in order to explain scientific concepts? The secondary, related research question was, How do students perceive their teachers’ use of scientific instructional humor? This chapter includes a discussion of the methods of inquiry, data collection, and data analysis for this qualitative research study. To conclude the chapter, both validity and data quality were also addressed.

As this research involved an examination of teachers’ use of scientific humor and their students’ perceptions of that instructional humor, a qualitative research approach (Creswell, 2007, 2009) was used in conducting this case study (Yin, 2009) of scientific humor. This study focused on the secondary level, primarily because so little research on instructional humor has been conducted at this level. Only four studies in over 30 contained in my review of the literature focused on secondary level instruction. Further, my area of expertise is secondary science. My exploratory research design relied mainly on descriptive data systematically collected through open-ended research methods.
(surveys, taped classroom observations, collection of instructional artifacts and student work samples, and interviews of teachers and students) and analyzed inductively to build a naturalistic (Lincoln & Guba, 1985) account of one aspect of secondary teachers’ teaching performance, specifically their use of humor to make scientific meanings. My methodological choice allowed an in-depth exploration without interfering with teachers’ typical instructional practices. I was also reflexive (Patton, 2002) in my attention to my own cultural, political, social, linguistic, and ideological origins as I strive to understand the voices of secondary teachers and their students. My use of triangulated methodology stemmed from my goal of providing a credible, valid, and authentic depiction of scientific humor as demonstrated by secondary teachers. To do so, I adopted a stance of neutrality as described in Patton (2002), which requires that researchers do not set out to prove a particular perspective but instead seek only to understand the complexities and perspectives as they emerge and to be balanced in reporting findings that both support and refute any conclusions offered.

**Survey and Blog Participants**

Teachers were made aware of the survey about scientific humor with a recruitment advertisement (see Appendix A) made available to members of the following organizations:

1. National Earth Science Teachers Association (NESTA). NESTA is a nonprofit 501(c)(3) educational organization founded in 1983, whose mission is to facilitate and advance excellence in Earth and Space Science education. Invitations were extended to teachers who taught in Albany, Green, Ulster, Dutchess, and Columbia counties.

2. Science Teachers Association of New York State (STANYS). The Science Teachers Association of New York State includes Pre-K to University and Informal
science educators. STANYS promotes excellence in science education and works with educators and communities to provide opportunities for all students to participate in and learn science. STANYS is a 501(c)(3) non-profit organization. Invitations were extended to teachers who taught in the abovementioned counties.

3. Science teachers who were not members of those organizations but who taught in Albany, Green, Ulster, Dutchess, and Columbia counties (convenience sample) of New York State.

The survey, using Surveymonkey.com (see Appendix B), was composed of a series of questions regarding demographic information such as grade levels taught, subjects taught, and years of teaching experience. I also asked survey participants for pedagogical information concerning teachers’ humor practices, including frequency of humor usage, types of humor commonly employed, strategies used to incorporate humor into their science topics, examples of their content-related humor, and strategies adopted to ensure science learning during humorous events. Respondents were encouraged to electronically attach examples of their content-related humor such as humorous videos, jokes, PowerPoint slides, test questions, laboratory activities, anecdotes, or any other instructional materials the respondent viewed as content-related humor.

Most survey respondents (60%) identified themselves as teaching more than one grade level. The largest “pure” group (19%) was teachers of freshmen. In addition to teaching more than one grade level, respondents said they taught more than one subject. The most frequently occurring subject was biology (42%), followed by any kind of science elective (37%), then earth science at 27%, chemistry at 21%, and physics at 10%, respectively. The majority of survey respondents identified themselves as having between 11 and 20 years teaching experience. Twenty-five percent had 6 to 10 years, 22% had 21
or more years, and only 10% of respondents had between 0 and 5 years teaching experience.

Members of NESTA and STANYS and teachers in surrounding counties were also invited to participate in a blog that asked for their feedback regarding their use of humor in the science classroom. Teachers were queried as to whether or not they occasionally used humor and whether they found it to be an effective classroom tool. Information gathered from the blog was used to further inform the purposeful sampling of teacher participants.

Teacher participation in this project was voluntary. Survey and blog respondents had differing levels of teaching experiences (novice to veteran), taught in different instructional settings (urban, suburban, or rural areas), and taught different content areas (biology, earth science, etc.) and grade levels (9 through 12).

**Observation and Interview Participants**

From the pool of survey respondents, I initially recruited six secondary teachers who provided the greatest variety of content-related scientific humor examples, as well as received school district approval for participation in the study. (The author is a teacher for the school district that agreed to participate in this research). Each of the six teachers were awarded a $50 honorarium for providing the greatest variety of content-related scientific humor, signing a pledge attesting to the fact that their submissions were actual examples of content-embedded humor that they have used in their classrooms, and participating in the observation and interview phases of the study. I observed 10 lessons per teacher (see Appendix C for scientific humor observation and quantitative data analysis protocol). Prior to videotaping, I asked the six teachers to describe 15 possible lessons in terms of purpose, instructional activities, and the nature of the humor they
would be employing (see Appendix D for lesson observation proposal). I then discussed the proposed lessons with the teachers and selected the lessons that I believed would yield the richest data set. Once the lessons to be observed were determined, I set up a video camera in a vantage point that was best able to record teacher instruction and also respect student anonymity. Any student faces that were inadvertently photographed were obscured in the final editing. During videotaping I also made detailed notes of my observations. Both Bloom’s (2001) and Morreal’s (2009) frameworks, as well as prior research in the field of instructional humor (Berk, 1996; da Silva et al., 2009; Dorion, 2009; Keogh & Naylor, 1999; Neuliep, 1991; Rule & Auge, 2005; Sadowski et al., 1994) informed the creation of the scientific humor observation and quantitative data analysis protocol (see Appendix C).

After observations were complete, I invited teachers to participate in interviews (for teacher interview protocol, see Appendix E) about their oral performances and asked them to provide sample artifacts of types of humor (jokes, comics, pictures, etc.) used in their classes. In the teacher interview protocol, participating teachers were asked to identify their humorous attempts in order to avoid researcher misinterpretation. Teachers were further asked to state their general student learning purpose. In total, the interview protocol was developed to directly query teachers as to how they employ content-related scientific humor to convey science concepts. Participating teachers were assigned pseudonyms. The six participants involved in the observation/interview phase of the study taught in the same urban high school and were all veterans with 8 to 26 years in instruction; four taught biology and two taught ecology.

In addition, after all 10 observations in each teacher’s classroom were completed, four students from the observed classes were also invited to participate in interviews.
related to their perceptions of their own learning with respect to their teacher’s use of scientific humor (for student recruitment and assent see Appendix F; for student interview protocol, see Appendix G). Student interviews were conducted after all classroom observations were completed for the purpose of providing an informed, purposeful sample so that students were selected who represented both those attentive to and inattentive to instructional humor use. The student interview protocol provided a guideline for the researcher to ask students to identify humorous attempts and describe their perceptions related to teacher humor and their own learning.

Bloom’s taxonomy of learning outcomes (Anderson et al., 2001) was informative in constructing student prompts for this protocol. The purpose of this student interview protocol was to inform the researcher of students’ perceptions of teachers’ content-embedded scientific humor. Student participants had differing cultural backgrounds and academic abilities. They were enrolled in either biology or ecology classes. Students who participated were offered a $10 gift certificate for either iTunes or Amazon as an honorarium. Participating students were assigned pseudonyms.

After viewing the classroom recordings and teacher and student interviews, two classrooms were selected to be included in this study. The final determination was based on the teachers who provided the richest selection of humor events, as well as interview data with regard to teacher and student descriptors of humor delivery and reception. The two teachers included in this study were Marin, a regents biology teacher and Ned, an honors biology teacher. Data from four students in each of their classes was also included in this study. All students were 10th graders and represented varying cultural backgrounds, academic abilities, and subject matter interest levels.
Timeline and Dataset

The timeline of this research study is shown in Figure 2.

There are seven main components of the data set:

1. A preobservation teacher survey soliciting information about teaching experience, school demographics, and examples of their content-related humor in the science classroom.

2. Blog posts responding to a solicited request for information about the use of humor during science teaching.

3. A corpus of recordings and field notes of classroom observations of each teacher performing 10 science lessons that included humor.

4. Collected artifacts that provided additional insights about how teachers use humor in the classroom such as jokes, cartoons, tests, or syllabi.

5. Postobservation recorded, semistructured teacher interviews (Bernard, 2002;
Robson, 2002) that lasted about 45 minutes. The interviews were designed such that the interviewer was free to modify the sequence and wording of questions, omit or add questions, and determine the amount of time and attention given to each question.

6. Postobservation, recorded, semistructured student interviews (Bernard, 2002; Robson, 2002) that lasted about 20 minutes. The interviews were designed such that the interviewer was free to modify the sequence and wording of questions, omit or add questions, and determine the amount of time and attention given to each question.

7. Student work products that included lab reports, classwork, responses to formative or summative assessments, and other samples that showed evidence of student learning.

The surveys and blog posts took place during the 2012-2013 and 2013-2014 school years. The observations, interviews, and artifact collections occurred during the 2013-2014 school year. The aim of this study was to examine the way that science teachers used humor in their teaching to positively affect students' perceptions of learning, and the surveys were intended to generate a sample of science teaching professionals that could address that concern. This study was intended to thoroughly investigate the use of scientific humor; therefore, it continued beyond simple teacher reporting. For this reason, instructional observations, teacher interviews, and collections of their humorous instructional artifacts built a more nuanced picture of the manner in which scientific content humor is employed. Students' perceptions of learning were ascertained through student interviews. Work samples were also collected in order to compare students' actual performance and comprehension to their perceptions of their own learning.
Data Analysis

I first examined the surveys for salient and recurrent trends that were mentioned with regard to teachers’ humor practices, including frequency of humor usage, types of humor commonly employed, strategies used to incorporate humor into their science topics, examples of their content-related humor, and strategies adopted to ensure science learning during humorous events. For example, much of the research regarding the use of humor was related to enhancing course or speaker appeal (Bryant et al., 1980; Gruner, 1970; Torok et al., 2004; White, 2001), engagement (Stuart & Rutherford, 1978; Wakshlag, Day, & Zillman, 1981; Watson et al., 2007; Weitkamp & Burnet, 2007; Young et al., 2011), managing conflict or other behavioral issues (Fovet, 2009; Norrick & Spitz, 2008), or managing anxiety (Berk et al., 1989; Berk & Nanda, 2006; McMorris et al., 1985, 1997). Surveys were quantitatively analyzed using the back page of the data sheet found in Appendix H. Column headings were informed by existing literature. A simple tally was taken to determine the purpose of scientific humor, the teacher’s favorite and objectionable humor, their criteria for selecting humor in the classroom, how humor is incorporated in their classroom, and how students taught with humor are assessed. I expected to find high frequencies of survey responses indicating that teachers use humor to enhance their own or course appeal, promote student engagement, and manage behavior and anxiety. I also hoped to find a group of respondents who used humor to teach scientific concepts. This was the group on which I focused.

From the pool of recruited secondary teachers, I examined classroom and interview recordings and the corpus of field notes for any salient and recurrent trends that occur during the instructional practice of teaching science with humor. In order to do this, I compared tallies, notes, and key words from the classroom observation and quantitative
analysis protocol (see Appendix C) to transcripts of recordings of teacher interview responses and noted any similarities, corroborations, points of divergence, contradictions, or other noteworthy effects. I focused on how teachers interrupted their more typically serious instruction for short periods of time to share amusing anecdotes; make sidebar (off-the-cuff) comments; and show and/or discuss amusing videos, photographs, drawings, diagrams, cartoons, or other humorous items relevant to the topic of study.

Following classroom observations, I conducted interviews with each of the teacher participants to discuss the kinds of humor used during instruction and the manner in which humor was presented. I collected additional information relating to the oral performance, teacher’s assessment of student learning, and the way that humor was integrated into science lessons. Artifacts related to the observed lessons were also collected. Artifacts included jokes, tests, videos, cartoons, or other teacher-provided materials that were intended to amuse, with the ultimate goal being student edification and the enrichment of science concepts.

After the teacher-related data were collected, I conducted interviews with four students from each class who were taught by each of the observed classroom teachers. I discussed the humor presented in the lesson and the students’ perceptions of whether they were amused by the teacher’s attempt at humor and what effect (if any) they believed it had on their learning of the science concept. In addition, I collected samples of their work products (lab reports, class work, responses to formative or summative assessments, etc.) that showed evidence of student learning. Work samples were collected in order to compare students’ actual performance and comprehension to their perceptions of their own learning.

Teacher and student discourse was systematically analyzed using Bauman’s
(1977) patterns of performance (see Appendix I for scientific humor discourse framework). Transcribed recordings, sequential analysis, and playback of recorded observations and interviews were conducted in order to accomplish this. Each humorous event (science concept that prompts the use of humor) was described by how it was enacted (telling of an anecdote, showing a video, modeling a process, etc.), whose role was involved in the humor event (teacher, actor in a video, student, etc.), and the genre in which it occurred (genetics, weather, biochemistry, etc.). Bauman described his study of predictable combinations of events, acts, genres, and roles and their interrelationships to be near the center of ethnography of performance in varying cultures. This framework was borrowed for the purpose of determining the interrelationships among the enacting of humor events, how they are enacted, who is the main actor in each event, and the science genres involved.

All recordings were transcribed in full and their content was examined to determine how teachers used humor and if doing so aided in the communication of science. Teacher interview analysis was used to triangulate information provided in the surveys, observations, and artifacts, and thus contributed to the reliability and validity of the findings. A similar method was used to triangulate student interviews against student work products in order to ensure reliability and validity.

Artifacts collected during interviews were analyzed using a framework recommended by McGreal, Broderick, and Jones (1984). Their analysis, in addition to providing an additional means of triangulation, can demonstrate heuristic power (McDonald, Le, Higgins, & Podmore, 2005) that supports instruction. Materials collected during the learning experience were grouped according to the key aspects of content, design, and presentation, based on McGreal et al.’s (1984) framework (shown in
Appendix J). The guidelines provided therein are intended to be a comprehensive basis for analyzing artifacts, and as such, artifacts are not intended to meet every criterion. Nonetheless, collected artifacts may satisfy many of the characteristics. In particular, artifacts were examined to determine in what way they aligned with the teacher’s instructional strategy. Humor that achieves conformity among the type of artifact, the strategy used in the presentation, and the type of humor used has a greater likelihood of conveying science concepts, and this was noted in the findings section.

Two other experts, certified New York State science teachers with at least 5 years teaching experience who studied Bloom’s taxonomy (Anderson et al., 2001), Moreall’s (2009) philosophy, Bauman’s (1977) patterns of performance for discourse, as well as McGreal et al’s frameworks (1984), were employed to assist me and helped to triangulate our interpretations of the survey, blog, observation, interview, artifact, and work product data. In these sessions, we collectively examined discursive records of particular key items in open-ended survey responses, blog posts, field notes, and interview transcriptions, shared individual analyses, and extensively discussed our interpretations. Figure 3 below graphically shows how communication among the three raters helped build an emergent account that was gradually adjusted to include any variations that surfaced from the reflective group interpretation of the data. This collaborative analytical approach contributed to guarding against individual researcher biases and helped to establish reliability and validity (Robson, 2002).
A scrupulous examination of classroom events as well as analysis of teacher interviews and artifacts was viewed in terms of Bloom’s taxonomy of learning objectives (Anderson et al., 2001). The degree of alignment was considered with regard to the levels of knowledge/remembering, comprehension/understanding, application, analysis, evaluation/synthesis, and creating. Alignment was further evaluated in consideration of student interviews with regard to student perceptions of learning, degree of humor, and the instructional goals of the humorous attempts.

As instructors’ humorous attempts were viewed through Bloom’s taxonomy, I also considered humor from the philosophical perspective discussed by Morreall (2009). Morreall (2009) proposed that stand-up comedy has eight similarities to philosophy. I propose that science teachers share these similarities. To establish this, I examined science teachers’ humorous attempts in terms of Morreall (2009; see Table 2).
These are observable behaviors that can be quantified and qualitatively examined to determine how they help students with learning objectives. For example, science teachers are critical thinkers and encourage their students to be, as well. Classroom events may establish incongruity, which, according to Morreall (1987), may cause uneasiness, feelings of loss of control, motivation to change the situation, or amusement.

Table 2

*Shared Characteristics of Comedians, Philosophers, and Science Teachers*

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Shared elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are conversational</td>
<td>Observations are presented in a dialogue</td>
</tr>
<tr>
<td>Reflect everyday experience</td>
<td>Reflections usually relate to puzzling everyday experiences</td>
</tr>
<tr>
<td>Ask questions</td>
<td>Puzzling experiences generate problems to be investigated</td>
</tr>
<tr>
<td>Explore questions in a detached manner</td>
<td>In comedy, philosophy, or scientific investigation a matter is examined in a detached, objective manner</td>
</tr>
<tr>
<td>Search out new perspectives</td>
<td>Cognitive shifts are embraced</td>
</tr>
<tr>
<td>Are critical thinkers</td>
<td>Be honest. Reject rationalization &amp; conformism. Ideas clear, coherent, and credible? Look for confusion, fallacy and incongruity</td>
</tr>
<tr>
<td>Do not defer to authority or tradition</td>
<td>Oppose blind, unquestioning obedience. Nothing is sacred</td>
</tr>
<tr>
<td>Perform “thought experiments” to mentally manipulate possibilities</td>
<td>Consider ontological arguments about the nature of reality</td>
</tr>
</tbody>
</table>

**Validity Issues**

There are techniques that support the validity claims of the researcher as outlined by Carspecken (1996). These include the use of multiple recording devices, a flexible observation schedule, a prolonged observation period, the use of low-inference vocabulary in the written record, the use of peer debriefing and member checks,
consistency checks on recorded interviews and observed activity, and using nonleading interview techniques. I strived to employ those techniques in order to enhance the validity of this work.

I employed audio and video as well as direct observation during the collection of classroom observations. In addition, multiple visits to sites were planned during the period of data collection. Observational protocols were completed as chronological collections of data, with a minimum of editorial comments. Interview questions were designed to be neutrally worded in order to elicit responses related to the topic of inquiry. Postobservation and interview consistency checks were made for each individual. Member checking was conducted after observation and interview in addition to peer analysis of data. Construct validity can be difficult to establish due to subjective statements made in the data, but using multiple sources of data and member checking can help to combat this downfall.

Peer debriefing, as described in Lincoln and Guba (1985) was achieved through analysis of the data with colleagues. Interview and observational data may leave room for interpretation, so it is important that researchers arrive at a consensus as to the proper interpretation of statements and events. Therefore, I triangulated survey, interview, observational, student work product, and artifact data, as well as discussed and arrived at a consensus with colleagues. These validity checks helped to ensure greater credibility of this research.

There were several aspects of data collection employed in this study that helped to guard against the Hawthorn effect, the process where human subjects of an experiment change their behavior, simply because of the environmental change of having an observer present. The teachers who were observed during this research signed statements attesting
to the fact that their submissions were actual examples of content-embedded humor that they used in their classrooms. Furthermore, multiple classroom visitations limited the likelihood of short-term behavior changes on the part of the participants. This is a loose approximation of the continuous observations mentioned in Cook (1973), but a realistic alternative. The focus of this study was a pedagogical strategy, not an aspect of worker productivity as in the Hawthorn experiment. Research subjects would suffer no ill effects from failing to provide relevant research data, and would, likewise, receive no tangible reward for providing relevant data. A nominal honorarium was offered for participation in all phases of the study, regardless of usability in the final reporting of findings. Finally, teacher participants were known in their educational communities to use scientific humor. Their students gave several examples of humor that their teachers used in class outside of the researchers’ presence. Coombs and Smith (2003) went so far as to suggest that social relationships between the researcher and field subjects are essential for the successful outcome of the research and that research subjects are partners with whom the researcher negotiates their contribution to the research process. In effect, this was accomplished through member checking.

Another validity issue is the ability to generalize the findings of the research. Generalizability is more difficult to establish with qualitative studies. However, Buchanan and Bryman (2009) explained that ethnographic studies on similar phenomena or in similar contexts can be used in qualitative analysis to form broader empirical understandings of phenomena. Furthermore, ethnography has relevance to theoretical generalization, which may be useful in forming new interpretations or re-examining earlier concepts. Finally, when research conclusions resonate with a reader’s empirical experiences, ethnography contributes to the naturalistic generalizability of findings.
Chapter IV

Survey and Blog Results

“How do teachers use humor in order to explain scientific concepts?” was answered through teacher query and direct observation. Responses to the bulk of a 17-question survey will be presented and analyzed first in this chapter. Following that, I will present and analyze the data collected in the discussion forum.

Surveys

As mentioned in my review of the literature, much of the research regarding the use of humor during science instruction relates to enhancing course or speaker appeal, engagement, managing conflict or other behavioral issues, or managing anxiety. Therefore, at the start of this research, I expected to find high frequencies of survey responses indicating that teachers use humor for those reasons. In fact, teachers did cite wanting students to have positive feelings, student engagement, and behavior management as reasons for using humor. These reasons were often combined by respondents and are clearly interrelated, as students who have positive feelings about the course tend to be more engaged and behave appropriately in class. Interestingly, the most frequently cited reason for using humor was to teach concepts (36%), which is an educational objective, and as such, appropriately addressed in Bloom’s taxonomy of educational objectives. During the instruction of concepts, the nature of each humorous event further clarifies the teachers’ intent to have students remember, understand, apply, analyze, evaluate, or create. In addition, the proposition that stand-up comedians, philosophers, and science teachers share similarities such as being conversational, reflecting everyday experiences, and searching out new perspectives tends to support the ideas that teachers want students to have positive feelings, be engaged, and manage their
behavior (see Figure 4).

![Purpose for Using Humor](chart1)

**Figure 4.** Scientific Humor Survey respondents’ purpose for using humor.

Respondents generally identified more than one criterion for their humor selections. Figure 5 shows that the main criterion for respondents was content relatedness (47%).

![Criteria for Humor Selection](chart2)

**Figure 5.** Scientific Humor Survey respondents’ criteria for humor selection.
Figure 6 depicts how respondents incorporated humor into instruction. Respondents typically used more than one method as evidenced by the fact that responses were greater than 100. The most frequent way humor was incorporated into instruction was classroom discussion (30%). Personal anecdotes were mentioned by 16% of respondents; cartoons and improvised humor represented 12% each, followed by 13 other methods for instructional humor incorporation. The fact that discussion was mentioned by 30% of teachers as a method for conveying humor suggests that much of classroom humor is verbal. It may occur as teachers are introducing or explaining new topics or before students are given guided or independent practice on class activities or labs.

![Pie chart showing how humor is incorporated into instruction](image)

- Discussions 30%
- Anecdotes 16%
- Cartoons 12%
- Improvised 12%
- Jokes 7%
- Role Play 5%
- Demonstrations 5%
- Puns 4%
- Labs 3%
- Rapport 3%
- Drawings 2%
- Funny Names 1%
- Funny Voices 1%
- Homework 1%

*N = 94*

*Figure 6. Scientific Humor Survey respondents’ methods for incorporating humor into instruction.*

Also considered important was appropriateness for high school (22%). Both of
these responses make sense given that educators have important information that they need to convey to their young students. Teachers may intuitively believe that humor is a helpful tool in delivering necessary content but that the humor used must be understandable and age-appropriate for the learners in question.

Survey respondents were asked to list their favorite types of humor and objectionable humor. Figure 7 depicts those mentioned by teachers. Twelve more favorite kinds of humor were listed than objectionable humor, which suggests that there are very few types of humor that teachers do not like. In fact, 39% of respondents specifically said there was no humor they would not consider for use in their science classroom. Thirty-five percent would not use inappropriate humor. Favored humor was variable in 32% of respondents, 15% liked puns, 14% liked jokes, and 13% like self-deprecating humor. Interestingly, 11% listed cartoons as a favorite but 4% found them objectionable, 6% liked sarcasm but 3% found it objectionable, 6% liked videos but 4% did not, and 4% liked silly or knock-knock jokes but 11% did not. The fact that respondents appeared to disagree about several types of humor supports the idea that many may believe intuitively that humor is in the eye of the beholder. The kind of humor one teacher may choose to use in the classroom may differ from another’s based on their comfort level or any of a number of other intangible feelings.
In order to determine whether teachers were testing student content knowledge on the topics for which they had used humor to deliver the material, the following question was asked: How do you use humor in assessment? However, the question was poorly written for this purpose. Although not apparent to me at the time, in re-reading this question during my analysis of this data, I found that misinterpretation by respondents was possible. Respondents may have interpreted the question to be asking if they used humorous items on test instruments. Figure 8 depicts whether respondents assessed the humor they used in class and how they assessed it. Most respondents said they did not assess science-related humor (52%). Student discussions were a form of student assessment 29% of the time. Test questions were identified by 23% as their method of assessing the humor they used in class. Therefore, the data collected from this question
may be an inaccurate reflection of assessments of scientific humor.

**Figures 8. Scientific Humor Survey respondents’ use of assessment of scientific humor.**

In summary, the main criterion for humor selection was content relatedness. Also considered important was appropriateness for high school. Both of these responses make sense given that educators have important information that they need to convey to their young students. The fact that discussion was mentioned as the most frequent method for conveying humor suggests that much of classroom humor is verbal. It may occur as teachers are introducing or explaining new topics, before students are given guided or independent practice on class activities or labs. Finally, respondents disagreed about their preferences for several types of humor, which supports the idea that humor is in the eye
Blog Postings

Teachers effectively nominated themselves or gave examples of the types of content-related humor they employed in their own classrooms in 47 different comments. On one hand, the examples they provided demonstrated the great variability and inventiveness of each teacher, with quips about Fluffy the Canoe Carrier and clips showing a character from *Jackass: The Movie* (Jonze et al., 2002) creating a human alluvial fan at the bottom of an escalator. On the other hand, the examples showed striking similarity when three separate commentators on the blog described placing marshmallows in a vacuum chamber to demonstrate the amusing effects of air pressure. Another point of similarity in how humor was used was the frequency of responses that included humorous drawings and cartoons. Table 3 depicts both the variability as well as the similarity of blog responses. The humorous examples posted on the blog can be placed on Bloom’s taxonomy of educational objectives in the cognitive domain. For example, the unique alluvial fan humorous event calls on students to rank this particular type of landform, which is an evaluative type of knowledge; whereas the similar marshmallows in a vacuum tube humorous events required students to evaluate and also called upon them to search out new perspectives (Morreall, 1987, 2009) in determining the cause of the changes in the marshmallows.
### Table 3

**Variability and Similarity of Blog Comments**

<table>
<thead>
<tr>
<th>Reason humor was used</th>
<th>How humor was used</th>
<th>Humor in assessment</th>
<th>Examples of humor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Humor enhances learning through laughter which brings extra oxygen to the brain.</td>
<td>I try to find science jokes and riddles and use puns when teaching a topic like elements or weather.</td>
<td>I have some multiple choice questions with “gag answers.”</td>
<td>Cast of characters: Fluffy the Canoe Carrier; International Geologist of Mystery</td>
</tr>
<tr>
<td>Students comment that it helps them relax and remember the answers to the questions I am asking.</td>
<td>I teach middle school life and physical science and often use cartoons that relate to concepts to open class. I also offer extra credit to students who bring in cartoons that have to do with anything in science.</td>
<td>I have been known to give a test with all of the answers the same letter.</td>
<td>I teach food chains by telling my kids that the arrows that show the flow of energy through a food chain do not move from animal to plant.</td>
</tr>
<tr>
<td>…making the classroom friendly and associating what is been studied with some fun makes it easier to grasp.</td>
<td>I teach physics and embed humor throughout the course. Jokes are purposefully added into presentations, demonstrations, labs, quizzes, and tests.</td>
<td></td>
<td>I’d set up my skeleton by the door to greet the students every day, with the joke of the day pinned to his chest.</td>
</tr>
<tr>
<td>Helps a teacher develop a good relationship with students, which is key in wanting to learn.</td>
<td>I use humor every day intentionally, unintentionally, often unplanned.</td>
<td></td>
<td>Mole jokes.</td>
</tr>
<tr>
<td>It makes students sit up and pay attention.</td>
<td>I change pronunciation of words.</td>
<td></td>
<td>Plastic doll head with hair pulled out, leaving small holes. I fill the head with shaving cream and plug the neck with a small stopper. I place this in a vacuum chamber and watch the fun.</td>
</tr>
<tr>
<td>Reason humor was used</td>
<td>How humor was used</td>
<td>Humor in assessment</td>
<td>Examples of humor</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>I write songs about physics that incorporate humor. Something I have added this year is a series of “Minute to Win It” type challenges; there is usually a physics twist which makes it impossible to win. My overall philosophy is that if I am not having fun, neither will my students.</td>
<td>A play on the word “schist”; just being silly; poke fun at myself; I think it’s important for kids to know it’s okay to laugh at yourself.</td>
<td></td>
<td>There is a scene from “Jackass” where WeeMan gets under an orange cone and stands at the bottom of an escalator. The people are forced to crowd together in a big muddle. After explaining alluvial fans, I click the mouse and an orange cone appears on the screen at the bottom of the alluvial fan.</td>
</tr>
<tr>
<td>I use humor in the classroom to keep students interested and also to build rapport.</td>
<td>I use humor when I teach a different meaning to a word.</td>
<td></td>
<td>I give each student a marshmallow and colored markers and ask them to make a self-portrait. Then I put them in the vacuum jar, stacked on top of each other in a circle, with their “faces” facing out so they can see themselves.</td>
</tr>
<tr>
<td>I do five to six standup acts a day! Using humor in my lessons adds a sense of ease in classroom; students see that I am a human who enjoys what I do.</td>
<td>I collect cartoons that are science related and put them into presentations. I also search for YouTube music videos and always aim for at least one song/topic.</td>
<td></td>
<td>I build a “marshmallow man” from eight marshmallows with toothpicks. I draw a smile and eyes with a marker.</td>
</tr>
<tr>
<td></td>
<td>I am the worst artist so my humans, animals, insects, etc. all take on the same shape (round with sticks) with slight variations to identify my animal.</td>
<td></td>
<td>I always tell them that they can eat the giant marshmallows when we’re done. They are very disappointed when the marshmallows shrink to an even smaller size than when we started because air won’t go back in.</td>
</tr>
</tbody>
</table>
Table 3 (continued)

<table>
<thead>
<tr>
<th>Reason humor was used</th>
<th>How humor was used</th>
<th>Humor in assessment</th>
<th>Examples of humor</th>
</tr>
</thead>
<tbody>
<tr>
<td>I use a great deal of stick figures in my geology diagrams.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>I spent a summer putting together my own science comic book filled with science-related cartoons.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

One commentator offered her own analysis of humor’s benefits by saying, “Humor enhances learning through laughter, which brings extra oxygen to the brain.”

Another described funny characters she used in her teaching such as Fluffy the Canoe Carrier and the International Geologist of Mystery and related student comments “that it helps them relax and remember the answers to the questions I am asking.” An earth science teacher similarly described a scenario whereby plants huddle together and attack a cow. It is this silly image that she thinks “helps them remember that the arrows move from the organism that is being eaten, to the organism that is eating, not the other way around.”

Not all comments were positive, however. One advocate of scientific humor on the blog stated, some recent colleagues (who I believe lack funny bones) have commented it is juvenile and unprofessional and have calculated statistics on how distracting they find those [humorous] questions. I firmly believe, though, that the benefits of using the humor outweigh some of these negative comments and will continue to use it!

The commentator found the terms “juvenile” and “unprofessional” leveled by her colleagues to be negative presumably because these are characteristics that would be undesirable for a self-described college statistics professor. This commentator possessed
the belief that scientific instructional humor has educational benefits. Clearly, in her experience, not all of her colleagues are of the same view.

Three separate commentators on the blog described placing marshmallows in a vacuum chamber to demonstrate the amusing effects of air pressure. One chemistry teacher described her lesson as follows:

I give each student a marshmallow and colored markers and ask them to make a self-portrait. Then I put them in the vacuum jar, stacked on top of each other in a circle, with their “faces” facing out so they can see themselves. Then I go into a story about them going to college and the “freshman” 15 lbs they will gain, I turn on the pump, and they “gain weight.” Then I tell them about getting older and wrinkled and I let the air back into the jar and they shrivel up. Then I go into another story about Botox and I turn the vacuum pump back on, then the nursing home look, when they have their 80th high-school reunion, what they will look like, and we let the air back in again.

This story requires students to interpret both the information presented verbally, as well as what they are visualizing happening to the marshmallows in the vacuum chamber. Interpretation is a type of understanding on Bloom’s cognitive domain. Since the teacher is presenting this as a story, it shares Morreall’s similarities in that the information is presented conversationally and is also reflective of everyday experiences.

Two teachers discussed making drawings in order to illustrate concepts, but the drawings also hold them up as good-natured dupes and show students that it is okay to show imperfections and laugh at yourself. One teacher said, “my humans, animals, insects, etc. all take on the same shape (round with sticks) with slight variations to identify my animal.” Likewise, nine separate commentators on the blog spoke about using jokes, riddles, cartoons, videos, songs, and puns to convey scientific ideas. One biology teacher said,

I use humor daily in all my classes. In fact, you might say, I do five to six standup acts a day! Using humor in my lessons adds a sense of ease in the classroom; students see that I am a human who enjoys what I do.
This biology teacher directly referred to his instruction as a “standup act.” This may be an unintentional reference to Morreall, but it illuminates this teacher’s philosophy of education. Throughout multiple classes every day, he demonstrates his ease with the material and simultaneously shows students his enthusiasm for the subject.

Another teacher of earth science showed a scene from *Jackass: The Movie* (Jonze et al., 2002):

where WeeMan gets under a giant orange cone and stands at the bottom of an escalator (coming down). The people are forced to crowd together in a big muddle. It’s pretty funny. I show this, and then I teach about alluvial fans. After explaining alluvial fans, I click the mouse and an orange cone appears on the screen at the bottom of the alluvial fan. It’s effective, relevant, and funny!

In summary, nearly 50 commentators on the blog gave examples of the types of content-related humor they employed in their own classrooms. The examples demonstrated the great variability and inventiveness of each teacher, yet showed striking similarity among several physics teachers in their presentation of vacuum chambers, as well as the use of humorous drawings and cartoons to teach science concepts. In any communication network such as in-service training, faculty or department meetings, informal collegial sharing, or electronic sharing on the internet, it is not surprising that many teachers of the same subject may have activities in common. It is also not surprising that when each individual teacher adopts an activity and makes it their own, they imprint their own particular style, technique, and thinking. That is where the creativity of the individual enters, changes are made, and perhaps the individual’s own brand of humor is included.
Chapter V

Teacher Marin: Results

In the first part of this chapter I will present Marin’s classroom observations, her instructional artifacts, and her interview, which will address the guiding research question, “How do teachers use humor in order to explain scientific concepts?” The secondary research question, “How do students perceive their teachers' use of scientific instructional humor?” was addressed through student interviews and a collection of student work products. Marin’s students, along with their work products, will also be presented and analyzed later in this chapter.

Marin is a 19-year veteran teacher. She has been teaching in this urban high school setting for much of that time. Her daily schedule includes three sections of biology and a human disease elective. Biology students are mainly sophomores, although classes may contain some freshmen as well. Many of the students in this particular section of biology are involved in extracurricular activities such as band and chorus. Marin was observed 10 times during her 9:30 a.m. class. Class periods are 40 minutes in duration. Students in Marin’s biology class will take the Living Environment Regents as a culminating exam in June 2014.

The “production side” of Marin’s scientific humor: the humorous events that occurred, instructional artifacts used, and teacher interview have been analyzed using four frameworks: Bloom’s revised taxonomy (Anderson et al., 2001); Morreall’s (2009) shared characteristics of philosopher’s and comedians; Bauman’s (1977) discourse framework; and McGreal et al.’s (1984) framework for instructional artifacts. Bloom’s revised taxonomy (Anderson et al., 2001) was paramount in discovering the cognitive processes involved in order to achieve factual, conceptual, procedural, and metacognitive
knowledge. Morreall’s (2009) lens was also highly instructive because this is a presentation of scientific content through humorous delivery. Bauman’s discourse framework (1977) is useful in examining the culture of the science classroom in terms of the various genres in which humorous events are enacted. Finally, using a framework for analysis of instructional artifacts (McGreal et al., 1984) is a means to determine how various instructional “props” contribute to Marin’s delivery of the scientific content.

Marin’s production of scientific humor was analyzed by three science education experts (the principal investigator in this study and two other certified New York State science teachers), as was the “reception side” of humor: student interviews and relevant student work products, which follow.

The largest and most instructive data sources were Marin’s humorous events and the instructional artifacts she used in the act of performing scientific humor. They are displayed below in Table 4. The final column of Table 4 describes the cognitive process that would be required to achieve the learning outcome for that particular type of knowledge, according to Bloom’s revised taxonomy (Anderson et al., 2001). Bloom’s revised taxonomy also deals with psychomotor and affective knowledge, however, all of Marin’s humorous events were within the cognitive domain.
Table 4

Analysis of Marin’s Cognitive Humorous Events Using Bloom’s Taxonomy

<table>
<thead>
<tr>
<th>Humorous event</th>
<th>Artifact</th>
<th>Bloom’s cognitive knowledge dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Chemistry formulas. Marin explains that an arrow is used instead of equal sign in chemistry. She exaggerates the P sounds in “points” and “product” and tells students they can use the similar sounds as a memory tool. She labels the reactants and products in the formula for water.</td>
<td><img src="image" alt="Chemistry formula" /></td>
<td>Students are expected to infer or draw a conclusion about the reactants and products in the formula, with the help of the teacher’s oral and graphic messages, and the direction of the arrow. The ability to make inferential conclusions is a type of procedural knowledge.</td>
</tr>
<tr>
<td>2: Plural and singular. Marin discusses the plural forms of nucleus and nucleolus with students. She exaggerates incorrect plural forms of those words: “nucleuseses” and “nucleouseses”.</td>
<td>N/A</td>
<td>Students are expected to be able to recognize the appropriate use of the plural and singular forms of nucleus and nucleolus. Remembering the appropriate use of words is a metacognitive type of knowledge.</td>
</tr>
<tr>
<td>3: Cell walls. Marin explains the nature of cell walls. She explains that their rigidity allows plant stems and tree trunks to grow upward against gravity. She compares plants without cell walls to human bodies without bones.</td>
<td>N/A</td>
<td>Students are expected to be able to predict what would happen to a plant without the structure of cell walls and humans without the structure of skeletons. The ability to predict events is a type of procedural knowledge.</td>
</tr>
<tr>
<td>4: Locomotion-paramecium. Marin explains that cilia are little hairs that paramecium have around their outer membrane. She waves her arms over her body to demonstrate that cilia hairs beat back and forth. She tells students that paramecium live in water and they create a little current in order to put food in their oral groove. She continues to demonstrate a paramecium by putting her hands to her sides and beating them. She asks students if they would be able to get very far in the water with that method of locomotion and if they’d like to try.</td>
<td>N/A</td>
<td>Students are expected to be able to identify and describe the motion of cilia on a paramecium. The ability to describe is a type of conceptual knowledge, which is an understanding of the interrelationships among the basic elements within a larger structure that enable them to function together. In this case, students are being taught about different microorganisms and their modes of locomotion. A mode of locomotion is a large generalization that can be categorized as cilia, flagella, and pseudopodia.</td>
</tr>
</tbody>
</table>
Table 4 (continued)

<table>
<thead>
<tr>
<th>Humorous event</th>
<th>Artifact</th>
<th>Bloom’s cognitive knowledge dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>5: Locomotion-euglena. Marin uses a diagram to explain that the “tail” is located at the front of the euglena. She makes swimming body movements and explains that the flagellum is the way the euglena swims.</td>
<td>See Appendix K for Marin’s Note Sheet Artifact used while teaching about characteristics of fungi.</td>
<td>Students are expected to be able to identify and describe the motion of a flagellum on a euglena. The ability to describe is a type of conceptual knowledge, as described in event 4 above.</td>
</tr>
<tr>
<td>6: Characteristics of fungi. Marin, using a chewing motion, asks students if they have ever seen a mushroom enjoying its food. She asks students if mushrooms eat. Students answer that mushrooms consume nutrients through absorption. Marin suggests that students remember that if an organism is “hungry” for food that it is heterotrophic. Marin then asks students if they ever opened a bread bag and heard bread mold complaining that they couldn’t breathe with the bag closed or saw mushrooms having difficulty breathing in the humidity of summer. When students admit that they haven’t, Marin explains that, in fungi, the oxygen/carbon dioxide exchange happens through diffusion. Marin uses mushrooms in another example about excretion when she asks students if they’ve ever seen a mushroom use a restroom. Excretion, too, happens through diffusion, she explains.</td>
<td></td>
<td>Students are expected to be able to interpret oral and written messages regarding absorption, diffusion, and excretion in fungi; classify them as heterotrophic; and differentiate those processes with how other heterotrophs exchange gasses, obtain nutrition, and remove wastes. Students’ ability to classify organisms in terms of how nutrition is acquired and differentiate cellular processes is a factual type of knowledge where they need to know basic terminology in order to answer questions and solve problems. Students’ ability to interpret oral and written messages is a type of conceptual knowledge, as described in event 4 above. Students’ ability to differentiate cellular processes is a type of procedural knowledge.</td>
</tr>
<tr>
<td>Humorous event</td>
<td>Artifact</td>
<td>Bloom’s cognitive knowledge dimension</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>----------</td>
<td>-------------------------------------</td>
</tr>
<tr>
<td>7: Ideal conditions for sprouting.</td>
<td>N/A</td>
<td>Students are expected to be able to describe the ideal conditions for sprouting seeds. Describing is a type of conceptual knowledge as described in event 4 above.</td>
</tr>
<tr>
<td>Marin explains that when deer eat apples they eat the core and seeds. She tells students that the seeds are not digested; they leave the deer’s body in its “poo-poo”. She explains that the “poop” provides the warmth and moisture so sprouting can occur.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8: Hydra egestion. Marin shows students a diagram of a hydra to identify different parts. She refers to part of the hydra’s anatomy and makes a large Y with her arms and tips her head back. Students identify the mouth of the hydra. Marin tells students that they may sometimes see the mouth called the mouth/anus, but that it’s really not an anus because they don’t poo; they just spit out what they don’t digest.</td>
<td></td>
<td>Students are expected to list various anatomical structures of the hydra, remember the purpose of those anatomical structures, and summarize information from the teacher’s oral and graphic messages about the mouth/anus of the hydra. Listing and summarizing are both factual kinds of knowledge.</td>
</tr>
<tr>
<td>9: Hydra somersault. Marin tells students that the hydra can do somersaults in times of danger. She draws a cartoon of a hydra somersault. After the picture is complete she explains that hydra can’t do it from her to a student in the front row, but they can do it once. She describes the action as like a marathon for hydra or a slinky going down a stair.</td>
<td>N/A</td>
<td>Students are expected to list the purpose of a hydra somersault, remember how a hydra somersault looks, and summarize information from the teacher’s oral and graphic messages about how this action might be an important form of locomotion for the hydra. Listing and summarizing are both types of factual knowledge.</td>
</tr>
<tr>
<td>10: Phagocytosis. Marin explains that some of the hydras inside layer of cells are phagocytic. She reminds students that this process is like the video game Pac Man. She explains that some of the inner cells can actually engulf [makes eating hand motions] some of the food particles.</td>
<td>N/A</td>
<td>Students are expected to list the purpose of phagocytosis in a hydra, remember how the hydra performs phagocytosis, and summarize information from the teacher’s oral and graphic messages about how this hydra’s tentacles begin the process of obtaining nutrition. Listing and summarizing are both types of factual knowledge.</td>
</tr>
</tbody>
</table>
In summary, all of the scientific instructional humor used in Marin’s classroom was cognitive in nature. Four humorous events each involved factual knowledge or conceptual knowledge. Three humorous events involved procedural knowledge. Factual knowledge involves the basic elements students must know to be acquainted with a discipline or solve problems in it. Conceptual knowledge is an understanding of the interrelationships among the basic elements within a larger structure that enable them to function together. Procedural knowledge is an understanding of the criteria for determining when to follow appropriate steps. Only Event 2 was metacognitive in nature because students were expected to be able to recognize the appropriate use of scientific terminology.

**Marin’s Scientific Humor Through Morreall’s Lens**

According to Morreall (1987), individuals experiencing incongruity may become uneasy, feel of loss of control, be motivated to change the incongruous situation, or become amused. Marin, this case study’s biology teacher, intended to amuse her students and thereby cause them to remember and learn the content more easily. I propose that Marin shares five out of eight similarities with comedians and philosophers. Marin exhibited observable behaviors that can be quantified and qualitatively examined to determine how they assist students with their learning objectives. For example, science teachers themselves will perform critical thinking as well as encourage their students to do so.

Table 5 lists the eight similarities that Morreall (2009) proposed that comedians and philosophers share. Marin was found to share five of these characteristics: her scientific humor was conversational during seven humorous events, she reflected everyday experiences during one event, she asked questions of her students within her
scientific humor during three events, she searched out new perspectives during one humorous event, and she performed thought experiments during two events.

**Conversational.** Dialogue was the prominent instructional format in Marin’s classroom. She made statements about chemistry formulas in Event 1; discussed cell organelles and their correct pronunciations and spellings in Event 2; made observations about euglena and paramecium locomotion in Events 4 and 5; explained her drawing of the hydra somersault in Event 9; and both showed and described what would be observed during a hydra’s completing phagocytosis in Event 10. These are all forms of direct instruction intended to inform and interest students as well as to introduce topics that students will examine in more depth during laboratory and other independent activities.

**Reflects everyday experiences.** Marin’s reflections in humorous Event 7 relate to a typical event found in the wilderness, an animal’s defecation, which contains seeds that may grow into a tree. She related this to previously learned information about the ideal conditions for sprouting. These may be puzzling everyday experiences to students in this urban school district. This humorous instruction, while engaging, may address unarticulated questions from urban students who have learned about conditions for sprouting in the classroom and realize that it occurs in nature, but who have not actually had the occasion to view it because of the lack of proximity to wildlife.

**Asks questions.** Marin asked questions during her instructional humor in Event 1 when she inquired about the direction of the arrow and where in the formula one can find reactants and products. In Event 2, she inquired as to the correct pronunciation of the plural forms of nucleus and nucleolus because these two words differ from the usual rule of adding “s” or “es” to plural forms of the words. In Event 3 she asked students to predict what would happen to a plant without the structure of cell walls and humans
without the structure of skeletons. These questions, which may seem elementary, may be the impetus to students considering previous experiences with formulas, spellings, or understanding about tissues that provide structure and investigating or analyzing them further.

**Searches for new perspectives.** Marin introduced several absurd scenarios regarding fungi in Event 6. The cognitive shift occurred when students were asked to imagine a fungus eating, breathing, and excreting. Students were expected to be able classify fungi as heterotrophic and differentiate how other heterotrophs exchange gasses, obtain nutrition, and remove waste compared to how it is done in fungi. These cognitive shifts are done dually for the purpose of amusement and to assist in the engagement of students, as well as to encourage them to consider the varying ways different kingdoms of organisms carry out life processes.

**Thought experiments.** In Event 3, Marin asked students to consider ontological arguments about the nature of reality, perform thought experiments, or mentally manipulate possibilities. In Event 3, students were asked to predict what would happen to a plant without the structure of cell walls and humans without the structure of skeletons. Marin presented this scenario to students as a puzzling experience that might be investigated. Of course this scenario defies the nature of reality; one could consider this an ontological question about the nature of reality. Although not expressly elaborated by Marin, high school students are likely mature enough learners to realize the scenario presented of a plant or human without structure is outside the norm and was intended as a caricature in order to encourage students to consider the purpose of structures like the cell wall.
Table 5

*Shared Characteristics of Comedians and Marin*

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Event</th>
<th>Shared elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conversational</td>
<td>1, 2, 4, 5, 8, 9, 10</td>
<td>Observations are presented in a dialogue.</td>
</tr>
<tr>
<td>Reflect everyday experience</td>
<td>7</td>
<td>Reflections usually relate to puzzling everyday experiences.</td>
</tr>
<tr>
<td>Ask questions</td>
<td>1, 2, 3</td>
<td>Puzzling experiences generate problems to be investigated.</td>
</tr>
<tr>
<td>Explore questions in a detached manner</td>
<td>N/A</td>
<td>In comedy, philosophy, or scientific investigation, a matter is examined in a detached, objective manner.</td>
</tr>
<tr>
<td>Search out new perspectives</td>
<td>6</td>
<td>Cognitive shifts are embraced.</td>
</tr>
<tr>
<td>Be a critical thinker</td>
<td>N/A</td>
<td>Be honest. Reject rationalization and conformism. Are ideas clear, coherent, and credible. Look for confusion, fallacy, and incongruity.</td>
</tr>
<tr>
<td>Do not defer to authority or tradition</td>
<td>N/A</td>
<td>Oppose blind, unquestioning obedience. Nothing is sacred.</td>
</tr>
<tr>
<td>Perform thought experiments to mentally manipulate possibilities</td>
<td>3</td>
<td>Consider ontological arguments about the nature of reality.</td>
</tr>
</tbody>
</table>

In summary, Marin shares five characteristics with comedians: her scientific humor was conversational during eight humorous events, she reflected everyday experiences during one event, she asked questions of her students within her scientific humor during three events, she searched out new perspectives during one humorous event, and she performed thought experiments during two events. By far, dialogue was the prominent instructional format in Marin’s classroom and it is the first shared element between comedians and philosophers.

**Marin’s Scientific Humor Through Bauman’s Lens**

Predictable combinations of events, acts, genres, and roles and their interrelationships are near the center of ethnography of performance in varying cultures,
according to Bauman (1977). This framework has been borrowed for the purpose of determining the interrelationships among the enacting of humor events, how they are enacted, who is the main actor in each event, and the science genres involved. Each humorous event is displayed in Table 6. Scientific humor discourse events are described by how they are enacted (telling of an anecdote, showing a video, modeling a process, etc.) and the genre in which they occurred (fungi, microorganisms, biochemistry, etc.). Marin was the actor in each humorous event listed in Table 6.

Table 6

*Scientific Humor Discourse Framework*

<table>
<thead>
<tr>
<th>Event</th>
<th>Act</th>
<th>Genre</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Chemistry formulas</td>
<td>Arrow points to product; exaggerated sound</td>
<td>Biochemistry</td>
</tr>
<tr>
<td>2. Plural and singular</td>
<td>Nucleus and nucleolus; exaggerated sound</td>
<td>Cell structure and function</td>
</tr>
<tr>
<td>3. Cell walls</td>
<td>Plants without cell walls and people without skeletons; physical</td>
<td>Cell structure and function</td>
</tr>
<tr>
<td>4. Locomotion-paramecium</td>
<td>Physically modeling cilia</td>
<td>Microorganisms</td>
</tr>
<tr>
<td>5. Locomotion-euglena</td>
<td>Physically modeling flagellum</td>
<td>Microorganisms</td>
</tr>
<tr>
<td>6. Characteristics of fungi</td>
<td>Questioning students about fungi eating, breathing, and excreting; physical</td>
<td>Fungi</td>
</tr>
<tr>
<td>7. Ideal conditions for sprouting</td>
<td>Deer poop anecdote</td>
<td>Plant growth cycle</td>
</tr>
<tr>
<td>8. Hydra egestion</td>
<td>Physically modeling hydra</td>
<td>Microorganisms</td>
</tr>
<tr>
<td>9. Hydra somersault</td>
<td>Drawing</td>
<td>Microorganisms</td>
</tr>
<tr>
<td>10. Phagocytosis</td>
<td>Physically modeling Pac Man</td>
<td>Microorganisms</td>
</tr>
</tbody>
</table>

To summarize, using the frame of Bauman’s (1977) patterns of performance, it can be demonstrated that Marin is the primary actor her scientific humor; her humorous events were very often physical (as in Events 3, 4, 5, 8, and 10); sometimes an
exaggeration of words (as in Event 1 and Event 2), or a drawing (as in Event 9). In the cultural environment of Marin’s classroom, physical scientific content humor was frequently found. It was often done conversationally, with cognitive shifts, or in asking students to perform thought experiments, much as do comedians and philosophers (Morreall, 2009). Most frequently Marin’s humorous events occurred for the purpose of having students remember or understand the nature of a particular scientific idea.

**Analysis of Marin’s Instructional Artifacts**

A total of four artifacts collected from Marin included: the Event 1 formula for water, the Event 5 diagram of euglena, the Event 6 note sheets in Appendix K and the Event 8 hydra diagram. The artifacts were analyzed by three science education experts (the principal investigator in this study and two other certified New York State science teachers) using the framework recommended by McGreal et al. (1984). Each artifact was individually examined and considered within the lesson in which it was presented, the manner in which it was presented, and the class to whom it was presented. The artifacts were then scored according to whether they possessed or did not possess characteristics relating to content, design, and presentation. Those 20 characteristics are listed in Appendix J. All four of the artifacts had every characteristic listed in Appendix J with two exceptions: Marin did not have her own artifact evaluation plan for those teaching materials and the characteristic of audio quality is not applicable since none of the artifacts were recordings.

In summary, this framework, recommended by McGreal et al. (1984) offers a rubric for showing that all of Marin’s artifacts were valid and accurate, appropriate for learners, relevant, motivational, could be used in other situations, were clear and concise, were in an appropriate medium, were meaningful and appropriate, followed a logical
sequence, were aligned with the instructional strategy, were engaging, were presented with effective use of time and pace, aided in understanding, had a high visual quality, and were durable. Even though it is not necessary for artifacts to meet every criterion, according to McGreal et al. (1984), all of Marin’s artifacts met nearly every criterion on the framework. Marin’s humor achieved conformity among the type of artifact, the strategy used in the presentation, and the type of humor used: in Event 1 the formula for water was dialogically explained with humorous emphasis on the arrow; in Event 5 the diagram of the euglena was dialogically explained and the flagella’s movement was humorously acted out; in Event 6 note sheets related to characteristics of fungi were presented dialogically with humorous questioning techniques; and in Event 8 the hydra diagram was dialogically presented and humorously acted out. This conformity of purpose, to convey scientific content, ensures that Marin’s instructional artifacts are of high instructional quality and, as such, have a greater likelihood of conveying science concepts.

**Teacher Interview: Marin**

Marin’s use of scientific humor tended to call upon students to be able to list, summarize, and describe biology concepts. She typically used humor to introduce topics and suggested students consider new perspectives or ask themselves questions. This is evident in her remarks about the purpose of her scientific humor:

> The humor I use depends on the topic. I intend it to make it so it’s not so dry. But sometimes I do it during the reproduction unit to lighten the mood so they’re not so embarrassed. It’s pretty much always topic related, but some units are drier than others.

> For example, in the mitosis hand model that I had the kids do, they all made the sound effects . . . and also my comment about turning into a Martian . . . it’s not really higher order stuff because I’m just introducing a new topic. They’re applying what they already knew to understanding this new concept. This is teacher directed. The higher order activities come when they’re doing the labs and
other independent class assignments. Then they do more analyzing and evaluating.

Marin’s comments below indicated an awareness of how students are receiving her humor and a desire to make connections between material to be learned and students’ experiences. Humor is content driven, which is supported by survey and blog reporting. Marin’s statements indicated that she hoped to trigger student memory by making the connection between swimming and microorganism locomotion. Her thoughts about student perceptions follow:

I know that students are amused by my humor because usually you get giggles and laughs; sometimes you just get expressions. Though there are certainly also times I use humor and they don’t get it. That’s when I hear crickets.

Marin was aware that humor can take many different forms. She used laboratory activities where students have fun simply through excitement; she talked about processes in biology that students are amused by due to the “ick” factor; and she used physical humor to get students to make connections. She comments on these activities below:

Students demonstrate their understanding through fun labs . . . though the labs may not be fun-NY. Like today we had hydra-daphnia wars during lab. The kids were so excited because they had not seen them before. Sometimes it was gross--and then they started laughing. Kind of like when I make references to poo and they start laughing because it’s icky. It’s also like normal people talking instead of being so sterile. They also think its funny when you say poo.

Also, during class discussions, when I was showing the locomotion for the euglena and paramecium, I was trying to get them to understand how those organisms move because it was a new topic; I wanted to give them a new perspective on single-celled organisms. The goal was to get them to apply that understanding to swimming, which was why I was trying to make that connection. I had hoped it would be memorable for the students by just having a conversation about the organisms’ unique anatomy.

Asking students to analyze through the use of humor is a higher order type of knowledge on Bloom’s cognitive domain. Marin mentioned using lower order knowledge to introduce units. The type of scientific humor that is used may also be dependent on the
topic being discussed. Below, Marin references the lesson on fungal life processes and her intent with regard to the scientific humor in assessment:

When I was talking about mushrooms and mold not “breathing” I was certainly trying to get them to understand how those organisms use the process of diffusion to take in oxygen. Also, I believe students needed to analyze whether those organisms have difficulty “breathing” in humid weather or in a closed bag. I’m asking them to ask themselves questions. Again, this is also offering them new perspectives because this is probably not something they think about on their own . . . bread mold suffocating in the bread bag. I believe classroom discussions like that is one form of assessment. Other, more independent forms are homework and tests, where their content knowledge is assessed, but I don’t question them with humor on those.

Here again, Marin wants to make humor meaningful. Her choices of what to include is content driven whether it is something she has done in class before or she is reacting to an unusual student request. She has a clear vision about how she decides what humor to include in class and what scientific humor is. See her comments below:

A lot of what I do is off the cuff, but I’ve been teaching for almost 20 years . . . the same subjects . . . I know what gets a laugh. I sometimes do something new if a student asks a different question and I’m trying to make it meaningful . . . it might just come out funny.

Although I generally say humorous things, I do sometimes see cartoons. I have one of a retrovirus . . . with an afro. Today I showed the hydra eating the daphnia video and I made the swallowing sound. That was the first time I did that.

“Just joking is where I tease the kids maybe even not related to class. But scientific humor is like a scientific play on words or puns.”

In summary, Marin’s use of scientific humor tended to call upon students to be able to list, summarize, and describe biology concepts. She typically used humor to introduce topics and mentioned using lower order knowledge to do so. Marin often suggested students consider new perspectives or ask themselves questions. Her comments indicated an awareness of how students are receiving her humor and a desire to make connections between material to be learned and students’ experiences. Her choices of
what to include is content driven whether it is something she has done in class before or
she is reacting to an unusual student request.

**Marin’s Students’ Perceptions of her Instructional Humor**

Marin’s students knew when she was trying to be funny. They recognized that it
was content related and it was intended to make the material more meaningful, although
some students may have been distracted. Student work products also indicated that
Marin’s humor was related to content and that most students were able to respond
correctly to content-specific questions.

Interviewed students were able to independently remember Marin’s humorous
attempts. They related it to topics they were learning or had learned. Several statements
below indicate the varied humorous attempts exhibited in class:

It was funny when she was pretending to be the cilia and the flagellum and
waving her arms around. On today’s test . . . cilia and flagellum were in the
choices. Every time I see those words I picture her doing that.

“Marin joked about seeds in the deer poop. That was funny. It related to seed
germination and spreading and stuff.”

When asked, some students spoke of Marin’s humor helping them to remember
while studying. They discussed their awareness of importance of learning the material
that was the source of the humor. One student expressed confusion with the humor.
Student perceptions follow:

“I remember when Marin raised her arms to teach us about the mouth of the
hydra. I remembered it when I was studying for the midterm.”

“Marin’s intent with humor is not just to be like . . . hey, you should pay attention
to this, but also I also believe it helps people remember.”

I realize the teacher is trying to relate her humor to science because she’s not off-
topic funny. Other people might find it helpful. But I have selective memory. Plus, when someone tells a joke to me, I totally focus on the joke and forget everything else about it.

Most of the students who were interviewed found Marin’s humor amusing and helpful to their learning. Techniques besides humor should be employed for students who are not as receptive to humorous comments. Student’s reactions to Marin’s humor follow:

“I can always identify when Marin uses humor. Most of the time it’s amusing.”

Marin’s humor makes me smile and helps me to remember. She uses physical and verbal humor . . . I shake my head sometimes with some of the things she does. There’s never a time when I’m not at least mildly amused. Without the humor I might not remember or have understood it as easily because it would have been just droning on.

Since many students identified the humor used, we can presume that it was attention getting and memorable. Students may also have realized differing techniques between verbal and physical humor. Not all students may appreciate the value of the scientific nature of the instructional humor, however. As with all instruction, a variety of techniques should be used. Comments below indicated students’ perceptions about the relationship between Marin’s humor and scientific content:

It stuck with me when Marin talked about the hydra doing the somersault. There was a homework question about it. Some of her humor is funnier than others but it’s always content related. Sometimes I laugh and the whole class will laugh.

Marin’s humor helps me understand the topics better on labs and tests. Although not hilarious . . . the things she says make me giggle. Sometimes I don’t even realize that its content related, but it is.

Some students referred to homework, labs, and tests that they felt they did better on as a result of Marin's use of humorous references. Although not all humor may strike students as extremely funny, many acknowledge it as a memory aid, which is a type of knowledge in Bloom’s cognitive domain. Student comments about their perceptions about humor and learning can be found below:
I remember the kingdom, phylum, class, order, genus, species acronym: Kingston police come over for gun shots. I had to use that on homework questions. We had to take circles and put them inside as to what group was bigger. I feel the humor helped me learn that material.

“I did find the phagocytosis explanation with Pac Man helpful. I didn’t find it funny, though.”

In summary, Marin’s students recognized that her humor was content related and it was intended to make the material more meaningful, although to some students it may have been distracting. Most students who were interviewed found Marin’s humor amusing and helpful to their learning. Other techniques besides scientific humor should be employed for students who are not as receptive to humorous comments. Some students referred to homework, labs, and tests that they felt they did better on as a result of Marin's use of humorous references. Although not all humor may strike students as extremely funny, many acknowledge it as a memory aid, which is a type of knowledge in Bloom’s cognitive domain.

As can be seen in Table 7, there is agreement between Marin and at least one other data source in the six areas. This evidence indicates that Marin does employ humor toward instructional objectives. At least three out of four students interviewed found her humor amusing and believe it helped their learning.
<table>
<thead>
<tr>
<th>Focus</th>
<th>Marin’s words</th>
<th>Data from surveys, observations, artifacts, and interviews</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purpose</td>
<td>Depends on the topic</td>
<td>All humor observed related to scientific topics</td>
</tr>
<tr>
<td></td>
<td>Intend it to make it so it’s not so dry</td>
<td>Some humor had sound effects</td>
</tr>
<tr>
<td></td>
<td>To lighten the mood</td>
<td>Much humor used was physical</td>
</tr>
<tr>
<td></td>
<td>Topic related; sound effects</td>
<td>Generally to aid memory and understanding</td>
</tr>
<tr>
<td></td>
<td>Not really higher order stuff</td>
<td>Teacher directed</td>
</tr>
<tr>
<td></td>
<td>Introducing a new topic</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Teacher directed</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Higher order activities: labs, assignments</td>
<td></td>
</tr>
<tr>
<td>Student</td>
<td>Get giggles and laughs; expressions</td>
<td>Three out of four students found Marin amusing with content-related humor</td>
</tr>
<tr>
<td>perception</td>
<td>Times I use humor and they don’t get it</td>
<td></td>
</tr>
<tr>
<td>Student</td>
<td>Fun labs; labs may not be fun-NY</td>
<td>Three out of four students were able to name a specific example of content humor used in class and tell what they learned from it (phagocytosis, a taxonomy acronym, and the plural/singular reference to nucleus)</td>
</tr>
<tr>
<td>demonstration</td>
<td>Hydra-daphnia wars; exciting/ gross</td>
<td></td>
</tr>
<tr>
<td>of learning</td>
<td>References to poo: it’s icky</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Normal people talking; conversations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Gives new perspectives</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Make connections; memorable</td>
<td></td>
</tr>
<tr>
<td>Humor in</td>
<td>Students needed to analyze whether those organisms have difficulty</td>
<td>Every laboratory artifact collected had content questions directly related to the humorous events from class discussions</td>
</tr>
<tr>
<td>assessment</td>
<td>&quot;breathing&quot; in humid weather or in a closed bag</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I’m asking them to ask themselves questions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>New perspectives, probably not something they think about on their own; bread mold suffocating in the bread bag</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Classroom discussions, one form of assessment</td>
<td></td>
</tr>
<tr>
<td></td>
<td>More independent forms are homework and tests where their content knowledge is assessed, but I don’t question them with humor on those</td>
<td></td>
</tr>
</tbody>
</table>
Table 7 (continued)

<table>
<thead>
<tr>
<th>Focus</th>
<th>Marin’s words</th>
<th>Data from surveys, observations, artifacts, and interviews</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deciding what humor to use in class</td>
<td>Off the cuff</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Teaching almost 20 years</td>
<td></td>
</tr>
<tr>
<td></td>
<td>I know what gets a laugh</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sometimes cartoons</td>
<td></td>
</tr>
<tr>
<td>Joking versus scientific humor</td>
<td>Joking is not related to class</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Scientific humor can be a scientific pun</td>
<td></td>
</tr>
</tbody>
</table>

**Work Samples from Marin’s Students**

Marin provided access to several student laboratory write-ups completed as a requirement to sit for the New York State Living Environment Regents. The following photographs are examples of student responses to lab questions that are related to topics that Marin humorously addressed in class.

Students in Marin’s class completed a lab related to microorganism life maintenance. In Figure 9, one student has drawn the labeled organisms as paramecium, amoeba, and euglena and has identified the various anatomical features of each. The anatomical features that the student has labeled are the same that Marin humorously referred to in class. The cilia and flagellum for locomotion were demonstrated by a swimming motion and the pseudopods were discussed along with ingestion and compared to the video game Pac Man. The student’s ability to correctly label the anatomical structures of the microorganisms that were discussed is indicative of factual knowledge within Bloom’s cognitive domain.
Figure 9. Marin’s student work product: Microorganism anatomy.

Figure 10 contains a table that students completed where they needed to identify various organisms’ means of nutrition, structures used for ingestion or to make food, and structures used for locomotion. Students listed structures such as cilia and flagellum, as well as the term phagocytosis as a means of ingestion, which Marin made humorous reference to in an earlier class. Students’ ability to classify the correct means of nutrition and structures for locomotion is indicative of factual knowledge within Bloom’s cognitive domain.
Figure 10. Marin’s student work product: Microorganism nutrition and locomotion.

Students in Marin’s class completed a lab related to the hydra. In Figure 11, one student has filled in several blanks related to the hydra’s digestive structures and tentacles, both of which Marin made humorous reference to in an earlier class. Students’ ability to interpret the opening of the hollow sac as the hydra’s mouth and understand that the stinging tentacles help the hydra obtain food is indicative of factual knowledge in Bloom’s cognitive dimension.

Figure 11. Marin’s student work product: Hydra lab.
Marin referred to the video game Pac Man when discussing phagocytosis with the class. Figure 12 is an example of a question related to this form of active transport. Figure 12 also shows a question about reproduction among amoebas, which is related to the humorous modeling process Marin demonstrated with her students. Students’ ability to respond to these two lab questions is indicative of their ability to list and describe two types of knowledge in Bloom’s cognitive domain.

![Figure 12. Marin’s student work product: Phagocytosis.](image)

In summary, Marin’s student work products offered several examples of knowledge as described in Bloom’s cognitive domain. Figure 11 depicted the anatomical features of a paramecium, amoeba, and euglena which a student has correctly labeled; Figure 12 depicted a student’s classification of the correct means of nutrition and structures for locomotion; Figure 13 depicts various digestive structures related to the hydra that a student has interpreted and understood the nature of. Figures 11, 12, and 13 are all indicative of factual knowledge within Bloom’s cognitive domain. Figure 14 relates to both active transport and reproduction among amoebas whereby students need to both list and describe. Listing and describing are two types of knowledge within Bloom’s cognitive domain.

As can be seen in Table 8, in several instances students remembered classroom humor employed by Marin related to means of locomotion for various microorganisms.
All of the student work products in this report relate to microorganisms, as Marin was teaching that unit for a large portion of the data collection period of this study. One student did mention a phagocytosis reference, which was also a content question in the student work sample depicted in Figure 13; however, the student did not find the Pac Man reference to be amusing. The collection of additional student work samples was limited by the time available, as well as the coordination of teacher schedules to allow such collection to occur.

Table 8

*Comparison of Student Interview and Work Products for Marin*

<table>
<thead>
<tr>
<th>Interview event</th>
<th>In the student’s words</th>
<th>Student work products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student identified humorous</td>
<td>S1- Remembered cilia and the flagellum from class humor and used knowledge for test questions.</td>
<td>Figure 17 Microorganism Anatomy: Students completed a lab related to microorganism life maintenance where they drew the labeled organisms paramecium, amoeba, and euglena and identified the various anatomical features of each.</td>
</tr>
<tr>
<td>attempts</td>
<td>S2-Remembered about seeds in deer poop and that it related to seed germination.</td>
<td>Figure 18 Microorganism Nutrition and Locomotion: Students completed a table where they needed to identify various organisms’ means of nutrition, structures used for ingestion or to make food, and structures used for locomotion. Students listed structures such as cilia and flagellum.</td>
</tr>
<tr>
<td></td>
<td>S4- Test used the words pinched off like when Teacher M used her hands to show us about mitosis…cell division.</td>
<td>No work products relevant to seed germination or mitosis were collected.</td>
</tr>
</tbody>
</table>
### Table 8 (continued)

<table>
<thead>
<tr>
<th>Interview event</th>
<th>In the student’s words</th>
<th>Student work products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students’ perception of Marin’s purpose</td>
<td></td>
<td>S1-I remember when Marin raised her arms to teach us about the mouth of the hydra when I was studying for the midterm.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S2- Marin’s humor helps people remember.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S3- When Marin was talking about the part of the plant that holds it up… and she compared it to human bones and without them we would be a big pile of meat on the floor… I totally focused on that. I thought she was talking about those tubes where the water and the food get into the plant… Science is a very hard subject to be humorous about.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S4- Marin breaks up the topics she’s talking about with a little bit of sarcastic humor to keep our attention.</td>
</tr>
<tr>
<td>Student’s reaction to Marin’s humor</td>
<td></td>
<td>S1- I can always identify when Marin uses humor. Most of the time it’s amusing.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S2- I smile about how she jokes around but nothing makes me really laugh.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S3- When I notice I think—Oh! You just tried to make a joke. But I don’t see it as to help me remember something… it’s just, like, oh… you’re being funny: LOL. I’m barely awake in that class anyway because its third period and I just ran out of coffee. Time of day definitely has an impact.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S4- Marin’s humor makes me smile and helps me to remember. She uses physical and verbal humor… Without the humor I might not remember or have understood it as easily because it would have been just droning on.</td>
</tr>
</tbody>
</table>

Although work products relevant to the hydra were collected, the print quality was not sufficient to include in this report.

No work products related to cell walls were collected.
Table 8 (continued)

<table>
<thead>
<tr>
<th>Interview event</th>
<th>In the student’s words</th>
<th>Student work products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students’ perception of relationship</td>
<td>S1- It stuck with me when Marin talked about the hydra doing the somersault. There was a homework question about it. Some of her humor is funnier than others but it’s always content related.</td>
<td>Figure 19 Hydra Lab: Hydra’s digestive structures and tentacles. Lab also contained information about escaping from predators.</td>
</tr>
<tr>
<td>between Marin’s humor and scientific</td>
<td>S2- I don’t feel like the humor that Marin uses helps me to apply or create anything in a lab as much as remember the content like—oh yeah this is the cilia that she did with her arms that one day.</td>
<td>Figure 18 Microorganism Nutrition and Locomotion: Students completed a table where they needed to identify various organisms’ means of nutrition, structures used for ingestion or to make food, and structures used for locomotion. Students listed structures such as cilia and flagellum.</td>
</tr>
<tr>
<td>content</td>
<td>S3- I remember Marin waved her arms and showed us cilia and I remember the paramecium has cilia but I don’t get what the humor was helpful for as far as content.</td>
<td>No work products related to taxonomy were collected.</td>
</tr>
<tr>
<td>Students’ perceptions about</td>
<td>S4- Marin’s humor helps me understand topics better on labs and tests. Sometimes I don’t realize that its content related, but it is.</td>
<td>No work products related to the nucleus were collected.</td>
</tr>
<tr>
<td>humor and learning</td>
<td>S1- I remember the kingdom, phylum, class, order, genus, species acronym: Kingston police come over for gun shots. I had to use that on homework questions.</td>
<td>Figure 20: Phagocytosis. A question related to this form of active transport and a question about reproduction among amoebas.</td>
</tr>
<tr>
<td></td>
<td>S2- I remember when she said nucleoliseseses and nucleoluseses to show us the singular and plural forms of those and also when she was talking about the plant cell wall and compared that to human bones and without them we’d be a big pile of cells on the floor—plop.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>S3- I did find the phagocytosis explanation with Pac Man helpful. I didn’t find it funny, though.</td>
<td></td>
</tr>
</tbody>
</table>

In summary, Marin’s humor is topic related, sometimes employs sound effects, is teacher directed, is found to be amusing by most students, learning connections can be made from the humor by most students, and content knowledge is assessed on independent work. This evidence indicates that Marin does employ humor toward
instructional objectives and at least three out of four students interviewed found her humor amusing and believe it helped their learning. All of the student work products in this report relate to microorganisms, as Marin was teaching that unit for a large portion of the data collection period of this study.
Chapter VI

Teacher Ned: Results

In the first part of this chapter, I will present Ned’s classroom observations, his instructional artifacts, and his interview, which will address the guiding research question, “How do teachers use humor in order to explain scientific concepts?” The secondary research question “How do students perceive their teachers' use of scientific instructional humor?” constitutes the “reception side” of humor and was addressed through student interviews and a collection of student work products. Ned’s students, along with their work products, will also be presented and analyzed later in this chapter.

Ned is a 27-year veteran teacher. He has been teaching in this urban high school setting for his entire career. His daily schedule includes two sections of advanced placement biology and a section of Grade 10 honors biology, and he also serves as the science department lead teacher. Ned was observed 10 times during his 9:30 am class. Class periods are 40 minutes in duration. Although students in Ned’s honors biology class will take the Living Environment Regents in June 2014 as a culminating exam, they are also encouraged to take the more rigorous subject area test of the Scholastic Aptitude Test intended for students who plan to pursue further college study. Students who take honors classes earn greater weighted credits toward their high school diploma to reflect the more stringent requirements of the course.

The frameworks used in analyzing the cognitive aspects of Ned’s instruction, Ned’s comedic presentation style, the performance patterns and genres Ned displayed, as well as the rubric for analyzing his various instructional materials will be instructive as tools for presenting the “production side” of Ned’s scientific humor. Ned’s scientific humor production was accomplished by the building of rapport with students and in
making associations between everyday occurrences and scientific content. The largest and most instructive data sources demonstrating this were Ned’s humorous events and the instructional artifacts he used in the act of performing scientific humor. All of the humorous events were within the cognitive domain; descriptions of those can be found below in Table 9.

Table 9

*Analysis of Ned’s Cognitive Humorous Events Using Bloom’s Taxonomy*

<table>
<thead>
<tr>
<th>Humorous event</th>
<th>Bloom’s cognitive knowledge dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>1: Black light.</td>
<td>Students are expected to describe why only certain colors are visible under a black light. Students are expected to interpret what colors will be absorbed and what colors will be reflected based on the wavelength of light an object is exposed to. Describing and interpreting are conceptual types of knowledge.</td>
</tr>
<tr>
<td></td>
<td>Students are expected to describe why grow lights for plants would cause greater plant growth than regular ultraviolet lights. Students are expected to interpret why green is reflected from plant leaves. Describing and interpreting are conceptual types of knowledge.</td>
</tr>
<tr>
<td>2: Grow lights.</td>
<td>Students are expected to describe why grow lights for plants would cause greater plant growth than regular ultraviolet lights. Students are expected to interpret why green is reflected from plant leaves. Describing and interpreting are conceptual types of knowledge.</td>
</tr>
</tbody>
</table>

Ned explains that the classroom lights are producing the spectrum of the different colors of light. He tells students that if there was only black light their clothes would look completely different. He asks them if they’ve ever gone to a night club and he makes the sound of electronic music and starts dancing. He says that most times everything looks black and the reason why the only colors of is light those articles of clothing are being exposed to is violet and ultraviolet, and unless they can reflect those back, then they’ll look black.

Ned tells students that one of his college suitmates had a “grow station” in the upper shelf of his closet. He explained that his suitemate bought black lights because he’d learned that those lights worked best. The reason, Ned said, is plants use that wavelength of light more effectively for photosynthesis.
Table 9 (continued)

<table>
<thead>
<tr>
<th>Humorous event</th>
<th>Bloom’s cognitive knowledge dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>3: Chitin.</td>
<td>Students are expected to be able to list the common places to find chitin and cellulose. Students are expected to be able to classify what sort of organic molecule cellulose is made from. Listing and classifying are both factual kinds of knowledge.</td>
</tr>
<tr>
<td>Ned discusses the polysaccharides cellulose and chitin with students. He asks them if they know where both are found. He describes a scenario where they are sitting at Red Lobster The lobster is brought out and they crack open the shell. He says the shell is made of chitin. He further explains that chitin is the stuff that makes up exoskeletons of bugs and crayfish. It goes crunch. He adds that he learned yesterday that Skittles are crunchy on the outside because they coat them in chitin. He says that he’s not sure what arthropods provide the chitin and instead of saying Skittles, taste the rainbow, you could say, Skittles, taste the ants.</td>
<td></td>
</tr>
<tr>
<td>4: Lipids.*</td>
<td>Students are expected to be able to rank an organic molecule as belonging to the family of lipids. Ranking is a type of factual knowledge.</td>
</tr>
<tr>
<td>Ned asks students what class of organic compounds does earwax belong to. He reminds them that they learned the major classes of organic compounds: carbohydrates, proteins, lipids, and nucleic acids. He told students the way you can tell if you’re dealing with a lipid: you try to mix it with water and it doesn’t—lipid.</td>
<td></td>
</tr>
<tr>
<td>5: The chemical components of processed foods.</td>
<td>Students are expected to be able to describe the Food and Drug Administration’s (FDA’s) policy with regard to nonfood parts found in food products. Describing FDA policies is a kind of conceptual knowledge.</td>
</tr>
<tr>
<td>Ned tells students that the food and drug administration has established legal maximum percentages of foreign animal parts allowed in food products and points out that the percentage isn’t zero. He explains that if a rat falls into a machine making frozen pizzas, that’s an acceptable amount. He uses a number of examples of odd ingredients that had been mentioned in class that might be added to foods to give them a particular color, texture, or flavor. He tells students that they’ve all eaten seaweed because seaweed extract is in ice cream and toothpaste.</td>
<td></td>
</tr>
<tr>
<td>Humorous event</td>
<td>Bloom’s cognitive knowledge dimension</td>
</tr>
<tr>
<td>----------------</td>
<td>----------------------------------------</td>
</tr>
<tr>
<td>6: Carbon dating.</td>
<td>Students are expected to be able to describe what carbon dating is used for. Describing is a conceptual type of knowledge.</td>
</tr>
<tr>
<td>Ned tells the students that the most natural form of change in the nucleus is called decay. He tells students that carbon 14 is naturally breaking down all the time into carbon 12. He reminds them that scientists have been able to use this for dating organic items like ancient pieces of cloth made out of cotton. He quipped that carbon dating is not when you go out with a carbon atom.</td>
<td></td>
</tr>
<tr>
<td>7: Shroud of Turin.</td>
<td>Students are expected to be able to describe what the Shroud of Turin has to do with carbon dating. The ability to describe is a type of conceptual knowledge.</td>
</tr>
<tr>
<td>Ned explains that how much carbon 14 compared to how much carbon 12 is in an organic object will determine how old it is. He tells students that Shroud of Turin is a piece of cloth that has an image on it that some people believe is of Jesus. They further believe that the shroud was his burial cloth. Ned explains that, if that were true, carbon dating should indicate that it is approximately 2000 years old. He tells students that carbon dating has been done on it and it’s about 600 years old.</td>
<td></td>
</tr>
<tr>
<td>8: Alcoholic fermentation.</td>
<td>Students are expected to list what the products are of alcoholic fermentation are. Listing is a factual type of knowledge.</td>
</tr>
<tr>
<td>Ned asks students if human beings ever perform ethyl alcoholic fermentation. He tells them that humans don’t but yeast does. He explains that yeast is a fungus that’s used in the baking and alcoholic beverage industry. He continues that yeast produces carbon dioxide that makes bread rise. While it does this, it also produces ethyl alcohol, which can be smelled before the bread goes in the oven. Ned kids one of the students by saying that it smells like Diggy on a Saturday morning. The student chimes back, “Sundays too.” Ned finishes up by saying that the alcohol burns off in the oven but the holes that are in the bread are the carbon dioxide bubbles that were produced by the yeast.</td>
<td></td>
</tr>
</tbody>
</table>
Table 9 (continued)

<table>
<thead>
<tr>
<th>Humorous event</th>
<th>Bloom’s cognitive knowledge dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>9: Discussing the biological significance of enzymes.</td>
<td>Students are expected to be able to compose a written text that describes the biological significance of enzymes. Composing is higher level type of procedural knowledge in which students actually create new information.</td>
</tr>
<tr>
<td>Ned explains to students how to properly complete the discussion section of a lab investigation. He tells them that most students just restate their results. He says they need to explain why the results turned out the way they did. He said that they needed to tell how enzymes work: by binding to substrates and lowering the energy of activation. They had to include that the enzyme binds with the substrate and the more enzymes that are around, the more substrates they can bind with. He elaborates by saying that the most important part of the discussion was the biological significance. He uses the example of a poor student model sentence: “Enzymes are found in lots of living organisms and are very important in everything that they do.” He asks if that sentence is a good explanation of the importance of enzymes. Students agree that it is not. Ned says that if he were an enzyme, he’d be insulted. To summarize the biological significance in two sentences is an insult to enzymes.</td>
<td></td>
</tr>
<tr>
<td>10: Fats as a source of energy.</td>
<td>Students are expected to list the organic molecule that is most easily used by the body as a source of energy. The ability to list molecules and their purposes is a type of factual knowledge.</td>
</tr>
<tr>
<td>Ned explains that any nutrient molecule can be broken down as a source of energy and that some provide more energy than others. Fats have huge amounts of energy in them compared to sugars; however, you need a lot more oxygen to break them down. Unfortunately, fats are not your body’s first choice for breaking down nutrient energy. He laments that if it was, all those doctors that make money doing cosmetic liposuction wouldn’t be needed. He jokingly tells students to: make a cut; get the vacuum cleaner; throw it on high. Then he makes body movements of fat being sucked out of his body. Students laugh.</td>
<td></td>
</tr>
</tbody>
</table>
11: Anaerobic Respiration Net 2 ATP*

Ned makes up a story about a student in the class: Erica is walking to school and some kid goes, “Psst! I’ll sell you this bag of 4 candy bars for 2 bucks. You can pretend you’re doing some fund-raising thing and make money!” Now Erica thinks to herself, “I can sell them for a buck apiece- Okay!” She takes the 2 bucks out and gives it to the kid. She goes to school and sells the candy for a dollar each. She made 2 dollars! Right? Ned shows students the glycolysis diagram illustrated by the story. A student asks: “Why would you do that work just for 2 dollars?” Ned responds that this is just glycolysis. By the time we go through the Krebs cycle and the electron transport chain our net gain of ATP is going to be 36. Now let’s say this- some kid goes “Hey, I got a bag of 38 candy bars. I’ll sell you the whole bag for just 2 bucks.” Now she takes it, goes in and sells all 38 candy bars. She takes in 38 dollars, but she spent 2 dollars to get them, so her net gain is 36. That’s a little more worth it, yes? Students agree that it is.

12: Electron transport chain*

Ned leads Students in a role playing activity where they are transporting electrons (balls) through an electron transport chain. Students are expected to be able to actualize how the electron transport chain works and demonstrate it to others, as well as to re-create a model of the activity. By actualizing the process involved in transporting electrons in order to make ATP, students create new information. This is a type of metacognitive knowledge.

Note. See Appendix L for Ned’s Note Sheet Artifact used while teaching about Lipids; see Appendix M for Ned’s Note Sheet Artifact used while teaching Anaerobic Respiration; see Appendix N for Ned’s Note Sheet Artifact used while teaching Electron Transport Chain.

In summary, all of the scientific instructional humor used in Ned’s classroom was cognitive in nature. Four of Ned’s humorous events involved factual knowledge: students needed to be able to list and classify information about chitin and cellulose; they were expected to rank organic molecules as belonging to the family of lipids; they were...
to list the products of alcoholic fermentation, as well as the organic molecule most easily used as a source of energy. Six of Ned’s humorous events involved conceptual knowledge: students were to describe the colors visible under black light and interpret color absorption and reflection; they needed to describe why plant grow lights cause greater photosynthesis than ultraviolet lights and interpret why green is reflected from plant leaves; students were expected to describe FDA policies, what carbon dating is used for, and how that relates to the Shroud of Turin; students were expected to explain the differences between anaerobic and aerobic respiration. One of Ned’s humorous events involved procedural knowledge: students were expected to compose a written text describing the significance of enzymes. One of Ned’s humorous events involved metacognitive knowledge: students were expected to actualize the process involved in transporting electrons in order to make ATP.

**Ned’s Scientific Humor Through Morreall’s Lens**

Ned, this case study’s biology teacher, intended for his students to become amused by the incongruity they experience as a result of his scientific humor, and thereby remember and learn the content more easily. Ned exhibited observable behaviors that can be quantified and qualitatively examined to determine how they assist students with their learning objectives. For example, science teachers use critical thinking and encourage their students to do so, as well. Table 10 lists the eight similarities that Morreall (2009) proposed that comedians and philosophers share.

Ned was found to share five of these characteristics: his scientific humor was conversational during seven humorous events, he reflected everyday experiences during three events, he asked questions of his students within his scientific humor during one event, he encouraged students to use critical thinking during one humorous event, and he
did not defer to authority or tradition during two events. An analysis of each follows.

Table 10

*Shared Characteristics of Comedians and Ned*

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Teacher Ned’s events</th>
<th>Shared elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Are conversational</td>
<td>1, 6, 7, 8, 10, 11, 12</td>
<td>Observations are presented in a dialogue.</td>
</tr>
<tr>
<td>Reflect everyday experience</td>
<td>1, 3, 4</td>
<td>Reflections usually relate to puzzling everyday experiences.</td>
</tr>
<tr>
<td>Ask questions</td>
<td>1</td>
<td>Puzzling experiences generate problems to be investigated</td>
</tr>
<tr>
<td>Explore questions in a detached manner</td>
<td>N/A</td>
<td>In comedy, philosophy, or scientific investigation a matter is examined in a detached, objective manner.</td>
</tr>
<tr>
<td>Search out new perspectives</td>
<td></td>
<td>Cognitive shifts are embraced.</td>
</tr>
<tr>
<td>Be a critical thinker</td>
<td>9</td>
<td>Be honest. Reject rationalization &amp; conformism. Are ideas clear, coherent, and credible? Look for confusion, fallacy and incongruity.</td>
</tr>
<tr>
<td>Do not defer to authority or tradition</td>
<td>2, 5</td>
<td>Oppose blind, unquestioning obedience. Nothing is sacred.</td>
</tr>
<tr>
<td>Perform “thought experiments” to mentally manipulate possibilities</td>
<td>N/A</td>
<td>Consider ontological arguments about the nature of reality.</td>
</tr>
</tbody>
</table>

**Conversational.** Dialogue was a prominent instructional format in Ned’s classroom. He made statements about black lights in clubs and the spectrum of light in Event 1, discussed carbon dating of organic materials in Event 6, talked about the scientific evidence associated with the age of the Shroud of Turin in Event 7, presented information to students about the alcoholic fermentation of yeast in the making of bread in Event 8, explained that fats are a large source of nutritive energy that the human body cannot harness without adequate amounts of oxygen in Event 10, Ned made up an amusing story to improve student understanding of anaerobic respiration of ATP in Event
11, and in Event 12, he led a role play in which students acted out the electron transport chain. All of these humorous events occurred during periods of direct instruction, classroom discussions, or student and teacher interactive activities that were dialogic in nature.

**Reflects everyday experiences.** Ned’s humorous Event 1 was a reflection of everyday experiences because most students had been at a club, party, or roller-rink with a black light and seen the effects of the lack of color in their clothes and other surfaces. Many students had also been to Red Lobster or had other experiences with shell fish as described in Event 3. They could imagine the cracking of the shells of arthropods and now knew that was the sound of the polysaccharide chitin. Similarly, students were familiar with the inability to mix oil or lipid with water, as discussed in Event 4, if they had ever washed dishes, cooked, or noticed oil sit on top of a watery broth in soup or other food. Students in this honors biology class were more likely than some students in Marin’s regents’ biology to have had these experiences due to differences in their family’s’ socioeconomic status.

**Asks questions.** Certainly students had encountered black lights before, as described in Event 1. Ned’s question about why clothing and other surfaces appear different under that type of light generated a problem that the class verbally investigated through their prior scientific experiences with the light spectrum. The puzzling experience was one that students had all encountered at various times in their lives, but they may not have known the reason for the phenomenon before Ned asked the question and called attention to its relevance to the topic they were studying: photosynthesis. Students were informed that plants perform the process of photosynthesis better within certain wavelengths of the light spectrum.
**Uses critical thinking.** In Event 9, Ned asked students to explain the significance of enzymes in their own words. They were encouraged to ask themselves if ideas were clear and credible; and they were prompted to look for confusion, fallacy, and incongruity. Ned led students in a discussion about how to make their writing coherent and thorough. He asked very specific, pointed questions about the functions of enzymes in class so that students’ future writing would be complete in explaining the importance of biological catalysts to the functioning of living organisms.

**Does not defer to authority or tradition.** In Event 2, Ned referred to grow lights in a college student’s closet, and the high school students listening to this anecdote correctly assumed that the lights were necessary for the purpose of growing marijuana, a substance whose illegality is controversial. Both philosophers and comedians demonstrate that nothing is sacred; through this anecdote Ned taught his students to oppose blind, unquestioning obedience (Morreall, 2009). In Event 5, Ned referred to a governmental body instituting a questionable policy, namely allowing non-food items in foods. He ridiculed the policy and, in this way, taught students to oppose blind, unquestioning obedience and that nothing is sacred (Morreall, 2009).

In summary, Ned shares five characteristics with comedians: his scientific humor was conversational during seven humorous events, he reflected everyday experiences during three events, he asked questions of his students within his scientific humor during one event, he encouraged critical thinking during one humorous event, and he did not defer to authority or tradition during two events. By far, dialogue was the prominent instructional format in Ned’s classroom and it is the first shared element between comedians and philosophers.
Ned’s Scientific Humor Through Bauman’s Lens

Each humorous event, act, and genre is displayed in Table 11. Scientific humor discourse events are described by how they are enacted (telling of an anecdote, showing a video, modeling a process, etc.) and the genre in which they occur (photosynthesis, cellular respiration, biochemistry, etc.). Ned was the actor in Events 1 through 7 and Events 10 and 11. In Event 8 he and one student were the actors; In Events 9 and 12 Ned along with the entire class were actors in the use of scientific humor.

Overall, Ned was the primary actor in his scientific humor; his humorous events were very often verbal, specifically quips or sarcastic remarks, anecdotes, or ridiculous or outrageous scenarios (as in Events 2, 3, 4, 5, 6, 7, 8, and 11) or, as in Event 12, when he playfully chided the class. Sometimes his humorous events involved sounds or physical movements (as in Event 1 and Event 10), or having students role play (as in Event 12). In the cultural environment of Ned’s classroom, verbal scientific content humor was frequently found. It was often done conversationally, very typically reflected everyday experiences, involved students in asking questions and critical thinking, and sometimes poked fun at authority by not shying away from topics such as government regulation of food production or cultivating marijuana (Morreall, 2009). Ned’s humorous events occurred for the purpose of having students make connections between the particular scientific concept to be learned and past experiences and other prior knowledge.
Table 11

**Scientific Humor Discourse Framework**

<table>
<thead>
<tr>
<th>Event</th>
<th>Act</th>
<th>Genre</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Black light</td>
<td>Making sound of club music and dancing</td>
<td>Photosynthesis</td>
</tr>
<tr>
<td>2. Grow lights</td>
<td>Anecdote of college-mate growing marijuana</td>
<td>Photosynthesis</td>
</tr>
<tr>
<td>3. Chitin</td>
<td>Anecdote of exoskeletons in candy</td>
<td>Biochemistry</td>
</tr>
<tr>
<td>4. Lipids</td>
<td>Quip about lipid in water</td>
<td>Biochemistry</td>
</tr>
<tr>
<td>5. The chemical components of processed foods</td>
<td>Description of FDA policy on non-food items in food</td>
<td>Biochemistry</td>
</tr>
<tr>
<td>6. Carbon dating</td>
<td>Quip about carbon dating</td>
<td>Biochemistry</td>
</tr>
<tr>
<td>7. Shroud of Turin</td>
<td>Quip about carbon dating and the Shroud of Turin</td>
<td>Biochemistry</td>
</tr>
<tr>
<td>8. Alcoholic fermentation</td>
<td>Quip about odor of a student’s use of alcohol being similar to yeast fermentation</td>
<td>Cellular respiration</td>
</tr>
<tr>
<td>9. Discussing the biological significance of enzymes</td>
<td>Chiding class about the biological significance of enzymes discussion in their lab write-ups</td>
<td>Biochemistry</td>
</tr>
<tr>
<td>10. Fats as a source of energy</td>
<td>Physically making body movements of fat removed from body by liposuction</td>
<td>Biochemistry</td>
</tr>
<tr>
<td>11. Anaerobic respiration Net 2 ATP</td>
<td>Describing an unlikely scenario whereby a student sold candy for a profit as an analogy to the ATP molecules necessary to start cell respiration</td>
<td>Cellular respiration</td>
</tr>
<tr>
<td>12. Electron transport chain</td>
<td>Role-play of the process of electron transport in the mitochondrion</td>
<td>Cellular respiration</td>
</tr>
</tbody>
</table>

**Analysis of Ned’s Instructional Artifacts**

A total of three artifacts collected from Ned included the Event 4 organic compounds worksheet (in Appendix L), the Event 11 glycolysis diagram (see Appendix M), and the Event 12 electron transport chain role play (see Appendix N). Each artifact was individually examined and considered within the lesson in which it was presented.
The artifacts were then scored according to whether they possessed or did not possess characteristics relating to content, design, and presentation. Those 20 characteristics are listed in Appendix J. All four of the artifacts had every characteristic listed in Appendix J with two exceptions: Ned did not have his own artifact evaluation plan for those teaching materials and the characteristic of audio quality is not applicable since none of the artifacts were recordings.

Overall, Ned’s humor achieved conformity among the type of artifact, the strategy used in the presentation, and the type of humor used. In Event 4, the organic compounds worksheet was presented dialogically with a humorous quip about lipids and water; in Event 11, the glycolysis diagram was dialogically described with an unlikely scenario whereby a student sold candy for a profit as an analogy to the ATP molecules necessary to start cell respiration; and in Event 12, the lesson plan for the electron transport chain role play was dialogically presented and humorously acted out by the entire class. This conformity of purpose, to convey scientific content, ensures that Ned’s instructional artifacts are of high instructional quality and, as such, have a greater likelihood of conveying science concepts.

**Teacher Interview: Ned**

Ned’s use of scientific humor tended to call upon students to be able to list and describe biology concepts. On occasion, students were asked to compose, analyze, or explain more complex processes. His remarks about the purpose of humor creating rapport indicated that students' participation in the more complex, yet humorous, activities might not have occurred had students not felt comfortable. Ned’s views about the purpose of his humor are evident in his remarks:

> From my observation, I don’t know if it’s the humor that aids in their
understanding. I think the humor creates avenues and rapport that makes them more comfortable opening up. If that didn’t exist, that electron transport chain activity probably wouldn’t have been as successful as it was because they would’ve felt self-conscious about doing it or concerned about what they look like, and I figure if I make myself look like as much of a fool as I can they won’t feel so bad about putting it out there themselves.

Ned used humorous associations to encourage student learning. If students do not make the association, he may use another technique in the future. From a cognitive standpoint, it seems reasonable that if a student recognizes some familiarity between what has been discussed in class and something they are already knowledgeable about, that student will be able to discuss the topic and perform higher order types of knowledge such as composing and forming conclusions, as described on Bloom’s cognitive domain.

Ned’s pragmatic view about how students perceive his humor follows: “If I use humor and they’re not amused, it’s usually because they don’t get it. I don’t try to explain it, I just move on.”

Ned’s philosophy about associations is his most often used technique. His role is helping students learn new things by connecting those concepts to things they already know. His comments below about getting students to remember and demonstrate their learning is indicative of Ned’s philosophy of scientific humor:

Today I started talking about circulatory systems and there are three choices: none, open, or closed. And I said, so if I’m a hydra [start waving his arms over his head] . . . and I was a hydra, and everybody laughed. So I said, “What’s the matter? You don’t like my hydra?” So any time anybody says hydra from now on they’re going to picture me standing in front of the room doing that.

He further stated,

As I’m teaching, the basic idea that goes through my head is association. That’s all I’m trying to do is associate to everyday experiences. That’s probably my most frequently used tool. I just picture a student going home and their parents ask what they did at school that day and they say, “Hey, did you know that skittles have cockroach skeletons?” It’s not like they have to explain anything, like what a carbohydrate is. If I’m a parent and my kid comes home and tells me about
cockroach skeletons I know they must be paying attention to something that’s going on in class. For me it’s about trying to take things that they may not already be familiar with and trying to connect them with things they are already familiar with.

Although Ned uses a wide variety of sources for his scientific humor, much like survey respondents, the humor is content driven. Even with humor directed at students with whom he has established rapport, his observed comments relate to instructional material. Unlike the joking, which he also sometimes employs, he has a scientific point when he is teaching. His comment below is an indication of the variety of instructional and assessment opportunities for his students.

Certainly the electron transport chain activity was an example of an assessment. Another form of assessment that I might use is the front cover of the Weekly World News. That is a wonderful source for biological information that just isn’t real. The farmer who captures a 22-pound grasshopper . . . I show a picture of a 22-pound grasshopper in class and ask “Why is that not possible?” And now you’re talking about the anatomy and physiology of an open circulatory system and an exoskeleton and you can assess what they know about that through a class discussion.

The assessments Ned uses are varied. Although he uses summative unit exams he also assesses student learning with class discussions, exit cards, and role-playing activities. A discussion of a headline students might see at a supermarket checkout is a real-world example of science in our daily lives. Ned accesses these experiences with his assessment practices.

Whether Ned uses a role-play or a headline from the supermarket checkout, he has many years of experiences in knowing what humor works best, how it is best used, and who to use it with. This teacher may be able to use humor in his instructional situation that may not be able to be used in another. Each teacher must decide upon the most effective instructional strategy for their students. This includes instructional humor as well, as Ned indicated in his comments below.
I’ve been teaching for 26 years, and although some things are off-the-cuff, I have a playbook. Some stuff is original thought, first time--at that moment, but a lot of it I’ve said before in some form. It has to do with the reaction that a student has. They react in a particular way to something and I respond to that. It’s kind of like a giant improvisation.

I do sometimes pick on individual students. I learned very early which ones I can get away with and which ones I can’t. There are a couple of kids in here that are in band and I’ve been working with them for a couple of years already. We have a rapport that goes way beyond the classroom. The comment about the alcohol and the other comment I made about the pot plants . . . and those aren’t the only ones . . . one time a student came to me and said they thought something I did was a little bit offensive and I came back and I apologized and I didn’t do it again. I make mistakes sometimes. Some of us, certainly me, if we were put up on a stage with a microphone and the first time someone laughs or applauds you’re like ‘Hey, I like this’ and you just keep on doing it.

He further commented, “In scientific humor, the intent is to make an educational point versus this joke is really funny and if I don’t tell someone right now I’m going to burst.”

With Ned’s extensive teaching experience, he has a library of instructional humor that has worked in the past. He can incorporate that with new ideas and feedback from students to create new twists on scientific instructional humor. He is also able to cross lines with students that might cause other teachers to hesitate.

The overarching theme found in Ned’s interview is the bifurcated purpose to his scientific humor: first is the creation of rapport so that students feel more comfortable and second is creating associations between everyday experiences and new scientific information. Ned builds rapport so that students feel free to participate in fun learning activities in situations where they might not have felt comfortable previously. Then Ted uses that rapport so that students are less inhibited and they more easily understand his humorous associations. From a cognitive standpoint, if a student recognizes some familiarity between what has been discussed in class and something they are already knowledgeable about, that student will be able to discuss the topic and employ higher
order types of knowledge such as composing and forming conclusions, as described in Bloom’s cognitive domain. Much of Ned’s humor is content driven.

**Ned’s Students’ Perceptions of his Instructional Humor**

Ned’s students realize when he is using humor, they very often understand the point he’s trying to make, and they believe he is trying to make learning fun and more memorable. Interviewed students were able to generate unaided examples of occasions when Ned used humor related to a science topic. Doing so is further evidence of factual and conceptual knowledge, as described in Bloom’s cognitive domain. The following comments from students are examples of humor that they have noted independent of any interviewer prompts:

Ned has used a humorous story behind what a catalyst does and how it’s something that remains unchanged and so there was a guy walking along Broadway, for example, and there was another person on the other side of the street. And the first guy said something to the other guy and that created a conflict between them but yet when they walked away from each other the first guy remained unchanged.

It’s all about grabbing the attention. Ned will say things that will disgust some kids just for that reason. I find it funny . . . not necessarily what he’s saying . . . but the reaction of the other kids. We were talking about the digestive system yesterday . . . already not a pretty thing to look at . . . and he was getting into detail and some of the other kids were grossed out and I think it gives a clearer picture of what’s actually happening in certain systems.

All of the interviewed students were able to generate some examples of Ned’s instructional humor without any prompts, which suggests that the humor was meaningful to them or that Ned used instructional humor frequently. Sometimes students also enjoyed teacher humor more with the reactions of other students in the class. Overall, they recognized the humor as a learning tool, as indicated by students’ perceptions of Ned’s purpose for using humor:

“I believe the times he’s being amusing . . . picking on someone . . . is meant to
“Capture our attention and be memorable.”

“He’s certainly intending for us to have fun. Like with the electron transport chain activity.”

“His purpose is to make us understand a concept better and also to make learning More fun so we enjoy what we’re doing.”

As supported by the survey data, humor is in the eye of the beholder. Some students recognized Ned’s failed humorous attempts or may not appreciate jokes at someone else’s expense. Yet, within the same classroom, other students liked disgusting humor, the fact that Ned’s humor is interactive, that the humor sometimes relates to aspects of life that they’ve experienced, and that the humor provides a mental break for learning. Scientific humor represents one learning strategy that teachers may employ and mix with a variety of other strategies in order to teach content to students. Some of the student reactions to Ned’s humor are mentioned below:

Not all of Ned’s humorous attempts are amusing . . . he may have some failures here and there. Or it might take a while to catch on to it if it’s something that we can’t completely grasp at first.

When Ned used humor with alcoholic fermentation is gives a break to what would otherwise be a very long type of lecture. And he picked on Diggy . . . so it’s interactive. When he makes jokes you can make a joke back.

Some of the humor is funny. But with the humor used in the alcohol fermentation discussion about the smell of alcohol and the reference to one student . . . I don’t do the kind of humor that’s to someone else’s slight expense but it does help it sink in so you remember it. In this case the teacher wouldn’t do it if he knew the student wouldn’t be okay with it.

Students were mature and circumspect about Ned’s humor. They recognized that not all of the humor will always be amusing to them. Still, they saw it as part of instruction. This ability on the part of students is probably a reflection of the caliber of student found in an honors class versus a regent’s class. The comments below related to
students’ perceptions about the relationship between Ned’s humor and scientific content:

The humor makes the information stick with you. Especially with the electron transport chain activity. He tries to make things more interactive in order to get you think about things critically. He wants to make a joke and have you make a connection to the material. He uses it as an extension of his teaching.

With the black light example I found the humor helpful because, when I was younger I used to go to the roller rink and they had black lights and we have a black light at home because my sister had a glow in the dark party and it was fun to walk around in the dark and watch your clothes glow. His humor did connect with me and made me remember that the different colors of light change what’s absorbed and what’s reflected and I ended up using that in a lab because I remembered it. We did a lab about photosynthesis called the plant game and we were asked to give two other examples of variables that would affect the plant’s photosynthesis and that was one of the variables I gave.

Ned’s honors biology students were cognizant of the effect humor has on their performance on assessments. They realized that making light of errors by using humor increases the chance that they will not be repeated. Certain words, when delivered with a humorous reference or sound may be more easily retrieved in an assessment situation.

These students know that learning that is kinetic and tactile may also increase their understanding and retention. Students discussed their perceptions about humor and learning below:

I love science but I think even for kids who have a hard time with science I think it makes it easier when he goes off topic a little and picks on kids and then brings it back. He’s picked on me before. I like it. It calls my attention to problems . . . he picks out a mistake I’ve made. The best way to learn is to make mistakes. If he points out that I’ve made a mistake I don’t make the mistake again. I do theatre with him and band with him so I’m used to him and I consider him a friend and so he picks on me quite a bit but I like it. I appreciate it; it helps.

Ned made a humorous reference about chitin and on a test question he asked where are cellulose and chitin found and I remembered his reference to the crunch and that helped me remember that was chitin was in exoskeletons and cellulose was found in plant cell walls. I know exactly where cellulose and chitin is because of that humorous comment he made about Red Lobster.

In summary, student interviews suggested that Ned’s students realized when he is
using humor, very often understand the point he is trying to make, and believe he is trying to make learning fun and more memorable. Both the survey and student interviews are in alignment with the finding that humor is in the eye of the beholder. Although some students see failed humorous attempts or may not appreciate certain jokes, other students may enjoy that humor for personal reasons such as its being interactive or providing a mental break for learning. Scientific humor represents one learning strategy that teachers may employ and mix with a variety of other strategies in order to teach content to students. Interviewed students were aware of the effect of humor on their performance on assessments and realize that certain words, when delivered with a humorous reference or sound may be more easily retrieved in an assessment situation.

Table 12 shows that there is agreement between Ned and at least one other data source in the following areas: (a) Ned created rapport through humor, (b) Ned made associations between everyday occurrences and scientific content and two students referred to connections they made during their interviews, (c) the observed roleplaying activity was a form of assessment that two interviewed students referred to as an activity that enabled them to independently re-create the process without needing to consult references, and (d) observed content humor appeared on laboratory artifacts.

This evidence indicated that Ned does employ humor toward instructional objectives. All four students who were interviewed found his humor amusing at least some of the time and they believed it helped their learning.
### Table 12

**Triangulation of Teacher Interview, Observations, Artifacts, and Student Interviews**

<table>
<thead>
<tr>
<th>Interview event</th>
<th>In Ned’s words</th>
<th>Data from surveys, observations, artifacts, and interviews</th>
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</thead>
<tbody>
<tr>
<td>Purpose</td>
<td>I think the humor creates avenues and rapport that makes them more comfortable opening up.</td>
<td>Observed humor related to science content approximately 60% of the time.</td>
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<td></td>
<td>I figure if I make myself look like as much of a fool as I can they won’t feel so bad about putting it out there themselves.</td>
<td>Direct observation of teacher/student rapport.</td>
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<tr>
<td></td>
<td>All students found Ned amusing. Some recognized that the humor may not always be appropriate</td>
<td></td>
</tr>
<tr>
<td>Student perception</td>
<td>If I use humor and they’re not amused it’s usually because they don’t get it and I don’t try to explain it, I just move on.</td>
<td></td>
</tr>
<tr>
<td>Student demonstration of learning</td>
<td>I’m trying to associate to everyday experiences. If I’m a parent and my kid comes home and tells me about cockroach skeletons I know they must be paying attention to something that’s going on in class.</td>
<td>All students were able to name a specific example of content humor used in class and tell what they learned from it. (electron transport chain; black light)</td>
</tr>
<tr>
<td>Humor in assessment</td>
<td>Electron transport chain activity was an example of an assessment. Front cover of the Weekly World News. I show a picture of a twenty-two pound grasshopper in class and ask “Why is that not possible?” You can assess what they know through a class discussion.</td>
<td>All humor related to scientific topics Teacher directed Generally to help students form associations and build rapport Every laboratory artifact collected had content questions directly related to the humorous events from class discussions</td>
</tr>
<tr>
<td>Deciding what humor to include in class</td>
<td>Although some things are off the cuff, I have a playbook. It has to do with the reaction that a student has. It’s kind of like a giant improvisation. I do sometimes pick on individual students. Frequently it’s a student I already know from something. We have a rapport that goes way beyond the classroom.</td>
<td>N/A</td>
</tr>
<tr>
<td>Joking versus scientific humor</td>
<td>In scientific humor, the intent is to make an educational point versus this joke is really funny.</td>
<td>N/A</td>
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</table>
Work Samples From Ned’s Students

The blog and survey, presented and analyzed in chapter four, and Ned’s
classroom observations, the collection of his instructional artifacts, and teacher interview
presented within this chapter (6) partially addresses the guiding research question, “How
do teachers use humor in order to explain scientific concepts?” In chapter five I presented
and analyzed a similar data set for Marin, the first teacher, which also addressed the
guiding research question. The secondary research question, “How do students perceive
their teachers' use of scientific instructional humor?” is addressed through student
interviews and a collection of student work products. I partially addressed the secondary
research question in chapter five with Marin’s student interviews and work products. I
will now more fully address that question with Ned’s student interviews and work
products.

Ned provided access to several student laboratory write-ups completed as a
requirement to sit for the New York State Living Environment Regents. The following
photographs are examples of student responses to lab questions that are related to topics
that Ned humorously addressed in class.

Ned discussed organic molecules in class and made a wry reference to lipids’
inability to combine with water. Figure 13 is example of one lab activity where a student
drew the chemical formulas for water and glycerol in addition to two other molecules.
Students' ability to rank a molecule as belonging to a particular organic family as well as
to visually depict that molecule are examples of ranking, which is a type of factual
knowledge that is addressed in Bloom’s cognitive domain.
Figure 13. Ned’s student work product: Chemical formulas for several compounds.

Figure 14 depicts several different student responses to lab questions dealing with the biological significance of enzymes. Figure 14 shows a student-constructed graph on which the rate of an enzyme reaction increases along with the increasing concentration of the substrate. Ned noted on this student’s paper where proper labeling is missing regarding the concentration of the substrate. Students were expected to be able to compose a written text that described the biological significance of enzymes. Composing is a higher level type of procedural knowledge in Bloom’s cognitive domain in which students actually create new information.
Figures 15 and 16 are different student responses to a request for their discussion of the importance of enzymes in living organisms. Ned has asked a student to more fully explain why enzymes work faster if there is a higher concentration of the enzyme (Figure 15). Students are encouraged to ask themselves if ideas are clear, coherent, and credible. This characteristic, which Ned encourages in students, is shared by both philosophers and comedians (Morreall, 2009).
In Figure 16, Ned asks this student to clarify why their laboratory results happened as they did. Composing is a higher level type of procedural knowledge in Bloom’s cognitive domain in which students actually create new information. Students are encouraged to look for confusion, fallacy, and incongruity. Once again, these characteristics are encouraged by Ned and they are shared by both philosophers and comedians (Morreall, 2009).
Figure 16. Ned’s student work products: Biological significance of enzymes.

Figure 17 depicts a student graph in which aerobic and anaerobic bacterial growth from glucose are compared. Ned addressed the topic of the differing amounts of energy produced from glycolysis versus the electron transport chain in class with an analogy of selling candy bars for a profit. This student’s graph indicates an understanding, or conceptual knowledge of Bloom’s cognitive domain and of the differing amounts of energy produced in aerobic versus anaerobic respiration.
In summary, Ned’s student work products offered several examples of knowledge as described in Bloom’s cognitive domain and Morreal’s philosophical perspective regarding shared characteristics of philosophers and comedians. Figure 15 depicted a student’s ability to rank a molecule as belonging to a particular organic family as well as diagram the molecule, which is an example of ranking, a type of factual knowledge; Figure 16 depicted where Ned had noted a student’s error in labeling the concentration of a substrate in their composition of a written text, a type of procedural knowledge. In Figure 17, Ned asked a student to more fully explain why enzymes work faster if there is a higher concentration of the enzyme (an example of clarity and
coherence: characteristics shared by both philosophers and comedians [Morreall, 2009]);

As can be seen in Table 13, in several instances students remembered classroom humor employed by Ned related to the electron transport chain role play as well as humor related to digestion, surface area, cell division, wounds, and the light spectrum. All of the student work products in this report relate to enzymes, organic molecules, and respiration.

Table 13

*Comparison of Student Interview and Work Products for Ned*

<table>
<thead>
<tr>
<th>Interview event</th>
<th>In the student’s words</th>
<th>Student work products</th>
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</thead>
<tbody>
<tr>
<td>Student-identified humorous attempts</td>
<td>S1-We were talking about digestion…and he was saying the greater the surface area, the greater absorption. One of the students asked about the surface area of a slushy and Ned kept kidding about not having to chew a slushy. I feel like adding humor helps to keep students alert. S2-Ned has used a humorous story behind what a catalyst does and how it’s something that remains unchanged and so there was a guy walking along Broadway, for example, and there was another person on the other side of the street. And the first guy said something to the other guy and that created a conflict between them but yet when they walked away from each other the first guy remained unchanged.</td>
<td>No work products related to digestion or surface area were collected. Figure 22: Biological significance of enzymes: Several different student responses to lab questions dealing with the biological significance of enzymes (catalysts). The first image of Figure 22 shows a student-constructed graph where the rate of enzyme reaction increases along with the increasing concentration of the substrate. The second and third images of Figure 22 are different student responses to a request for their discussion of the importance of enzymes in living organisms.</td>
</tr>
<tr>
<td>Interview event</td>
<td>In the student’s words</td>
<td>Student work products</td>
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| **Students’ perception of Ned’s purpose** | S1-I believe the times he’s being amusing…picking on someone…is meant to capture our attention and be memorable.  
S2- I think his using humor is part of his personality. He would get bored if he didn’t and he understands that kids would also get bored. He wants you to take class seriously, but he also wants you to have fun.  
S3-He’s certainly intending for us to have fun. Like with the electron transport chain activity.  
S4-His purpose is to make us understand a concept better and also to make learning more fun so we enjoy what we’re doing.                                                                                                                                                                                                                   | No work products related to the electron transport chain role play were collected.                                                                 |
| **Students’ reaction to Ned’s humor**  | S1-Not all of Ned’s humorous attempts are amusing…he may have some failures here and there.  
S2- I like when he brings up a personal story. If he were talking about how a wound heals…he’d bring up a story about his son falling off a bike. I like that he connects to stories because then you’re taking a break off of the science concept  
S3-When Ned used humor with alcoholic fermentation it gives a break to what would otherwise be a very long type of lecture. And he picked on Diggy…so it’s interactive. When he jokes you can joke back.  
S4-Some of the humor is funny. But with the humor used in the alcohol fermentation discussion about the smell of alcohol and the reference to one student…I don’t do the kind of humor that’s to someone else’s slight expense, but it does help it sink in so you remember it. In this case the teacher wouldn’t do it if he knew the student wouldn’t be okay with it.                                                                                   | No work products related to cell division or wounds were collected.  
Figure 23: Comparing anaerobic and aerobic respiration. Student graph comparing aerobic and anaerobic bacterial growth from glucose. Ned addressed the topic of the differing amounts of energy produced from glycolysis versus the electron transport chain in class with his analogy of selling candy bars for a profit. Ned addressed the topic of alcoholic fermentation giving off alcohol and carbon dioxide and that the holes in bread were left after the carbon dioxide evaporated. |
<table>
<thead>
<tr>
<th>Interview event</th>
<th>In the student’s words</th>
<th>Student work products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students’ perception of relationship between Ned’s humor and scientific content</td>
<td><strong>S1</strong>- A lot of times Ned’s humor is off topic—he tells a story and then we get back on topic. Talking about the electron transport chain for 40 minutes gets to be too much but when you get off topic every once in a while it’s easier to get back into it.</td>
<td>No work products related to the electron transport chain role play were collected.</td>
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<td></td>
<td><strong>S2</strong>- The humor makes the information stick with you. Especially with the electron transport chain activity. He tries to make things more interactive to get you to think about things critically. He wants to make a joke and have you make a connection to the material.</td>
<td>No work products related to the light spectrum were collected.</td>
</tr>
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<td></td>
<td><strong>S3</strong>- When he first introduced the electron transport chain I did not understand it at all. Then we got to see it and do that activity. It was a lot more fun. It did help me to understand the process. I know the process well enough now that I don’t need to refer to notes to answer questions about it.</td>
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<td><strong>S4</strong>- With the black light example I found the humor helpful because there were black lights at the roller rink I went to. Ned’s humor helped me remember the different colors of light are absorbed or reflected. We did a lab about photosynthesis called the plant game and we were asked to give two other examples of variables that would affect the plant’s photosynthesis and that was one of the variables I gave.</td>
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Table 13 (continued)

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<thead>
<tr>
<th>Students’ perceptions about humor and learning</th>
<th>In the student’s words</th>
<th>Student work products</th>
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<tr>
<td>S1- I think even for kids who have a hard time with science it makes it easier when he goes off topic a little and picks on kids and then brings it back. He’s picked on me before. I like it. It calls my attention to problems…he picks out a mistake I’ve made. The best way to learn is to make mistakes. I do theatre with him and band with him so I’m used to him and I consider him a friend and so he picks on me quite a bit but I like it. I appreciate it; it helps.</td>
<td></td>
<td>No work products related to chitin or cellulose were collected.</td>
</tr>
<tr>
<td>S2- Ned made a humorous reference about chitin and on a test question he asked where are cellulose and chitin found and I remembered his reference to the crunch at Red Lobster and that helped me remember that was chitin was in exoskeletons and cellulose was found in plant cell walls.</td>
<td></td>
<td>Figure 21: Chemical formulas for several compounds. Ned discussed organic molecules in class and made a wry reference to lipids’ inability to combine with water. In a lab one student drew the chemical formulas for water and glycerol, in addition to two other molecules.</td>
</tr>
<tr>
<td>S3- If we’re taking an assessment, the humor may make me remember a particular word so that I’m better able to insert that and, perhaps, apply the idea.</td>
<td></td>
<td>No work products related to the electron transport chain role play were collected.</td>
</tr>
<tr>
<td>S4- Some of the stuff Ned does is fun. It depends on the thing. I’m not sure they count as humor. I’ve heard that doing tactile activities helps students learn material better. And we do a lot of activities where we pretend to be molecules and stuff. When we acted out the electron transport chain that helped me remember the process and I don’t think I’ll be forgetting that any time soon. We had several questions afterward to complete on our own and I was able to just answer them from memory. The activity was fun.</td>
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</table>

In summary, Ned created rapport through humor, made associations between everyday occurrences and scientific content, and employed humor toward instructional
objectives. Further, students reported that the electron transport role-playing activity enabled them to independently re-create the process without needing to consult references. This type of humorous, physical learning benefitted them. There were other examples of humor in which Ned’s students could remember without prompts, specifically digestion, surface area, cell division, wounds, and the light spectrum. In terms of student work products, all in this report relate to enzymes, organic molecules, and respiration since Ned was teaching those units for a large portion of the data collection period of this study.
Chapter 7
Discussion

In this final chapter, I will discuss and review the outcomes of the study. The first section will address the two research questions and how this study contributes to understanding the topic of scientific humor. I will then outline the limitations of this research. Finally, I will examine the theoretical implications, the practice implications, and the implications for future research.

Research Question 1

The guiding research question asked “How do teachers use humor in order to explain scientific concepts?” The two biology teachers involved in this study demonstrate both differences and similarities in the use of instructional scientific humor. Notwithstanding that each is a unique individual, the type of biology course taught, and therefore, the caliber of learners in the class differed. Marin taught a regents’ biology class and Ned taught an honors biology class, where, in addition to the Living Environment exam, students are encouraged to take the subject area test of the Scholastic Aptitude Test intended for students who plan to pursue further college study. Ned was able to use clever or sarcastic comments to make points. Although he demonstrated ideas with anecdotes or outrageous scenarios, some of his humor was more subtle and students needed a depth of understanding, interest, and attentiveness to comprehend it and find it humorous. Marin often used physical humor and question-asking. Many of the observed humorous events were done for the purpose of getting students to remember or understand. Both Marin and Ned were conversational in their presentations, and both asked their students to perform thought experiments.

The tendency to perform thought experiments, as described by Morreall (2009) is
a characteristic that comedians and philosophers share and is one of the eight points of similarity that I draw between those two groups and science teachers. Biology teachers, Marin and Ned mentally manipulate possibilities as easily as some think about reality. Morreall (2009) used the ontological argument about reality or the nature of being as an example of a thought experiment. For example, in Event 3, Marin asked students to predict what would happen to a plant without the structure of cell walls and humans without the structure of skeletons. This was presented as a puzzling experience that might be investigated, while it, of course, defies the norm or nature of reality.

Marin exhibited humorous events that mainly were aimed at student remembering and understanding. Marin’s humor events were mainly conversational, encouraged students to ask questions, and encouraged them to perform “thought experiments” to mentally manipulate possibilities. Marin very often used physical humor, but sometimes used an exaggeration of words or a drawing. In the cultural environment of Marin’s classroom, physical scientific content humor was frequently found. It was often done conversationally, with cognitive shifts, or in asking students to perform thought experiments, much as do comedians and philosophers. Most frequently, Marin’s humorous events occurred for the purpose of having students remember or understand the nature of a particular scientific idea. Although Marin’s use of humor is intuitive, there is much research to be found showing that humor has a comprehensive positive relationship to learning (Garner, 2006; Gorham, 1988; Gorham & Christophel, 1990; Kaplan & Pasco, 1977; Wanzer et al., 2010; Worner et al., 2010; Zillman et al., 1980; Ziv, 1988). Yet this research, with the exception of Wanzer and Frymier (1999), generally focused on higher education and collected data primarily through surveys and content tests.

Ned exhibited humor events that most frequently served the purpose of having
students remember or understand the nature of a particular scientific idea. Yet, on several observed occasions, Ned used humor that required greater cognitive processing in order to have students explain and analyze, rank and evaluate, and create. It was often done conversationally, very typically reflected everyday experiences, involved students in question asking and critical thinking, and sometimes poked fun at authority by not shying away from topics such as government regulation of food production or cultivating marijuana. As Ned tended to use humor that required higher order thinking, it is appropriate to draw on several studies that examined the cognitive skill of analysis in order to put his instruction in perspective. Much of the research sited with this theme involved the use of modeling, illustrations, and cartoons (da Silva et al. 2009; Dorion, 2009; Keogh & Naylor, 1999; Rule & Auge (2005); and Sadowski et al., 1994). This was a very diverse group of studies, spanning upper elementary to college, all with a variety of data collection methods (surveys, observations, etc.). The predominant theme was higher cognitive learning in the form of analysis. The fact that Ned tended to encourage students toward this level of thinking during mostly verbal exchanges (as opposed to using illustrations or cartoons) makes his instructional presentation unique.

Ned had the main role in conveying scientific information to the students across the various genres. His actions were sometimes making sounds or physical movements or having students do a role-play, but he often used verbal humor, specifically quips or sarcastic remarks, anecdotes, or ridiculous or outrageous scenarios. Ned also employed verbal humor when he playfully chided the class. In the cultural environment of Ned’s classroom, verbal scientific content humor was frequently found.

**Research Question 2**

The secondary, related research question asked “How do students perceive their
teachers' use of scientific instructional humor?” Three out of four students in Marin’s class reported finding the humor she used useful for remembering science concepts. One student recognized the humor, but did not find it helpful for remembering content. All four students in Ned’s class reported the humor he used useful for remembering science concepts. Two students mentioned some of the humor being potentially offensive, although both of them reported finding it helpful, regardless. Student work products in both classes reflected the topics of the scientific humor observed in class.

In several instances Marin’s students remembered classroom humor employed by their teacher related to means of locomotion for various microorganisms. All of the student work products in this report relate to microorganisms because Marin was teaching that unit for a large portion of the data collection period of this study. One student did mention the phagocytosis reference, which was also a content question in the student work sample depicted in Figure 13; however, the student did not find the Pac Man reference to be amusing.

In several instances, Ned’s students remembered classroom humor employed by their teacher related to the electron transport chain role-play, as well as humor related to digestion, surface area, cell division, wounds, and the light spectrum. All of the student work products in this report relate to enzymes, organic molecules, and respiration since Ned was teaching those units for a large portion of the data collection period of this study. The electron transport chain was investigated as Instructional Humor Event 12 and the lesson plan to that activity can be found in Table 8.

Although student perceptions were addressed in some previous humor studies (Bryant & Zillman, 1988; Conkell et al., 1999; Torok et al., 2004), data were primarily collected through surveys or content texts. Students tended to be more receptive toward
instructors who used humor and were more motivated about the class. No other studies attempted a comparison of student perceptions of their learning through interviews and an examination of student work products.

**How This Study Contributes to Understanding of the Topic**

By far, the majority of research regarding the use of humor in education relates to enhancing course or instructor appeal, student engagement, managing conflict or other behavioral issues, or testing concerns (Bryant & Zillman, 1988; Conkell et al., 1999; Hackathorn et al., 2011; Rule & Auge, 2005; Wanzer & Frymier, 1999; Wanzer et al., 2010; Wizner & Oliveira, 2012; Zillman et al., 1980; Ziv, 1988). This study goes a step farther. I have looked at specific types of humor that biology teachers have used in teaching their content. Further, I have also examined student perceptions of their teacher’s humorous instruction and how those students have experienced its impact on their science content learning.

The two cases examined in the study show that both teachers employed the domains of remembering and understanding. The regent’s teacher’s (Marin’s) humor tended to be more physical. The honors teacher (Ned) used more upper end process dimensions by asking students to explain, evaluate, and create. This is in keeping with his more academically inclined students. Both teachers were conversational in their delivery and encouraged student questioning, the regent’s teacher used “thought experiments” and cognitive shifts, and the honors teacher encouraged more critical thinking and poked fun at authority. Both teachers assumed the main role in humorous science delivery.

Most students in the regent’s class reported finding the humor helpful and student work products reflected that the humorous science content was assessed through lab questions. All students in the honors class reported finding the humor useful, but in some
instances it was found to be potentially offensive. Student work products reflected that the humorous science content was assessed through lab questions in the honors class.

My study begins to fill the gap in the literature in terms of the educational level in which scientific humor studies have been conducted. Many studies have been done at the higher education level (Bunce et al., 2010; Johnstone & Percival, 1976; Mann & Robinson, 2009; Stuart & Rutherford, 1978; Young et al., 2011). A few have been done among young elementary students (da Silva et al., 2009; Zillman et al., 1980). In addition, the information to be gleaned from the existing research is rather superficial. For example, Wanzer and Frymier (1999) asked students about their perceptions of their previous professor’s humor. There was no way to determine how many instructors were described by the respondents. Wanzer et al. (2006) deemed humorous behaviors as either appropriate or inappropriate. Yet, Ned sometimes used what some might term inappropriate humor, and students used various levels of knowledge within the cognitive domain. Kaplan and Pasco (1977) conducted a well-designed study at the undergraduate level to investigate the effect of humor on content learning as well as student perceptions. However, instruction was delivered by means of black-and-white video tape, and the results of the study are over 30 years old. The seven data-collection sources used in this study (survey, teacher and student interviews, teacher observations, artifact collection, student work product collection, and teacher discussion forum) offer a more triangulated view of the various perspectives involved in humor production and reception, and as such, help to achieve a deeper understanding of the phenomenon. One key thought that emerges from this study is that the use of scientific humor involves some risk on the part of the teacher. Possibly through silly, exaggerated movements or mocking authority, teachers take risks for the reward of making their material memorable.
Theoretical Implications

Prior to this research, no known study had focused only on how secondary science teachers use humor to explain scientific concepts nor on secondary students' perceptions of the instructional humor. This study may encourage more science education research in the field of instructional humor and may encourage science teachers to investigate ways that they can use scientific humor in the secondary classroom in order to convey content-related concepts. Many teachers noted the overall positive effect of humor on learning (Garner, 2006; Gorham, 1988; Gorham & Christophel, 1990; Kaplan & Pasco, 1977; Wanzer et al., 2010; Worner et al., 2010; Zillman et al., 1980; Ziv, 1988). Additional research could spur the accumulation of a database of scientific instructional humor across the disciplines.

Helping students use critical thinking is a trademark of science teachers. Philosophers and comedians are not typically mentioned in the same sentence with science teachers, but they share some important attributes that learners would also benefit from acquiring. Science teachers who adopt the attributes of philosophers and comedians may impart behaviors like critical-thinking skills, the ability to explore questions in a detached manner, and the ability to search out new perspectives, on their students. These characteristics can help science teachers teach their content critically. If teachers present incongruities to students in order to encourage critical thought, according to Morreall (1987), students may react through uneasiness, feelings of loss of control, motivation to change the incongruous situation, or amusement. Bringing incongruity to the attention of an adult or secondary learner will bring about change in some manner, which is the result of learning.
Practice Implications

Continuing education courses or electives at the teacher education preparatory level would both be wonderful avenues to encourage teachers to share and adopt new content humor examples and techniques. Courses might be content specific, relating to the major subjects taught in high school: biology, earth science, chemistry, and physics. Topics covered within the courses would relate directly to the topics taught to high school students (biochemistry, evolution, plate tectonics, or ecology, for example). Teachers could share instructional humor that they have used in the past and what learning outcomes might be seen in students. Connections to learning outcomes are important objectives given our present ranking in the areas of math, science, and reading (Hanushek et al., 2012).

Regardless of the subject or topic covered, scientific humor is conversational. It may occur as teachers are introducing or explaining new topics, before students are given guided or independent practice on class activities or labs. A practical implication of these findings is that instructional humor can be a big tent that includes all sorts of activities that may be silly, yet interesting to students in order to combat factors that work against student engagement (Adams, 2006; Christenson & Thurlow, 2004; Moore et al., 2008, Nworie & Haughton, 2008).

Content relatedness aside, humor is as unique as each individual and it is in the eye of the beholder. The kind of humor one teacher may choose to use in the classroom may differ from another’s based on their comfort level or any of a number of other intangible feelings. The Internet provides many opportunities for teachers to share their ideas, labs, demonstrations, and other instructional information. With that network, it is not surprising that many teachers of the same subject will have activities in common. It is
also not surprising that, when each individual teacher adopts an activity and makes it their own, they imprint their own particular style, technique, and thinking. That is where the creativity of the individual enters and changes are made, and perhaps the individual’s own brand of humor is included.

Intuitively, teachers may believe that humor is a helpful tool in delivering necessary content but that the humor used must be understandable and age appropriate for the learners in question. An important implication of this finding is that teachers must be aware of their audience. Students vary geographically, but also across classrooms within the same school. The sort of humor used in one class might not work as well in another. It is up to each teacher to determine what sort of humor they feel comfortable with and what will work with their student populations. There is certainly enough data to support the use of in the science classroom as an instructional technique for delivering content (Garner, 2006; Gorham, 1988; Gorham & Christophel, 1990; Kaplan & Pasco, 1977; Wanzer et al., 2010; Worner et al., 2010; Zillman et al., 1980; Ziv, 1988).

Limitations

A limitation of this study is attributable to the nature of case study design. The findings in this study relate to only two biology teachers in two separate classrooms in an urban high school. The findings about student perceptions of teachers’ scientific instructional humor are based on collection from only two data sources. Further, the first data source, student interviews, is based only on four students in each classroom. Also, the collection of the second data source, student work products, was limited by the time available as well as the coordination of teacher schedules to allow such collection to occur. Research collected over at least an entire school year, preferably observing teachers multiple times throughout the day with different groups of students would
provide a richer source of data from multiple units and multiple types of classrooms.

Generalizability is more difficult to establish with qualitative research. However, Buchanan and Bryman (2009) explained that ethnographic studies on similar phenomena or in similar contexts can be used in qualitative analysis to form broader empirical understandings of phenomena. Furthermore, ethnography has relevance to theoretical generalization, which may be useful in forming new interpretations or re-examining earlier concepts. Finally, when research conclusions resonate with a reader’s empirical experiences, ethnography contributes to the naturalistic generalizability of findings. If readers note any similarities between a given situation and the events described in this paper, they may consider my findings useful in informing their own practice.

**Implications for Future Research**

Additional study on how secondary science teachers use humor to explain scientific concepts would be welcome. I hope that additional science teachers are spurred to investigate novel ways that instructional humor can be used in their classrooms. A searchable database of subject-specific and topic-specific instructional humor would be useful for all teachers as they look for ways to deliver content to their students. Similarly, the creation of an instructional humor science content taxonomy of different humorous cognitive processes for achieving different knowledge dimensions in each scientific subject area would be helpful to preservice and in-service teachers alike.
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Appendix A

Call for Participants

Research Study—Participants Needed!
Honorarium for Participation

To: Secondary Science Teachers
New York State Members of the National Earth Science Teachers Association (NESTA), Science Teachers Association of New York State (STANYS), and science teachers in the Albany, Green, Ulster, Dutchess, and Columbia counties of New York State

Dear Science Teacher,

Little research has been done on the use of humor as an instructional tool. The purpose of this study is to examine the way that science teachers use humor in their teaching to positively affect student learning.

Science teachers who would be willing to participate in a research study examining the use of scientific instructional humor are needed. Interested teachers are asked to first please respond to eighteen short prompts at https://www.surveymonkey.com/s/scientifichumor. The final prompt on the website is a request for examples of your content-related humor. A $50 honorarium will be awarded to those respondents who provide the greatest variety of content-related scientific humor and agree to participate in the observation/interview phase of the study.

If you would like to participate, please complete the survey at surveymonkey.com. Please try and be complete as possible with the survey. If selected for the study following the survey, you will be contacted by me, the Primary Investigator for this study. Participants in the observation/interview phase of the study will each receive a $50 honorarium.

The results of this study conducted in school districts throughout New York State will provide valuable information for science education courses. The names of participating school districts, school buildings, and teachers will not be stated in any published documents and participation is voluntary.

All contact information will be kept confidential. Thank you for your time and cooperation.

Sincerely,

Francine Wizner
Doctoral candidate
University at Albany
wiznerf@gmail.com
Appendix B

Survey of Use of Humor in Teaching Science Practices

Dear Teacher,

This survey is part of a research study about how secondary science teachers use humor to convey scientific concepts. Specifically, you are being asked how you use humor to get your students to remember concepts, understand ideas, apply what they have learned, analyze relationships, evaluate information, and create/synthesize/hypothesize new designs.

Below you will be asked (1) to provide your professional and contact information and (2) to generally describe how you tend to use humor (jokes, off-the-cuff remarks, videos, cartoons, etc.) to facilitate the learning of science in your classroom.

Professional and Contact Information
Teacher’s Name: _____________________________ Date: __________________
School: ___________________________________________________________________
Level(s) Taught (Freshman, Sophomore, Junior, Senior): __________________________
Subjects Taught: __________________________________________________________________
Years of Teaching Experience: __________ Email: __________________________
Mailing Address: __________________________________________________________________
Phone Number: __________________________________________________________________

Humor in the Classroom
1. How often do you use humor with your students during a typical class period? For what purpose(s)?
2. Do you and your students have any favorite types of humor? Please list them below.
3. What makes the above types of humor favorites?
4. Are there particular jokes, anecdotes, cartoons, or videos that you and your students dislike, and if so, which?
5. What makes the above types of humor objectionable?
6. What criteria do you use to select humor for your classes?
7. How do you incorporate humor into your science teaching?
8. Do you assess what your students learn from your science-related humor? How and for what purpose?
9. Please provide examples of your content-related humor. You are encouraged to attach documents or files that demonstrate your scientific content-related humor. A $50 honorarium will be awarded to those respondents who provide the greatest variety of content-related scientific humor and agree to participate in the observation/interview phase of the study.

A $50 honorarium will be awarded to those respondents who provide the greatest variety of content-related scientific humor and agree to participate in the observation/interview phase of the study.
## Appendix C

Scientific Humor Classroom Observation and Quantitative Data Analysis Protocol

Teacher ___________________________ Years of Experience ___________________________ Subject/Level _________ Date _____________________

### Length of Class:

### Beginning Time:

### Dismissal Time:

**Key:**
- **C** = Conversational
- **EE** = Reflects Everyday Experiences
- **Q** = Asks Questions
- **DE** = Detached Exploration of Questions
- **CS** = Cognitive Shift/Perspective
- **CT** = Critical Thinking
- **OBO** = Opposes Blind Obedience
- **TE** = Thought Experiments

* Check if applies

<table>
<thead>
<tr>
<th>Type of Humor (Joke, Anecdote, Cartoon, Picture, Video, Other)</th>
<th>Learning Objective(s) Addressed (Knowledge/Remember; Comprehend/Understand; Apply; Analyze; Synthesize/Evaluate; Evaluate/Create)</th>
<th>C *</th>
<th>EE *</th>
<th>Q *</th>
<th>DE *</th>
<th>CS *</th>
<th>CT *</th>
<th>OBO *</th>
<th>TE *</th>
<th>Observer Comments</th>
<th>Teacher's Stated Reason for Humorous Event (Stated During Interview)</th>
<th>Was Learning Assessed for this Topic (Y/N), if so How?</th>
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<td>J A C P V O</td>
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<td></td>
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<td>Y/N</td>
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</tbody>
</table>
Appendix D

Lesson Observation Proposal

Dear Teacher,

You have been asked to suggest two to three possible lessons to be observed as a part of a study on the use of content humor in science instruction. The principle investigator (person in charge of this research) is interested in obtaining the best examples of the content humor that you use to teach science topics. The principal investigator will use the information that you provide on this form and possible follow-up discussions with you to determine the most appropriate lesson(s) to observe. Please provide a general outline of the purpose of three separate lessons, what sort of instructional activities will occur in each, and the nature of the humor you will be employing in each.

Lesson #1 Purpose:
____________________________________________________________

Instructional Activities:
________________________________________________________________________

Nature of Humor to be used within Lesson:
________________________________________________________________________

Lesson #2 Purpose:
____________________________________________________________

Instructional Activities:
________________________________________________________________________

Nature of Humor to be used within Lesson:
________________________________________________________________________

Lesson #3 Purpose:
____________________________________________________________

Instructional Activities:
________________________________________________________________________

Nature of Humor to be used within Lesson:
________________________________________________________________________
Appendix E

Postobservation Teacher Interview Protocol

1. Please identify your humorous attempts in the class that was just observed.

2. Please identify the purpose(s) of each of these humorous attempts (For example, if the purpose was student learning, was it for students to be able to better remember, understand, apply, analyze, evaluate, or create [synthesize]?)

3. How do students react to your use of humor? How do you know if they are amused?

4. How can students better demonstrate their learning using humor?

5. How do you use humor in assessment?

6. How do you decide what humor to use?

7. Where do you get the material you use from?

8. How do you see the difference between scientific humor and joking?

9. Please provide additional examples of your content-related scientific humor

10. May I have copies of the examples of scientific humor you used in the observed class?

Follow-up interview questions for clarification.
Appendix F

Student Recruitment and Assent
(To be read aloud to secondary students)

Hello everyone, my name is Francine Wizner. I am here to request your participation in a study that I am doing. The purpose of this study is to find out how science teachers use humor in their teaching of science concepts to help you learn better. Your teacher will be video recorded while teaching a science lesson in your classroom.

Although the video camera will be mostly focused on your teacher, you may also be recorded while talking to the teacher. Your grade will not be affected by this study, nor will any information about you be given to your instructor or other classmates.

I will also be asking several of you to answer some questions for me. The questions will be about your opinions about anything you may have found funny or unusual when your teacher was explaining science ideas to the class. If you are interested in participating in this study, I must receive the signed consent forms from both you and your parent. If you are not interested in participating in this study, simply don’t return either form.

I am passing out the informed consent statement, one for you and one for your parent to read and sign.

Even if your parents sign the informed consent statement, if you do not wish to participate then you do not have to. Simply don’t turn in the form, or tell me you don’t want to participate. Does anyone have any questions?

Please sign and return this form only if you are interested in the possibility of being interviewed for this study. If so, your parent’s signed form must also be returned to me.

__________________________________________________________
Student Signature                                           Date
Appendix G

Postobservation Student Interview Protocol

1. Please identify any humorous attempts in the class that was just observed (whether or not you found them amusing). [Prompts of observer-perceived or teacher-articulated humorous attempts by teacher may be provided here.]

2. What humorous attempts (if any) did you find amusing?

3. What (if any) purpose did your teacher have in producing each of these humorous attempts? (For example, if the purpose was student learning, was it for students to be able to better remember, understand, apply, analyze, evaluate, or create [synthesize].)

4. How did you react to your teacher’s use of humor? Is this your normal reaction?

5. How do you typically react when your teacher uses humor?

6. Please tell me about any relationships between your teachers’ use of humor and what you are learning.

7. If so, please provide examples of humor that helps you learn and why it helps.

Follow-up interview questions for clarification.
Appendix H
Quantitative Data Analysis of Scientific Humor Survey Responses:

Data Sheet

Secondary Teacher

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total Reported on Survey</th>
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<tbody>
<tr>
<td>Level Taught:</td>
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<tr>
<td>Subject(s):</td>
<td></td>
</tr>
<tr>
<td>Years Teaching Experience:</td>
<td></td>
</tr>
<tr>
<td>Types of Content Related Humor Used</td>
<td></td>
</tr>
<tr>
<td>During a Typical Class Period</td>
<td></td>
</tr>
<tr>
<td>Jokes</td>
<td></td>
</tr>
<tr>
<td>Anecdotes</td>
<td></td>
</tr>
<tr>
<td>Cartoons</td>
<td></td>
</tr>
<tr>
<td>Pictures</td>
<td></td>
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<tr>
<td>Videos</td>
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<tr>
<td>Other</td>
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<tr>
<td>Humor Frequency During a Typical Class Period</td>
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<td>Period Total:</td>
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(Continued on next page)
<table>
<thead>
<tr>
<th>Tally of Scientific Humor Survey By Question</th>
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</thead>
<tbody>
<tr>
<td>O = Other  L = Lesson  A = Assessment</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Teach Concepts</th>
<th>Manage Behavior/Anxiety</th>
<th>Positive Feelings About Course or Teacher</th>
<th>Engagement</th>
<th>O</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purpose</td>
<td></td>
<td></td>
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<tr>
<td>Jokes</td>
<td>Anecdotes</td>
<td>Cartoons</td>
<td>Videos</td>
<td>O</td>
</tr>
<tr>
<td>Favorite Humor</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jokes</td>
<td>Anecdotes</td>
<td>Cartoons</td>
<td>Videos</td>
<td>O</td>
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<tr>
<td>Objectionable Humor</td>
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<tr>
<td>Amusing</td>
<td>Content Related</td>
<td>Age Appropriate</td>
<td>Not Offensive</td>
<td>O</td>
</tr>
<tr>
<td>Criteria for Selection</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Before L</td>
<td>During L</td>
<td>After L</td>
<td>Throughout L</td>
<td>O</td>
</tr>
<tr>
<td>How Incorporated in Teaching</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>Summative A/Test Questions</td>
<td>Summative A/Project/Presentation/Performance</td>
<td>Formative A/Questions Asked in Class</td>
<td>Formative A/Homework/Classwork</td>
<td>O</td>
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<tr>
<td>Student A of Topics Humorously Taught</td>
<td></td>
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</table>

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Appendix I

Scientific Humor Discourse Framework

<table>
<thead>
<tr>
<th>Event</th>
<th>Act</th>
<th>Role</th>
<th>Genre</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Concept that</td>
<td>(Anecdote, video, modeling a process,</td>
<td>(Actor humor event: teacher, actor in</td>
<td>(Genetics, weather, biochemistry,</td>
</tr>
<tr>
<td>prompts use of humor)</td>
<td>etc.)</td>
<td>video, students, etc.)</td>
<td>etc.)</td>
</tr>
<tr>
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</tbody>
</table>
## Appendix J

Artifact Analysis Framework

<table>
<thead>
<tr>
<th>Content</th>
<th>Design</th>
<th>Presentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valid and accurate</td>
<td>Is the medium (e.g., film, handout) appropriate?</td>
<td>Effective use of time</td>
</tr>
<tr>
<td>Appropriate for learners</td>
<td>Meaningful</td>
<td>Pace</td>
</tr>
<tr>
<td>Relevant</td>
<td>Appropriate</td>
<td>Does it aid understanding?</td>
</tr>
<tr>
<td>Motivational</td>
<td>Logical sequence</td>
<td>Visual quality</td>
</tr>
<tr>
<td>Is it a model that can be used in other situations</td>
<td>Does instructional strategy align with artifact format?</td>
<td>Audio quality</td>
</tr>
<tr>
<td>Clear</td>
<td>Engagement</td>
<td>Physical quality (durable, convenient)</td>
</tr>
<tr>
<td>Concise</td>
<td>Is there an artifact evaluation plan?</td>
<td></td>
</tr>
</tbody>
</table>
Marin’s Artifact: Event 6: Characteristics of Fungi

CHAPTER 7 part 2 ~ MAINTENANCE IN LIVING THINGS

I. FUNGI ~~~ KINGDOM: _______________

A. NUTRITION - Obtaining and processing _______________ for use by cells.

1. All fungi are __________________, which means they must ______________ their food.

• They are classified as saprophytes (decomposers).
• Live ON their food supply and help to decay it.
• Have RHIZIODS that grow into the food source and secrete DIGESTIVE ENZYMES into the food.
• Digestion is said to be EXTRACELLULAR because it takes place OUTSIDE of the fungi’s cells.
• All useable products then DIFFUSE into the rhizoids and DIFFUSE throughout the organism to be used by individual cells.

B. TRANSPORT - The circulation and absorption of materials.

1. No special system. All transport occurs by Passive & Active transport.

C. GAS EXCHANGE - No special system.
Appendix K
Marin’s Artifact: Event 6: Characteristics of Fungi

- Oxygen (in) & Carbon Dioxide (out) are exchanged through the respiratory surfaces (cell membranes) by diffusion.

D. **EXCRETION** - The removal of liquid and gaseous metabolic ________.

1. No Special System. All metabolic wastes are removed through the cell membranes by diffusion, osmosis & active transport.

- Wastes include: _______________________

E. **REGULATION** - No special system.

F. **LOCOMOTION** - NONE - They are considered to be __________.

G. **REPRODUCTION** - Making more of the same ______________.

1. Fungi are ______________

- They reproduce by ____________________

- Sporulation is:

![Diagram of sporulation]

Bread mold A  Bread mold B
Appendix L

Ned’s Artifact: Event 4: Lipids

Living Environment

Name ____________________________

Internet Assignment – Biochemistry

Instructions: Follow the website guides and instructions to answer each of the numbered questions. Answers should be written in complete sentences.

• Log onto the Chem4Kids website (www.chem4kids.com)

• At Chem4Kids Website
  - click on “Biochemistry”, then “Carbohydrates”
  - read the section on Carbohydrates.
    1) What are carbohydrates primarily used for in living organisms?

    2) Explain the difference between a monosaccharide and a disaccharide.

    3) Why is glucose such an important monosaccharide?

    4) Name 2 important STRUCTURAL polysaccharides.

• Scroll back to the top of the page and find the “Basics of Biochemistry”
  - click on “Lipids”
  - read the section on Lipids.

    5) What do plants use wax for?

    6) What is a “triglyceride”? What is a triglyceride made of?

    7) Tell the difference between SATURATED FATS and UNSATURATED FATS.
Appendix M

Ned’s Artifact: Event 11: Anaerobic Respiration Net 2 ATP
Appendix N

Ned’s Artifact: Event 12: Electron Transport Chain

The Electron Transport Chain - A Physical Demonstration

Objective: Student groups will use themselves to demonstrate the components of oxidative phosphorylation. Each group will need:

1. People
   - Electron Carrying Complexes - 6 students
   - NAD+ - 1 student
   - FADH - 1 student
   - Oxygen - 1 student
   - ATP Synthase - 2 students

2. Materials
   - Hydrogen ions (hydrogen cards)
   - Electrons (electron cards)
   - ADP and Phosphate (cards)

Procedure:
1. Students should wear their identity cards.
2. Electron Carrying Complexes should line up, in numerical sequence.
3. ATP Synthase should stand in line with complexes, at the very end.
4. Oxygen will stand in the near vicinity of the last carrier (cytochrome oxidase).
Appendix N

Ned’s Artifact: Event 12: Electron Transport Chain continued

5. A pool of H+ will be placed on the floor in the matrix.
6. NAD will drop off an electron to Carrier I and toss its H+ onto the floor in the matrix
   a. Carrier I will pass the electron to II and toss the H+ into the intermembrane space
   b. II will pass electron to III, and so on until VI has the electron.
   c. As the electron is passed from III to IV, III will pick up a H+ from the matrix (floor) and toss it into the intermembrane space.
   d. As the electron is passed from V to VI, V will pick up a H+ from the matrix (floor) and toss it into the intermembrane space.
   e. ATP Synthase F0 will collect the H+ from the intermembrane space and pass them to ATP Synthase F1.
   f. ATP Synthase F1 will hand H+ to Oxygen. Every time F1 hands a H+ to oxygen, it will phosphorylate one ADP → ATP
6. FADH will drop of an electron to Carrier II and toss its H+ onto the floor in the matrix.
   a. Perform steps b-f above.

Check your understanding. Write your answers on a separate sheet of paper.

1. A chemical poison attaches to Carrier I, preventing it from accepting electrons. How will this affect ATP Synthesis? Explain.
2. A different chemical poison perforates the inner membrane with lots of holes. How will this affect ATP Synthesis? Explain.
3. Below are the events associated with oxidative phosphorylation in the mitochondria, BUT THEY ARE OUT OF SEQUENCE! Rearrange them, placing them in the correct sequence.

   1. H+ flow rapidly through ATP Synthase
   2. Electrons are dropped off by NADH and FADHn
   3. Intermembrane space gets packed with H+
   4. ATP Synthase adds third phosphate to ADP
   5. Electron Flow Through the Electron Transport Chain
   6. Electrons & H+ join with O2 to form H2O
   7. H+ are pumped from matrix into the intermembrane space