A COMPARISON OF SECONDARY SCIENCE TEACHERS' REPORTED AND ACTUAL USE OF NON-INSTRUCTIONAL MASS MEDIA: IMPLICATIONS FOR SCIENCE EDUCATION AND MEDIA LITERACY

By

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To my Lord and Savior: Through whom all things are possible

To my husband: My rock, my anchor, and my lighthouse – always showing me the way home

To my children for their unending patience, unconditional love, and for making me a proud Mommy

To my Mom for being my best friend and steady shoulder

To my Dad who is my first teacher, my daily source of knowledge, and my strength

To my brother, Stephen, for bringing me ladybugs and believing in me

To my extended family and friends who have taught me the true meaning of love and how to live in the moment

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TABLE OF CONTENTS

APPENDIX

LIST OF TABLES

LIST OF FIGURES

Abstract of Dissertation Presented to the Graduate School
of the University of Florida in Partial Fulfillment of the
Requirements for the Degree of Doctor of Philosophy

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By

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Major: Curriculum and Instruction

Current students, inundated by messages about the world through mass media, rely on media more than teachers and textbooks for their information about science. As the decision-makers on instructional methods and tools, and as the first modelers of how science is done, teachers' reasons for and uses of media in the science classroom have the potential to influence student understandings of science. Currently, there is a lack of knowledge about how and why teachers use mass media in their classrooms and more specifically, non-instructional mass media (NIMM) which were not originally intended to be used in the science classroom.

This naturalistic study investigated secondary science teachers' reported and actual classroom uses of NIMM. The following research questions guided this study: (a) To what extent do secondary science teachers report using NIMM in the science classroom? (b) How do secondary science teachers, who report frequent use of NIMM, actually use NIMM in the science classroom? (c) How do secondary science teachers,

who report frequent use of NIMM, conceptualize NIMM? and (d) How do secondary science teachers' uses and conceptions of NIMM compare and contrast?

The participants of this study were secondary science teachers from one K-12 university laboratory school. Data were analyzed inductively using the grounded theory approach and constant comparison method resulting in a grounded theory to explain the factors influencing secondary science teachers' NIMM use.

In general, teachers reported and actually used a variety of NIMM types and a diverse range of instructional strategies for interacting with media. Moreover, the teachers in this study had specific ideas about what media could do for them in the science classroom. Those ideas were influenced by their personal ideologies and the ideas they held about media. They were also influenced by the perceived priorities of their context and the content discipline in which they worked. Collectively, teachers drew on "Six Knowledges" in their choice and classroom use of NIMM. The findings of this study were used to generate suggestions for science teacher education and research in science education and media literacy education.

CHAPTER 1
INTRODUCTION

> "If it were possible to define generally the mission of education, one could say that its fundamental purpose is to ensure that all students benefit from learning in ways that allow them to participate fully in public, community, and economic life." (New London Group, 1996, p.1)

Public, community, and economic life are not the same for 21st century students as they were just twenty years ago. The traditional pedagogies of schools have been content-oriented and framed for a specific type of student with specific future roles in society (New London Group, 1996). Current students live in a global society, connected by resources and tools that allow them to access the world in a matter of seconds. They see endless representations of the world through video games, television, and the internet. They are undaunted by the amount of information they filter each day as students in a classroom, peers in their social circles, children in their familes, and as consumers of mass media. While most students are using family, peers, and the media more frequently than teachers and textbooks to receive their information about current science topics (Reis & Galvao, 2004), our science education system is doing little to recognize this shift and to help students process the large amount of information they are receiving. The traditional pedagogies of school alone can no longer address the needs of our global students.

Reforms in science education have attempted to shift with the political, economic, and social trends of the times. The shifts from learning science as an individual endeavor to one that requires collaboration and hands-on inquiry is both a result of developments in technology and insights into how students learn (Duschl, 2008). Our new global society will require science education to further expand its collaborative efforts and cross interdisciplinary borders to adequately prepare our students to participate in society. This will require science educators to not only help learners develop scientific literacy, but also address the current issues of globalization.

This chapter begins with a description of Literacy and how *scientific* literacy is subsumed by Literacy and then proceeds with a brief overview of how scientific literacy, as described here, fits within the sociocultural frameworks for teaching and learning. An examination of media literacy education and its alignment with the goals of science education will then be discussed to provide a rationale for the current study. The research questions and related assumptions will then be detailed, concluding in an overview of the potential significance and limitations of the study.

Literacy

Several scholars have made attempts to define literacy, with the definitions ranging from a basic ability to read and write to an ability to interact through the use of language. In line with Norris and Phillips (2003), the premise for the subsequent research rests on the belief that literacy is more than "a simple, word-recognition-and-information-location" (p.225) process and requires more than "knowing the words and locating information in the text" (p.226). Instead, literacy requires inferring meaning from texts and recognizing that texts are open to interpretation; "text" meaning any form of symbolic expression used in the communication of meaning (Barthes, 1972). It is assumed that this process of interpretation and inferring meaning will then enable an individual to participate as an engaged and reflective member of society (NAMLE, 2008). In this sense, literacy becomes Literacy with a capital "L" because it subsumes other forms of literacy (e.g., basic reading and writing) and is more comprehensive in its scope.

However, in today's political climate where student achievement is measured as an outcome through standardized tests, it is easy to discount the dependence of learning outcomes on learning processes (Calabrese Barton, 2007). It is equally easy to limit science in the classroom to the content required to pass standardized tests and discount the broader reach of science into our personal, political, and social lives. It is equally easy to limit our view of *scientific literacy* to the science classroom, where educators focus only on present levels of student scientific knowledge and their immediate learning environment. In order to be scientifically literate, students need to learn that science extends beyond the classroom walls and depends upon knowledge and use of more general skills and strategies central to Literacy.

Scientific Literacy

Roberts (2007) proposes that previous definitions of scientific literacy can be placed into one of two categories, Vision I or Vision II. Vision I definitions of scientific literacy focus on the "processes and products of science itself" emphasizing domain-specific knowledge, while Vision II definitions focus on the scientific nature of "situations in which considerations other than science have an important place at the table" (p.730). Vision II definitions strive to highlight the relevance of science to the life of the average citizen rather than to a select group of scientists, and focus on the skills needed to understand science in larger social contexts.

Roberts' (2007) framework is a comprehensible means to compare definitions of scientific literacy, and in his report he clearly illustrates how definitions of scientific literacy in the last ten years have primarily focused on aspects of content knowledge thereby taking a more Vision I approach. As definitions of scientific literacy include discussions of science-related situations or applications of other theoretical constructs from fields such as linguistics, they move towards Vision II definitions; this includes Norris and Phillips' (2003) *fundamental* scientific literacy.

Fundamental scientific literacy, or "reading and writing when the content is science" (Norris & Phillips, 2003, p.224) has historically been overlooked in definitions of scientific literacy. Scientific literacy in the fundamental sense is typically overshadowed by an emphasis on the "derived sense" of scientific literacy, or "being knowledgeable, learned, and educated in science" (p.224), and focusing on "substantive scientific content" (p.235). However, because "oral and written language is the symbol system most often used by scientists to interpret, construct, describe, and present science claims and arguments" (Hand, Alverman, Gee, et al., 2003, p.608), fundamental aspects of scientific literacy should not be overlooked or oversimplified. According to Norris and Phillips,

> Scientific literacy is different from other literacies because of its substantive content. However, the comprehension, interpretive, analytical, and critical capacities required to deal with science text are largely, if not entirely, the same as those required for texts with different substantive contents. Thus, scientific literacy in its fundamental sense is not unique at all, save that the texts are scientific. (p.233)

Rethinking Scientific Literacy

Drawing upon Vision II definitions of science and the necessity of scientific literacy in the fundamental sense, *scientific* literacy in this study means that individuals are able to develop understandings of 1) *science content*, 2) *literacy skills*, and 3) the *contexts* of science to participate as engaged and reflective members of society. Assuming that the goal of science education is to develop scientifically literate students, scientific literacy then becomes less about preparing scientists and more about producing students who can "understand and make critical judgments about science"

(Carter, 2008, p.628). This approach aligns with Roberts' (2007) Vision II of scientific literacy "in which [scientific literacy] is being promoted as important for purposes other than those of the academic science culture" (Roberts, 2007, p.751).

At the most basic level, most researchers agree scientific literacy depends upon an individual's ability to acquire some level of *science content* knowledge (Roberts, 2007). Science content knowledge is the substantive content of science and is a specialized set of knowledge unique to the discipline. Only in science do students encounter topics such as the wave and particle nature of light, or explore relative gravity on other planets to infer relationships between mass and weight. Just as language arts has its own content (e.g., sentence structure, verb tense, literature), science embodies its own set of facts, concepts, and generalizations.

Second, because interpretation of texts determines an individual's level of Literacy, how that interpretation occurs merits clarification. In order to interpret texts, individuals need to develop *literacy skills* including the ability to access, analyze, evaluate, and create meaning. Norris and Phillips (2003) refer to these skills and strategies as "literate constructs" which are not necessarily scientific in nature, but are necessary to comprehending scientific texts. These literate constructs go beyond the basic decoding of scientific vocabulary, or even the more complex task of comprehension; they include developing an understanding of texts, how they are constructed, and using "the resources of text to determine what they mean, or might mean" (p.231). *Literacy skills* then are not unique to science and instead cross disciplinary boundaries.

As Norris and Phillips (2003) point out, focusing on the development of literacy skills or “literate constructs” does not imply that fundamental scientific literacy is the totality of science; it is only part of the meaning of “doing” science. When asked *how* science is done, the typical response includes an explanation of steps that scientists follow to conduct research. In fact, a listing of the skills required to do science traditionally includes observation, communication, classification, measurement, prediction, and inferential thinking (Peters & Stout, 2006). However, in the same way that a focus on science content alone undermines comprehension of the discipline and applications of science, ignoring literacy skills as a necessary component of scientific literacy undermines what it takes to be a scientist or to apply scientific knowledge. This is because “Nobody can acquire a sophisticated level of scientific knowledge … and science itself could never exist without individuals literate in this way” (Norris & Phillips, 2003, p.236).

Third, scientific literacy depends upon an individual’s ability to recognize and to understand the *contexts* of science. The *contexts* of science include science-related situations and social issues with historical and economic significance. Examples of science *contexts* include the controversy surrounding the theory of evolution and even continuation of funding for the United States space program. These topics are science based, but decisions made related to the issues are influenced by the political and economic climates of the time. Lemke (2001) argues that if we teach our students all about the concepts of science but nothing about their historical, economic, or social significance, we miss the relevance of science to students’ lives. This means recognizing science in societal issues when making decisions on those science-based issues.

Similar to *literacy skills*, the *contexts* of science are not unique to science. Science is a social enterprise and therefore has the same fundamental features that all social enterprises have. Therefore, every science context contains elements of history, economics, anthropology, and/or psychology. As Wynne (1992) states, “it is this social dimension which permeates all experience of and responses to science.”

What differentiates scientific literacy from literacies in other disciplines, or Literacy in general, is the goal to make more literate individuals *when the content is science*. Literacy, which subsumes scientific literacy, “involves gaining the skills and knowledge to read and interpret the text of the world and to successfully navigate and negotiate its challenges, conflicts, and crises” (Kellner, 2001, p.69). Therefore, scientific literacy involves gaining the skills and knowledge to read and interpret *scientific* texts of the world and successfully navigate and negotiate scientific contexts. Additionally, engagement in Literacy practices requires negotiating “socially-constructed forms of communication and representation” (Kellner, 2001, p.74), while *scientific* literacy requires negotiating the socially-constructed forms of *scientific* communication and representation. By focusing on *science content* and using *literacy skills,* individuals can begin examining the *contexts* of science in order to participate as engaged and reflective members of society.

Scientific Literacy and Sociocultural Theory

Developing scientifically literate students requires application of theories of teaching and learning. The research study detailed in this proposal is based upon sociocultural frameworks of teaching and learning which posit that learning is based upon, and is a product of, the social and cultural environments in which it occurs (Brown, Collins, & Duguid, 1989). Similarly, individuals within a learning environment interact with each other and with available resources in order to make meaning in their environment. This meaning-making process is dependent upon the participants, their prior background and knowledge, current location in time and space, use of available resources, and collective intentions (Alverman, Moon, & Hagood, 1999). As such, all learning is situated and cannot be removed from its social or cultural context.

Sociocultural theories of learning also view learning as more than content acquisition within a classroom. Learning occurs through the utilization of the tools, individuals, and culture in which learning occurs (Daniels, 2001); with "culture" extending beyond the immediate classroom environment. When students are in the classroom, they make meaning by drawing upon their cultural experiences in both formal and informal learning settings. For example, a student learning about waves in the classroom uses information from his teacher and textbook (i.e., formal learning experiences) to acquire a scientific definition of waves, and simultaneously uses information from his visits to the beach and jumping rope (i.e., informal learning experiences) to appropriate the formal definition with his informal experiences. "Culture" therefore encompasses the immediate learning environment, and the individual experiences the learner brings to the meaning-making process from outside of the classroom.

The physical resources with which students interact and the experiences they bring to the meaning-making process are not the only type of tools they use to make meaning. “Just as important are the meaning-making tools that mediate communicative and reflective action…. Chief among these [is] … language in all its modes” (Wells & Claxton, 2002, p.4). This is because it is through language and discourse that shared meaning is made and knowledge is organized. “Language is not a *domain* of human knowledge; language is the essential condition of knowing, the process by which experience *becomes* knowledge” (Halliday, 2003, p.94, original emphasis by author). Sociolinguistics, or the study of how culture influences the use of language and vice versa, suggests that each mode of communication conveys a message and individuals communicate in different ways for different purposes (Lemke, 2001).

In the science classroom, the meaning-making process is dynamic and influenced by the teachers’ instructional choices. Just as students’ informal cultural experiences and interactions with each other influence their meaning-making, the resources teachers bring to the classroom, how they formally introduce them during instruction, and their use of language influence how students make meaning of science. This is true of both traditional instructional resources like textbooks and non-instructional resources such as newspapers, films, and videogames that are readily accessible to the public but were not originally intended for use in the classroom.

Media Literacy and Science Education

Teachers are bringing non-instructional mass media (NIMM) resources into the classroom as instructional tools for teaching science in an attempt to facilitate relevancy to student lives by mimicking student choices for information about science (Yates, 2002). A National Science Foundation report (2000) confirms the increasing role of NIMM by reporting that television is the leading source of information for students about new developments in science and technology, followed by books and newspapers.

Similarly, Reis and Galvao (2004) found that students identify television as their main source of information on science (53.6%), followed by print news (26.1%), Internet (23.8), and media in general (16.7%). This should not be surprising as Martinson (2004) suggests that our population's growing diversity increases the likelihood that students will rely on different forms of media for information rather than on teachers or textbooks.

The reliance on non-instructional resources presents new challenges for science educators. The same teachers and students that use these sources for science learning often assume that the information reported in non-instructional resources is reliable and neatly translates to textbook or classroom science when, in fact, this is not always the case (Marks, Kalaitzandonakes, Wilkins, & Zakharova 2007; Nisbet & Mooney, 2007). If teachers choose to use NIMM as sources of information about science in the classroom to meet the interests of their students, they need to realize that students may not be able to critically evaluate mass media for their sources of information or levels of credibility, and need explicit instruction on how to interpret and use media before they can accomplish scientific literacy as set forth in this research (Elliott, 2006; Kolsto, 2001). This explicit instruction on how to read and interpret media is known as media literacy education.

Media literacy education is more than just using media in the classroom; it includes teaching *about* media (Buckingham, 2003). This means teaching about the content of media as well as its socially constructed nature. Following the general assumption that media is transparent and the representation of topics in the media is clear, Jenkins and colleagues (2006) state that in order to see “through” media to the underlying issues, its conventions, biases, and patterns of construction need to be deconstructed. Just as the contexts of science are influenced by political and economic factors, so is the development of mass media resources.

Media literacy education also includes teaching students how interpretations of text are made and how background knowledge and experiences influence interpretation. Under sociocultural theories of learning, if mass media is used to learn about science, then understandings of science will be based, at least in part, upon interpretations of that medium. As Norris and Phillips (2003) state, any one scientific text can have multiple interpretations based upon the reader's background knowledge and experiences. Background beliefs can either take a dominant role in the interpretation of texts by shadowing the perceived importance of the science content in the text in favor of prior background knowledge and experiences, or background knowledge and experiences can take a backseat to the science content of the text. In this latter case, students place greater value on the science content of texts than on their prior knowledge despite any potential shortcomings of the text in terms of its credibility as a source of information. This is especially problematic when teachers use NIMM because NIMM were created independent of consideration for students' background knowledge and were not originally intended for classroom use.

Just as one outcome of science education is the development of scientifically literate students, the desired outcome of media literacy education is media literacy. Media literacy, or the ability to access, analyze, evaluate, and communicate messages in a variety of forms (Hobbs, 2003) parallels Norris and Phillips' (2003) description of scientific literacy in the fundamental sense. Students who are scientifically literate in the fundamental sense have,

> the metacognitive ability to examine not only the sources of knowledge, its limits, and its certainty, but also to interpret texts in various ways, to adjudicate those ways in light of available evidence, and to adopt a stance towards the texts that is neither deferential nor dismissive but properly critical. (p.235)

In the field of media literacy education, researchers agree that media literacy education cannot be an add-on approach (Scheibe, 2004). “Media literacy … offers not a new subject to teach but rather a new *way* to teach and even more important, *a new way to learn”* (Thoman & Jolls, 2004, p.21). It has been suggested that incorporating media literacy education within specific content disciplines like science allows teachers to multi-task while addressing their content area standards. In fact, some researchers have argued that media literacy education cannot be de-contextualized. “Different social groups have different orientations towards the media, and will use them in diverse ways" (Buckingham, 2003, p.39). For this reason, if students are using media to learn *about* science, then media literacy education must occur *in* science to address both the media and science orientations students may use to understand media’s portrayal of science.

Problem Statement

Teaching is a dynamic endeavor involving both the student and the teacher. The role of the teacher is complex and requires knowing the students, their conceptual knowledge, and their ability to gain new knowledge. Under sociocultural theories of teaching and learning, teachers must also understand the social context where learning occurs and recognize that pedagogical choices contribute to the development of student conceptual knowledge (Daniels, 2001). Therefore, as the decision-makers on instructional methods and tools, and as the first modelers of how science is done, teachers' reasons for and intended uses of NIMM in the science classroom are worthy of investigation.

Research in media literacy education has begun looking at the general media literacy skills of students (Paradise & Bergstrom, 2004), and media use by teachers in the classroom (Hobbs, 2006a), yet little is known about the media literacy skills of teachers. Additionally, some research in media literacy education has found that teachers use media in the classroom to cover content, but that they rarely initiate discussions about the specific conventions or patterns found in the media and the potential biases they present (Hobbs, 2006a). However, in addition to naïve conceptions of media, there is the potential that educators who use media in their classrooms without an awareness of how media representations are constructed will contribute to inaccurate or incomplete student understandings of content knowledge. Research indicates there is a strong association between teacher assumptions about learner capabilities and their own understandings and their chosen pedagogical practices (Henderson & Bradey, 2008), therefore explicit and implicit teacher assumptions about their own media literacy skills and the media literacy skills of their students may affect how educators use media as well as how students perceive the use of media in the classroom.

Purpose of the Study

This study investigated how secondary science teachers use mass media in the classroom. Specifically, detailed examination focused on how teachers used *non-instructional* mass media (NIMM) resources*, or* mass media that were not originally intended to be used in the classroom.

Mass media is any tool or instrument used to convey a message and intended to reach large numbers of geographically dispersed audiences simultaneously and is classifiable according to its purposes (e.g., instructional, informational, entertainment, or a combination of purposes), levels of interactivity (i.e., ability to alter content based on user interaction), and mode of communication (e.g., print, visual, auditory, or digital). Because instructional forms of mass media (i.e., media created with the *initial* intent to be used in classrooms) are typically supplemented with teacher support materials for classroom use, and NIMM resources typically lack that support, only NIMM were considered in this study.

Additionally, because m*ass media* is any tool or instrument used to convey a message and intended to reach large numbers of geographically dispersed audiences simultaneously, this study excluded point-to-point, person-to-person, social networking, and person-to-small community methods of communication. For example, an email between a teacher and a student was excluded from the study because its intention is person-to-person communication. Similarly, a blog created for classroom use, and not intended to be "mainstreamed" or used by large numbers of geographically dispersed audiences, was excluded.

Although an individual piece of media may contain overlapping purposes, in order to create boundaries for this study, a clear definition of media was needed. Generally, NIMM was identified by one the following five categories, which incorporate levels of interactivity and mode of communication (see Figure 2-1): newspapers and magazines, trade books, television and film, radio, or digital media.

Research Questions

This study explored the extent to which NIMM resources played a role in teachers' instructional activities in secondary science classrooms. Specifically, four questions related to teachers' classroom use of NIMM and their conceptions of mass media were investigated.

1. To what extent do secondary science teachers report using non-instructional mass media in the science classroom?
   a. What type(s) of mass media do they report using?
   b. What science topics do they report choosing to explore through mass media?
   c. What is their reported frequency of mass media use?
   d. How do they report using mass media?
   e. What are their reported purposes for using mass media in the science classroom?
2. How do secondary science teachers, who report frequent use of non-instructional mass media, actually use non-instructional mass media in the science classroom?
   a. What type(s) of mass media do they use?
   b. What science topics do they choose to explore through mass media?
   c. How often do they use mass media?
   d. How do they use mass media?
   e. What functions does mass media use serve in the science classroom?
3. How do secondary science teachers, who report frequent use of non-instructional mass media, conceptualize non-instructional mass media?
   a. What are their reported media literacy skills?
   b. What ideas do they hold about the media literacy skills of their students?
4. How do secondary science teachers' uses and conceptions of non-instructional media compare and contrast?
   a. How do secondary science teachers' *stated* use of non-instructional mass media compare to their *actual* use in the science classroom?

b. How do secondary science teachers' uses of non-instructional mass media in the science classroom compare to teachers' conceptions of mass media?

Discussion of Research Questions

Research Question 1: Stated Use

The first question and associated sub-questions examined teachers' *stated uses* of NIMM in the classroom, or their vision for how or why instruction with NIMM will occur in the classroom (van den Akker, 1998).

Sub-question 1a. This sub-question examined the types of NIMM teachers report using in the science classroom as identified by one the following five categories: newspapers and magazines, trade books, television and film, radio, or digital media (see Figure 2-1).

Sub-question 1b. This sub-question examined the choices teachers made with regard to the topics they report exploring through mass media. This included investigation of whether teachers reported using NIMM to address textbook representations of science, complex or abstract science ideas not otherwise presented in textbooks, controversial science issues, or if they used them in other, unforeseen ways.

Included in the investigation was how the topics they reported exploring through mass media compared to the types of mass media they reported using. For example, some teachers may more frequently report using newspapers in the classroom than film; however, they may only report using newspapers when investigating multiple perspectives on a controversial issue whereas they may report using film to illustrate an abstract scientific concept.

Sub-question 1c. This sub-question investigated teachers' frequency of mass media use in the secondary science classroom as reported by the teachers. Research on frequency included how often teachers chose to use mass media in the classroom and how often they chose to use specific types of mass media.

Sub-question 1d. This sub-question investigated how teachers report using NIMM in the classroom. This included the sequence, treatment, and ownership of media use in the classroom. Examination of sequence included where in the instructional sequence secondary science teachers reported using mass media and where within an individual lesson within that instructional sequence they choose to use mass media. Investigation of treatment included how teachers introduced mass media - if teachers referenced it as a transparent tool for investigating science or if teachers encouraged examination of its construction and presentation. Exploration of ownership considered who was interacting with mass media. Do teachers use media as a teacher-directed activity or is it more student-centered in nature as proposed by Tyner (2004), which is more consistent with sociocultural theories in science education about how children learn.

Sub-question 1e. This sub-question examined teachers' reported purposes for using NIMM in the secondary science classroom. While mass media is created primarily for entertainment, instructional, or informational purposes, teachers' reasons for using mass media may be significantly different than how the media were originally intended to be used.

Research Question 2: Actual Use

The second research question examined the in-class actions, or teachers' *actual use* of NIMM. The same sub-questions examined in Question 1 were investigated *in action* in this second question.

Research Question 3: Conceptions of Media

The third research question and associated sub-set of questions examined the ideas teachers hold about mass media. It also examined their *media literacy* skills and the ideas teachers hold about the media literacy skills of their students. *Media literacy,* in this study, is defined as the ability to access, analyze, evaluate, and create media (Hobbs, 2003).

Sub-question 3a. The first sub-question investigated teachers' reported media literacy skills. Teachers' media literacy skills were examinable through their understanding of how to obtain copies of mass media, critically examine the codes and conventions of different media genres, recognize that media is constructed for a specific purpose and for a particular audience, effectively compare the strength or weakness of a mass media, or produce media (Hobbs, 2006a).

Sub-question 3b. Similarly, teachers' ideas about the media literacy skills of their students were explored through their discussions of their mass media use in the classroom, or their vision for how or why instruction with mass media occurred (van den Akker, 1998).

Research Question 4: Comparisons

The fourth research question drew comparisons between the results of the previous three research questions.

Sub-question 4a. This first sub-question sought to draw comparisons between teachers' stated uses of NIMM and their actual uses.

Sub-question 4b. This second sub-question explored how a teachers' actual use of NIMM compared and contrasted to their stated use and the conceptions they held about mass media. This question considered teacher discussion of their stated uses of mass media, accounts of their actual classroom practice, and teacher discussions of mass media.

Assumptions

Following the work of Aufderheide (1993, p.2), this research made the following assumptions regarding mass media:

- All media is constructed with a specific purpose for a specific audience. Media is constructed for instructional purposes, for disseminating information, for entertainment, or for a combination of the before-mentioned purposes;
- Media messages are produced within economic, social, political, historical, and aesthetic contexts;
- Media have unique 'languages,' or characteristics which typify various forms, genres, and symbol systems of communication;
- Media representations play a role in people's understanding of social reality.

Additionally, this research assumed the following about instructional practices and the use of mass media in the classroom:

- Media literacy skills are essential to understanding the content of media.
- A teachers' actual use of mass media is not necessarily aligned with their stated use.

Significance of Study

The results of this study have the potential to further develop the definition of scientific literacy as it is understood in the scientific community by providing a new way of looking at scientific literacy in the fundamental sense through the investigation of NIMM use in the secondary science classroom. Investigation of media use in the science classroom may illuminate the benefits and potential constraints of using media in the science classroom as well as contribute to the field's understanding of how teachers' stated use of instructional materials compares to their enacted use. Rather than assuming teachers and students have the skills necessary to use media effectively to understand science, this study provides evidence of teachers' skills compared to their reported and assumed skills. The results of this identify a need for media literacy instruction in science education, which impacts the face of secondary science pre-service teacher education programs. Finally, the results of this study contribute to the field of media literacy education which currently lacks an understanding of how media is used in specific content disciplines.

Summary of Chapters

Following this chapter, which includes a description of the problem and its significance to the field of science education, Chapter 2 provides a review of the relevant literature. Chapter 3 details the research design and methodology. Chapters 4-6 report the results of the research questions. A summary and discussion of the results, implications of those results, and suggestions for future research on media and science education are included in Chapter 7.

CHAPTER 2
REVIEW OF THE LITERATURE

Since its inception in the 1930s in Great Britain, "media literacy" has moved from a focus on appreciating forms of mass media to a focus on "empowering individuals to be more active and informed citizens of mass media" (Broz, 2001, p.3). Media literacy, or the ability to access, analyze, evaluate, and communicate messages in a wide variety of forms (Hobbs, 2006a) has evolved as perceptions of media and its influence on audiences have changed. Original models of media consumption positioned audiences as passive consumers of media incapable of seeing through its propaganda-filled ideologies. The current model of media consumption follows other constructivist theories that posit the audience as an active constructor of knowledge who draws upon prior knowledge and experiences to interpret text. "Text" refers to any form of symbolic expression used in the communication of meaning (Barthes, 1972) including visual, printed, auditory, static, or interactive texts (i.e., those whose content changes with user participation). Although learners are capable of constructing new knowledge through this interpretation of text, as Alvermann, Mood, and Hagood (1999) suggest, "there is no assurance that they are making meaning that goes beyond their own expert understanding" (p.29).

To examine some of the unique features related to science classroom use of mass media, the current literature review will move from a discussion of general to specific. First, it will present a general overview of classroom use of mass media. Second, it will introduce a theoretical framework used by scholars of media literacy education to analyze and evaluate media texts. Third, as a means to categorize the research on secondary science classroom use of media, this framework will be used to critically review and synthesize literature related to how teachers and students in secondary science classrooms use the following five categories of media: 1) newspapers and magazines, 2) trade books, 3) television and film, 4) radio, and 5) digital media. The chapter will also include a more detailed discussion of some of the strengths and limitations of the literature presented. Finally, a brief summary of the major findings will precede a discussion of how the following study intends to expand on the previous work cited, and also contribute to the literature in both science education and media literacy education.

Overview of Classroom Media Use

Among developed nations, the United States is one of the few countries lacking a required media literacy program in secondary schools. While most developed countries mandate media literacy education, Hart and Suss (2002) showed that mandating media literacy education does not ensure consistent implementation of the goals of media literacy education. Their report of the media literacy education programs of twelve European countries found that teachers' reported use and actual use of media in the classroom varies widely. Additionally, teachers' choices for types of media to include in media literacy education programs varied between countries and programs.

Teachers in the United States report using a variety of media types in their classroom instruction including newspapers, television, trade books, and magazines. Yates (2002) surveyed 350 K-12 teachers from both public and private schools in a small southeastern city in the US and found that two-thirds of the teachers surveyed reported using media in the classroom. Forty-one percent of the teachers said they would prefer to address media more often in their classrooms and forty-eight percent of those surveyed reported teaching *about* media as a part of other subjects. Yates also found that teachers thought students were competent using media but lacked a developed understanding of media including an ability to self-regulate media use, distinguish fact from fiction in media reports, and choose useful or valuable media to support their arguments.

The teachers in Yates' (2002) study reported several constraints to using media in their classrooms. Among them were the lack of materials, time, and training – barriers also found in media literacy research (Hobbs, 2005; Kubey, 2004). Additionally, the teachers in Yates' study cited administrative and parental objections as constraints to incorporating mass media in the classroom. Hobbs (2003) reported a similar finding and found that media use was seen by teachers as "subversive" (p.104). Teachers were concerned with how administrators and parents would view media use in the classroom because it was often deemed a controversial source of information and felt the need to "fly below the radar" if they used media in the classroom.

Finally, some teachers reported using mass media sparingly because they felt their students were too young to benefit from its use or to understand the complex ideologies found in mass media to read mass media texts responsibly. However, other studies in media literacy education have shown that children as young as eight years old are able to identify persuasive messages and decipher the intent of advertisements following media literacy instruction (Paradise, 2004). Teachers with little or no personal experience with media literacy education would be unaware of this potential and might be quick to discount media as a learning tool because they feel students are unable to critically read media.

While surveys administered to large numbers of teachers gives a better picture of how teachers are intending to use mass media, and teacher interviews and media literacy interventions show promise in documenting teachers' and students' abilities to engage in media literacy instruction, previous research has not delineated between the practices of teachers in different content disciplines (i.e., social studies, science, math, or reading). Given the large amount of research on media literacy instruction in language arts, it would not be surprising if the teachers in Yates' (2002) study who reported high mass media use, for example, were from language arts or other traditional reading and writing content areas. Additionally, while Yates' study reported on teachers' stated use of mass media in the classroom, it did not include any observations of actual practice. The teachers surveyed claimed to use mass media, but it is unclear if their intentions matched their actual practice.

Only two known studies have looked at the reported use of media by teachers in science classrooms (Jarman & McClune, 2002; Kachan, Guilbert, & Bisanz, 2006). Jarman and McClune, in an attempt to "explore the extent and nature of teachers' use of print media" (p.999), researched science classroom use of newspapers in Northern Ireland. They interviewed fifty science department chairs and found that most (92%) reported using newspapers in their classrooms in some manner. The interviewed teachers varied in how they used newspapers, with few (34%) using them systematically and intentionally and even fewer (4%) using newspapers to encourage critical evaluation of media. Most teachers reported using newspapers to stimulate students' interest in a topic or provide real-life connections to science content, and most often used newspapers to explore environmental, human biology, health, or genetics related themes. This supports the results of Wellington's (1991) content analysis of science-related news articles, which revealed that most news articles are highly "issue-based" covering topics of current concern, and focus primarily on the biological sciences. While Jarman and McClune's study examined science classrooms, as compared to Yates' (2002) study of all teachers, they only included one type of media in their investigation – newspapers.

Kachan, Guilbert, and Bisanz (2006) expanded on Jarman and McClune's (2002) study and added magazines, television, radio, and the internet as possible sources of informational media. Their study examined teacher use of media in a Canadian science classroom. In addition to interviewing teachers about their reported use of media, Kachan and colleagues examined multiple national and international policy statements for direct references or statements supporting science classroom use of news media. *Science for All Americans* (AAAS, 1990) and its related guide, *Benchmarks for Scientific Literacy* (AAAS, 1993) contained the most direct reference to the use of mass media in the science classroom, while national documents contained the fewest statements. Similar to the European programs reported in Hart and Suss (2002), Canadian provinces all have mandated media literacy education programs incorporated in their English and Language Arts curriculum (Duncan, Pungente, & Andersen, 2002), so they found it surprising that national documents made so few references.

In terms of classroom use, the twenty-four science teachers interviewed all reported using mass media in their teaching with more than half (74%) reporting frequent use. The types of media used varied from newspapers (71%) and magazines (58%) to television (33%), radio (17%), and the internet (42%). Similar to the findings of

Jarman and McClune (2002), most of the teachers used media reports to illustrate science-technology-society connections to classroom content and to increase students' interest in science. Teachers used media reports most often as discussion material and as motivators to begin a science lesson. Lastly, teachers reported that most of their students (88%) reacted positively to the use of media reports in the science classroom and actively participated in media-related classroom activities.

While Kachan and colleagues (2006) expanded on Jarman and McClune's (2002) findings by including multiple forms of media, they relied on teachers' reported use of media and not their actual classroom use. Only one known study has looked at how science teachers actually use mass media in the classroom when the content area is something other than media literacy education, as is seen in several European countries. Mayoh and Knutton's (1997) observation of 103 science lessons included reports of science teachers using mass media, but described the incidents as "episodes involving out-of-school experiences," which were defined as "any experience or understanding arising outside formal classroom-based instruction" (p.850). Mayoh and Knutton recorded who initiated the episode, the type of classroom interaction or activity (i.e., small group, talk, teacher-led talk), the apparent role played by the episode within the classroom, whether the episode was planned or spontaneous, and whether the use of the episode was made explicit to the students or if it remained implicit. Twelve percent of the 215 episodes recorded were media-related. Other types of episodes included references to personal accounts of science in their lives such as knowing a fireman or descriptions of how a pot of water boils on the stove.

Of those episodes classified as media-related, most were teacher initiated, seemed to spontaneously occur during discussions, concerned science in the news as seen on television or in newspapers, and referenced environmental issues. Only two recorded episodes showed any planned use by the teacher, and both of those episodes were homework assignments in which teachers asked students to find an example of science reported in the news. While mass media was only one potential out-of-school experience in this study and was not its focus, this study was unique in that it examined actual science classroom practice and included investigation of more than one type of media use.

While a look across the school curriculum shows widespread media use and the use of multiple types of media, beyond the study by Kachan and colleagues (2006), science education research has limited itself to investigations of teachers' use of individual types of mass media such as newspapers or television or film. Additionally, comparisons between teachers' stated use of mass media and their actual use are lacking.

The following sections will highlight findings from science education research that examine science classroom use of select types of mass media. The review uses a media literacy perspective to provide a framework for critically analyzing and synthesizing the literature, which is described in more detail in the following section.

A Framework for Media Literacy Education

Current dialogue surrounding media literacy education recognizes that "visual, electronic, and digital media are reshaping the knowledge, skills and competencies required for full participation in contemporary society" (Hobbs, 2006a, p.20). As such, scholars in media literacy education have worked to develop a conceptual framework of media literacy for K-12 practitioners that might be useful for incorporating media literacy education in the current curriculum. The framework assumes that contemporary education requires attending to new forms of literacy. These new forms of literacy require that students understand the significance of media authorship and its relationship to audiences, the unique properties of media “texts,” and the contexts in which different types of media are used. Therefore, the framework used in the following pages consists of three categories: (1) authors and audiences, (2) messages and meanings, and (3) representations and reality.

As illustrated in Table 2-1, the framework draws on the assumptions of mass media presented in the previous chapter. It also recognizes that instruction needs to look at the meaning potential of texts, the meaning potential of the context (i.e., how texts used in the classroom contribute to how students view literacy in the classroom), and the physical and cultural resources the reader brings to the exercise of reading texts (Jewitt, 2008; Unsworth, 2001). As Table 2-1 illustrates, each category is addressable through media literacy instruction using three guiding questions (Share, Jolls, & Thoman, 2009).

The first of the three categories, authors and audiences (AA), describes the essential role of both the author and audience in the meaning-making process. Authors create texts for a specific purpose and choose the format and mode of communication based on those purposes. Similarly, audiences choose texts to meet their own needs. While creators of media texts target specific audiences, those audiences have the liberty to choose which media text to read or use. The relationship between authors and audiences is interdependent; one cannot exist without the other or else the transmission of media messages does not occur. The second of the three categories, messages and meanings (MM), looks at the way authors and audiences create meaning by changing the way messages are presented, interpreted, or processed. The messages within media text are created and presented using specific symbol systems (language, image, music, sound) and delivery systems (print, visual, auditory, and digital), and each of these systems have specific codes and conventions unique to the type of genre used to convey a message. Genres in this study will follow Baram-Tsabari & Yarden's (2005) definition; a genre is a text type defined by function, sociocultural practices, and communicative purposes. For example, the authors of a video on global warming may choose to use dramatic music in addition to images to catch the attention of an audience. The *type* of media is film. Within the film, the author uses multiple *modes* of representation: music, moving images, and written text. The *genre* of music used, whether classical or pop rock will influence the way an audience receives a message. The music genre may convey global warming as a classical or contemporary issue based upon the choice of music. Similarly, a written story about polar bear habitat destruction differs from a series of moving images conveying the same message. Moving images and written text are two different modes of representation. An author chooses the mode based upon the intended audience and effect. Similarly, the author chooses different genre (i.e., a poem about the polar bear or a non-fiction informational text) to convey the content of a message about habitat destruction. Therefore, each of the types, modes, and genres are comparable and classifiable based upon how they convey a message.

In addition to message construction, the audiences receiving the messages build meanings. Based upon constructivist theories of learning, audiences build their own understanding of the messages within media texts by using their prior knowledge and experiences. How a reader processes information from a written story differs from how they process information in a visual image (Kress, 2000). Additionally, once audiences build understandings, their interpretation influences further action in terms of decision-making, attitude formation, worldview, and behavior.

The final category, representations and reality (RR), considers how texts influence audiences' perceptions of reality. Authors have their own set of ideologies that limit the perspectives authors use to create media texts. Therefore, they omit information either intentionally or unintentionally. This creates media texts that are inherently biased and limited in their points of view, which , in turn, influences an audience's ability to construct a complete picture of 'reality.' Audiences are dependent upon authors to share information about a topic, but an author's knowledge and, possibly, the amount of space they have to share that information, limits the amount of shared information. Furthermore, authors may intentionally use techniques beyond omitting information to influence an audience's perception of reality. For example, sensationalism is a widely recognized technique used by authors of media. By adding sensationalistic features to a story, audiences are more likely to react in favor of the authors' point of view by buying more copies of the media or taking action in regards to the topic discussed. Representations of reality in media texts may or may not influence individuals' understandings of a particular context or influence their action within that context.

Performing the Search

Exclusion Criteria

Three variables limited the literature that was included in this review. First, literature discussing secondary science classroom use of mass media was given priority over literature discussing other classroom contexts or general uses to mimic the context of the subsequent research. This research included both students' and teachers' use, with teachers' use encompassing both pre-service and in-service teacher experiences.

Second, while there is abundant research on classroom use of *instructional* forms of mass media (or media created with the *initial* intent of use in classrooms), the following review includes research limited to *non-instructional* forms of media (i.e., informational and entertainment media). This distinction was made under the assumption that instructional forms of mass media more often come with instructions for how to use the materials in the classroom than non-instructional mass media (NIMM). Therefore, secondary science classroom use of NIMM requires teachers to make decisions about which media to use and how to use them without ancillary support.

Third, although practitioner journals are peer-reviewed and contain useful suggestions for classroom use of mass media, they were not included. Given the empirical research orientation of the following study, this review excludes anecdotal reports of classroom media use. Descriptions of studies found in practitioner journal articles typically lack the detail required to analyze and synthesize the studies under review.

Search Terms

The following search engines and databases were used to locate the research presented in the next sections: EBSCO Host (including Academic Search Premier, Communication and Mass Media Complete, and Sociological Collection), Web of Science (including Science Citation Index Expanded, Social Sciences Citation Index, and Arts & Humanities Citation Index), and Wilson Web (including ERIC, Education Full Text, and Education Index Retro). Table 2-2 illustrates the types of media targeted in the search and the relevant search terms and phrases.

In addition to individual searches using the keywords or phrases, searches were conducted using the types of media in combination with the following terms: media, mass media, multimedia, media texts, multimodal, science education, science, science teaching, science classroom, teaching, learning, media literacy, media literacy education, and critical media. Most of the identified research came from journals in the fields of Science Education, Media Literacy Education, Public Understanding of Science, Journalism and Mass Communication Studies, and Instructional Technology.

Structure of the Review

The remainder of this review of the literature uses the previous outlined media literacy framework to examine and categorize the research on secondary science use of non-instructional forms of media falling in one of the following five categories: 1) newspapers and magazines, 2) trade books, 3) television and film 4) radio, or 5) digital media. Preliminary review of the literature revealed that previously used distinctions between media purposes (i.e., informational or entertainment), modes of presentation (print, visual, auditory, or digital), or level of interactivity (static or interactive) were too limited to allow for all forms of media considered in this study. For example, some television broadcasts may have informational purposes (e.g., *NBC Nightly News)* while others are for entertainment (e.g., *Heroes*) and still others are for a combination of purposes (e.g., *How Stuff Works).* Similarly, some videos are strictly visual, meaning they contain moving images (e.g., silent films), while most are a combination of visual and auditory. Others are a crossover been visual, auditory, and digital (e.g., streaming video on the Internet). Therefore, this study classifies media types according to a combination of their purposes, modes of presentation, and levels of interactivity, while recognizing that these are also not discrete categories and that some overlap may occur. A more detailed illustration of how this review classifies mass media is in Figure 2-1.

Once the type of media considered within a study was identified, the studies were individually analyzed using the media literacy framework in Table 2-1. For example, if a study investigated secondary science classroom use of an entertainment film, and the focus of the study was on a teacher's ability to judge the credibility of the information within the film, the study was categorized as focusing on the Representations and Reality (RR) elements of media. Similarly, if an informational newspaper article was used and students' background knowledge was correlated to their ability to critically evaluate the article, the study was categorized as focusing on the Messages and Meanings (MM) elements of media. Each study was classified according to how its focus aligned with the tenets of media literacy and guiding questions found in the framework in Table 2-1.

Through the analysis process, some studies fell into more than one category as they investigated more than one element of media literacy. In those cases, the studies were considered in multiple categories in order to attend to the multifaceted nature of the study.

Once the media literacy framework was used to individually analyze and categorize each study, all of the studies falling within a category (i.e., AA, MM, or RR) were collectively analyzed. The following review reports a synthesis of the major findings from this second layer of analysis.

Using these three categories provides a succinct and simultaneously detailed framework for looking at teachers' instructional goals and objectives. To examine the broad range of instructional decisions made in the classroom on a second by second basis, a classification tool for instructional practice makes it easier to identify the many facets of teaching. This classification scheme, because media literacy educators conceptualized it with experience examining the instructional intentions and practices of teachers, serves as a good starting point for examining instructional practices involving mass media in the science classroom. However, the categories, in order to provide a loose classification scheme, are necessarily imperfect and do not account for the variability that is seen within individual research studies. Therefore, overlap between some categories does occur.

Newspapers and Magazines in the Science Classroom

Newspapers and magazines are the two most commonly reported types of mass media used in the classroom (Mayoh & Knutton, 1997; Tuggle et al., 2000; Yates, 2002). Wellington (1991) calls newspapers and magazines "informal sources" of learning because individuals voluntarily access them, learning typically takes place in an unstructured and learner-led environment, and there are many unintended outcomes of using these informal sources of learning. Newspapers and science newsmagazines are static forms of print media texts whose purpose is informational to incite awareness.

Authors and Audiences

When teachers use newspapers or magazines they choose articles from a variety of sources and vary in their ability to evaluate the articles. Kolsto (2006) asked pre-service teachers to locate and evaluate an informational article on prominent socio-scientific issues and write responses to the articles evaluating their trustworthiness. The researchers gave the teachers criteria upon which to evaluate the articles in the form of two articles on critical evaluation techniques, which the teachers may or may not have read. The study did not explicitly examine the reasons for teachers' article choices; however, the teachers were able to identify characteristics of authors and author expertise as contributing to the trustworthiness of an article. The teachers were less likely to identify the larger institutional factors influencing article publication as a criterion for judging trustworthiness.

Elliott (2006) worked with 19 science pre-service teachers to determine if they 1) could identify why informational articles are written, 2) evaluate the article's level of accuracy, 3) assess whether the reporting was balanced, and 4) identify how science and scientists were portrayed. Similar to Kolsto (2006), the researchers gave the teachers a set of criteria by which to evaluate the media. First, the teachers learned how to evaluate informational media using a sample evaluation of an informational article, and then were instructed to carry out the process on their own. The task required the teachers to examine the articles' headlines, newsworthiness, sources, scientific content, portrayal of scientists, illustrations, and use of balance and bias. The researchers also encouraged the teachers to look for any editorial comments prompted by the article, and to highlight any particularly interesting features of the article. All of the pre-service teachers were able to find newspaper or magazine articles referencing issues of biotechnology. Most teachers selected articles from major national newspapers or tabloid magazines. In terms of identifying the authorship of the articles, the teachers were "surprised by the extent to which the journalists had relied upon the press releases for their information" (Elliott, 2006, p.1257). The pre-service teachers were also able to identify the intended audience of the articles by calculating the readability of the articles. They found that, on average, their articles had reading age of 16.5 years (equivalent to 10^{th} grade in the United States). Fewer than 10% of the pre-service teachers commented on the articles' scientific accuracy, although they did notice that media focused more on current science-related issues than on science and how science was conducted.

The results of Kolsto (2006) and Elliott's (2006) studies indicated that pre-service teachers, with guided practice, could identify the author and audience elements of print news media. While neither study explicitly examined why teachers chose the articles they evaluated, they reported using an author's "expertise" as a way to evaluate the trustworthiness of an article and recognized that journalists rely on press releases for their information. High reliance on press releases may reduce the credibility and accuracy of articles (Hartz & Chappell, 1997). The teachers were also able to identify targeted audiences by calculating article readability levels. Journalists write newspapers at an eighth-grade reading level with the intent of drawing a larger audience (Meyer, 2004), and it seems as though this would contribute to why teachers consider them appropriate resources for the classroom. What is still unknown from a media literacy perspective is how teachers' choice of science newspaper or magazine articles for instructional purposes coincides with their understandings of the authors and audiences of non-instructional media texts. Additionally, it is unknown if *students* are able to identify how authors of newspapers and magazines target specific audiences.

Messages and Meanings

In their survey of classroom use of newspapers, Jarman & McClune (2002) found that teachers chose newspapers because they were written with a non-science audience in mind, used limited technical language, and used language that captured student interest. Halkia (2003, 2005) explored the elements of media texts that attracted teachers and students' personal reading choices to suggest implications for classroom practice. Halkia's (2003) findings of teachers' personal reading choices contrasted those of Jarman and McClune's study on classroom choices and found that teachers preferred to read articles using scientific language and those that presented complex theory in a simple manner. Meanwhile, students chose articles about contemporary technological discoveries and preferred to read science articles that presented science in a provocative and narrative manner (Halkia & Mantzouridis, 2005). Although the results of these three studies collectively imply that teachers choose articles for classroom use based upon student preferences and not upon their own preferences, no current research has explicitly examined this connection and the implications of these differences on classroom instruction.

Halkia's (2003) research also examined teacher and student's preferences in terms of how articles differed in their "code," or the way the authors addressed the audience. The articles either used a scientific code including several scientific terms and graphs, or an informal, popularized code that used a narrative style. Halkia refers to these patterns in newspapers and magazines as "press science" and those in scientific journals as "formal science." Teachers preferred the formal science code, while students “highly appreciated the narrative elements of popularized code” (Halkia & Mantzouridis, 2005, p.1407). Halkia and Mantzouridis suggest that this difference may exist because students were more familiar with narrative codes of communication.

Students also reported preferring the use of analogies and metaphors found in newspaper articles because they helped them understand the underlying science concepts in the articles. Reports of content analyses of newspapers and magazines support the prevalence of language tools in newspapers and magazines (Pramling & Saljo, 2007). However, student reports of enhanced understanding should be interpreted with caution as there was no evidence presented to suggest that these techniques actually helped students better learn the concepts in Halkia’s (2003) study.

The student’s in Halkia’s study (2003) also reported that the pictures and catchy article titles drew student attention to an article. While this does not guarantee increased comprehension of the article’s contents by the students, Srinivasan and Crooks (2005) explained that learning is more likely to happen when it is occurring through more than one cognitive processing channel. Humans have two major cognitive processing channels: the visual-pictorial channel processes pictures and the auditory-verbal channel processes words. Therefore, it is likely that newspapers and magazines that use both print and visual images to convey messages are more comprehensible to students.

Baram-Tsabari and Yarder (2005) investigated secondary biology students’ ability to read, comprehend, and apply information found in two different types of print text that students may encounter: primary scientific accounts presented in scientific research articles, and secondary, popularized accounts like those found in newspapers and magazines. Similar to the work of Halkia (2003) who investigated “press science” and “formal science,” the secondary, popularized accounts in Baram-Tsabari and Yarder’s study had more narrative patterns and relied on more metaphors and analogies. In contrast, primary research articles made use of the passive voice, abstract nouns in place of verbs (nominalization), and verbs of abstract relation in place of verbs of material action (Lemke, 1990). They noted that scientists would likely claim that research articles are easier to follow than popular accounts because of their organization. They also predicted that students would better understand the processes of science by reading primary accounts. In fact, students who read the primary literature did present a better understanding of the processes and methodology of scientific inquiry than those who read the secondary popularized literature. Those who read the secondary literature, on the other hand, demonstrated better comprehension of the text. This may be due to the inherent downfall of research articles; they are “more permissive to information gaps than a popular article and lack the reader-friendly use of metaphors, analogies and examples" (Baram-Tsabari & Yarder, 2005, p.404). Additionally, they found that students who read the secondary accounts had less negative attitudes towards science than those who read the primary literature. Given the critique on the validity of measures of student attitudes (Osborne, Simon, & Collins, 2003), one should interpret this finding with caution; however, it does have possible implications for the classroom and those hoping to improve student attitudes towards science.

The prior research highlights teachers and students’ abilities to identify the communication codes of newspapers and magazines. It also highlights the potential impact of these codes on how teachers and students select and ultimately understand informational articles. However, further examination of the literature illustrates that there is more to understanding texts than just the messages, or communication codes of newspapers and magazines. Several articles have reported the impacts of prior knowledge and experience on understanding the meaning of media texts.

Phillips and Norris (1999) studied ninety-one high school students and their ability to evaluate the claims of newspaper and magazine articles. The authors asked students about their background beliefs on a topic before reading an article discussing that topic. After they read the article, they were asked if they were more, less, or equally certain of their background beliefs. The authors then evaluated if students relied on the text or on their previous background beliefs to substantiate their claims. Most students offered text-based reasons for their claims and did not integrate their background beliefs after reading the article. Additionally, "those students who expressed either less or more certainty about their background beliefs tended to do so, not on the basis of a critical evaluation of the text, but on the basis of mere deference, echoing, or affirmation of the text" (p325). This heavy reliance by students on the claims in an article for their decision-making on science-related topics would seem to contradict Hobbs' (2003) suggestion that audiences interpret text using life experiences, prior knowledge, and social position.

Several researchers suggest that without prior knowledge in science, it would be unlikely for teachers or students to substantiate their claims based upon more than what they read in media texts; however, scientific background knowledge does not guarantee the ability to interpret media texts (Kolsto, 2006; Norris & Phillips, 2003; Ratcliff, 1999).

Ratcliffe (1999) studied secondary, undergraduate, and science graduate students and their ability to evaluate science newsmagazine articles. Ratcliffe found that students needed some prior knowledge on a topic to make substantiated claims and to evaluate news articles. Only forty percent of secondary and undergraduate students were able to identify the limitations of the science presented in the newsmagazine articles, as compared to eighty-percent of science graduate students. Ratcliffe attributed secondary teacher support as the primary reason for the similarity between secondary and undergraduate student ability, and the extended formal science educational experiences of graduates as the reason for their increased ability. Therefore, Ratcliffe suggested that prior knowledge of science and science methodology are essential to a student's ability to evaluate science-related informational articles.

Similarly, Kolsto's (2006) study on pre-service science teachers' examination of article "trustworthiness" found that the ability to understand texts and decipher reality from fiction was dependent upon teachers' own competencies with science. Kolsto reported that pre-service science teachers use a variety of strategies for evaluating articles, and that content knowledge is necessary but not sufficient for critical examination of texts. The limited number of criteria individual students used to evaluate a claim as well as the variety of strategies used among the group of students illustrated this distinction between the requirement for and the limitations of content knowledge.

Klemm (2001) also looked at teachers' ability to evaluate the credibility of science newspaper and magazine articles. Through a comparison with scientists' ratings of perceived credibility, Klemm found that scientists rate media as less credible than teachers. Secondary science teachers' ratings were more consistent with the scientists' ratings than comparison between scientists and elementary teachers. Lower science content knowledge correlated to higher credibility ratings. Klemm did not offer any suggestions, beyond background content knowledge, for why elementary and secondary teachers' credibility ratings differed from scientists. Additionally, this study did not look at teachers' ability to interpret newspaper or magazine articles, but rather surveyed teachers' perceptions of credibility based upon a list of news sources.

Teacher perceptions and ability are two different constructs. In fact, Norris and Phillips' (2003) found that undergraduate science students (similar to the pre-service teacher population) are overconfident in their ability to interpret media reports of science. Overall, the undergraduate students "displayed a certainty bias in their responses to questions regarding truth status, confused cause and correlation, and had difficulty distinguishing explanations of phenomena from the phenomena themselves" (Norris & Phillips, 2003, p.139). Supporting the findings of Kolsto (2006), they found that science background knowledge did not guarantee success in interpretive tasks. Norris and Phillips suggested that this was because of the differing codes and conventions of media texts compared to instructional texts with which students are more familiar:

> Generally, science textbooks used in high school and early university do not provide information on why researchers do their research, on the histories of research endeavors, on the motivation underlying particular studies, on how scientific questions arise out of the literature or anomalous events, or on the texture and structure of the language used in science. By contrast, scientific media reports often include the history and background to studies, information on the motivation for the reported research, and a variety of textured and structured language. In short, there is a mismatch. (Norris & Phillips, 2003, p.141)

The previous articles suggest that prior knowledge and background experiences influence student and teacher interpretation of science newspaper and magazine articles, and that the codes and conventions of media texts are recognizable by teachers and students. However, current research does not include how interpretation of news articles influences further action in terms of decision-making, attitude formation, worldview, and behavior. Inaction assumes audiences are passive and do not interact with text. From a media literacy perspective, action is an unavoidable component of participating as an audience member of media texts. Beyond skepticism of claims prompting requests for more information from undergraduate science majors (Korpan, Bisanz, & Bisanz, 1997), it is unknown how secondary science teachers and students act in response to reading newspaper and magazine articles.

Representations and Reality

Nelkin claimed that "often the media present a sensationalist representation of science, using only certain stories and treating controversial theories as facts and scientists as superior beings who live in a world apart" (Nelkin in Reis & Galvao, 2004, p.1622). Others noted that newspapers and magazines were limited in their ability to illustrate the conceptual frameworks surrounding techno-factual material and methodology used by scientists to conduct their work (Dimopoulos & Koulaidis, 2003). Ryder (2002) argued that the use of media reports in the science classroom could help students evaluate their own understanding of the epistemology of science. He proposed that while no one source of newspapers or magazines contains the full details of scientific inquiry, by examining multiple sources of media on the same issue, students could examine the variability in the methods or measurements presented. However, research evidence suggests that while teachers have the ability to identify possible misrepresentations of science or scientists in newspapers or magazines, students often lack the ability to distinguish science fiction from science fact.

Kolsto (2001) worked with twenty-two high school students to determine which factors students use to judge the trustworthiness of an informational article about power transmission lines and their link to pediatric cancer. Kolsto defined trustworthiness as "the extent to which information and knowledge claims were seen as sufficiently reliable for inclusion in the pupils' decision-making bases" (Kolsto, 2001, p.880). Following a series of classroom activities instructing students how to evaluate the trustworthiness of claims, the researcher used structured interviews and student responses to written questions to determine how students evaluate the trustworthiness of news articles. Kolsto found that students deemed claims that were compatible with their prior knowledge as trustworthy more often than those with which they were less familiar. He also found that the more serious a claim appeared, the more likely students deemed it trustworthy. Lastly, Kolsto found that students relied on the authority of scientists as presented in the news report and rarely questioned scientists' claims. From a media literacy perspective, Kolsto's study would suggest that students seldom critically evaluate media representations of science. Instead, students tend to believe what they read in newspapers and magazines and do not recognize that the ideologies of media producers may result in omission of details and may present biased views of science.

In contrast, in Kolsto's previously discussed study of pre-service teachers (Kolsto, 2001), teachers were able to identify the one-sidedness of representations of science reflecting author ideologies:

> Sometimes [pre-service teachers] called attention to possible interests that could have influenced a study, findings, evaluations, or presentation … the kind of interests related to economy and workplace … professional prestige and position for experts, institutional interests, and loyalty to friends. The idea the [pre-service teachers] use in this kind of evaluation

> seems to be that a claim or an argument is less trustworthy if it seems like certain interests might have colored its content. (Kolsto, 2006, p.645)

Because the pre-service teachers in Kolsto's study were science majors, their ability to understand the texts and decipher reality from fiction was dependent upon their own competencies with science.

Other criteria teachers identify to evaluate the news articles are manipulative strategies such as using persuasive language and emotion to persuade readers. The pre-service teachers in Kolsto's (2006) study identified such strategies, as did other studies of pre-service and inservice teachers (Elliott, 2006; Jarman & McClune, 2002). Specifically, teachers were able to identify the use of sensationalism in headlines and illustrations, and representations of science that reflected political biases. While none of the research investigated if teachers were affected by the manipulative strategies, teachers were at least able to identify them.

Summary of Newspaper and Magazine Use

Research on classroom use of informational print media is abundant. In summary, the research surrounding secondary student and teacher use of newspapers and magazines indicates that, at least in some capacity, teachers and students are able to identify and evaluate the tenets of media literacy put forth in Table 2-1. At least one study has examined each category outlined in the media literacy framework in Table 2-1, with the majority of studies examining how teachers and students identify the communication codes of newspapers and magazines and how they use their background knowledge and experiences to interpret meaning. Each study reviewed consisted of researcher interventions or reported use and interpretation of newspapers and magazines by teachers and students. It is still unknown if teachers and students would exhibit the same critical thinking abilities if these forms of print media were authentically used in science classrooms.

Trade Books in the Science Classroom

A trade book is any book published for distribution to the public. Trade books are static forms of print media and exist in a variety of genres including fiction, non-fiction, biographies, poetry, and even comics. The reported readability of trade books and comics as compared to newspapers and magazines is not significantly different, as they usually contain middle school level language (Meyer, 2004); however, trade books differ from newspapers and magazines in that their primary purposes fluctuate between informational and entertainment depending upon the genre. For example, biographies are informational, while comic books are for entertainment purposes.

Trade books, such as fictional trade books based on real scientific problems (sometimes called fictas), are increasingly being used as science classroom teaching materials (Brier, 2006). This is especially true at the primary (i.e., elementary) level where literacy and science instruction occur within the same classroom. Scholars in science and literacy education tout the usefulness of trade books as alternatives to science textbooks and cite science trade books as preferable because they are less arduous to read, provide better contexts for relevant instruction, better highlight the work of minorities in science, and improve students' attitudes towards science (Broemmel, 2006; Daisey, 1994).

Authors and Audiences

Several studies have examined the scientific and literary content of trade books and inferred whether audiences would be able to determine the authors' purposes for creating the text. Mellor (2003) illustrates how many popularized physics texts blur the lines between past and present, using “both the past successes of physics and the culture presence of futuristic technologies to claim a future for physics” (Mellor, 2003, p.530). Because of this blurring, audiences can rarely distinguish the purposes of authors. Authors may have “a genuine desire to explain their science to non-scientists” or they may “be motivated solely by the need to make some money” (p.530). Content analyses of physics trade books have shown that fact and fiction are so heavily blurred that readers would be unable to identify the authors.

Overall, the research is limited in its reports of actual teachers or students’ ability to identify an author’s purpose for writing a trade book. It is equally unknown how teachers select trade books for science classroom use, despite the abundant suggestions for teachers wishing to use them (Broemmel & Rearden, 2006; Fredericks, 2003; Pringle & Lamme, 2005).

Fang and colleagues began a year-long collaborative effort between university reading and science specialists and middle school science classroom teachers to highlight the benefits of using reading strategy instruction and trade books in the science classroom (Fang, Lamme, Pringle, et al., 2008). Over the course of a year, the teachers infused weekly reading strategy instruction into their science curriculum and engaged students in a home reading program. The reading strategy lessons consisted of teacher-directed introduction and modeling of a reading strategy, followed by teacher support for students to use the strategy with readings from their science textbook or science trade books. The home reading program consisted of students choosing, reading, and responding to one science trade book each week.

In their report, Fang and colleagues (2008) discussed how they chose the two hundred trade books used for the home reading program. As science and reading specialists, they chose to use “award-winning” literature to ensure content accuracy and quality in writing. The classroom teachers, however, requested specific genres of trade books, regardless of their award status, to coincide with their curriculum study of scientists and science-related careers. Beyond award status and topic preference, Fang and colleagues did not discuss if or how they critically evaluated the contents of the trade books. The authors were admittedly concerned about choosing the appropriate books for teachers to use, and as demonstrated by their eager participation, the teachers obviously recognized that their students needed reading instruction. However, the study did not divulge if or why the teachers thought trade books were a valuable source of scientific information beyond exposing students to more science at home and encouraging family participation.

The assumption was that trade books are less boring and difficult to read so students would be more likely to read them than textbooks. The goal of Fang and colleagues (2008) was to improve reading and science content knowledge, not students’ understanding of what made the texts they read more or less boring and how they could use that knowledge to inform book selection in the future. Therefore, while the researchers discussed their own ability to purposively select trade books for classroom use, it is unknown whether teachers or students would be able to do the same for themselves.

A second study by Lewis (2003), reported on the use of trade books in four high school environmental classes. Using a quasi-experimental design, two classes received class sets of four trade books to read over the duration of a semester. Lewis administered The Children's Environmental Attitude and Knowledge Scale (CHEAKS) to all four classes of students at the beginning and the end of the semester to determine any changes in students' environmental attitudes or science content knowledge. Lewis found no significant difference in scores between the control and experimental groups. While the results of her study are significant for measurements of cognitive and affective gains, in contrast to Fang and colleagues (2008), Lewis' report does not contribute much from a media literacy perspective. The study did not include any information on why the teachers chose the selected trade books. Lewis briefly discussed that the two experimental teachers selected and agreed upon the books from a collection provided by the researcher; however, no additional details on the reason for the books' inclusion in the researcher's collection were provided. Therefore, it is unknown if the researcher was aware of the author's intent for writing the trade books selected or the teachers' intentions as audience members for selecting the four books used in their classrooms.

Scientific accuracy is usually the paramount criteria suggested for book selection followed by realism, entertainment value, and alignment with curriculum. Broemmel and colleagues (2006) suggested that teachers needed to gain awareness of the purposes of various genres of trade books ranging from storybooks with entertainment purposes to non-narrative trade books with informational purposes to make more informed trade book selections. However, until more is known about teachers' understandings of the authors of trade books, and their actual reasons for selecting trade books for classroom, it is difficult to determine their level of media literacy. From a media literacy perspective, science teachers' knowledge of the authors and audiences of trade books should be paramount in choosing trade books as instructional materials.

Messages and Meanings

As with newspapers and magazines, trade books have identifiable codes and conventions. For example, trade books, like newspapers and magazines, often rely on narrative structures to convey a message. Weitkamp and Burnet (2007), using a science-based comic book, attributed student scientific understanding after reading the comic book to its narrative format. Supporting this idea, other studies have shown that students as young as nine (4^{th} grade) can create trade book materials and prefer narrative formats. With scaffolding from their teachers, students can incorporate their scientific knowledge and narrative writing skills to create interesting and publishable trade books (Ritchie, Rigan, & Duane, 2008). In trade books, authors "use narratives to reconstruct authentic details of setting, language, and customs" (Nathanson, 2006, p. 10), which are needed for students to begin drawing causal relationships between characters and between events. The narrative format also allows authors to take a fantasy characterization of a scientist and place him/her in a factual scientific context. In addition to their narrative formats, trade books offer other features that are appealing to teachers and students, including the use of metaphorical language and illustrations (Reis & Galvao, 2004).

Beyond the structural elements of trade books that influence student interpretation, two studies have examined the influence of trade books on student's future scientific attitudes and behaviors. Fisher (1980) prepared a study to compare secondary students' cognitive and affective differences following science classroom use of trade books. Using a quasi-experimental design, two seventh grade groups were encouraged by their teachers to read science trade books in addition to their normal textbook reading. Fisher compared these two experimental groups to a control group in which the teacher neither encouraged nor discouraged the students from reading trade books.

Students with variable reading abilities showed larger cognitive and affective gains following the use of trade books than students in the control group. The students in the experimental groups reported preferring using the illustrations in trade books to make sense of science. Additionally, the use of trade books involved “the reader emotionally in what is happening” (Fisher, 1980, p.176). Fisher showed that students recognized that trade books conveyed scientific messages through illustrations and storytelling and were also able to identify the symbol systems (e.g., images and language) inherent in trade books. Fisher also found that the use of trade books “stimulated talk outside class about science” (p.176). This finding indicated that trade book use initiates further action by student readers. Although newer studies showed no significant differences in student attitudes towards the environment following the use of trade books in the environmental science classroom (Lewis, 2003), Fisher suggested that the interpretation of scientific messages in trade books could influence future the behaviors, attitudes, and actions of students more immediately.

The results of Fisher’s (1980) study supported earlier work by Barrileaux (1967) who followed two classes over two years to determine the effect of textbook use versus alterative library source use in classroom instruction on students science achievement, attitudes, critical thinking ability, writing in science, and library usage as measured by various standardized assessments and observations of library visits. The students received the assessments at four different points: the beginning of eighth grade, the end of eighth grade, during the ninth grade, and at the end of ninth grade. On average, the students in the class using the library materials (i.e., trade books) scored higher in science achievement, attitudes, and writing in science than those using a standard classroom textbook. While there was no significant difference in student critical thinking ability, a most significant observation from a media literacy perspective were the findings on student's library utilization. Students using a non-textbook sequence (i.e., science trade books) made more library visits, participated in additional free reading activities, located and used more library materials in their science and non-science classes, and checked out more library items. The use of library materials opened the students' eyes to the different possibilities for science and non-science learning, and consequently, influenced their later action for checking out books and attitudes towards science. However, this does not mean that teachers or the researcher made this change in behaviors explicit to the students.

While the results indicated that classroom use of library materials (i.e., trade books) encouraged further use of those materials outside of the classroom, Barrilleaux's (1967) study was more about information literacy in which students were locating sources than it was about students knowing the differences and merit of each source they chose. Also, possible teacher effects on this research cannot be negated. While the same teacher was teaching both classes, and all attempts were made to balance the teacher's level of enthusiasm, there was no guarantee that happened. Nor was there guarantee that the instructional procedures used were equivalent. Taken together with the results of Fisher's (1980) study, Barrilleaux's study does provide promise for the fields of science and media literacy education. Initial steps towards understanding how teachers and students interpret the messages and meanings of trade books are underway; however, more information is needed on how background knowledge and experiences contribute to teachers and students' understanding of the messages of trade books.

Representations and Reality

Several scholars have suggested that mass media heavily influences student conceptions of science and scientists; this is particularly true of trade books (Reis & Galvao, 2004). Research on the sources of students' ideas about science and scientists cite comic books like *Bugs Bunny* and books like *Frankenstein* and *Dr. Jekyll and Mr. Hyde*. This reliance on trade books makes research into the use of trade books to convey scientific representations and realities essential.

Content analyses of science trade books used in secondary science classrooms reveals that trade books rarely disclose their sources of scientific information, thereby perpetuating the idea that science is a discrete set of facts uninfluenced by human exploration (Schulesser, 2008). Informational trade books represent science as a series of experiments and observations, while artistic trade books encourage creative forms as observations and aesthetic approaches to science discovery (Ford, 2006).

Schulesser (2008) specifically targeted children's trade books on plants to determine their content and representations of science. Analysis of 108 trade books (including storybooks, informational books and dual-purpose books, which conveyed factual information in a fictional format) revealed that trade books lacked robust discussions of science content and presented information in ways that could lead to the development of several misconceptions. Schulesser noted that the authors of the trade books analyzed were obviously not scientists as evidenced by their incomplete and often inaccurate discussions of science content. Representations of science were selective based upon the author's knowledge and ability. In the classroom, this is problematic as a teacher may not know the author's background but may use children's books that provide limited views of scientific information. Schulesser suggests that more research should look at trade books within the context of classroom instruction, and admits that her study did not investigate actual classroom use of the books. Naturalistic studies would elucidate if students or teachers could identify inaccuracies in books and determine when and why teachers should use trade books in the classroom.

While no known research examines teachers or students' abilities to decipher the representations of science and scientists in trade books, a study by Reis and Galvao (2004) took an alternative approach by examining student *creation* of book-like materials, specifically science fiction stories. Because media literacy is the ability to access, analyze, evaluate, and *create* media messages, Reis and Galvao' study is certainly worthy of consideration.

Reis and Galvao (2004) examined the science fiction stories of eighty-six 11th grade students across five "Earth and Life Science" classes to determine students' ideas about science and their ideas about what made a good science fiction story. Teachers assigned the science fiction writing task as a homework assignment. Reis and Galvao did not state when or where during the course of instruction the teacher assigned the homework assignment; however, they conducted seventeen follow-up interviews with students to "clarify, deepen and discuss the ideas" (p.1624) presented in their science fiction stories.

Reis and Galvao (2004) found that student representations of scientists reflected their skepticisms about science and scientists and their motives for conducting their research. While most students portrayed science and scientists positively, several stories highlighted student concerns about science. The follow-up interviews revealed that students were concerned about the unintended negative consequences of science and scientist actions. The students varied in their representations of scientists from the scientist as hero to the scientist as a mad or eccentric human being. These representations are common throughout other forms of trade books such as in superhero comics, which present scientists as either heroes or villains, presenting a dichotomy between good and evil (Locke, 2005).

Reis and Galvao (2004) concluded that media has a significant role in conveying stereotypes of science and scientists, and as such, teachers and researchers should carefully attend to media's influence on students. Given the lack of details regarding how and when teachers assigned the science fiction stories, caution should be used when interpreting the results of their study. Also, the dominant role of the researcher in interpreting student stories (and subsequent lack of teacher involvement), and the lack of focus placed on teachers more generally, highlights the need to attend to teachers' conceptions about science and scientists and the role of media in influencing their conceptions.

Summary of Trade Book Use

In summary, as a community in need of more participants, the science discipline could benefit from the documented student and teacher interest and ongoing dialogue surrounding secondary science classroom use of trade books. Similar to the research on science classroom use of newspapers and magazines, a lack of research exists on how and why teachers select trade books for secondary science classroom use. It is also unclear if teachers and students can identify the intended audience of trade books and authors' intentions for writing the books. In contrast to the research on classroom use of newspapers and magazines, research on science classroom use of trade books focused on how their use influences future student attitudes and behaviors, rather than on how background knowledge and experiences influence meaning-making when using trade books. Lastly, while Reis and Galvao (2004) showed that student creation of science trade books illustrated students' conceptions of science and scientists, it is unknown if teachers and students could critically evaluate trade books to elucidate their inherent representations of science and scientists.

Television and Film in the Science Classroom

Television and film are static forms of visual and auditory media with both entertainment and informational purposes. Unique to television and film are the presence of visual images, which are different from images in trade books or newspapers and magazines because the images move. Moving images add an additional layer of cognitive processing demands on the viewer (Srinivasan & Crooks, 2005).

Limited research exists on *non-instructional* television programs and films. Television programs, such as *Channel One* (12-minute daily newscasts available on the internet) are crossing borders between informational and instructional resources by providing instructional support materials for teachers using the resource in the classroom despite the fact that *Channel One* was originally created for teen audiences. Research on the use of newscasts like *Channel One* have shown that supportive classroom use in social studies correlates to a students' likelihood of accessing the program outside of class (Anderman & Johnston, 1998); however, research has not investigated whether this correlation exists in the science classroom. Given the ubiquitous nature of *television* and film in adolescents' lives, these types of media merit investigation. Furthermore, because a limited amount of television and film programming focuses on factual science and instead focuses on fictional accounts of science or sensationalized portrayals of science (McSherry, 2002), the critical viewing and listening of these genres becomes more imperative.

Authors and Audiences

Currently, no research has looked at how or why teachers select non-instructional television or films for science classroom use. While research is absent of studies examining whether teachers and students are able to identify the purposes of these media and their authors' intentions, one known study looks at how students behave as authors when they create television programs on science, technology and societal issues.

Watts, Alsop, Zyibersztajn, and de Silva (1997) examined how students (eighth graders) approached creating a television program about a nuclear accident in Brazil. Watts and colleagues found that when teachers asked students to create a program for "the general public," as authors, students considered their audience when creating the programs. Most students chose a documentary format or a debate panel with science specialists to convey the most amount of information while maintaining the drama of the presentation. Those groups who thought children would be their audience proposed the use of animations to convey their messages. All of the groups struggled with how much information to share with their "lay public" audience. Lastly, because the students were targeting the "lay public," most groups chose to balance their coverage of the science and societal issues surrounding the topic to maintain audience interest. Each of these features shows that students as young as fourteen are aware of media's need to target specific audiences.

Beyond this study, no known research in the science classroom has addressed Author and Audience elements of non-instructional television or films. However, research that serves the interests of television programming companies has several implications for science education from a media literacy perspective.

For example, Mares, Cantor and Steinbach (1999) investigated which elements of television broadcasts are most effective in targeting children's (fifth graders) enjoyment, knowledge, and attitudes towards science. Mares and colleagues found that presenting scientific content within a larger story or context and avoiding labeling episodes as "science" correlated to greater student enjoyment and knowledge of science. Also, more frequent exposure to science-related television programs correlated to more positive attitudes towards science, regardless of the viewing environment (e.g., school or home). From a media literacy perspective, this study is significant because it highlights the way authors manipulate the presentation of material to target and influence specific audiences. While the researchers did not make the students aware of the subtle differences between the content of the television broadcasts, such information could influence their ability to examine television broadcasts outside of the classroom.

In another example, Dingwall and Aldridge (2006) performed a content analysis of wildlife documentary programs addressing evolution and found that different genres of documentaries create different representations of science. "Blue chip" documentaries are those that extensively use high cost graphics, dramatic storylines, and present themselves as neutral, thereby lacking political or cultural perspectives. “Presenter-led” documentaries, in contrast, present a more human approach to content, are rampant with editorials and individual perspectives, and are typically low cost and quick production films. Although blue chip wildlife documentaries exude more scientific authority and neutrality, presenter-led documentaries are more effective at accurately representing science. Dingwall and Aldridge account for this disparity as follows:

> For large media organizations, blue chip programming is a token of status and authority, emblematic of the claim to a social mission that transcends commercialism. Our analysis, however, suggest that it should be better understood as a spectacle. Its economic and cultural constraints limit its capacity adequately to communicate the complexities of science.”
> (Dingwall & Aldridge, 2006, p.147)

Teachers may choose “blue chip” documentaries for use in the classroom because of their established authority and perceived lack of bias, but Dingwall and Aldridge showed that such a choice may inhibit students’ development of more accurate or complete understandings of science. Research recognizes that authors and audiences’ reasons for creating and selecting media are important, but it ignores those features of media construction when television and films are used in the science classroom.

Messages and Meanings

Five studies have researched science classroom use of non-instructional television and films to investigate the messages and meanings of media. From a media literacy perspective, the codes and conventions of television and films influence student interpretation of media messages. Additionally, background knowledge and experience influence students’ ability to interpret television and film media messages.

Dhingra (2003) investigated how television genres differ in their portrayal of science as reported by students, and which elements of television genres make them more engaging to high school students. This was done through a survey administered to sixty-three high school students (tenth and eleventh grade) asking them to report which television programs they watch in which they see the most science. Students provided examples from the following four genres: news, documentary, fictional programming, and magazine TV format. Students watched segments of each genre and then either answered open-ended questions, participated in small group discussions based upon open-ended questions, or were interviewed using open-ended questions.

Student responses were categorized according to their recognition of the ethics and validity of science as portrayed in the genre, whether they questioned the claims made in each genre (i.e., presentation of final form science), how students' interpreted the portrayal of science by its practitioners in each genre, and students' ability to identify differences between school science and television science. Dhingra (2003) found that each television genre elicited different student responses. News genres elicited more student awareness of the ethical limitations of science reporting. In fictional genres, students' familiarity with storytelling style and plot mediated their understanding and engagement. Documentary genres portrayed a high level of authority and therefore were not questioned by students. In magazine genres, although perceived as final-form science, character development was important to students' level of engagement.

Dhingra's (2003) study showed that students were able to identify differences between representations of science and scientists as portrayed by different television genres. From a media literacy perspective, recognition of the differences between students' understandings of science within each genre is significant; however, Dhingra's study leaves a reader to wonder if students could identify these differences on their own, or if awareness of these differences in student understandings is only attainable by a researcher examining collective student responses. Furthermore, the report included no discussion of whether teachers would actually use the television segments used by Dhingra in their regularly scheduled classroom instruction, therefore the likelihood of students encountering similar segments in science class are questionable.

In terms of the messages of television and film, research has shown there is a cyclical pattern to how and if teachers and students are able to interpret media messages. Scientific background knowledge affects critical viewing ability, but critical viewing ability also may affect scientific knowledge.

Wang, Wu, and Huang (2007) investigated the relationship between biological content knowledge and biology self-efficacy, level of interest in biology, and science-oriented television viewing patterns for over four thousand middle school (eighth and ninth grade) students. While the study did not measure correlations between the affective measures, it did find that students who "frequently" watched science-oriented television programs had higher biological content knowledge than those who "never" watched such programs. "Seldom" watchers also had higher content knowledge than those who "never" watched. Wang and colleagues looked at correlations and not causations, and therefore the results of their study should be interpreted accordingly. The correlations, however, did lead the authors to suggest that "teachers should encourage students to watch science-oriented TV programs to facilitate their biological concept learning” (Wang et al., 2007, p.462). This suggestion assumes that students will critically view television programs and that further watching will not contribute to additional misconceptions. However, Barnett, Wagner, Gatling, Anderson, Houle, and Kafka (2006) found how problematic the using films or television programs can be when used in the classroom.

Specific to the science fiction film genre, Barnett and colleagues (2006) worked with an eighth grade Earth Science teacher who taught a four-week unit on the Solar System to five classes. At the end of the unit, three classes watched the popular fiction film *The Core*, while the remaining two classes completed portfolios related to the unit of study. Barnett and colleagues administered pre and posttests and conducted interviews with students to measure student conceptual knowledge. Their investigation found that the use of the movie *The Core* influences students’ understanding of science. While student posttest scores were not significantly different, student misconceptions did surface for students who watched the film. In fact, students relied on specific examples from the film to answer content questions related to earth science rather than their hands-on, in-class experiences. This study showed that students relied on films used in the classroom for information about science. Therefore, teachers should pay attention to the accuracy and representations of science in films when using them in the classroom. Additionally, Barnett and colleagues noted that the film spends a large amount of time establishing the credibility of the main character (a geophysicist). This “authority” increased the likelihood that the students would rely on misconceptions presented in the film rather than on their hands-on, in-class experiences. In light of this, Barnett and colleagues made the following case for media literacy education:

> Therefore, rather than avoiding showing science fiction films in schools it may be a better strategy to engage students in the critique of a science fiction films. Such an approach may engage the students in reflecting not only on the science as presented in the movie but also on their own ideas and how their own ideas compare to those presented in the movie.
> (Barnett el al, 2006, p.190)

In another example, Perales-Palaciosa and Vilchez-Gonzalezb (2005) investigated the potential of using animated television cartoons in the science classroom. The study focused both on using cartoons as a learning tool and as a form of assessment (i.e., building content knowledge from critical viewing experience as well as building critical viewing ability from background knowledge and experiences). In a series of four stages, students first watched clips from either a *Pokemon* television episode or a *Simpsons* episode that presented a fictitious representation of science content. In the second and third stages, teachers walked students through identifying specific scenes that were inaccurate, and discussed the inaccuracies and corresponding accurate scientific conceptions. In the fourth stage, students were assessed on their ability to critically evaluate a new segment from the *Simpsons* as a summative assessment task. Perales-Palaciosa and Vilchez-Gonzalezb found that teaching physics by showing cartoons motivated students to discuss science and resulted in more positive student attitudes towards science. Like the results from Barnett and colleagues, Perales-Palaciosa and Vilchez-Gonzalezb found that student misconceptions often aligned with the incorrect physics presented in the cartoon. The results were an example of how critical viewing ability may affect scientific knowledge. Similarly, increased student background knowledge and practice evaluating cartoons influenced students' ability to interpret future representations of science in animated television cartoons. This indicated that background knowledge and experiences influences critical viewing ability.

Lastly, a study of high school students' use of television broadcasts by Solomon (1992) showed that background knowledge in science (in terms of basic scientific vocabulary) was required for students to discuss their attitudes and values related to social issues presented in the broadcasts. Additionally, "personal prejudice or history brought about a kind of mental filtering which could distort the social information given on the video" by students (p.434). Solomon's study showed the significance of background knowledge and experiences on students' interpretations of media messages. Once again, researcher-driven interventions highlight the influence of genre and background knowledge on students' interpretations of media messages and the potential impact of media on future attitudes and actions. However, lacking from all of the previous studies are investigations of teachers' perceptions and actual use of non-instructional television and films.

Representations and Reality

Matthews and Davies (1999) reported that television and school equally contributed to high school students' conceptions of science and scientists. Most prevalent from a media literacy perspective investigating representations and reality are anecdotal accounts of using films, such as science fiction films, in the classroom (e.g., Dubeck, 1993; Freudenrich, 2000). Additionally, books dedicated to the use of science fiction in the science classroom agree with anecdotal accounts, which present the representations and reality elements of mass media as the most widely investigated and important elements to investigate in the science classroom when using television or films (Cavanaugh & Cavanaugh, 2004; Dubeck, Moshier, & Boss, 1994). This should make sense because "movies impact citizens' conceptions of science by either encouraging excitement, instilling fear about science and technology, or by leading to the development of stereotypes of science and scientists" (Barnett, 2006, p.181). Similar to the production of newspapers and magazines, the authors of science fiction films are limited in their science knowledge and perspectives on science issues. Their limited perspectives contribute many of the incomplete and sometimes inaccurate representations of science in science fiction films (Kirby, 2003). Despite these anecdotal accounts, only three empirical studies include a discussion of teachers or students' interpretations of science representations in films (Furman & Calabrese Barton, 2006; Rose, 2003).

Dhingra (2003), as previously discussed, found that each genre of television differed in its portrayal of science and scientists as reported by students. The television genre altered students' perception of science and scientists and reflected ideologies not just of the specific television medium, but also of the genres within the medium. In news and fiction television genres, students saw science as full of tentative knowledge claims that are dependent upon social negotiation. Fictional genres allowed students to identify with and admire specific characters who played the role of scientists. Documentary and magazine formats "were largely perceived as depicting final form science, in which there was a low perceived need to question, the expertise of a few was accepted, and knowledge production activities responsible for the truths stated on the programs were opaque" (Dhingra, 2003, p.250).

Rose (2003) discussed the issue of credibility and the potential for the use of entertainment films in the classroom by discussing four movies he used to complement his general biology course. He argued that scientific accuracy was not a necessary component of science fiction films; however, that for the authors of films, plausibility was a necessary component to sell movies to the general audience. He said that "plausible ideas have far greater potential than accurate details to motive the public toward a better understanding of science" (p.291). Furthermore, Rose contended that teachers who addreseds the inaccuracies of films decreased student interest in the lesson or film being used because "scientific accuracy is often at odds with good storytelling" (p.295). Conversely, addressing the plausibility of ideas got students (and the general public) to "wonder whether the fictional science is possible" (p.291). While Rose's article did not discuss the details of how he used movies in the biology course or evidence of student interest or learning, he did identify four questions he uses to focus class discussions about the films used. Interestingly, from a media literacy perspective, Rose addressed two of the three categories of media literacy (see Table 2-1) in his instruction. He addressed the messages and meanings of films when he asked what additional science was necessary to achieve the film's goals and what theoretical flaws or technical limitations existed that might make them impossible. He also addressed representations and reality when he asked if there were any real science analogies to the fictional science presented and how the goals and implications of the real science compared with the fictional treatment.

Lastly, Furman and Calabrese Barton (2006) investigated middle school students' use of documentary filmmaking to capture student conceptions of science and scientists. The students participated in an after-school science and technology program and were taught how to use video cameras and editing software with the challenge of creating a mini-video documentary about science. The students chose the topics, the content of the movie, and its length. The researchers served as support during the movie making process, and focused their own investigations on how student conceptions were conveyed during the process.

Furman and Calabrese Barton (2006) created a case study of two boys, Anthony and William, to examine the different ways student conceptions were conveyed during the project. Anthony and William held contrasting perspectives of school science. Anthony was a more challenging student with a large peer network outside of class; William was identified as the student who excelled in class with a limited peer network. Furman and Calabrese Barton found, through examination of students' actual words and their words in action (i.e., participation), that the boys created their mini video documentaries emphasizing the ideologies they held about science. Anthony resisted school science, but was quick to incorporate out-of-the-classroom experiences in his filming. This allowed Anthony to position himself as knowledgeable in the video project group while maintaining his popularity outside of the classroom by distancing himself from formal science. William, on the other hand, enjoyed school science and drew upon that interest to interview district administrators and cleverly advocate for field trips. Filming allowed William to pursue his school science interests while inserting an element of fun and entertainment to his persona, thereby increasing his standing among his peers. Through their investigation, Furman and Calabrese Barton showed that students' movie making choices and representations of science are clearly influenced by their ideologies. The content they chose to film and include in their video documentaries was reflective of their own personalities, and students omitted information not included among their interests. While this implicit decision-making process was not made explicit to the teachers involved in the project, or to the students themselves, the work by Furman and Calabrese Barton clearly show that even amateur videographers, and in this case science students, create products reflecting their own ideologies.

Summary of Television and Film Use

The literature included in this review discussed empirical studies investigating the use of non-instructional television and film, which was limited to literature primarily focused on the *messages and meanings* and *representations and reality* of these media types as used in the science classroom. Specifically, research examined how background knowledge and experiences influences interpretation and how interpretation then influences background knowledge. The literature also showed that different film and television genres portray different representations of science as identified by students, and students create films reflecting their own ideologies. However, from a media literacy perspective, these findings are limited in that no study looked at if teachers or students were able to reflect on the influence of television and films on their conceptions of science and scientists. Additionally, all of the aforementioned research looked at researcher-imparted interventions. It is still unknown if, or how, teachers actually use non-instructional television and films in their classrooms.

Digital Media in the Science Classroom

Digital media, in this study, includes video games, simulations, and the internet. Digital media are different from the other types of media discussed in that they are interactive in nature. Interactivity means that media users receive information, process the information, react to the media by inputting some signal (e.g., typing a word or moving a joystick), and the media processes the input and alters subsequent information provided to the user (Kirriemuir & McFarlane, 2006). This is in opposition to static media whose content and outcomes are unalterable by the audience.

Distinguishing between instructional and non-instructional digital media requires familiarity with digital language. Often, digital media intended for classroom use is called “edutainment” or “serious.” Games and simulations with these labels are created for instructional purposes with specific curricular goals in mind during their creation. Conversely, “mainstream,” “commercial,” or “off-the-shelf” games and simulations are created for entertainment purposes to maximize the profit of publishers (Kirriemuir & McFarlane, 2006).

Additionally, while debate exists on how to distinguish video games from simulations, for the purposes of this study, video games and simulations differ based upon their design and end goals. Simulations are often a remodeling or recreation of some real-world experience, whereas games have the potential of taking on unique virtual realities. Furthermore, games have a pre-determined ending or goal that involves winners (and losers); whereas the end point for simulations may change at any time.

Not surprisingly, the bulk of classroom research has focused on instructional forms of digital media. This is because using mainstream digital media in the classroom requires a lot of teacher training, cultural acceptance of digital media as a potential learning tool, and compatibility with school hardware (Kirriemuir & McFarlane, 2006). However, as students continue interacting with digital media in out-of-school social settings and teachers begin experimenting with new ways to motivate students in the classroom, it is expected that the literature base on the use of non-instructional digital media will increase.

Authors and Audiences

A longitudinal study of teachers' internet use in the science classroom shows that in a country which mandates internet use among students (i.e., England), most teachers use the internet during instruction, but still lack the confidence to integrate internet use seamlessly in the curriculum (Sorensen, Twidle, Childs, & Godwin, 2007). Similarly, teachers are motivated to use videogames in science classrooms, but express concern over the limited amount of science classroom time they have available to incorporate videogames (Annetta & Murray, 2008). In addition to concerns about adequate hardware and internet access, teachers cite their own lack of knowledge on how to evaluate websites for quality information as a barrier to their classroom internet use. While instructional digital media is frequently used, and teachers report concerns of their ability to use digital media, no known studies in science education explicitly require teachers or students to identify the intended audience or authors intentions for creating a piece of digital media. Only one known study explores how and why teachers select digital media for classroom use (Wallace, 2004)

Wallace (2004) investigated high school science teachers' use of the internet. In her study, Wallace interviewed and observed the classroom practice of three teachers who were not receiving special support for using internet in their classroom. Using qualitative analytic techniques, Wallace explored the contexts, content, and actions of teachers using the internet in secondary science instruction. Wallace used naturalistic methods in that no researcher-driven intervention was imparted and data were collected during the course of teachers' already planned units of instruction.

Wallace found that each of the three teachers used the internet in different manners, which were reflective of their own goals and understandings of the potential of the internet as an instructional tool. The first teacher, Darcy, used the internet during instruction because she wanted to provide her students access to technology and time to practice effective searching techniques; the interactive nature of the internet was an appealing feature. The second teacher, Mark, used the internet to reinforce literacy instruction in science. Specifically, he felt that the internet would reinforce students' ability to read, write, and think. The third teacher, Lucy, used the internet to motivate students and to "help students learn to evaluate information and improve their critical thinking skills" (Wallace, 2004, p.466).

The teachers' success with using the internet as an instructional tool varied. Wallace found that the teachers chose to use the internet to provide content information when the teachers' own background knowledge was limited. They chose websites based on the perceived authority of the websites, and did not use any particular method for evaluating the websites. In fact, Wallace found several inaccuracies in the websites the teachers used. Lucy chose websites for her students to use based upon another colleagues recommendation, while Darcy had students openly explore the internet and assumed the students would evaluate the authority of websites before collecting information from them. Because of the limited amount of support Darcy offered her students, she found that her instruction was not as effective as planned. Lucy had similar results, but did not attribute students' lack of success with the quality of the websites.

The teachers’ intended purposes for using the internet did not align with their students’ ability to critically evaluate the websites they encountered or their own reasons for using the internet, and therefore instruction using the internet was not as effective as hoped. Similar results have been documented by Lucasa, Martinez, and Mendez (2008) regarding elementary students’ use of videogames:

> For the children, videogames are elements of their everyday life related to their free time and therefore foreign to what they experience in the school. For the teacher, videogames are also a means of entertainment, to which she finds it hard to assign an educational meaning…. In this light, we see that introducing into the classroom a tool that belongs to the popular culture beyond the school gates assumes that all the participants, adults and children, can successfully make joint efforts to unite their own subjectivities by joining their voices together. Our research shows that this is not an easy task. (Lucasa, Martinez, & Mendez, 2008, p.102)

Messages and Meanings

Unlike static forms of media (e.g., newspapers, trade books, or films), digital media change with user interaction. Digital media can take many forms and its interactive nature allows users to interpret meaning from their environments on a minute-by-minute basis. Wallace (2004) concluded that digital media are instable resources in that their content and context are always changing. Instability is difficult to overcome. Part of overcoming the instability of digital media is learning how authors create them and the techniques they use to engage users. This also requires recognition that the techniques used to engage users varies by genre, and that users’ background knowledge and experiences with digital media, and science, influence their ability to interact with digital media.

For example, videogames may allow users to create their own virtual worlds, such as in *Second Life,* or they may have a fixed environment in which users must explore their own existence, such as in *World of Warcraft.* Steinkuehler & Duncan

(2008) through investigation of online discussion threads of *World of Warcraft*, a massively multiplayer online game (MMOG), used the AAAS benchmarks (1993) and Chinn and Malhotra's (2002) framework for evaluating inquiry tasks to determine to what extent users use scientific inquiry strategies to participate in virtual worlds. They found that most online discussions showed evidence of scientific discursive practices including building on the ideas of others, using multiple forms of argument, and social knowledge construction. Less frequently, participants in the forums used model-based reasoning or displayed understandings of theory and evidence. However, in gaming environments in which players interact with their environment and with each other, there exists the potential to extract student scientific literacy practices and potentially use videogames to develop them further.

Although no reports exist of their secondary science classroom use, the use of commercial videogames like *Second Life* in university settings has shown that three features of videogames contribute to the success of using them as learning platforms (Delwiche, 2006). First, the accessibility of the games is crucial. Some videogames are more difficult than others to learn and master. Higher levels of difficulty combined with lower levels of user support lead to frustration by the user. Frustration can inhibit learning associated with the objectives for the course. Second, the genre of videogames is important to learning. While some students may enjoy theme-oriented videogames like *Everquest* or *World of Warcraft* (both of which are popular fantasy videogames), a dislike for the genre may inhibit learning. Delwiche suggests using more theme-neutral games in classrooms like *Second Life.* Third, the success of videogames as a classroom instructional tool is enhanced if the videogames are extensible, meaning instructors or players can extend the game environment or themes to develop new game scenarios or classroom lessons.

Additional investigations into the structural elements of science instructional videogames such as *River City, Quest Atlantis,* or *Mad City Mystery* offer implications for teachers wanting to incorporate commercial games in the science classroom. Nelson and Erlandson (2008) examined the design of a science instructional videogame, *River City,* to determine how its structural features affect cognitive load. Cognitive load is the effort users exert to filter verbal and visual information. The idea is that if cognitive load is reduced, then users can maximize their ability to deal with new incoming information. Nelson and Erlandon (2008) also explored if multimedia design principles such as coherence (removing extraneous information) and modality (using spoken words rather than written words to convey meaning) are applicable to videogames and could reduce cognitive load.

Nelson and Erlandson (2008) performed content analyses of *River City* and found several design elements within the game that would increase cognitive load. Nelson and Erlandson suggest that if multimedia design principles are applied to videogame design, then cognitive load would decline thereby increasing the likelihood that students will achieve the learning goals associated with the videogame. Following their investigation of *River City,* Nelson and Erlandson admit that several multimedia design principles are inapplicable to videogames because of their level of interactivity and due to the fact that videogames necessarily contain extraneous information in order to simulate real-world contexts. For example, a user in a videogame knows her avatar is walking down a street through context-clues such as pavement, streetlights, cars, or other pedestrians. All of those context-clues are extraneous in terms of science content, but necessary to the context of the videogame. Therefore, Nelson and Erlandson proposed future research to investigate the potential limits of using multimedia design principles in videogames.

Steinkuehler & Duncan (2008), Delwiche (2006), and Nelson and Erlandson (2008) all discussed features of videogames that enhance their usability and functionality in classroom settings. However, the studies reported on research conducted at the post-secondary level, independent of classrooms, or on videogames initially created for instructional purposes. While they did not specifically address secondary science use of non-instructional digital media, the results of their findings may be applicable to the secondary classroom and to the use of non-instructional digital media.

Beyond the features of digital media that make them useful in classrooms, from a media literacy perspective, how audiences interpret meaning using digital media is as worthy of investigation as are the structural features of digital media. Audiences with different abilities, interests, or familiarity with digital media may interpret them differently.

Almqvist & Ostman (2006) looked at how adolescents (ages 10-15) use websites to investigate the greenhouse effect. Almqvist and Ostman specifically aimed to determine if, and how, students in the secondary science classroom privilege information they find on a website. Investigation of six groups of students revealed that students do not evaluate information they encounter on websites and they make limited meaning of information they find on websites. Instead, students directly copy information they find on a website without questioning its accuracy. Students in

Almqvist and Ostman's study were more concerned about completing an assignment than they were about judging the quality of their sources. This was not surprising the researchers because the classroom they observed neither supported, nor reinforced critical evaluation of websites, and the "institutionalized habits" of completing assignments without more careful consideration of information sources was commonplace.

Just as previous studies of student use of the Internet in science education have done, Almqvist and Ostman (2006) allowed student access to particular pre-selected websites. At first glance, this may seem to have undermined students' ability to work with the Internet, but as Hoffman, Wu, Krajcik, and Soloway (2003) showed, students do not "explore much, do not evaluate sources … and use Web tools naively" (p.324).

Hoffman and colleagues looked at middle school science students' use of Web-based resources over the course of a year. Just as in the previous study, the researchers created databases of websites from which students could use to learn more about the current unit of study. The students completed a series of assignments over the school year requiring them to perform simple searches and seek information on questions related to the current unit of study. It was not clear from the report if teachers played an integral role in determining the websites included in each database, or if the teachers designed the learning activities completed by students using online resources as support; however, data sources included student interviews, videos of individual student computer use, and video of the classroom computer lab to discern student content understandings and teacher scaffolding techniques. Content understandings were determined by gauging students' ability to offer explanations, articulate connections among sources of knowledge, and extending explanations beyond that found in their original source of information.

Although content understandings among students were diverse, from a media literacy perspective, the authors' realized correlation between content understandings and student inquiry strategies is significant. Those students who demonstrated adequate or high engagement with inquiry strategies (e.g., ask, plan, search, assess write, synthesize, and create) were found to have greater content understandings. Specifically, students with greater use of effective search strategies (e.g., using phrases in lieu of keywords and being highly selective in their choice of resources) and more complicated assessment strategies (e.g., examining website trustworthiness by examining the URL) demonstrated greater content understandings. Student ability to interpret the information from a website, therefore, was correlated to their background knowledge and experiences using inquiry strategies online.

Recent research also suggests that in addition to users' prior knowledge and experiences, their epistemological views of science may influence user ability to interact effectively with digital media. Using two surveys, Lin and Tsai (2008) explored the relationship between high school students' epistemological views (SEV) towards science and their "information commitments" (i.e., student evaluative standards and searching strategies on the internet). An SEV survey explored students' understandings of the creative, theory-laden, tentative, social, and cultural facets of science; an IC (information commitments) survey explored how students reported assessing a websites' correctness and usefulness, and how they employed specific searching strategies such as using search engines and keywords or phrases.

Lin and Tsai (2008) used the majority of their report to discuss the reliability and validity of their two instruments and they discussed their use of confirmatory factor analysis and structural equation modeling to elaborate on previous research and determine the applicability of the surveys at the high school level. Their results indicated that students, who adapted constructivist epistemologies of science and reported understanding of the tentative and changing nature of scientific knowledge, used more critical evaluation strategies when working with web-based materials. Lin and Tsai showed that background knowledge and experience are not enough to interpret media messages and use mass media effectively, but that students' epistemologies are equally important. Additionally, Lin and Tsai suggested that, "students' various perspectives on SEVs might guide their utilization of different evaluative criteria and searching strategies for approaching online science resources" (p.2015).

While the results of Lin and Tsai's (2008) study suggest a significantly new way for thinking about how students use and interpret information presented through digital media, additional qualitative analysis of students' actual use of these media may provide a more accurate view of the relationship between students' epistemological views of science and their information commitments. Lin and Tsai relied solely on students' reported activity. Furthermore, comparisons between teachers' epistemological views of science and their reasons for using the internet may result in new implications for science teaching.

Representations and Reality

No known research has investigated how the internet and authors of websites on the internet represent science and scientists, nor has researched looked into how teachers and students view science and scientists following use the internet. Additionally, beyond instructional videogames like *Quest Atlantis, River City, Mad City Media,* and *Astronomy Village,* which are created for science classroom use by scientists and science education researchers, and therefore arguably contain accurate representations of science and scientists, research into commercial and mainstream videogame representations of science and scientists is also non-existent. Only one known study has investigated how students determine the credibility of information found in digital media.

Clark and Slotta (2000) investigated the effects of media-enhancement and source authority on high school science students' ratings of credibility of scientific theories as presented on the internet. Clark and Slotta developed websites containing twelve pieces of evidence supporting either the meteor theory or the geologic theory of dinosaur extinction. Each website included differing levels of media-enhancement (i.e., addition of images) and were written by authors with differing levels of authority (e.g., university professor or a newsletter writer). After gauging students' perceptions of the initial two theories and authority of the authors prior to reading evidence, Clark and Slotta noted that students successfully distinguished between the authority levels of authors, citing the university professor as a more credible author. However, after reading the evidence supporting each theory, students did not cite the authority of the author as an important factor in choosing the most significant evidence supporting each theory. In fact, Clark and Slotta found that students' interpretation of the information presented on the websites is more dependent upon their prior conceptions of theory credibility and less dependent upon the authority of authors or presentation of the information (e.g., text or text plus image). These findings are similar to those of Kolsto (2001) and students' evaluation of print media trustworthiness, but are in contrast to Barnett and colleagues' findings in which students are more likely to develop and hold onto misconceptions about earth science when the authority of the author established in films (Barnett et al, 2006). Barnett and colleagues' research may be limited in its interpretation of the *effects* of media, while Clark and Slotta took the additional initial step of measuring students' prior conceptions in addition to their conceptions following research on the internet. On the other hand, Clark and Slotta developed the websites for instructional purposes, thereby limiting its findings to the application of non-instructional digital media use in the classroom. Despite these disparities, comparison of the studies does leave an individual to wonder if different forms of mass media have different effects on student interpretation of the credibility of media when an author's authority changes.

The lack of research on the representations and reality elements of digital media may be attributed to the sheer size of the internet and the inability to perform content analysis on such a large database of resources, and to the fact that mainstream videogames rarely target science content. Given the diverse representations of science and scientists in other forms of non-instructional media (e.g., films, television, and trade books), representations of science and scientists in non-instructional digital media merit investigation.

Summary of Digital Media Use

In summary, limited research examines secondary science classroom use of *non-instructional* digital media. Among the four known studies, research primarily focuses on the relationship between an audiences' prior knowledge and experiences and their use of digital media. Specifically, research targets student audiences. Beyond the work of Wallace (2004), a naturalistic study of secondary science classroom use of the internet, research assumes teachers can critically evaluate digital media, its authors and intended audiences, its codes and conventions, and its representations of science and scientists. Survey of the literature also reveals that research considers non-instructional simulations (as distinguished previously from videogames) are synonymous with non-instructional videogames; thereby explaining why the prior review did not include discussion of non-instructional simulations.

Limitations of the Review

This literature review is admittedly not comprehensive in that it does not include all applications of classroom mass media use. However, it did thoroughly investigate the various forms of media used by secondary science teachers and students. Early review of the literature revealed that a simple classification scheme for media types was not possible. Therefore, the review used a multi-faceted classification scheme for categorizing media types and imposed a media literacy perspective on the evaluation of the relevant literature. Therefore, the frameworks proposed early in this chapter provide boundaries for this review of literature.

For example, while credibility and trustworthiness can be considered elements of *representations and reality* (i.e., more credible sources contributing to more accurate representations of science and scientists) and are questioned as such in Table 2-1, the research reviewed primarily considered how teachers and students' prior knowledge and experiences impacts their ability to evaluate the credibility of claims. Therefore, those studies were included in the discussions of *messages and meanings.* The issue of credibility and trustworthiness is an example of how the media literacy framework used to review the literature is imperfect and does not account for the variability seen within individual research studies. Therefore, while this review attempted to categorize research within the framework, some overlap between categories did occur.

Lastly, this review was also limited in that one category of mass media outlined in Figure 2-1, namely radio, is missing. Radio is an auditory form of media with both entertainment (e.g., *Radio Disney)* and informational (e.g., *NPR)* purposes. Although radio listening among students as a source of scientific information has declined in past two decades (Dawson, 2000), new forms of radio, such as podcasts, are becoming more prevalent among adolescents. Podcasts, in this study, are considered a type of radio broadcast as they are essentially radio broadcasts accessible via the internet (Piecka, Studnicki, & Zuckerman-Parker, 2008); podcasts are not considered digital media because they lack interactivity characteristic of digital media.

Other than a proposal for future research by Piecka, Studnicki, and Zuckerman-Parker (2008), the literature search revealed no research on the use of non-instructional radio or podcasts in the science classroom. This is disconcerting because research has shown that particular attention needs to be paid to emerging forms of media, such as podcasts, as they cannot be evaluated using the same techniques applied to traditional print media (Austria, 2007). Expectantly, the literature base will increase as students' use of portable and interactive technologies such as the iPod increases.

Summary and Implications for Future Research

Each of the previously reviewed studies attempts to identify implications for using mass media in the science classroom. When instructional media (i.e., media created specifically for classroom use) is excluded, teachers are no longer explicitly supported in classroom use of mass media. Using mass media in the classroom that was created for either entertainment or informational purposes leaves the teacher without instruction on how to use the media and also leaves it to the teacher to self-learn the unique features of media that may influence the science being portrayed and students' understandings of science.

The previously discussed research in science education that did address elements of media literacy as laid out by the media literacy framework in Table 2-1 did so in piecemeal. In the past, research in school science has largely focused on the use of instructional materials like textbooks and instructional films. More recently, research is looking into the use of serious videogames and instructional science simulations. Historically, investigations into the usefulness of these instructional materials in secondary science classrooms slowly progressed from anecdotal evidence and content analyses to genuine classroom applications. In 1963, Lumsdaine said this about textbooks and research on classroom textbook use:

> The extensive literature dealing with textbooks contains relatively few experimental studies of effects; empirical research in this field is mostly limited to content analyses and readability studies, which, in most all cases, have used correlational comparisons, rather than experimental manipulation of a particular piece of instructional content. (Lumsdaine in Barrilleaux, 1967, p.27)

Similarly, the use of NIMM is in transition between what we know about these forms of media in terms of content analyses and anecdotal reports and how teachers actually use them in the classroom. This literature review highlighted how little we, as researchers, know about science classroom use of non-instructional mass and the potential effects on student learning.

Research in the fields of Journalism and Mass Communication rarely consider the science classroom as a space for investigation. This is likely because these fields are more interested in journalists and their immediate needs than the needs of students. Similarly, the field of Public Understanding of Science usually considers the scientific understandings of the general public. Once again, the classroom is largely ignored. In the field of media literacy education, research is minimal due to the early state of the field, and it often lacks a content focus; most studies in media literacy education are limited to investigations of English language arts, social studies, fine arts, health education, communication, and performing arts classrooms (Hobbs, 2005).

Table 2-3 illustrates the studies discussed in the prior review, the types of non-instructional media considered, and how each study aligned with the tenets of media literacy and the guiding questions outlined in Table 2-1. Other studies discussed in the review that are not shown on in the table are not seen because they either discussed research in settings other than secondary science classrooms (e.g., post-secondary science classrooms or clinical settings) or focused on instructional forms of mass media. They were discussed in the aforementioned review to highlight potential implications of the research on classroom practice in cases in which scant research existed on that media type (i.e., digital media) that fulfilled the exclusion criteria for this review.

As outlined in Table 2-3, most of the research reviewed looked at the *messages and meanings* of media, while others focused on elements of *representation and reality,* and less often on the *authors and audiences* of mass media. No single piece of research considered each of the elements as contributing to how a message is constructed and transferred through media.

Furthermore, the research based lacked studies that examined how students or teachers explicitly viewed the credibility of sources or how it affected understandings of science or the nature of science. Additionally, all but two known studies reported on researcher-directed interventions, not on authentic science classroom use of mass media. How are teachers using media on a day-to-day basis? Without the guidance of researchers, are they choosing newspapers as a source of scientific information for their students or are they using animated films loosely related to science? Why are they using those sources? Do they recognize the tenets of media literacy that contribute to message construction and meaning-making? Are they instructing their students how to evaluate mass media? In short, when a researcher leaves the classroom, what does mass media use in the classroom *really* look like and how does a teacher's use of NIMM compare to his or her conceptions of media more generally?

The subsequent research expanded on earlier studies in four ways. First, the study included investigation of all forms of NIMM used in the secondary science classroom including media created for both informational and entertainment purposes. Second, the study went beyond looking at teachers' reported use and investigated their actual use of NIMM in the secondary science classroom. Third, the study investigated teachers' conceptions of mass media and their media literacy skills to investigate teachers' assumptions about their students' abilities to engage effectively with NIMM in the science classroom. Lastly, the study drew comparisons between teachers' conceptions of mass media and their reported and actual uses of NIMM in the science classroom.

Table 2-1. Media literacy framework adapted from Hobbs (2006b) and Share, Jolls, & Thoman (2009)

Tenets	Description of Tenets	Related Questions
Authors and Audiences	authors create media for specific purposes (e.g., power, profit) authors create media with specific audiences in mind audiences choose which media to read	Who created this message? Who is the target audience (and how do you know)? Why might this message matter to me?
Messages and Meanings	media texts use different symbol systems to convey a message (e.g., language, images, sound) media texts contain identifiable patterns that follow the codes and conventions of specific genres meaning from media messages are interested by audiences using prior knowledge and experiences audience interpretation influences future decisions, behaviors, attitudes, and worldviews of audiences	What creative techniques are used to attract my attention? How might different people understand this message differently from me? What might a reader do with this message?
Representations and Reality	media texts use techniques that affect an audience's perception of reality (e.g., sensationalism) media texts reflect the ideologies of authors and thus selectively omit information and contain biased views	What lifestyles, values, and points of view are represented or omitted? Is this fact, opinion, or something else? Is it credible?

Table 2-2. Categorization of media for literature review

Media Types	Keywords or Phrases	Mode of Presentation (print, visual+, auditory)	Purpose* (informational, entertainment)	Interactivity Level (static or interactive)
Newspapers Magazines	News reports Newspapers Newsmagazines Magazines Editorial cartoons	Print	Informational	Static
Trade books	Trade books Fiction Non-fiction Science fiction Narrative Comics	Print	Informational Entertainment	Static
Television Films	Television Streaming video Drama Science fiction Documentary Animated cartoons	Visual Auditory	Informational Entertainment	Static
Radio	Radio Podcasts Music	Auditory	Informational Entertainment	Static
Digital	Videogames Internet WWW	Visual Auditory Print	Informational Entertainment	Interactive

*Instructional media was not included in the study

+ Visual media contains moving images

Table 2-3. Studies investigating secondary science classroom use of non-instructional mass media within the media literacy framework

Media Type	Authors and Audiences	Messages and Meanings	Representations and Reality
Newspapers	Kolsto (2006)	Jarman & McClune (2002)	Kolsto (2001)
Magazines	Elliott (2006)	Halkia (2003)	
		Halkia (2005)	
		Baram-Tsabari & Yarder (2005)	
		Phillips & Norris (1999)	
		Ratcliff (1999)	
		Kolsto (2006)	
		Klemm (2001)	
		Norris & Phillips (2003)	
Trade books	Fang et al (2008)	Weitkamp & Burnet (2007)	Reis (2004)
	Lewis (2003)	Fisher (1980)	
		Barrlieaux (1967)	
Films	Watts et al. (1997)	Dhingra (2003)	Dhingra (2003)
Television		Wang et al. (2007)	Rose (2003)
		Barnett et al. (2006)	Furman & Calabrese Barton (2006)
Digital	Wallace (2004)	Almqvist & Ostman (2006)	
		Hoffman et a. (2003)	
		Lin & Tsai (2008)	

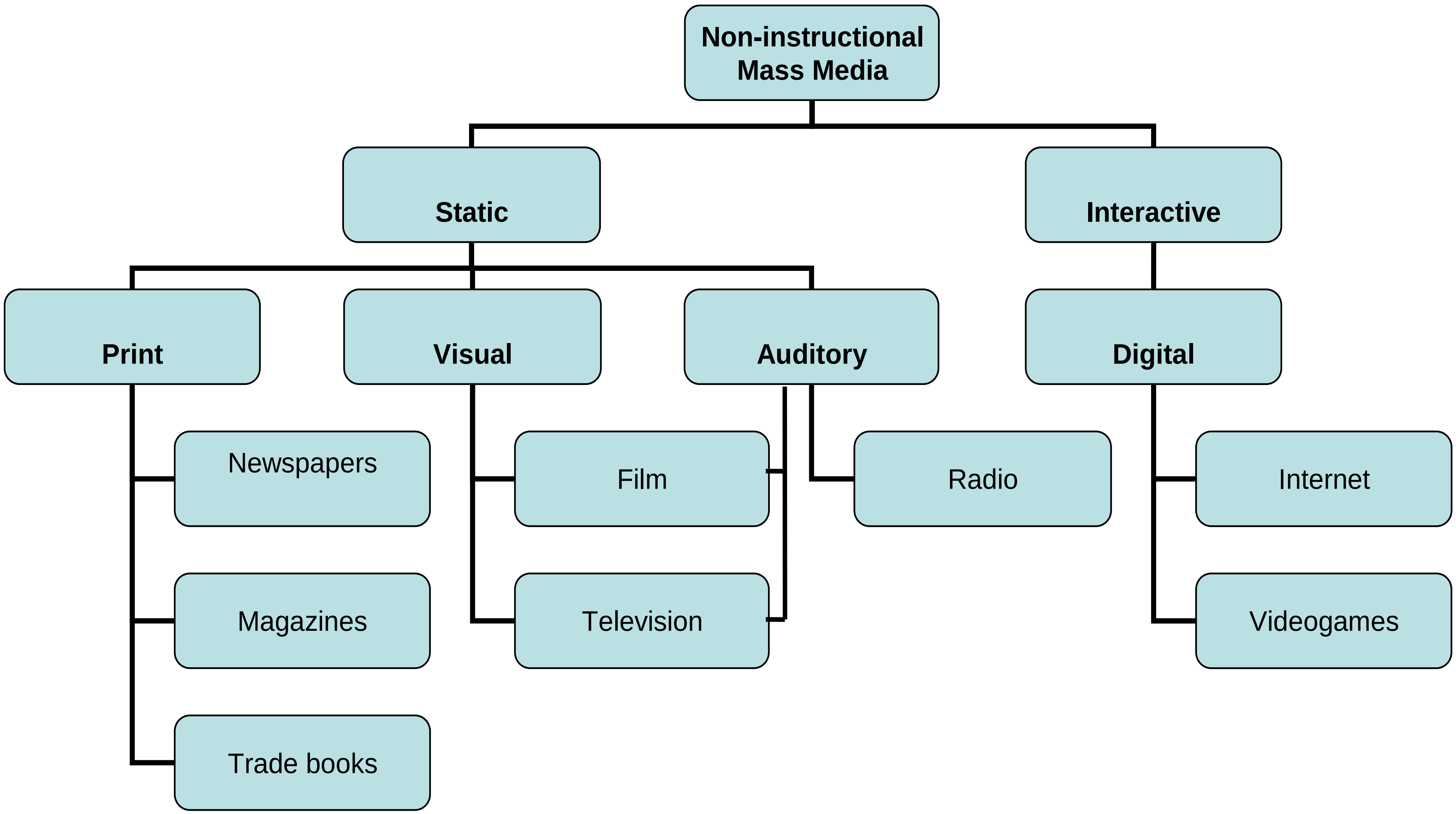

Figure 2-1. Classification scheme for non-instructional media

CHAPTER 3
METHODOLOGY

The purpose of this study was to examine secondary science teachers' reported and actual classroom uses of mass media and the extent to which teachers' media literacy skills and their assumptions about the media literacy skills of their students aligned with their use of mass media as an instructional tool. Specifically, it was reasoned that instructional mass media, such as educational films and serious video games, are packaged with instructions for teachers to use the materials in the classroom, whereas non-instructional mass media (NIMM), such as popular fiction novels and entertainment films, lack such support. Therefore, this study examined secondary science teachers' use of NIMM, as NIMM were not created with the original intent to be used in the classroom and require teachers to make decisions about which media to use and how to use them without ancillary support.

Methodological Framework

As discussed in Chapter 1, this study was shaped by sociocultural theories of teaching and learning, which suggests all actions (including teaching and learning) are situated and intricately woven into the fabric of their cultural and social contexts. Similarly, this research was also influenced by my own assumptions about knowledge and the construction of knowledge. It is my belief that interpretations of *reality* are socially constructed and vary from individual to individual and location to location. In essence, multiple realities exist simultaneously and are determined by the individual, based upon their cultural and social context. Therefore, the closest we can get to making any truth claims in research is when individuals are examined in their natural contexts and their perspectives are collected through their own words. Given my personal ontological and epistemological beliefs, this research aligned with naturalistic paradigms and used the naturalistic inquiry process to examine the practices of secondary science teachers.

The Naturalist Paradigm

Guba and Lincoln explain naturalism as a paradigm, or basic set of beliefs, based upon ontological, epistemological, and methodological assumptions. Naturalism adheres to relativist ontology, transactional and subjective epistemology, and hermeneutical and dialectical methodology (Guba & Lincoln, 1994). Naturalism, according to Lincoln and Guba (1985), is not a definable term; however, is best understood through examination of five axioms or sets of beliefs about reality, knowledge, and how one comes to know.

First, under the naturalistic paradigm, multiple realities exist and are best examined holistically. True understanding of individual realities cannot be achieved through investigation of individual parts without recognition of the whole. Examination of an individual's reality requires investigation of the individuals, their contexts, and their actions. The entirety of an individual's experience must be examined in order to understand that individual and her actions. Second, individual realities cannot be generalized to other situations. As contexts and participants change, so do individually constructed realities. Everything is time and context dependent. Third, the relationship between what is known and who holds knowledge are interdependent and inextricably connected. Fourth, under the naturalistic paradigm cause and effect relationships are indeterminable. The momentary interactions between objects and individuals or individuals with other individuals simultaneously shape reality – one does not cause the other. Guba and Lincoln (1994) describe this as the "transactional" nature of the naturalist paradigm. Lastly, under the naturalistic paradigm no actions (including interpretation and description) are value-free. The values of individuals and their larger contexts all influence the way experiences and actions are conducted and then interpreted and described by others.

When research is conducted under the naturalistic paradigm, Lincoln and Guba (1985) coin the process "naturalistic inquiry." Although naturalistic inquiry has also been called ethnography, phenomenology, or hermeneutics by other scholars (Crotty, 1998; Glense, 2006; Hatch 2002; Merriam, 1998), the methods for this research study will follow the guidelines initially proposed by Lincoln and Guba (1985) in their text *Naturalistic Inquiry.* Several characteristics of research coined "naturalistic inquiry" must be followed in order to adhere to the previously presented axioms of the naturalistic paradigm.

Among those Lincoln and Guba (1985) insist that research should occur in a natural setting. Contexts of inquiry must be natural and examined as they exist because naturalist paradigms assume human behaviors are necessarily woven in their natural contexts (Sherman & Webb, 1988). Additionally, because all behaviors (including those of the researcher and the participants) are time and context-dependent and value-laden, naturalistic inquiry posits the researcher as the data collection instrument. How a researcher decides to conduct her research and then evaluate data is dependent upon the researcher, her location in time and space, and her values. As all information initiates and passes through her, she becomes the primary instrument. Naturalistic inquiry also requires tactical knowledge from the viewpoint of multiple participants because knowledge is socially constructed and multiple realities exist.

Lastly, naturalistic inquiry usually relies upon qualitative research methods to illuminate the multiple realities and possibilities for interpretation. These hermeneutic and dialectic elements of naturalistic inquiry will guide the following research.

Additional features of the naturalistic inquiry process can be seen in Figure 3-1. This figure illustrates how Lincoln and Guba (1985) conceptualize the naturalistic inquiry process as participant and context-dependent. The hermeneutical nature of naturalistic inquiry posits it as a cyclical, ongoing, and adaptable research design.

Grounded Theory

Grounded theory is central to the naturalistic paradigm. Grounded theory is not a data analysis process, but rather is the overall approach used to discover "theories, concepts, hypotheses, and proposition directly from data" (Taylor & Bogdan in Westbrook, 1994, p.249). Grounded theory is especially useful in situations in which the goal is to answer "why" and "how." Not meant to predict future behaviors, the grounded theory approach typically does not produce results that can be generalized, as no two situations are identical. In fact, grounded theories are "likely to reflect the complexity of that which is studied rather than oversimplifying it" (Westbrook, 1994, p.250).

Grounded theory is both an inductive and deductive approach. It is inductive in the sense that theory development is grounded in the data collected during research. However, the interplay between the researcher and the data cannot be undermined and, thus, grounded theory is also deductive. Corbin and Strauss (2008) remind researchers that no one enters research completely removed from the experience and with "blank and empty minds" (p.326). Grounded theory is "deductive in the sense that concepts … are interpretative; that is, constructed by the analyst from data" (p.326).

Theoretical Comparisons

Following the grounded theory approach, theories about a phenomenon under investigation must emerge from the data collected rather than conforming to or serving as rebuttal for an *a priori* hypothesis or theory. However, the development of new theory does not need to occur isolated from recognition of prior theories. As Corbin and Strauss (2008) explain, theory development can be accomplished by expanding upon previous theories that describe phenomenon in one situation in order to make sense of similar phenomenon in new situations. This study adopts this perspective by applying frameworks of media literacy to explore media use in science education contexts. Using frameworks created by scholars in media literacy education as a theoretical base for exploring concepts in science education can add to the "depth, breadth, and level of abstraction" offered by the prior frameworks (Corbin & Strauss, 2008, p.42).

Constant comparisons are traditionally used in research studies as a means to analyze data in an attempt to generate theory (Glesne, 2006; Lincoln & Guba, 1985). When using constant comparisons, researchers look at raw data, identify incidents, develop concepts that account for those incidents, and then compare concepts to develop substantive theory that explains the phenomenon under investigation. Corbin and Strauss (2008) suggest that theoretical comparisons are equally powerful when using the grounded theory approach.

Theoretical comparisons are "analytic tools used to stimulate thinking about properties and dimensions of categories" and are used when researchers "want to think about an event or object in different ways" (Corbin & Strauss, 2008, p.65). Hsieh and Shannon (2005) refer to theoretical comparisons as "directed content analysis" and suggest researchers turn to this analysis method when "existing theory or prior research exists about a phenomenon that is incomplete or would benefit from further description" (p.1281).

Conducting theoretical comparisons is similar to the constant comparative method described by Lincoln and Guba (1985), but deviates on one major point. Rather than examining individual incidents and developing concepts that account for those incidents, theoretical comparison begins with the concepts as the initial coding categories for raw data. This can be done "because it is not the specifics of an experience that are relevant but the concepts and understandings we derive from them" (Corbin & Strauss, 2008, p.76). Following identification of instances related to the theory, theoretical comparison proceeds in a similar fashion to the constant comparative method by following the remaining three stages: 1) integrating categories and their properties, 3) delimiting the theory, and 4) writing the theory.

Using theoretical comparisons should not be confused with imposing theory on data or seeking patterns in data to confirm previous theory. Instead, Corbin and Strauss explain the process of theoretical comparisons as follows:

> We use the properties and dimensions derived from the comparative incident to examine the data in front of us. Just as we do not reinvent the world around us each day, in analysis we draw upon what we know to help us understand what we don't know. Theoretical comparisons are tools designed to assist the analyst with arriving at a definition or understanding of some phenomenon by looking at the property and dimensional level. (p.75)

By looking at the property and dimensional level, rather than at specifics or raw data, theoretical comparisons allow the researcher to obtain an additional level of abstraction which is desirable to substantive or mid-level theory development. Theoretical comparisons do not violate any of the axioms of the naturalistic paradigm, but rather serve as a feasible method for data analysis under the grounded theory approach (Strauss & Corbin, 2008).

Research Design

Following guidelines of naturalistic inquiry, this research study describes situations as they were experienced in an exploratory manner with the goal of developing theory about teachers' uses of NIMM in secondary science classrooms. Although no naturalistic study can explain a situation, issue, or phenomena completely (Erlandson, Harris, Skipper, & Allen, 1993), this research attempts to offer a full explanation that might otherwise be elusive using other research designs.

The goal of this research was to elucidate human experience from a holistic perspective, attending to all elements of the experience – the context, the participants, and their actions. Therefore, in this research I assumed that teachers' choices and actions were inseparable from their physical contexts as well as from the students with which they worked. The choices teachers made were equally dependent upon goals for themselves, the curricula to which they attended, and the audiences (i.e., students) of their curriculum decisions.

Research Questions

1. To what extent do secondary science teachers report using non-instructional mass media in the science classroom?
    a. What type(s) of mass media do they report using?
    b. What science topics do they report choosing to explore through mass media?
    c. What is their reported frequency of mass media use?
    d. How do they report using mass media?

e. What are their reported purposes for using mass media in the science classroom?

2. How do secondary science teachers, who report frequent use of non-instructional mass media, actually use non-instructional mass media in the science classroom?

    a. What type(s) of mass media do they use?
    b. What science topics do they choose to explore through mass media?
    c. How often do they use mass media?
    d. How do they use mass media?
    e. What functions does mass media use serve in the science classroom?

3. How do secondary science teachers, who report frequent use of non-instructional mass media, conceptualize non-instructional mass media?

    a. What are their reported media literacy skills?
    b. What ideas do they hold about the media literacy skills of their students?

4. How do secondary science teachers' uses and conceptions of non-instructional media compare and contrast?

    a. How do secondary science teachers' *stated* use of non-instructional mass media compare to their *actual* use in the science classroom?

    b. How do secondary science teachers' uses of non-instructional mass media in the science classroom compare to teachers' conceptions of mass media?

Significance of Question Order

This research study progressed through four phases, each corresponding to a research question listed above. The research questions listed above were deliberately sequenced to follow the progression of this study. The selection of participants for the second through fourth research questions was based upon ongoing analysis of the results from the first research question; the questions were deliberately sequenced so that ongoing data collection and analysis from one phase shaped the collection and analysis in subsequent phases. This element of emergent research design adhered to the naturalistic inquiry process outlined by Lincoln and Guba (1985) and seen in Figure

3-1. Investigation of question four relied upon the primary analyses from the three prior phases. Comparisons between the primary analyses from the first three phases informed question four.

Setting

The following study was conducted at a K-12 university research school located in the southeastern United States charged with developing innovative instructional programs for dissemination to other public schools in the state. The student population was representative of the state in gender (48% female, 52% male), socioeconomic and racial-ethnic composition. Specifically, the racial-ethnic composition was as follows: 51% Caucasian, 24% African American, 16% Hispanic, 5% multi-racial, 3% Asian.

This school was chosen as the research site for three reasons, the first of which being the high probability of mass media use by secondary science teachers at the school. Second, the school was chosen due to its willingness to host research projects and its familiarity with the research process. Third, the grade composition of the school (i.e., the fact that it was K-12) made it an ideal setting.

At the time of the study, the school was undergoing several technology integration initiatives at the secondary level increasing the likelihood that media were being used in the classrooms. While the use of educational technology likely favors digital media use, several forms of static print and visual media are accessible from digital sources, thereby increasing the probability that teachers would be accessing those forms of media as well.

High probability of mass media use by secondary science teachers was also determined by examining the educational mission for the school. As reported on the school website, the school's primary role is to "develop, evaluate, and disseminate exemplary programs" (*Educational Research*, 2009). Teachers at the school consistently participate in professional development targeting classroom use of innovative instructional programs; therefore, it was probable that teachers were using non-conventional (i.e., beyond the textbook) approaches to secondary science instruction. Similar to the potential impact of educational technology initiatives, the use of non-conventional approaches increases the likelihood that secondary science teachers are using mass media during science instruction.

As the research site was a university research school, the school often assisted in research projects conducted by educational researchers. Therefore, teachers and students at the school were accustomed to having researchers in the classroom. This made the school an ideal setting for conducting naturalistic research in that any effects potentially caused by my presence were minimized.

Moreover, the fact that the school was a K-12 school made it an ideal setting for the subsequent research. This research study initially targeted all secondary science teachers, including those who taught middle school and high school, or grades 6-12. Conducting research at this school allowed me to develop a richer understanding of the cultural context in which I and the participating teachers were working. I believe this enhanced the quality of my descriptions offered through my research.

Data Sources

This study examined secondary science teachers' reported and actual uses of NIMM in the classroom as well as their conceptions of mass media. I conducted this study in four phases; whose alignments to the major research questions, the number and selection of participants, and the primary data sources can be seen in Table 3-1, and will be elaborated in this section. While data collection occurred in phases to address the research questions previously outlined using the theoretical and methodological frameworks discussed, in line with the iterative process of qualitative research (Glense, 2006; Guba & Lincoln, 1985), analysis of each phase of data collection informed how I conducted the subsequent phases of data collection.

Reported Use of Media Interview

Interviews are useful in cases where researchers are trying to better understand participants' ideas about a particular phenomenon. Interviews are particularly useful because they allow researchers and participants to move back and forth in time in order to uncover any possible patterns of behavior (Lincoln & Guba, 1985). Interviews also "allow the investigator to probe, to clarify and to create new questions based upon what has already been heard" (Westbrook, 1994, p.244); and therefore, are flexible allowing for the capture of a maximum amount of information surrounding the participant's role with a particular phenomenon.

In contrast, interviews are limited in that they rely on participants' verbal accounts of phenomena. They lack concrete evidence of an event actually happening, and instead assume participants are honest and forthcoming with their responses. They are also limited by the strength and type of relationship between the researcher and participant (Glesne, 2006; Holstein & Gubrium, 2003). Using interviews in conjunction with observations and establishing rapport prior to the interview process are suggested in order to overcome these limitations.

For this study, semi-structured interviews were chosen in order to allow for directed questioning with the flexibility to probe and clarify to gain a better understanding of how secondary science teachers report using mass media in the classroom. The initial semi-structured interview was designed to probe teachers' ideas about the following: (a) their reported reasons for using NIMM in the classroom, (b) their reported strategies for using NIMM in the classroom, (c) their expectations for using NIMM in the future, and (d) their frequency of use.

All secondary science teachers from the university research school who consented to participate in the study were interviewed. Six teachers (three middle school and three high school) participated in the research process. Teachers consented to participate by signing informed consent (see Appendix A), approved by the university Institutional Review Board, which described the nature of the study and expectations of the teachers. Sample of interview questions from the first interview are included in Appendix B.

Developing the interview protocol. Because the target of the study was teachers' *non-instructional* mass media use, it was decided that providing a definition and some examples of NIMM at the beginning of the interview would help focus the teachers' attention on the types of media under investigation. While this places some limitations on the interpretation of data, I felt it was a necessary step to limit the scope of the interviews and for making comparisons across research questions in later phases of the research study.

Questions for the interview were informed by previous research on classroom use of mass media (Jarman & McClune, 2002; Kachan et al., 2006; Tuggle, Sneed, & Wulfemeyer, 2000) and aimed to specifically target research sub-questions 1a-1e. The questions were deliberately sequenced in order of increasing complexity and not necessarily in order of the research questions, beginning with "grand tour" questions to eliminate frustration or confusion by the teacher participants and to provide more information about the context of NIMM use (Lincoln & Guba, 1985).

The main intent when constructing the interviews was to encourage participants to discuss their personal uses of NIMM in the science classroom. The questions and question order went through several iterations and were reviewed by two colleagues knowledgeable in interviewing techniques and question development in order to avoid leading or compound questions and to increase the comprehensibility of the questions (Glense, 2006). The interviews were designed to last approximately 30-45 minutes. As can be seen in Table 3-1, all interviews were conducted in the spring semester of 2009. The interviews took place in the teachers' classrooms at a time that was most convenient for them thus explaining the lapse of time between some interviews. All interviews were audio-recorded and transcriptions of the interviews were completed by the researcher within 48 hours of each interview. A portion of a sample interview transcript is presented in Appendix C.

Observations of Media Use

The main goal of observation is to understand the participants, their contexts, and their actions *as they occur,* rather than relying upon participant reports of their actions (Glense, 2006). As LeCompte, Preissle, and Tesch (1993) report, "one problem researchers encounter is that participant reports of activities and beliefs may not match their observed behavior … observation is a check, enabling the researcher to verify that individuals are doing what they (and the researcher) believe they are doing" (p.197).

Lincoln and Guba (1985) also say that observations are useful for making "the strange familiar and the familiar strange" (p.51). Researchers can make the strange familiar through ongoing examination of a phenomenon. They can make the familiar strange by constantly questioning their own assumptions about what is occurring and examining their own biases during the process. However, as Dewalt and Dewalt (2002) caution, elimination of the researcher's role in observations under the naturalist paradigm, even when the researcher strives for unobstructed observation, is impossible. According to the naturalistic paradigm, it is impossible to remove oneself from the role of participant during observations because the researcher is the "main research instrument as he or she observes, asks questions, and interacts with research participants" (Glense, 2006, p.5); and analysis of data should be approached accordingly.

The second phase of the research study explored teachers' *actual* use of NIMM and addressed research questions 2a-2e. Observations were used as the primary means to document teachers' actual NIMM use. As previous studies have not looked at the variety of ways secondary science teachers use mass media in natural classroom settings or NIMM more specifically, the use of observations allowed for an authentic look at this phenomenon.

Selection of participants. Because the purpose of qualitative research is not to offer generalizations on behaviors, but to fully describe the practices of specific individuals, I used purposeful sampling to identify teacher participants for the second through fourth phases of the research study. As Patton (2002) stated, "the logic and power of purposeful sampling … leads to selecting *information-rich cases* for study in depth. Information-rich cases are those from which one can learn a great deal about issues of central importance to the purpose of the research" (p.46).

The three participants chosen for the second through fourth phases of the study were purposefully sampled from the initial group of six secondary science teachers. Teacher participants were selected using extreme case sampling. Glesne (2006) defined extreme case sampling as choosing participants who are unusual or special in some way. In this research study, the teachers were special in that I chose them to maximize the likelihood of seeing how mass media was used in secondary science classrooms. Therefore, purposeful sampling was used in order to determine the three teachers who (relative to the other teachers) were most likely to use NIMM in their classrooms. This extreme case sampling was based upon data collected during the initial interview, as well as upon the survey of public online documents. Specifically, I reviewed daily class agendas for each of the six teachers as found on their class websites to identify previous evidence of NIMM use.

Records, or “statements prepared by or for an individual or organization for the purpose of *attesting to an event* or *providing an accounting*” (Lincoln & Guba, 1985, p.277) are useful sources of data because they are inexpensive, stable, and contextually grounded. Under the assumption that prior actions predict future behaviors, incidents of NIMM use as indicated by the online daily class agenda during the previous school year were assumed predictive of teachers’ mass media use in their classrooms in the future. In this sense, it was assumed that these records were stable in that they were representative of the teachers’ pedagogical choices. The online class agendas were not primary sources for data analysis, but they served as a source for purposively sampling teacher participants for the second phase of this study.

The comparison of public documents available on the internet combined with information garnered from the initial interviews were used to determine what constituted “frequent use” in this study. Frequent use was found to be a relative term as all teachers reported using NIMM in their classrooms more than once each instructional unit. Therefore, the *most* frequent users of NIMM were targeted in order to identify the three teacher participants that were most likely to use NIMM in the following school year.

Due to the reality of conducting research in an educational setting, other factors inhibited my access to teacher participants and their classrooms. For example, one teacher notified me that he was not planning to return the next school year. Therefore, he was eliminated from my pool of potential participants for later phases of the study.

Scheduling the observations. I conducted several observations of the three selected teachers’ classrooms over the course of one nine-week marking period. While naturalistic inquiry ideally proceeds until the point of saturation (i.e., the point at which no new information develops out of the data), “constraints of time, energy, availability of subjects, and other conditions” (Corbin & Strass, 2008, p.324) inherently limit how long and how often data collection can occur. In this study, the nine-week marking period was chosen for several reasons. First, the end of the marking period is a naturally occurring break in the school schedule; therefore, the beginning and end of the marking period are natural entrance and exit points for researchers. Second, it was reasoned that within a nine-week period, teachers are likely to exhibit most of their pedagogical strategies because teacher routines are identifiable quickly through observation and are rarely modified (Yinger, 1979). Third, an ending point eventually needs to be determined in all research projects (Lincoln & Guba, 1985), so one was predetermined to accommodate the time restrictions of the researcher and the teacher participants. Saturation was reached before the end of the nine week period for all three teachers.

The goal was to determine how teachers actually use NIMM in the classroom, and therefore, limiting observations to specific classes was not warranted. Therefore, if any teacher taught more than one science class (i.e., biology and environmental science), then I allowed the teacher to choose which class I observed over the nine week period. In one case the teacher did not have a preference and allowed me to choose. I chose to observe the class that best fit in my larger observation schedule across the three teachers.

Observations were scheduled ahead of time as determined through agreement between the teachers' and my schedules as well as by consented access to the teachers' classrooms. Three factors guided the scheduling process. First, observations were scheduled on a weekly basis to establish a constant presence in the classroom to reduce any potential negative effects of my presence. This also increased my understanding of the individual classroom contexts. Second, I was in weekly communication with the teachers and visited their class websites on a daily basis to notice any increased likelihood of seeing NIMM use in the classroom. If the online class agenda indicated that a teacher planned to use NIMM during a class period outside of my weekly scheduled visit, every attempt was made to observe that class period. Third, comparison of teachers' class websites and the initial interview with teachers was used to schedule observations. In the first interview, teachers were asked which science topics they were most likely to explore through the use of NIMM. If the online agenda indicated the teacher was going to cover that science topic in class, every attempt was made to observe additional class periods during that unit of study.

Overall, every attempt was made to observe classes in which it was likely that teachers used NIMM during their lesson. Because previous studies have not examined the wide variety of possible uses of NIMM in actual classroom contexts, this research was exploratory and rightfully purposively selected when to observe. The goal was to catch as many cases of NIMM use as possible. A log of all observations is presented in Appendix D.

Structure of the observations. The observations began as unstructured and became more focused as time moved on in accordance with the naturalistic paradigm (Guba & Lincoln, 1985). Field notes in the form of running notes were taken to record "everything the investigator saw, experienced, and remembered as well as notes on emotions and analytic comments" (Westbrook, 1994, p.246). Because the focus of the study was on teachers and their instructional decisions, observation notes documented the actions of teachers and the context of their instructional choices and did not focus on students, student voices, or student actions. As it was unknown when during the course of the instructional sequence a teacher would actually use NIMM, field notes were taken during the entire class period. This also ensured that detailed accounts about the context in which media were used were recorded.

Because "good qualitative research reports the range and frequency of actions and meaning perspectives that are observed, as well as their occurrence narratively" (Erickson, p.1155), each set of field notes were expanded immediately following the observations (see an excerpt of expanded field notes in Appendix E). The expanded field notes included accounts of teachers' NIMM use including (but not limited to): the source of media used, the context in which the use occurred, the associated classroom interaction or activity, and the apparent role played by the episode in the larger instructional sequence. I also included interactions I had with the teacher and/or students during the lesson. I used a different color font to identify these interactions in my expanded field notes. To capture the instructional sequence surrounding episodes of NIMM, what happened before, during and after each episode was captured in a table format within the field notes. These tables were used as the primary unit of analysis as described in a later section of this chapter.

With the teachers' permission as outlined in the informed consent process, I videotaped all classroom observations. The focus of the videotape was on classroom teachers; therefore student images were not captured or included in the study. I used the tapes to check the handwritten notes I took during the observations.

When possible, I acquired a copy of the NIMM used during the instructional sequence. The NIMM samples collected were treated as documents "existing naturally in the context of the study" (Merriam, 1998) as opposed to the online class records used to select participants for the study. They were used to help describe the teachers' actions and choices and were not subjected to any content analyses as separate documents.

Conceptions of Media Interview

The third phase of the research study probed teachers' ideas about the following: (a) their conceptions of NIMM, (b) their reported media literacy skills, and (c) the media literacy skills of their students. Therefore, this phase addressed research questions 3a-3c.

Developing the interview protocol. The protocol for the final semi-structured interview was initially informed by earlier studies of classroom media use as well as by the tenets of media literacy discussed in the previous chapter (Hart & Suss, 2002; Hobbs, 2006b; Share, Jolls, & Thoman, 2009). The interview consisted of three parts. In the first part of the interview I asked questions that required the three teachers to elaborate on their uses of NIMM. I specifically asked questions about their use of NIMM in episodes I observed during the nine week observation period and that I deemed representative of their overall NIMM use. The goal was to encourage them to think about why and how they used NIMM in those specific episodes.

Because the goal was to discuss teachers' ideas about NIMM, it was necessary for me to direct the conversation accordingly at the start. Therefore, I again provided the teachers with my definition of NIMM as well as several examples. A teacher may be interested in discussing how she used a chemistry simulation during instruction, but if the simulation was an instructional form of media it would not be relevant to the focus of my study and discussions about its use would be superfluous to the purpose of the study. Similarly, a teacher may not recognize his use of a comic strip from the newspaper as using mass media; however, discussions of its use are central to the purpose of this study.

The second part of the interview focused on the reported media literacy skills of the teachers. Because schools in the United States typically lack media literacy education programs, it was assumed that questions explicitly asking "what are your media literacy skills" would have little relevance to the teachers participating in this study. Therefore, I explored the teachers' reported media literacy skills by asking questions that implicitly explored whether teachers recognized the tenets of media literacy. Table 3-2 illustrates sample questions I used to explore teachers' media literacy skills and how they aligned with the tenets of media literacy. As shown in the table, the questions again referred to specific observed episodes of media use. I used specific episodes as a context for exploring teachers' media literacy skills because I wanted to know what (if any) media literacy skills they actually employed (intentionally or unintentionally) in the selection and use of that media.

The third part of the interview explored teachers' ideas about the media literacy skills of their students. Rather than explicitly focusing on the tenets of media literacy, to avoid redundancy in the interview, the third set of questions focused on the general aims of media literacy education. Specifically, questions referred to the definition of media literacy (i.e., the ability to access, analyze, evaluate, and create media) and teachers' ideas about how well equipped they think their students are to accomplish those goals.

This final interview was designed to last sixty to seventy-five minutes and occurred following the completion of classroom observations. All interviews were audio-recorded and transcribed by me within 48 hours of each interview.

Comparisons of Teacher Uses and their Conceptions of Media

The fourth phase of the study did not require any additional data collection. The fourth phase, which addressed research question 4, used the primary analyses of questions 1-3 as data sources. Therefore, this phase can be thought of as an additional data *analysis* rather than a unique data *collection* phase.

Data Analysis

Theoretical Comparison Method

Theoretical comparisons, as described previously, are an alternative to constant comparisons and are used to develop or expand upon theory that explains a phenomenon under investigation. Theoretical comparisons require the researcher to draw upon prior experience or literature to determine a comparable theory for examining data. Therefore, theoretical comparisons begin with the identification of comparable theory.

Analysis of this research study initially occurred using the theoretical comparison method and drew upon the media literacy framework in Table 2-1 developed by scholars in media literacy education. Specifically, the tenets of media literacy which attempt to explain how media is constructed and how audiences interact with media was used as a theoretical lens for preliminary examination of the data.

In the theoretical comparison method, once the theoretical lens is chosen, all instances related to specific parts of that theory (i.e., the individual concepts) are highlighted in raw data (Hsieh & Shannon, 2005). This stage is synonymous to the first stage of the constant comparative method; however, it deviates because rather than identifying “emergent” categories, the initial coding categories are predetermined.

The third stage of the theoretical comparison method involves integrating categories and their properties in order to determine if an instance “exhibits the category properties that have been tentatively identified” (Lincoln & Guba, 1985, p.342). At this stage, data analysis “begins to take on the attributes of explanatory theory, or at least (and more to the point for the naturalist), a particular construction of the situation at hand” (p.343). In the theoretical comparison method, integrating categories and their properties allows the researcher to determine if instances in the new context exhibit the category properties identified by the initial theory. This allows for clearer description of the extent to which the initial theory has explanatory power in a new context.

The final stage of the theoretical comparison method, delimiting theory, is more similar to constant comparisons. Delimiting theory focuses on the development of new theory (or possible expansion of theory under the theoretical comparison method) through the ongoing comparison of data and instances highlighted as belonging to specific categories. Just as the constant comparative method requires continual review of data and comparison of all incidents in each category in order to develop descriptions and limitations of categories as well as their relationships to each other, the theoretical comparison method requires continual review of data and comparison of incidents identified as explaining categories. Less modification within and across categories reduces the size of categories because of increased articulation of what constitutes a category (i.e., its properties and dimensions). Theory is also delimited due to saturation in which no new data is unaccounted for under the refined categories (Lincoln & Guba, 1985).

Research Question 1

Research question 1 addressed teachers' reported use of NIMM. First, detailed interview logs were maintained to document participants and interview times and locations. Second, a summary of each interview transcript was created for review by participating teachers as part of the member-checking processes. The assumption was that asking teachers to read full interview transcripts is too time-intensive and places an unnecessary burden on teacher participants. Summaries of interviews are more manageable and less time consuming to review. Member checking at this stage provided teacher participants with the opportunity to correct, clarify, delete or insert information, thereby increasing credibility of the analysis.

One randomly selected transcript and accompanying summary were then independently reviewed by me and two researchers. The two researchers were chosen for their familiarity with qualitative analysis and varying levels of familiarity with media literacy education. The second researcher is a leading scholar in science education with limited familiarity with media literacy education. The third researcher is an emerging scholar in science education with a degree of familiarity of media literacy education that mirrors my own. I reasoned that having collaborators both familiar and unfamiliar with media literacy education would offer a range of perspectives in the analysis process and increase the validity of my claims.

We independently searched the transcripts for incidents aligning with the categories Authors and Audiences (AA), Messages and Meanings (MM), and Representations and Reality (RR) as outlined in Table 2-1. The initial goal was to code each of these incidents using these categories (i.e., AA, MM, and RR) to serve as initial concepts for understanding the data under the theoretical comparison method. The tenets of media literacy would then serve as initial descriptions of the categories. Comparisons within and across categories would then be made to determine if any sub-categories exist or if any incidents could be explained by the initial theory.

After an initial review of the transcripts, however, we found that while the tenets of media literacy education were useful for designing the interview protocol and for reviewing prior research studies, it was not a useful framework for analyzing data. All three researchers found that descriptions of NIMM use frequently aligned with more than one category. The blurred boundaries between categories indicated that the media literacy framework was more appropriate as an explanatory framework than an analytical framework.

Therefore, we continued the analysis process with an independent examination of two interviews by me and the second researcher. The purpose of this stage was to familiarize ourselves with the data, identify some preliminary themes that emerged from the data, and discuss a strategy for ongoing analysis. Eight themes were initially identified. Discussion of the themes revealed that five of the themes related to the first research question (teachers' reported use of media) while the remaining three were unprompted but prominent in the data set.

The second round of analysis consisted of us independently reviewing a third transcript in order to identify any new themes and any sub-categories within those themes that described teachers' reported selection and use of NIMM resources. A follow-up discussion revealed that both researchers identified one additional theme (for a total of nine) and mutually agreed upon the need for sub-categories within four of the larger categories. We discussed the properties of each sub-category and discussed representative evidence until consensus was reached on all sub-categories.

In addition to the identification of themes and sub-categories, we noted that each interview transcript (the initial unit of analysis) consisted of smaller units in which teachers spoke of specific episodes of NIMM use in their classrooms. We decided that a second layer of analysis was warranted in order to examine these episodes in more detail.

The third round of analysis occurred in two parts. First, comparison of the major themes and sub-categories in a fourth transcript resulted in 100% inter-coder consistency with the exception of two categories in which the second researcher and I agreed with 96% and 93% consistency. Due to the high level of consistency, it was determined that I would continue with the analysis of the remaining two transcripts and engage in a peer debriefing process with the second researcher to check my interpretations.

Then, the third researcher and I proceeded by examining two new interview transcripts in order to define the term “episode” and identify episodes of NIMM use in each of the two interviews. Two transcripts were reviewed for episodes of NIMM use. Six and seven episodes, respectively, were independently identified with 100% agreement by the two researchers. Two new transcripts were then independently coded for episodes to check and refine the proposed definition. The researchers independently identified and coded five episodes with 100% agreement. Due to the high level of consistency, it was determined that I would continue with the analysis of episodes in the remaining transcripts. Following my analysis of the remaining transcripts and episodes, I engaged in a peer debriefing process with the third researcher to check my interpretations.

A running record of emergent categories, sub-categories, their descriptions, and excerpts from the interview transcripts and summaries that exemplify the categories and their descriptions were maintained and are discussed in detail in Chapter 4.

Research Question 2

Research question 2 addressed teachers’ actual use of NIMM. While it is recognized that preliminary data analysis occurs at the immediate onset of interviews or observations in naturalistic inquiry because the researcher is the instrument (Glense, 2006), and that expanded field notes are an additional layer of analysis because information is processed and initial categories are developed in the mind of the researcher, the expanded field notes in this study were considered the raw data source for analysis.

I maintained detailed observation logs to document participants, observation times, science topics covered during the class, whether or not the teacher used NIMM during the observation, and the type of NIMM used (see Appendix D). I also documented the class periods I did not observe the teachers, the topics explored during those lessons, and whether or not the teacher planned to use NIMM. I was in daily contact with the teachers to ensure the accuracy of my logs.

Immediately following each observation period, I expanded and analyzed my field notes which served as the raw data source for analysis. Given the theoretical perspective underlying my entire study (sociocultural perspectives on teaching and learning), and findings from the earlier phase of this study regarding teaches' purposes for using media, I decided to attend to the nature of the interactions surrounding teachers' use of NIMM in the classroom and teachers implicit or explicit purposes for using NIMM. Specifically, I attended to what happened in the teachers' classrooms before, during and after specific episodes of NIMM use and whether those interactions were between two individuals, within small groups, or as a whole class. To summarize my initial interpretations, the expanded field notes for each observation period were condensed into a chart. A sample chart is available in Appendix F. The expanded field notes and summary chart were used as evidence to support the cases developed in Chapter 5.

To ensure the credibility of my interpretations, I shared this chart with participating teachers as part of the member-checking process. All columns in the chart were explained to the teachers via email to help them understand my initial interpretations and categorizations of their actions. Again, the assumption was that reading expanded field notes would be too time-intensive for the teacher participants. In contrast, by using a chart that summarized my observations and characterized the nature of those observations, I helped reduce any unnecessary time burden placed on the teachers while simultaneously providing them access to my initial interpretations. Similar to member checks of interview summaries, member checking at this stage provided teacher participants with the opportunity to correct, clarify, delete, or insert information, thereby increasing credibility of my analysis.

Research Question 3

Research question 3 explored teachers' conceptions of NIMM, their reported media literacy skills and their ideas about the media literacy skills of their students. In prior phases, the media literacy framework did not prove useful as an analytic framework. I reasoned this was because prior phases were informed by the framework; however, in those prior phases, the framework did not dictate the questions I asked or the observations I made. In the final interview, however, I asked questions specifically targeting teachers' understanding of each of the tenets in the media literacy framework and their properties. Given this congruency between the framework and the actual questions asked, the media literacy framework was useful in this phase of analysis for indentifying excerpts from the final interviews related to each tenet of the media literacy framework.

I used the tenets from the media literacy framework (AA, MM, and RR) to isolate excerpts related to each tenet from each of the three interview transcripts. The second researcher and I then independently reviewed the excerpts that aligned to each category, one teacher at a time. We then met to discuss our interpretations of the excerpts and representative evidence to support our descriptions of the following: 1) teachers' knowledge about the construction of NIMM, 2) the extent to which teachers' used their knowledge of media construction when selecting and using NIMM in their classrooms, and 3) teachers' ideas about the media literacy skills of their students. These descriptions are used as evidence to support the cases developed in Chapter 5.

Research Question 4

Research question 4 explored the comparisons between teachers' uses of NIMM and their conceptions of NIMM. This phase of analysis deviated from the prior two in that it drew upon the prior analyses rather than depending upon its own unique data set. In essence, this phase of data analysis was a secondary analysis of primary analyses.

The codes and categorical descriptions from the first two phases were used as the starting point for analysis in this fourth phase. Comparisons between the primary analyses were made to discern any consistencies or inconsistencies between what teachers reported doing and what they actually did in the classroom in terms of their NIMM use. Only data collected for the three teachers chosen for the development of cases were examined in this round of secondary analysis. This ensured that comparisons were made between like groups of participants and that case reports of comparisons accurately reflect the experiences and actions of the same unique cases.

Sub-question 4a specifically drew upon the analyses of teachers' reported and actual uses of NIMM and thus relied upon the codes and categories that resulted from the initial teacher interviews and subsequent observations. Sub-question 4b drew upon the analyses of teachers' uses and conceptions of NIMM and thus relied upon the codes and categories that resulted from both the initial and final interviews and the observations. Specifically, comparisons were made to discern 1) how teachers' media literacy skills compare to their actual uses of media, 2) how teachers' perceptions of their students' media literacy skills compare to teachers' reported and actual uses of mass media, 3) if teachers consistently focus on one element of media (i.e., AA, MM, or RR) in their reports of media use, and 4) if teachers implicitly or explicitly address any elements of media during classroom instruction and how addressing the elements may or may not align with their conceptions of NIMM. These comparisons are used as additional evidence to support the cases developed in Chapter 5.

Developing Theory

The initial four research questions sought to explore and compare teachers' uses and conceptions of media in a descriptive sense. As data collection and analysis progressed, the focus of my interviews and observations shifted. While I continued to explore the descriptive elements of *what* I was hearing and seeing the teachers' classrooms (and therefore attending to the original research questions), I found myself asking questions about *why* teachers were (and were not) using NIMM. At some point during the nine week observation period, I began focusing my observations and final interview to understand the following question: What factors influence a science teachers' use of NIMM in the classroom? This question required me to think abstractly about the data to seek explanations for what I was observing. Abstraction is necessary for the development of grounded theory (Corbin & Strauss, 2008).

I reviewed my data collection methods (i.e., observations and interviews) to determine if I needed to add new sources of data to explore this new question in depth. In consensus with the second researcher through several rounds of peer debriefing, I determined I had sufficient amounts of evidence to account for an explanation of teachers' NIMM use. Exploration of this new question depended on ongoing analysis of the data rather than new collection. As I made interpretations, I continually returned to the second researcher in a peer debriefing format to discuss my interpretations and supporting evidence. The second researcher asked clarifying questions and challenged my claims to force me to consider alternatives to my interpretations. These ongoing discussions provided me with a context for increasing the strength of my interpretations which are presented in Chapter 6 to explain the factors influencing science teachers' classroom use of NIMM.

Trustworthiness

Traditionally, the quality of research has been determined by the researcher's ability to establish the validity, reliability, and objectivity of the study. Internal validity examines the "truth value" of claims, external validity examines the generalizability of those claims, reliability examines the extent to which the data instrument used would produce similar results under the same conditions, and objectivity examines the extent to which researcher-bias is eliminated from interpretation of the research findings. In qualitative research under the naturalistic paradigm, there is little merit for evaluating research in this manner. This is because the ontological and epistemological assumptions underlying the naturalistic paradigm do not adhere to conventional positivist thought.

Instead, Guba and Lincoln (1985), as well as others (Corbin & Strauss, 2008; Erlandson et al., 1993; Glense, 2006; Merriam, 1998) have noted that establishing the trustworthiness of research claims offers more insight into the quality of qualitative research. In order to account for the critiques of qualitative research, Lincoln & Guba (1989) describe how four criteria for trustworthiness align to conventional notions of validity, reliability, and objectivity, and how those criteria can be applied to ensure quality analysis.

Credibility

Credibility is similar to conventional notions of internal validity. In qualitative research, the credibility of interpretations can be enhanced through prolonged engagement in the natural setting, peer debriefing during the analysis process, and through the use of member checks throughout the course of data collection and analysis. This particular research study used each of these three suggested actions as detailed in Table 3-3.

Prolonged engagement helps researchers "overcome distortions that are due to his or her impact on the context, his or her own biases, and the effect of unusual or seasonal events" (Erlandson et al., 1993, p.30). Member checks allow the participants in a study to agree, disagree, clarify, or add new insights to researchers' data and subsequent analysis in order to provide a more accurate and detailed understanding of the participant's perspective which is forefront under the naturalistic paradigm (Glense, 2006).

Transferability

Transferability is similar to conventional notions of external validity. Transferability is provided by thick descriptions of the context, participants, and participant actions; however, it is up to the audience to determine whether the results of the study are transferable to other situations as interpretations is both audience and context-dependent. Purposeful sampling also contributed to the transferability of research findings because “naturalistic research seeks to maximize the range of specific information that can be obtained from and about that context. This requires a sampling procedure that is governed by emerging insights about what is relevant to the study and purposively seeks both the typical and divergent data that these insights suggest” (Erlandson, 1993, p.33). Selection of extreme cases in which it is most probable that NIMM is used will maximize the transferability of the research findings from this study. The specific activities used in this research to fulfill the trustworthiness criteria of transferability are shown in Table 3-3.

Dependability

Dependability aligns with conventional notions of reliability. Dependability is provided through detailed descriptions of methodology that assure the reader that the researcher did what he or she reported doing. Lincoln and Guba (1985) call this the “dependability audit,” while Erlandson (1993) calls this the “running account of process.” The dependability audit is especially important in iterative qualitative research such as naturalistic inquiry in which the research design is necessarily emergent. The dependability audit not only logs anticipated methodology, but also includes detailed accounts of how and why the research process changes as time progresses. The specific activities used in this research to fulfill the trustworthiness criteria of dependability are shown in Table 3-3.

Confirmability

Confirmability is comparable to conventional notions of objectivity. The major difference in naturalistic inquiry is that researchers recognize they are the primary data instrument and therefore objectivity is impossible. In qualitative research, however, confirmability ensures that "data (constructions, assertions, facts and so on) can be tracked to their sources, and that the logic used to assemble the interpretations into structurally coherent and corroborating wholes is both explicit and implicit in the narrative of the case study" (Guba & Lincoln, 1989, p.243). Confirmability is traced through the confirmability audit which should illustrate how interpretations of data trace back to the source. The specific activities used in this research to fulfill the trustworthiness criteria of confirmability are shown in Table 3-3.

Subjectivity

When conducting qualitative research it is impossible, and even undesirable, to claim objectivity during data collection and analysis. This is most obvious when one considers the researcher as the instrument for collecting and analyzing data. However, in order to identify emergent theories from evidence grounded in data, it is necessary to identify how one's individual perspective can influence collection and interpretation. Identifying individual subjectivities strengthens the trustworthiness of a study. The following paragraphs will highlight some of my own subjectivities, as the researcher, in an attempt to make my personal biases transparent to the reader. It is my belief that interpretations of data are as context and time dependent as individual realities and therefore should be used in other contexts cautiously. It is my hope that by delineating some of my subjectivities, the interpretations of my findings are less influenced by my personal biases and that future readers (and possible users) of my interpretations will have a better understanding of my perspective in relationship to my data and findings.

First, the entire purpose for this research study stems back to my own experiences as a middle and high school science teacher. When I was teaching, I recognized that my students were more motivated to participate in science when I used alternative teaching resources, such as films, trade books, and comic strips. I particularly enjoyed using those resources because they provided students with a real-world context in which to learn science that the textbook and other instructional resources lacked. Therefore, I personally value NIMM resources as science instructional resources.

Second, while I value those resources, it was not until I left the classroom as a teacher that I learned about media literacy and the potential impact of using mass media haphazardly in the classroom. I did not consider the constructed nature of media and the complex interactions that occur when an audience member engages with media. Learning that there was an academic field (i.e., media literacy education) that looked at these interactions and media constructions was a revelation for me. I have because placed value on the need to learn how to critically evaluate media texts.

Interpretation is always dependent upon one's own frame of reference. While I attempt to describe the experiences and ideas of my participants in this report, I acknowledge that my own frame of reference, or relevance structures, influenced the descriptions I provide. Analysis is unavoidably a value-laden action in qualitative research; qualitative research does not espouse objectivity. Therefore, when conducting this research, I underwent a continual process of questioning my own assumptions and how my own experiences may influence interpretations of what I heard and saw. This "bracketing" of my own values allowed me to more clearly *see* the values of my participants and consider their viewpoints and values as important to understanding the situation being examined (Berger & Kellner, 1981). Furthermore, the use of extensive records, peer debriefing, and member checking helped ensure that the data were interpreted through my perspective as opposed to being generated by my perspective.

Limitations

- This study only examines the instructional intentions and practices of teachers who are self-reported frequent users of media and volunteered to participate in the study. The exploratory nature of this study limits the ability to generalize the results to teachers other than the ones in the study.
- The definition of NIMM used in this research guides the study and discussion of the results, although teachers (and other scholars) may have other conceptions of NIMM.
- The choice to declare an ending point to data collection limited the amount of classroom observation time available per teacher. As such, the results are based upon a snapshot of classroom teaching, and cannot be assumed to be fully representative of each teacher's instructional practices.
- Exploration of science classroom NIMM use and discussion of the results are all based upon the assumptions previously outlined.

Summary

This study used naturalistic inquiry and grounded theory to uncover the extent to which secondary science teachers interact with NIMM resources in their classrooms and the factors that influenced their use of NIMM to teach science. Through an ongoing process of data collection and analysis, this study offers rich descriptions of teachers' reported and actual uses of mass media as well as their conceptions of NIMM.

I conducted this study in four phases beginning with an investigation of teachers' reported use of NIMM via interviews. All secondary science teachers at a local university research school were asked to participate in the study. Three of the teachers were purposively selected for the remaining phases of the research study due to their high classroom usage of NIMM relative to the other teachers in the study.

The remaining phases of the study included extended observations of teachers' actual practice, followed by interview investigations of teachers' conceptions of NIMM, their reported media literacy skills, and the ideas they hold about the media literacy skills of their students.

Data analysis of the first three phases of study proceeded using constant comparisons, culminating in the secondary analysis of all three primary data analyses to discern any relationships between teachers' uses and conceptions of NIMM in the fourth phase. A final round of analysis of all data was conducted to uncover the factors influencing teachers use of NIMM to teach science. I used the suggestions provided by Lincoln and Guba (1985) to establish the trustworthiness of this study.

Table 3-1. Alignment of research questions to research design

Research Phase	Research Question	Participant Criteria	Data Used for Participant Selection	No. of Participants	Data Sources (and date collected)
Phase 1	To what extent do secondary science teachers report using non-instructional mass media in the science classroom?	• All secondary science teachers at local university research school	• Faculty listing of secondary science teachers • Signed informed consent	n=6	• Reported Use of Media Interview (May-June 2009)
Phase 2	How do secondary science teachers, who report frequent use of non-instructional mass media, actually use non-instructional mass media in the science classroom?	• Frequent user of non-instructional mass media (relative to other teachers) • Maximum likelihood for using non-instructional mass media	• Reported Use of Media Interview (Spring 2009) • Survey of public online documents (Spring 2009)	n= 3	• Observations of Media Use (August-October 2009)
Phase 3	How do secondary science teachers conceptualize non-instructional mass media?	• Participants from prior phase of research	• Participants from prior phase of research	n= 3	• Conceptions of Media Interview (October-November 2009)
Phase 4	How do secondary science teachers' uses and conceptions of non-instructional media compare and contrast?	• Participants from prior phase of research	• Participants from prior phase of research	n = 3	• Primary Analyses from Phase 1-3

Table 3-2. Alignment of interview questions regarding teachers' media literacy skills to the tenets of media literacy

Tenets of Media Literacy	Description of Tenet	Interview Questions
Authors and Audiences	authors create media for specific purposes (e.g., power, profit) authors create media with specific audiences in mind audiences choose which media to read	How did you select (XXX media) for that lesson? Why did you choose to use (XXX media) during that lesson? Some people suggest that media are constructed with a specific audience in mind. Would you agree or disagree with that statement for (XXX media)? Why?
Messages and Meanings	media texts use different symbol systems to convey a message (e.g., language, images, sound) media texts contain identifiable patterns that follow the codes and conventions of specific genres meaning from media messages are interested by audiences using prior knowledge and experiences audience interpretation influences future decisions, behaviors, attitudes, and worldviews of audiences	Was there anything specific about that particular medium that made it better to use during that lesson than another medium? Are there any criteria you used for determining whether or not to use that piece of media?
Representations and Reality	media texts use techniques that affect an audience's perception of reality (e.g., sensationalism) media texts reflect the ideologies of authors and thus selectively omit information and contain biased views	What impact would that have on how students interact with media? How well do you think (XXX media) accurately reflected how science is done? Explain. How well do you think (XXX media) accurately reflected what scientists do? Explain.

Table 3-3. Procedures for establishing the trustworthiness (Lincoln & Guba, 1985) of the study

Conventional Criteria	Trustworthiness Criteria	Suggested Action	Actions taken in this specific study
Internal validity	Credibility	Prolonged engagement	The entire study spanned seven months between the time of the initial and final interview with regularly scheduled observations over a nine week period.
		Member checks	All summaries of transcripts and narratives based upon field notes were provided to the participants to allow them the opportunity to correct, clarify, delete or insert information. Teachers selected as cases for the last three phases were provided with the opportunity to make corrections to the drafts of the final chapters of the study.
		Peer Debriefing	Three randomly sampled interview transcripts and accompanying summaries were independently analyzed by the researcher and a knowledgeable second reviewer to determine the accuracy and adequacy of categorical descriptions.
External validity	Transferability	Thick description	Detailed case reporting allows the audience to determine if the results of the study are transferable to other situations.
		Purposeful sampling	Teachers for each stage of the study were purposively sampled based upon maximum likelihood of seeing non-instructional mass media used in their classrooms.
Reliability	Dependability	Dependability audit	Detailed observation and interview logs were maintained as well as transcripts, summaries of transcripts, original field notes, narratives based upon field notes, and any email communications between teachers and the researcher. The researcher also kept all printed online documents used for purposeful sampling, and copies of the non-instructional mass media resources used by teachers during classroom instruction. Finally, any changes in the research design were thoroughly documented and discussed in subsequent chapters.
Objectivity	Confirmability	Confirmability audit	Presentation of the results is transparent in how data was checked and rechecked throughout the study to build an emergent theory. Specific examples (and non examples) used to support the emergent theory are included. Full transcripts, summaries of transcriptions, and narratives based upon field notes with codes are provided.

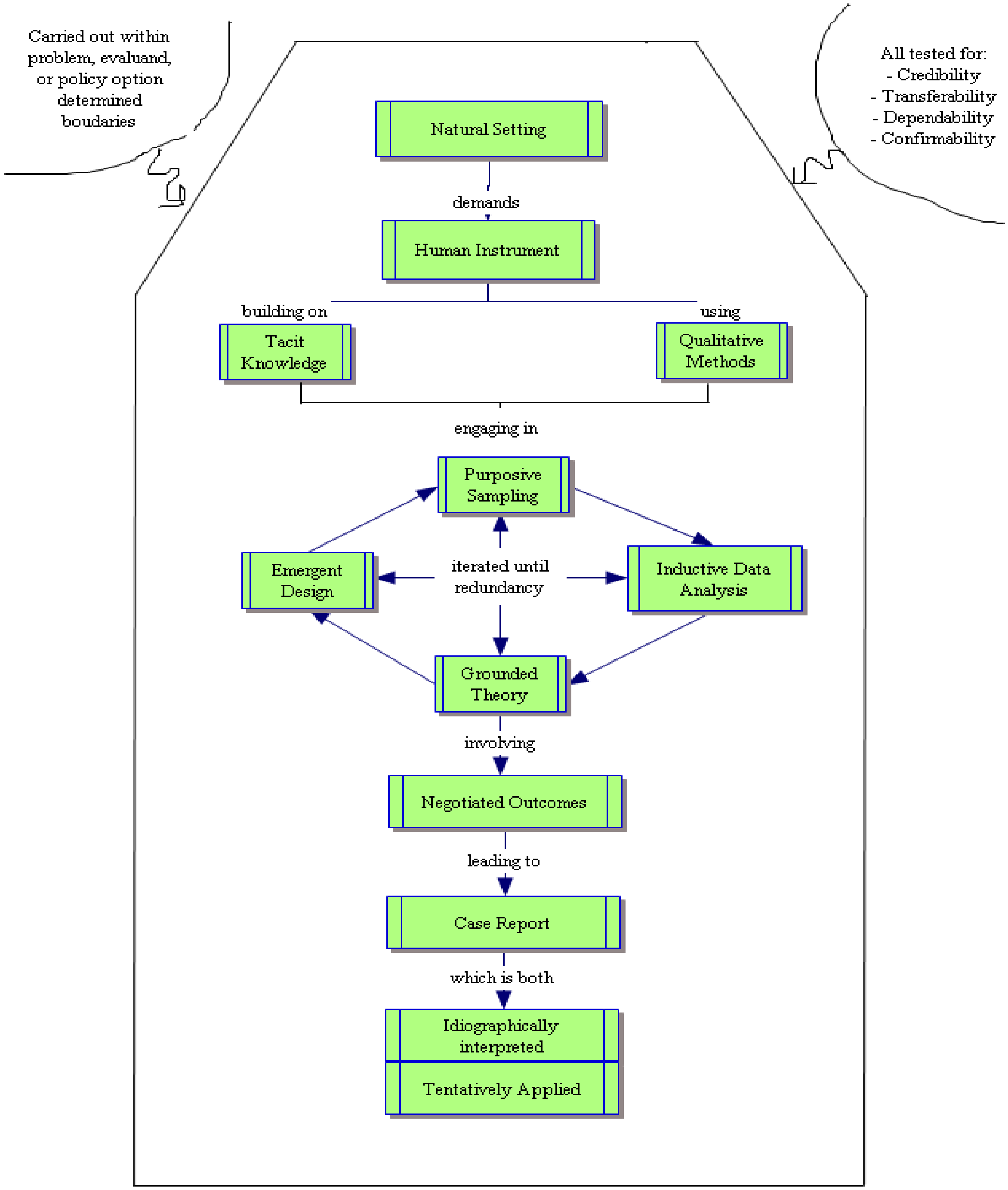

Figure 3-1. Naturalistic Inquiry as conceptualzed by Guba & Lincoln (1985).

CHAPTER 4
TEACHERS' REPORTED MEDIA USE

The purpose of this chapter is to outline the results of the first phase of my research study in which teachers' reported use of non-instructional mass media (NIMM) was investigated to better understand the extent to which NIMM resources play a role in the secondary science classroom. In addition to exploring the general themes related to teachers' reported use of NIMM, the purpose of this phase was to identify the participants from the initial sample of teachers to follow for the remaining phases of my study.

The following chapter is divided into three parts to reflect these goals. The first section discusses general themes related to teachers' reported media use. The second section provides a description of specific episodes of media use and patterns found across episodes that emerged from the data. The third section presents a rationale for selecting participants for subsequent phases of my study.

General Themes

During the initial interview process, I interviewed six science teachers in their classrooms at times that were most convenient for them during April and May of 2009. The teachers taught a variety of subjects and varied in their teaching experience and prior educational experiences. A summary of their profiles is presented in Table 4-1. Pseudonyms are used in place of actual names of persons to protect their anonymity as outlined in the informed consent process.

In the following reports, an abbreviation scheme is used to identify the original source and location of quotes from the initial interview transcripts. The abbreviation scheme indicates the teacher, followed by the data source and the location of the quote in the data. For example, AI1.132 indicates interview 1 with Amanda, line 132 in the transcript. The first initial of the teacher's pseudonym indicates the source (e.g., A for Amanda, C for Charlotte, and H for Hugh). When an interview quote contains more than one voice, the first initial of the teachers' pseudonym is used to indicate the teacher's statement, and R is used to indicate my voice.

As discussed in the previous chapter, theoretical comparisons did not hold as an analysis framework and therefore teacher interviews were analyzed using the constant comparison method under the grounded theory approach (Corbin & Strauss, 2008). One experienced researcher and I independently reviewed the transcripts in order to identify and evaluate themes and descriptions of categories that emerged from the data related to teachers' reported use of NIMM resources. Three rounds of analysis resulted in an average inter-rater consistency of 96% across the following nine categories: types of media, science topics, frequency, strategies for using, rationale, choosing mass media, supports, barriers, and student impact. All nine categorical codes and their included subcategories can be found in Appendix G and are discussed in more detail below. All nine categories emerged following analysis of the interview data. The first five categories directly relate to the original research sub-questions related to teachers' reported use of NIMM, while the remaining four categories are general themes related to teachers' media use not addressed in the original question set.

Types of Media

Research question 1a explored the types of NIMM science teachers reported using. All six teachers reported selecting and using a variety of NIMM resources to teach science. Using the categorical scheme outlined in previous chapters, the types of NIMM the teachers used fell into one of the following four categories: digital media, newspapers and magazines, television and films, or trade books. No teacher reported using radio in their classrooms to support instruction.

As can be seen in Table 4-2, all six of the teachers' reported using digital media in their classrooms. While all of the teachers reported using the internet to support instruction, only Hugh mentioned using commercial videogames (*Spore* and *RaftWars)* to illustrate concepts of natural selection and the scientific method, respectively, with his students.

All six teachers reported using newspapers and magazines in their classrooms to teach science; however, Amanda was the only teacher who specifically discussed the use of science journals in her classroom. Commonly used magazines as reported by the teachers were the *Smithsonian* and *National Geographic.* The local newspaper was also a popular resource for all of the teachers.

All six teachers reported using television shows and films (both documentary and entertainment films) in their classrooms. PBS documentaries were popular among the teachers, as were science fiction entertainment films like *Jurassic Park* and *Journey to the Center of the Earth.* The most widely used television show was *Mythbusters*, which four of the teachers reported using in their classrooms.

Three teachers reported using trade books in their classroom. Dennis and Hugh discussed their use of non-fiction trade books such as *Uncle Tungsten* and *Florida's Fabulous Spiders* , while Amanda discussed using both non-fiction and fiction trade books such as *The Hot Zone*. None of the six teachers discussed using radio in their classroom.

Science Topics

Research question 1b investigated the topics teachers reported exploring through the use of NIMM. Analysis of the interviews revealed teachers report using NIMM primarily to discuss life and environmental science topics, followed by earth and space topics, science and applications of science, controversial issues, and lastly, physical and chemical science topics. The number of references to specific examples of NIMM used in their classrooms, classified by topic, can be seen in Table 4-3.

In order to identify any patterns between instances of NIMM use, topics explored, and the focus of teachers' courses, I reviewed the state standards for each of the teachers' courses. I then identified the focus of each teacher's course in terms of content topics as belonging to life and environmental science, physical and chemical science, or earth and space science. A review of the standards revealed that every course should include a discussion of scientists and applications of science. According to the state standards, none of the courses required inclusion of controversial issues.

No patterns were identified between the number of teachers, the focus of their course in terms of content standards, the types of media used, and the number of references to content topics explored through NIMM. Given that three teachers were identified as life science teachers, the higher number of references to using media to explore life and environmental science topics might be expected. However, as can be seen with other topics, the number of teachers does not correlate to the number of references to using media to explore physical or chemical science topics compared to earth or space science topics. Charlotte was the only earth and space science teacher in the study, however there was a larger number of references to using NIMM to explore earth and space science than physical or chemical science, which was covered by two teachers. Additionally, in several instances Betsy and Dennis (teachers of physical and chemical science, respectively) discussed using media to explore life science topics in their courses and noted the lack of resources for exploring traditional physical or chemical science topics like chemical equations or forces and motion.   For example, Betsy said, “It’s hard to find news articles on what I talk about. It’s just hard” (BI1.364).

Outside of traditional content areas, the teachers discussed nine instances of using NIMM to explore controversial issues such as global warming, stem cell research, and nuclear energy, none of which was required in the state standards. The teachers reported ten instances of using NIMM to explore general topics in science such as “the work of scientists on the field and the applications [of science] to everyday life” (DI1.365). No patterns were identified between the types of media used and instances of NIMM use to explore controversial issues or general topics in science.

Frequency

Research question 1c explored how frequently teachers’ used NIMM in their classrooms as reported in the interviews. When I asked how often they used NIMM resources in their science classrooms, all six science teachers said they used NIMM at least once in any given instructional unit. Dennis and Melissa reported using media at least one time during each instructional unit. Betsy reported using digital media every week as a part of a regular assignment on the internet, but reported less frequent use (i.e., once each instructional unit) of other types of media. Amanda and Charlotte reported using media in their science classrooms every day depending on the instructional unit. Hugh reported using media everyday regardless of the instructional unit.

Strategies for Use

Research question 1d examined how teachers reported using NIMM in their classrooms. Analysis of the interviews revealed teachers reported using the following instructional strategies in their classrooms when using NIMM: student creation, independent exploration, engaging in scientific practices, note-taking, teacher-led discussion, identifying fact or fiction, critical evaluation of media, and practicing reading strategies. Table 4-4 illustrates each strategy, the teachers who reported using each strategy in their classrooms, and representative evidence from interviews with the teachers.

As can be seen in Table 4-4, teachers reported strategies for using NIMM in their classrooms were further classifiable as either being student-centered or teacher-directed uses. Student-centered uses are those in which students are in control over what they focus on while using or creating the media. Student creation of NIMM, independent exploration (watching, reading, or listening), and engaging in scientific practices with media were examples of student-centered uses reported by the teachers. Teacher-directed uses are those in which teachers provide probing questions or specific prompts to direct students' attention to specific aspects of the media. In teacher-directed uses, students are expected to complete a task made explicit by the teacher prior to interacting with the media. Examples of teacher-directed uses, as reported by the teachers, were showing an excerpt of a film and directing students to take notes on its content, teacher-led discussions, instructing students to identify scientific fact and fiction within a medium, practicing reading strategies as outlined by the teacher, and critical evaluation of media. No clear pattern was identified between the numbers of teachers using either student-centered or teacher-directed strategies in their classrooms. A brief description of each of the strategies for using media follows.

Student-centered strategies. Charlotte and Hugh reported engaging their students with NIMM by having students create videos to demonstrate their science learning. In both of their classrooms the students had control over what to include in their videos and the materials they used to create them.

Independent exploration of media was a strategy reported by three teachers (Amanda, Hugh, and Melissa). During independent exploration of media, teachers provided students with mass media and time to either watch, listen, or read media on their own without specific prompts for what to explore or how to explore the media.

Two teachers, Amanda and Hugh, used media to engage students in scientific practices. These two teachers described engaging students in scientific practices as using media as a resource or vehicle for practicing scientific process skills such as collecting data or communicating results. As an example, Hugh used digital media to engage his students in scientific practices when he used the commercial videogame *Raft Wars* in his classroom. The students in Hugh's class were instructed to take measurements and record data as they changed variables during videogame play in order to improve their personal scores. The students then communicated their findings and shared their results to become better as a class compared to the "normal" player. This was a student-centered use of mass media because the students had control of which variables to change during game play and how to communicate their findings with other students.

Teacher-directed strategies. All six teachers reported using note-taking as a strategy for classroom use of mass media. In several instances, the teachers described showing videos or assigning readings from mass media texts and requiring students to take notes on the scientific information discussed in the medium. In each instance of note-taking reported by the teachers, students were given a specific prompt for what information to take notes on while interacting with the medium.

Amanda, Charlotte, Hugh and Melissa reported using teacher-led discussions as a strategy for using media in their classrooms. During teacher-led discussions, students were not asked to write responses to specific prompts or complete any other assignment; however, they also did not explore the media independently. Teacher-led discussions were whole class discussions led by the teacher which revolved around information found in a particular medium.

Charlotte, Hugh and Melissa reported using the identification of scientific fact and scientific fiction as a strategy for using NIMM in their classrooms. The identification of fact and fiction occurred when teachers presented students with a piece of media such as a comic strip, videogame, film, or newspaper article, and asked students to identify the correct and incorrect scientific information in that media.

Another strategy reported by Amanda and Hugh was practicing reading strategies. Both Amanda and Hugh discussed the use of a particular reading strategy, reciprocal teaching, to engage students with parts of written text within media in an effort to improve their comprehension of the information in that text.

Amanda, Betsy and Hugh reported using critical evaluation of media as a strategy in their classrooms. During this strategy, teachers reported having their students watch, read or listen to a piece of media and do one of two things: 1) determine elements of that particular medium that were missing and could be added, or 2) determine whether or not the author and information presented was credible. This was different than identifying fact and fiction in an article because with critical evaluation of media strategies the teachers asked their students to evaluate the level of credibility of the author and his or her sources of information rather than identify if it was right or wrong.

Amanda discussed her use of a variety of strategies as essential to getting and maintaining her students' interest, "They don't like to do any one thing too much so you have to do a variety of different strategies to keep them informed and interested." (AI1.288) As reported in Table 4-4, all six teachers used a variety of strategies when using NIMM in their classrooms. Other than the connection between reading strategies and print media (e.g., newspapers, magazines, and trade books), no pattern was identified between the types of strategies and the types of media teachers reported using.

Rationale

Research question 1e examined teachers' purposes for using NIMM. Teachers' described using NIMM in their classrooms for four reasons: teachers preferred NIMM over another instructional resource or method (referred to as "Preferred medium" in Table 4-5), media's potential to share scientific information ("science"), media's interdisciplinary potential ("interdisciplinary"), or media's potential to aid in classroom management ("classroom management"). These four categories emerged from discussions with the six teachers in which they described why they felt media could be used in their science classrooms. A description of each category, properties of those categories and examples from the interview data are discussed below and presented in Table 4-5.

Preferred medium. Teachers discussed using NIMM because they were less time consuming than using other instructional methods or resources, they were more current than other types of instructional resources, they allowed teachers to present information more effectively than if presented through a different medium, they allowed teachers to make otherwise inaccessible information accessible to their students, or they were easily accessed.

Hugh discussed his use of videogames as a means to save valuable class time because he thought that using videogames to simulate the scientific method was less time consuming than using conventional scientific experiments. Amanda chose to use NIMM because it was a more current resource than textbooks. Amanda felt she could acquire more current information through the use of NIMM than through textbooks because of the time it takes to write, print, and adopt textbooks for classroom use. By the time the textbooks ended up in her classroom for student use, they were already out of date. Charlotte discussed her use of NIMM because they presented information in a mode (i.e., visual, auditory, or print) that may be more compatible with student learning styles. As a very visual learner herself, she reported preferring the use of videos for her students who she thought were also visual learners, The mode of presentation (audiovisual) of media she used matched her own learning style and the learning styles of her students.

The teachers also stated they used NIMM because it had the potential to make otherwise inaccessible science content and experiences more accessible to their students. For example, Betsy describes the use of videos to show her students the inside of a wind turbine. Betsy felt non-instructional videos had the potential to illustrate the inside of a wind turbine which is something she was not able to show her students in person.

Lastly, Hugh, Melissa, and Dennis each reported using NIMM because it was easily accessible in their classroom when they needed it. Specifically, NIMM was favored by Dennis because it was accessible to both him and his students both inside and outside of his classroom. This accessibility was not limited to digital media. Melissa, for example, cited the easy access of newspapers as her reason for using NIMM in the classroom.

Science. Teachers reported using NIMM because of its potential to convey both science content and the applications of science. In terms of science content, NIMM was chosen because teachers felt NIMM could be used to introduce new science content and re-present content previously covered in their classroom. In terms of the applications of science, NIMM was described by the teachers as having the potential to illustrate real people in science, the prevalence of science in society, and real examples of how science is done.

As illustrated in Table 4-5, all of the teachers, except for Melissa, reported using NIMM because they felt it could introduce new science content (referred to in Table 4-5 as "new content"). Charlotte discussed her use of a documentary on volcanoes to introduce students to the layers of Earth's atmosphere. Similarly, Dennis discussed his use of a non-fiction book "to supplement the textbook quite frequently." (DI1.283)

All of the teachers also reported using NIMM because of its potential to re-present content previously covered in their classrooms (referred to as “prior content” in Table 4-5). For example, Hugh discussed his use of a video to readdress concepts in taxonomy by having students practice classifying animals they saw in a film by taxonomic levels. Similarly, Charlotte showed *Journey to the Center of the Earth* to re-address previously covered content related to rocks and the layers of Earth.

Amanda, Betsy, Dennis, and Melissa also felt that NIMM could illustrate applications of science by illustrating real people in science (referred to as “people in science” in Table 4-5). Even if students were unfamiliar with information shared through a non-instructional video about chemistry, for example, Betsy felt such videos had the potential to show students examples of chemists and their working environments. This was similar to making otherwise inaccessible science accessible to her students, however was different in that the specific focus of the media was to illustrate scientists and their work rather than just scientific concepts or access to otherwise inaccessible environments.

Amanda, Betsy, Dennis and Melissa also discussed using NIMM because of its potential to illustrate the prevalence of science in society (referred to as “prevalence of science” in Table 4-5). Science influences and is influenced by our everyday lives. Amanda reported that media had the potential to illustrate “what’s really going on in the world” (AI1.246).

All of the teachers, except for Melissa, reported using NIMM because of its potential to illustrate the practice of science, or real examples of how science is actually done (labeled “scientific practices” in Table 4-5). This included discussions of the process of experimentation, the evolving nature of scientific knowledge, and how scientists communicate their findings. For example, Amanda felt NIMM could illustrate how scientists communicate their findings by presenting students with excerpts from scientific journals; Betsy said the television show *Mythbusters* could be used to illustrate how scientists go through the process of experimentation to prove or disprove hypotheses; and Dennis felt the use of a non-fiction trade book could illustrate the evolving nature of scientific knowledge.

Interdisciplinary. Teachers reported using NIMM because of its potential to serve as an interdisciplinary connection between science and language arts. Specifically, Amanda and Dennis discussed the reading initiatives at their school. They felt the written format of newspapers, magazines, and non-fiction trade books could be used to reinforce reading strategy instruction that was required of all teachers at their school (referred to as “mode of presentation” in Table 4-5). Amanda and Dennis viewed print NIMM as a potentially valuable resource in terms of meeting their goals for science and their school’s mandates for classroom reading.

Classroom management. Lastly, the teachers described using NIMM in their classrooms because of media’s potential to aid in classroom management (referred to as “classroom management” in Table 4-5). Specifically, teachers felt NIMM could entertain their students, engage their students, and potentially serve as a classroom management tool.

All of the teachers, except for Charlotte, reported using NIMM because of its potential to entertain students. Entertaining students was defined as capturing students’ interest. Hugh discussed the potential of non-fiction books with colorful illustrations to capture student interest; and Melissa discussed the entertainment value of the movie *Evolution* as a reason to use NIMM.

All of the teachers, except for Melissa, reported using NIMM because of its potential to engage students. Engaging students was defined as more than capturing students' interest and included maintaining students' focus over a period of time. For example, Amanda discussed using videos such as *Bill Nye*, a popular informational video series, to capture and hold students' attention.

All six teachers reported using NIMM because of its potential as a classroom management tool. This meant that teachers saw NIMM as a potential resource for holding students' attention when teachers were absent from the classroom or when the teachers needed to accomplish another task. As a classroom management tool, NIMM had the potential to reduce or eliminate any behavioral issues in the classroom by occupying students' attention.

The types of NIMM teachers reported using in their science classrooms, the topics they chose to explore through the use of NIMM, the frequency at which they used NIMM, the strategies they employed to interact with NIMM in their classrooms, and teachers' reasons for using NIMM in their classrooms were all themes that emerged from the initial interview data and addressed the first research question and related sub-questions of this study around teachers' reported use of NIMM. In addition to these categories discussed above, inductive analysis of the interviews revealed four other general themes related to science teacher use of NIMM. Those four themes are as follows: choosing media, supports for using media, barriers to using media, and student impact. A description of each category, their properties, and representative evidence from the interviews are presented below.

Choosing Media

During the interviews, teachers discussed issues related to choosing NIMM for use in the science classroom. Choosing media was further categorized into locating media and the selection criteria that teachers use when choosing media. Table 4-6 illustrates these properties of choosing media, the teachers who discussed these issues of choosing media, and representative evidence of each property from interviews with the teachers.

Teachers reported using internet searches, information as a result of their memberships in various organizations and/or subscriptions to magazines, word of mouth, and inadvertent exposure to find NIMM resources for their classrooms. Internet searches were the most commonly used method for locating NIMM resources for the science classroom. Betsy, Dennis, Hugh and Melissa reported using internet search engines to do a basic search for topics they were covering in class. Using the links suggested by the search engines, they then located media to use in the classroom related to their original topic search.

Teachers also reported using membership materials related to their memberships in organizations such as United Services Automobile Association (USAA) or personal subscriptions to magazines such as *The Smithsonian* or *National Geographic* to located NIMM for classroom use. All of the teachers, except for Betsy, reported using membership materials from organizations to which they belonged as instructional resources.

Word of mouth was also a powerful means of locating NIMM for the science classroom. Either through recommendations by their own children, other teachers in the school, or other support personnel (i.e., the school's technology coordinator), Amanda, Dennis, and Hugh reported using recommendations by other individuals to locate media for classroom use.

Lastly, inadvertent exposure was reported by Amanda, Betsy, and Charlotte as one of their strategies for locating NIMM resources for the science classroom. Inadvertent exposure was categorized as when teachers reported using NIMM for their own personal use, not purposely looking for materials for the classroom. Afterwards, the teacher realized the resource was usable in the classroom as an instructional tool.

In addition to the strategies teachers used to locate NIMM for classroom use, teachers used a variety of selection criteria for choosing media once the media was located. Selection criteria included issues around the science contained in the medium, elements of the medium itself, and the relevance of the media to the teacher and the students.

Selection criteria were categorized differently than why teachers chose media because selection criteria focused on which piece of media to choose rather than a choice about why to use media in general. Sometimes selection criteria and reasons for using media overlapped because a teacher's reason for using media may have dictated which piece of media that teacher chose; however, a teacher may have multiple reasons for using media, but ultimately they had to use one or more criteria for selecting the specific piece of media.

Issues around the science contained in the medium included making sure the content in the media was related to the content being covered in class, making sure the content addressed in the media was accurate, and choosing media based upon its use of scientific language and terminology. All six teachers felt media should be chosen based on its connection to the content being covered in their classrooms. Amanda felt the scientific accuracy of information in the media should be considered when selecting media. Dennis felt the language used in the media should be reflective of the scientific language and terminology he used in his classroom.

Elements of media considered by the teachers when choosing NIMM for their classrooms were the author of the media, its presentation of balanced perspectives, its length, its timeliness, and its use of quality visuals. Amanda and Hugh thought that author of NIMM should be considered when selecting media for their classrooms. Dennis and Charlotte reported selecting media based upon its ability to present balanced perspectives on a science issue. Especially in the case of controversial science topics, Dennis selected media that presented both sides of an issue. Betsy chose NIMM that was short in length, thereby reducing its impact on her instructional time. Amanda, Betsy, Charlotte and Dennis reported selecting media that was timely. Timeliness, as a selection criterion, meant the information in the media needed to be current and not out of date. Amanda and Hugh also chose NIMM that contained quality visuals as opposed to containing poor or low-budget footage.

Lastly, teachers chose media based upon its appropriateness and interest to students and its personal interest to the teachers. The appropriateness of the media was determined by comparing the reading level of print media to students' reading levels. Amanda, Charlotte and Hugh all reported selecting print media based upon its correspondence to student reading levels. All of the teachers, except for Dennis, chose media based upon what they thought would interest their students. Charlotte, Dennis, and Hugh, however, chose media based upon its personal interest to them as teachers.

Supports for Using Media

During the initial interviews, teachers reported drawing upon two types of support for using NIMM in their classrooms: other teachers and professional development. Amanda, Betsy, Charlotte, Hugh and Dennis discussed support they received from other teachers as contributing to their use of NIMM. These "other teachers" were identified as teachers outside of science as well as the school's technology coordinator.

The teachers discussed support they received from other members of their faculty as supporting their use of media. Hugh discussed his collaboration with math teachers to document student data collection through videogame play: "We made like automatic charts out of Excel which I actually don't know how to do … and the math teacher helped. The math teacher taught them how to do formulas with Excel." (HI1.169) Similarly, Amanda discussed her collaboration with English teachers while using the science fiction trade book *The Hot Zone* in her classroom. The English teacher took the responsibility of reading the book with the students while Amanda covered a science unit on infectious disease while examining the scientific accuracy of the trade book with her class.

Amanda, Betsy, Charlotte and Hugh also discussed using support by the school's technology coordinator, Steve, to use NIMM in their classrooms. Hugh, for example, collaborated with Steve to both select the videogame *Spore* for use in his classroom and to plan how he was going to introduce it to his students to convey information about evolution and natural selection. I asked Hug how he set up the use of videogames and he said the following:

> H: Well I just discussed with Steve how we were going to do that because we couldn't license it out. It's an expensive game. It's probably $60 a game if you buy it at the store.
>
> R: Per license?
>
> H: Yeah. So if you like went out and bought your own copy it would be $60. Um. I don't know how a school license works. I don't know if they have any deals on that. This was really a trial and it was a really successful trial so [Steve and I] talked about how to do that and we decided to play the game – to start playing it without the information about evolution and natural selection as a warm up and have a lot of discussions. (HI1.99)

Beyond the use of other faculty members, Amanda and Charlotte discussed their participation in professional development experiences as supporting their use of NIMM in their classrooms. Charlotte discussed how her participation in a reading initiatives workshop supported her use of print media as an alternative form of text in which she could engage her students in reading. Charlotte said the workshop helped her see that you can use other resources to read" (CI1.531). Similarly, Amanda discussed her participation in science teacher conferences, such as those sponsored by the National Science Teachers Association as influencing her choice and use of NIMM in her classroom.

Comparisons of the types of media teachers used and the supports they received revealed that professional development training in literacy instruction influenced teachers' use of print media such as newspapers and trade books to teach science, while support from other teachers within their school primarily influenced teachers' use of interactive media such as the internet and commercial video games in science.

Barriers to Using Media

In addition to issues around choosing media and supports for using media in their classrooms, the teachers in this study reported several barriers to using NIMM. Discussions with the teachers revealed barriers related to features of media, features of the teachers' context, features of students, and features of the teachers themselves. Table 4-7 illustrates each of these barriers, their properties, the teachers reporting each of the barriers, and representative evidence from interview data that illustrates each of the identified properties.

Features of media were barriers directly related to the specific NIMM teachers chose to use in their classrooms. Teachers felt they were limited in how they used NIMM in their classrooms because of five reported features of media: incomplete representations of science, dated materials, length, distracting elements, and availability.

When the teachers reported selecting media for instruction, Betsy discussed that the incomplete representations of science in some of the media she encountered limited her use of NIMM. Amanda and Dennis stated that materials they located were often out of date. NIMM that contained information that was not current was a barrier to teachers' classroom use of those resources. Betsy discussed how some videos are too long which limits her use of such resources. Amanda discussed how, in addition to dated materials, when NIMM was too flashy or contained information that could potentially distract students from the main message, her use of NIMM was limited. Lastly, Amanda, Dennis, Hugh and Melissa discussed the importance of availability to teachers' use of NIMM. When the right to use or the ability to gain access to a particular resource was compromised, teachers were limited in their use of those resources. Amanda highlighted the issue of copyright as limiting her media use, while Melissa highlighted how her personal lack of a magazine collection limited her use of magazines in her science classroom.

Features of context were identified as additional barriers to teachers' classroom use of NIMM. Specifically, four of the teachers reported a lack of time as a barrier to using media in their classrooms. With an already packed science curriculum and external demands on teachers' time, classroom use of additional resources such as NIMM seemed too time-consuming for some of the teachers.

Features of students were also reported as barriers to teachers' use of NIMM in their classrooms. Teachers were limited by their students' inability to use media or lack of interest in NIMM. The teachers discussed student difficulty using media in terms of the NIMM either not being readable or navigable by students due to students' reading levels or unfamiliarity with the medium. Melissa and Betsy emphasized students' inability to navigate NIMM resources while Amanda, Betsy, Dennis and Melissa discussed student difficulty in terms of their insufficient reading levels. For Amanda, Charlotte, Dennis, and Hugh, a lack of student interest also presented a barrier to their NIMM use. Even when materials were considered interesting to the teacher, as in Hugh's case during his use of the *Planet Earth* documentary film series, a lack of student interest limited Hugh's use of the series in his classroom.

Lastly, features of teachers were reported barriers to teachers' use of NIMM. Teachers' preferences for other methods of instruction, their own lack of content knowledge, the difficulty they encountered in locating media, and their lack of knowledge of how to use NIMM in the classroom were all reported as features of teachers that limited their use of NIMM. Four of the teachers discussed their own preference for using other instructional methods such as hands-on labs or outdoor experiences as limiting their use of NIMM. Melissa was also honest about her lack of content knowledge in the domain of space science as limiting her ability to select appropriate NIMM to use in the classroom. Amanda, Betsy and Melissa discussed their own limited abilities to locate NIMM related to the topics they were covering in class as restricting their classroom use of NIMM to teach science. They noted that although the resources may exist, they were unaware of how to locate them. Lastly, Melissa admitted to not knowing how to use or incorporate some forms of NIMM in her classroom instruction. While Melissa recognized the potential for using trade books or videogames in her classroom, for example, she could not conceptualize what instruction using those resources would look like in her classroom. This lack of knowledge served as a personal barrier to using NIMM.

Student Impact

Betsy, Charlotte and Dennis each spoke about the impact of using media on their students. While the interview questions did not directly address student impact, the category of student impact was emphasized by these three teachers and therefore was categorized as a theme related to teachers' use of NIMM. In particular, the teachers discussed how their use of NIMM in their classrooms had the potential to empower their students and encourage later personal use of NIMM by their students.

For example, Charlotte discussed how her classroom use of flip cameras to make movies about rocks and testing rocks empowered her students:

> Well, they all love the technology part I think in the movies. They are so active so they get to move and they get to talk. They feel important like they feel I'm not a kid anymore. They have a chance to do this." (CI1.496)

Betsy also discussed how her use of digital media encouraged her students to seek out and then personally use other types of media – incorporating properties of both student empowerment and encouraging personal use of media by students:

> It's so funny because I feel like when I was in school we'd say oh, let's bring the internet in and the teachers would be surprised that we could do that and now we're using a lot of internet and the kids are bringing in a lot of other sources like comic books and magazines and other books that they found. I had a kid bring in a manual on how to build a solar panel water pump thing today on his own. So they're bringing those into the classroom. (BI1.77)

Lastly, Charlotte discussed her belief that by using newspapers frequently in her classroom, her students were encouraged to seek out newspapers for their own personal use:

> We were talking about earthquakes and there was the earthquake in the North-Central area last year. A minor one here and the kids showed up to the door, "There was an earthquake! There was an earthquake!" and I remember that day I had not read the newspaper yet and I'm like, ok. [laughs] But if you do it and you bring the newspaper I think the ones that have it, start. They kind of browse through it or do it too. (CI1.68)

Episodes of Media Use

While these were all general themes related to teachers' NIMM use, it became apparent during the analysis process that these nine themes applied to teacher discussions about their media use in both an applied and in a hypothetical manner. An applied use of NIMM is one that actually occurred in the teacher's classroom during some previously slated period in time. A hypothetical use is one in which the teacher proposes using media, and using media for specific purposes, but does so in a hypothetical sense – as though this use *may* happen in his or her classroom in the future. The distinction between applied and hypothetical uses was not made prior to preliminary analysis of the interview data; therefore, the general themes previously discussed included issues related to teachers' applied and hypothetical uses of media.

Analysis of the interview data revealed, however, that each interview transcript consisted of a series of more specific conversations in which teachers spoke of applied uses of NIMM in their classrooms. The second researcher and I agreed that a second layer of analysis was warranted to examine those *episodes* in more detail.

During the initial interview, I did not aim to ask the teachers about specific episodes of media use; however, the teachers chose to talk about episodes during their interviews. Episodes were discussed either as an elaboration of their thoughts or as a specific example of how they used NIMM in the past. The teachers considered the events significant enough to include in their discussions to help tell their stories of how they used NIMM in their classrooms; therefore, I considered these episodes as potentially useful snapshots for understanding teachers' past use of NIMM. The following section discusses teachers' reported *episodes* of media use, the results of the second layer of analysis, and a discussion of how I used those results to influence data collection decisions in future phases of my research study.

Episode Definition

As discussed previously, *episodes* of NIMM use were initially identified as applied uses of NIMM in which teachers discussed times they actually used NIMM rather than their hypothetical or planned uses for NIMM. Although this initial definition of an episode as an applied use was identified through preliminary analysis of the interview transcripts, additional analysis by myself and the third researcher led to the demarcation of an episode as containing the following five elements:

- Use of non-instructional mass media

- Occurred in the science classroom
- An applied use of media meaning the event was not hypothetical in nature, but had actually transpired in the classroom
- Could be recounted by the teacher in enough detail that a reader could imagine what transpired in the classroom (i.e., some sequence of instructional events were clear)
- Evidence around the teachers' purpose for using media was provided

Independent analysis of the interview transcripts revealed that episodes of NIMM use were identifiable in every interview transcript. Table 4-8 illustrates the number of episodes identified in comparison to the types of NIMM used in each episode, and the total number of episodes identified in each interview transcript. A discussion of an example and non-example of an episode follows.

Example of an Episode

Charlotte discussed several episodes of NIMM use during her interview. One type of media Charlotte reported frequently using in her classroom was newspaper articles. Charlotte reported reading the newspaper daily and in the following excerpt discusses her use of a comic strip from the newspaper in her science classroom:

> C: I just read. But I'm always looking for my curriculum and how to tie it up. Like this cartoon. Like I went to a training last summer and they brought up the cartoons and I don't consider myself funny at all [laughs]. And I'm like, oh, cartoons. So I would throw away - right away - the cartoon section from the newspaper. But after that training, the FRI training, have you heard of it?
>
> R: Yes.
>
> C: So I said, oh, every single Sunday I check. I go through all the cartoons quickly to see if there's any. And there's the coolest thing. How in the world? I never thought that and this one – the cartoons for the atoms – this one I use as a warm up too. But they had to correct and find and they read it. We had fun. And then I'm like – now you have to, there are some mistakes, so what are the mistakes? And it was at the

> beginning of the chapter, of the matter chapter – really simple. And I was surprised because right away I knew they had already read. They were already aware of protons, neutrons, electrons. They knew the mistakes so then I just have to move on.
>
> R: So it helped you know what their prior knowledge was?
>
> C: Exactly. Yes. (CI1.175)

Charlotte's discussion of her use of a comic strip meets the five criteria of an episode as follows:

- The discussion was about Charlotte's use of non-instructional mass media.
- The event took place in her science classroom.
- The discussion was about an applied use of media which actually occurred in Charlotte's classroom during the prior school year.
- Charlotte recounted the event in enough detail that an instructional sequence of events was clear. Charlotte presented the comic strip as a warm up and had her students identify the accurate and inaccurate scientific information in the article.
- Charlotte discussed her purpose for using the media – to assess students' prior knowledge about atoms.

Non-Example of an Episode

In several instances a teacher would discuss his or her past use of NIMM but a lack of details would exclude the event as being classified as an episode. For example, Dennis discussed his use of newspaper articles in his classroom:

> D: This year we had a current even project search on climate change and then also one on nuclear power and it was neat to see the kids bring in stuff that was much more current than the articles that I had made copies of and had them read.
>
> R: So when you made the copies of your article, you said you kind of had your favorites. What makes them your favorite?
>
> D: That they were written [pause] – like so I like the whole idea of controversial subject matter. So I found some good articles in the past that present both sides of the debate or maybe are interviewing two different people. Like someone who is – like in the case of nuclear power – one was a nuclear physicist who was arguing for the use of nuclear

> power and another one was an environmental agency spokesperson who was arguing against the use of that. But the format of the article was such that it led to a nice discussion prompting of the debate. (DI1.93)

In this excerpt, Dennis recounts a time he actually used NIMM in his science classroom. However, the instructional sequence and his purpose for using them are less clear. Dennis mentioned that his use of the articles prompted a debate, but it is not clear what he or the student actually did with the articles once he located them and before the debate. Dennis also mentioned that he likes choosing articles covering controversial subject matter, but his purpose for selecting and using those types of articles in this instance is not clear.

Affordances of Non-Instructional Mass Media

When teachers' rationales for using NIMM were initially identified and described (see Table 4-9), they were based upon analysis of all six teacher interviews and within the context of both teachers' applied and hypothetical uses of NIMM. As discussed previously, one criterion for classifying an event as an episode was evidence of teachers' purposes for using media. As episodes were identified, the third researcher and I noticed subtle differences between how rationales were previously conceptualized and how teachers' spoke of their purposes within the specific context of an episode. Whereas previous discussions of rationales addressed teachers' ideas about the *potential* of using media in the classroom, when the teachers discussed specific episodes, they discussed what that particular resource actually allowed them to do in their science classrooms. Teachers' purposes, therefore, became interwoven with their strategies for using media and less easily identified as rationales alone. A combination of rationale and strategies overlapped in a way to describe the *affordances* of media, or what media allowed the teachers to do in their classrooms.

To further examine this finding, the third researcher and I pulled all dialogue related to episodes of NIMM out of the interview transcripts for reanalysis. We then independently reviewed all data drawn from two randomly selected transcripts and coded the individual episodes for affordances. To do this, we read through all of the dialogue for an episode collectively like a story. Using the teachers' words when possible, we listed descriptions of what media allowed the teachers to do in their classrooms. For example, Amanda mentioned using journals to illustrate how scientists communicate. She referred to this as having her students "emulate that style" (AI1.61), meaning the style of scientists, when they write their own journal articles later in the school year. Emulating the style of scientists then became a category for one type of affordance.

We both identified three affordances to describe the same set of episodes from the two transcripts. Although our initial wording for the affordances was slightly different, our descriptions for the affordances were identical. Given this high level of consistency, I continued by coding affordances for the episodes from the remaining four transcripts and the third researcher reviewed my descriptions in a peer-debriefing format. In those sessions, the third researcher reread the episode data and reviewed the accuracy of my interpretations and asked clarifying questions when needed. Overall, five affordances of using NIMM emerged from the data and were identified as follows: emulating the style of scientists (ESS), assessing scientific knowledge (ASK), delivering scientific content knowledge (DSK), illustrating real science (IRS), and managing the classroom environment (MCE).

Emulating the Style of Scientists

As illustrated in Table 4-9, Amanda and Hugh reported using media to emulate the style of scientists (ESS). During episodes of media use, Amanda and Hugh discussed using media to first show and then engage students in the processes of science - including experimentation and communicating findings. In order to ESS through media, the teachers chose media that illustrated scientists in the field, the scientific processes they use to conduct their research, and the ways in which scientist communicate their findings. The teachers then used the media to encourage students to engage as scientists, use process skills to collect and analyze data, and communicate their findings.

For example, Hugh discussed his use of a videogame *Raft Wars* to emulate the style of scientists. By choosing a videogame, Hugh selected an activity that was relevant and of interest to his students, and that required his students to "use their knowledge to become awesome scientists." (HI1.184) He went on to explain how his students used science process skills during their engagement with a videogame called *Raft Wars* to become better players of the game:

> The process of science made us better at *Raft Wars* because we had data and they had spreadsheets posted all over…. People would go to somebody who like got the highest score and they would look at their spreadsheet and they'd copy all their angles and they would be able to repeat the experiment, right? This is all science. And then they would get a really high score in *Raft Wars*. (HI1.162)

While digital media may seem a natural use of media to ESS because of its interactive nature, Amanda reported using journal articles, a static form of print media, to accomplish the same action in her classroom. Amanda had her students read news reports and journal articles together. Through the process of reading and analyzing the print materials, Amanda used media to ESS. She engaged her students in the tasks of predicting and communicating - two science process skills:

> We may be hypothesizing what might come next in the study or how it would be used or things like that and then somebody summarizes … one person is doing each job and then they share out and they write this down so that I have some kind of document that proves they're doing this. (AI1.88)

In order to ESS through media, according to Amanda and Hugh, the media must be interesting to students, it must connect to their prior knowledge or to the content being covered in class, and it needs to be current. In order to ESS through media, all students must have access to the media and teachers must encourage students to use science process skills while they use media.

Assessing Scientific Knowledge

Charlotte, Dennis, and Melissa reported using NIMM to assess students' scientific knowledge (ASK). This affordance of media depended both on the accuracy of the information in the medium used and the way in which the teachers used the medium. According to Melissa, media allowed her to assess her students' understandings of what is science fact and what is science fiction in media. For example, Melissa had her students create a timeline of evolution according to the events portrayed in the movie *Evolution*. Following the movie, she engaged her class in a discussion of the events portrayed in the film. Through the discussion, they "talked about so evolutionarily speaking, that can't happen" (MI1.332). This was a form of formative assessment to gauge students' thinking during a unit of instruction.

The teachers also reported using media as a summative assessment. The approach of asking students to identify scientific fact and fiction in a media as a summative assessment was used by all three teachers. Melissa showed the film

Dante's Peak at the end of a unit on volcanoes and had students complete an accompanying Internet search to evaluate the accuracy of the scientific principles illustrated in the film. Charlotte reported using the film *Journey to the Center of the Earth* in a similar manner. Dennis used a similar approach with digital media rather than through videos. Dennis had his students use the internet to compare their knowledge of the periodic to table of elements to the scientific fact and fiction of an assigned comic book character:

> D: I have used the periodic table of comic books before. When I have an assignment at the beginning of the year, a student researches an element and writes a research paper on it. And I pull up the periodic table of the comic books - and you can click on each element -and it will pull up a list of all comic books
>
> R: This is online?
>
> D: Uh huh. And it'll pull up a picture of a comic book page where that particular element has been referenced -from Superman to Batman to whatever. And so I give the students an assignment that … after their research paper is done and turned in, I want them to go back and look up all the references for their particular element in the comics and talk about the accuracy of the [comic]…. So things like gamma rays changing Bruce Banner into the Incredible Hulk - that doesn't really happen. But there are other incidents of where they'll talk about an element being radioactive, and yes, it actually is. And so the author of that comic book really had some science behind him. (DI1.416)

Lastly, Charlotte also used media to determine students' content knowledge before a unit of instruction as a diagnostic assessment. Charlotte used a comic strip from the newspaper to activate students' prior knowledge. This, in turn, influenced her future instructional decisions:

> Every single Sunday I check. I go through all the cartoons quickly to see if there's any, and there's the coolest thing … the cartoons for the atoms…. I'm like – now you have to, there are some mistakes, so what are the mistakes? And I was surprised because right away I knew they had already read - that they were aware of protons, neutrons, electrons. They knew the mistakes so then I just have to move on. (CI1.84)

In order to ASK through media, according to the teachers, the media must be interesting or entertaining to students, it must be connected to the content covered in class, and it must contain and/or portray some scientifically accurate concepts as well as scientifically inaccurate concepts. Media that are accompanied by pictures or illustrations are also preferred by Charlotte because they provide clues for students.

Delivering Scientific Content Knowledge

Amanda, Charlotte, Dennis, and Hugh reported using NIMM to deliver scientific content knowledge (DSK). The teachers discussed this affordance in terms of the ability of media to supplement information students would otherwise collect from traditional science textbooks. However, like all affordances, DSK depended upon how the teachers used media in addition to their purposes for using the medium. For example, Dennis wanted his students to learn new science content about macromolecules. To do that, he showed his students a clip from a popular television show, *Good Eats*, which discussed carbohydrates, fats, and proteins and then had his students take notes:

> They have three column notes - one for each of the molecules - and I asked them as they were watching the video to see how many things they already had in their notes and to be adding things as he was discussing things like omega-3-fatty acids, for example. (DI1.53)

To use media to DSK, according to the teachers, the topic of the media needs to be related to the content being covered in class. The information in the media should also be “up to date” to contribute to new content learning. Lastly, the media must contain enough new information for students to contribute to new learning.

Illustrating Real Science

All of the teachers, except Hugh, reported using media to illustrate real science (IRS). Illustrating real science, according to the teachers, included using media to illustrate the people who do science, the contexts in which they work, and the prevalence of science in everyday life. Dennis additionally spoke of how he uses media to illustrate how shifts in scientific thought occur over time. IRS is different than previous discussions of emulating the style of scientists (ESS) because IRS does not require students to engage in scientific practices while using the media. IRS is also different than delivering scientific content knowledge (DSK) because while students may be introduced to new knowledge through the medium, its focus on the people, places, and practices of science make it unique to IRS.

For example, Betsy discussed her use of a documentary film about Percy Julian, a famous African American chemist, to illustrate someone who does science and the context in which scientists work:

> In [the video] if they're talking about some phenol, they may have no idea what a phenol is but the pictures they see up on the screen, they can see that it's a molecule and they're putting things together and taking things apart and they can see who that chemist is and the lab that they worked in and be able to have something to draw on when someone talks to them about a chemist later on. They have the background knowledge now to say "I know who a chemist is' or 'I remember seeing what a chemistry lab looks like." (BI1.150)

Charlotte also used media to IRS. Charlotte discussed one episode during her interview in which she used a newspaper article about the Hubble space telescope following her class discussion of telescopes:

> We had talked about the type of telescopes and we talked about how Hubble space telescope is this type of telescope. So the next day the newspaper has the image of the space shuttle with the Hubble. They got it out of orbit, put it in the space shuttle, and they were fixing it. There was a

> picture of that, so I have to go over and say, "This is what we talked about. This is the telescope." (CI1.22)

The newspaper included an article about a topic recently discussed in class and Charlotte took the opportunity to use the media to illustrate the prevalence of science in everyday life.

Dennis also discussed using media to IRS. He reported using the trade book, *Uncle Tungsten* to get his students to understand the changing nature of scientific knowledge:

> I think that's why I use them, the *Uncle Tungsten* book a lot because it really shows how we used to think that atoms are indestructible and now we understand that atoms are made up of subatomic particles that can be rearranged and everything. So getting them to understand that major shifts in ideas occur within science helps them to have a better understanding of just the tentative nature of our science knowledge and that they personally still have contributions to make to the field of science. That science's not done. So I think that media has been very powerful through me in showing them that science is not done. (DI1.373)

As illustrated in this previous excerpt, Dennis' purpose for using the book combined with the way he used it determined the affordance of IRS. Dennis talked about his purpose of showing the shifts in real scientific knowledge, but did so with the disclaimer that media was only able to do that through his choices for how to use the media in his classroom.

According to the teachers, in order to use media to IRS the media must be entertaining enough to keep students engaged. The media must also be about some scientific concept, but not necessarily related to one that is currently being explored during class. IRS, according to Melissa, is more about exposing students to different applications of science and the work of specific scientists than it is to portray specific science content knowledge.

Managing the Classroom Environment

Amanda, Charlotte and Melissa reported using media to manage the classroom environment (MCE). MCE was described by the teachers as entertaining or engaging students to the point that they were able to accomplish other tasks while the students were using the media. This included completing other administrative work in their classrooms while their students were there, as well as feeling confident that their students would behave while they were absent.

Melissa discussed her use of the movie *Jurassic Park* to MCE while she was accomplishing other administrative tasks. She said, “It’s not like it’s planned in there specifically…. You want to know when it is? It has nothing to do with the unit. It has everything to do with - oh my, grades are due, how am I going to get all of this done?” (MI1.292) Charlotte discussed her use of the movie *Journey to the Center of the Earth* to ensure her students’ good behavior while she was absent:

> It’s loaded with action. But it came out last summer I think. Yes. So it was after I had taught the whole year and I’m like “Oh my gosh - look at this!” So I had already planned for that. I am going to show them the movie. I did it when I was absent so that it – it works better. But they’re really excited and I know they are going to behave good. But they have to do that worksheet on facts and fiction while they’re watching it. (CI1.156)

This latter quote shows how one episode, Charlotte’s use of the film *Journey to the Center of the Earth* provided two affordances. As shown here, it was used to manage the classroom environment (MCE), but as discussed previously, through the identification of fact and fiction, Charlotte also used the movie to assess her students’ prior scientific knowledge (ASK).

According to the teachers, in order to use media to MCE media must be interesting or entertaining to the students and it must, in some way, be connected to the content being covered in the regular curriculum. Melissa advocates for a combination of entertainment and relevancy. She said, "Yeah, they're really funny but it's very, you know, it's still scientific. I mean there are things in there that you can pick out and talk about" (MI1.345). The availability of accompanying worksheets for students to complete while watching the movie helped all of the teachers use media to MCE.

Summary of General Findings

As presented in the sections above, nine themes related to teachers' reported use of NIMM emerged through analysis of the initial interviews. The types of media teachers use, the science topics they choose to explore through media, the frequency at which they use media, the strategies teachers employ to interact with media, and their rationales for using media were all addressed. The remaining four themes – choosing media, supports for using media, barriers to using media, and student impact – all emerged as additional themes related to teachers' reported classroom use of NIMM and were therefore included in this chapter.

In summary, the six science teachers reported using a variety of media types in their classrooms. With the exception of radio, all other types of NIMM addressed in previous chapters were reported as used by the science teachers. Moreover, teachers used media to cover a wide variety of science topics, and reported doing so at least once during each instructional unit. Teachers used a diverse collection of strategies when interacting with media, including both student-centered strategies in which students selected the aspects of media on which to focus, and teacher-directed strategies in which teachers explicitly directed students to focus on specific aspects of the NIMM used. Teachers chose to use media for a variety of purposes and drew upon their own subscriptions and memberships when selecting which types of media to use.

When determining specific excerpts of NIMM for use in the science classroom, the six teachers identified specific selection criteria as guiding their choices. Other teachers and professional develop experiences supported science teachers' use of NIMM, while features of the media, features of the teachers' context, features of students, and features of the teachers themselves served as barriers to their use of NIMM. The teachers also reported that students were impacted by their use of NIMM either by empowering them as consumers of NIMM or by encouraging their future use of NIMM.

Summary of Affordances

Teachers reported media as affording them five specific actions: emulating the style of scientists (ESS), assessing scientific knowledge (ASK), delivering scientific content knowledge (DSK), illustrating real science (IRS), and managing the classroom environment (MCE). The most commonly reported affordance among the teachers was using media to IRS. A comparison of affordances by media type revealed that audiovisual media such as television shows and films (both entertainment and informational) provided the most affordances for teaching science. Teachers used a variety of instructional strategies to mediate the affordances and their ability to mediate the affordances was dependent upon both features of the media and features of the teachers' classroom context. For example, the media's connection to the science curriculum, its layout, and its clarity in presentation of scientific content affected the teachers' ability to use media, while teachers' access to the media, available time, and students' participation levels also affected the teachers' ability to use NIMM to teach science.

Choosing Participants for the Next Phase

To choose participants for the next phase of the study in which I investigated teachers' actual use of NIMM in the science classroom, I initially planned to select participants based on maximum likelihood of observing NIMM use in their science classroom. All six participants from this first phase reported using NIMM in their classrooms, and frequently enough, that I was confident I would observe multiple occasions of NIMM use during the next phase of the study in all of the teachers' classrooms. Therefore, I selected participants based upon their availability and their diversity of media use to maximize the types of NIMM use I would see being used in the classroom.

I was limited by the availability of the teachers in the following school year. Dennis chose to leave the school to pursue an advanced degree in science education; therefore, I was unable to observe his actual classroom practice the following year. This narrowed my pool of teachers to five. The remaining five participants were all willing to participate in my study, so I examined the types of media the teachers used as my second criterion for selection.

Among the remaining five teachers, Hugh was the only teacher who reported using commercial videogames in his classroom to support science learning. Given his unique use of videogames, I asked him to participant in subsequent phases of my study. Similarly, only Hugh and Amanda reported using trade books in their classrooms, so Amanda became the second participant for the ongoing study.

The remaining three teachers were comparable in terms of their reported frequency and diversity of types of media used, therefore I decided to go back to the results of the analysis on their affordances of using media to determine if what teachers perceived media to be able to "do" in their classrooms varied between teachers and if affordances could serve as additional sampling criteria (see Table 4-9). Using the results of the analysis on affordances from the remaining three teachers, I noticed Charlotte reported using media for a larger range of reported affordances than either Betsy or Melissa. I chose to follow Charlotte for this reason.

Because I was limited in resources in terms of time and ability to access multiple classrooms on any given week, and I wanted to develop a deep understanding of the teachers and their classrooms for the participants I did choose to follow, I limited the number of participants for subsequent phases to three. Hugh, Charlotte, and Amanda seemed the most appropriate options for my future research.

I recognize that choosing Amanda, Hugh, and Charlotte may preclude me from seeing other possible uses of NIMM in Betsy's and Melissa's classrooms. I also recognize that the first interview may not be totally indicative of the teachers' use; however, I had to select participants based upon the evidence I did have. I chose participants under the assumption that reported frequency in use, diversity in the types of media they used, and affordances would maximize my probability of observing a variety of NIMM used, for a variety of purposes, and in a variety of ways, and therefore would provide a more complete picture and understanding of possible science classroom uses of NIMM.

Table 4-1. Participant profiles

Teacher	Highest Degree Earned	Certification	Yrs of Tchg. Experience*	Yrs at Creekside	Course(s) Taught	Grade Level
Amanda	MEd (Science Education); MA (Architecture)	Biology 6-12; Art K-12	19	9	AP Environmental Science; Marine Science	11th/12th
Betsy	MEd (Science Education)	Biology 6-12	4	4	Physical Science	8th
Charlotte	PhD (Pharmacology)	Science 5-9	3	3	Earth Science	6th
Dennis	EdS (Science Education)	Chemistry 6-12	6	6	Chemistry	11th/12th
Hugh	MEd (Science Education)	Science 1-10; Technology; Music	10	9	Life Science	7th
Melissa	EdS (Teacher Leadership)	Biology, Chemistry, & Earth Space Science 6-12	11	6	Earth Science; Biology	9th/10th

* Teaching Experience and Years at Creekside include 2009-2010 school year.

Table 4-2. Types of media used as reported by the teachers

Teacher	Digital media	Newspapers and magazines	Television and films	Trade books	Radio
Amanda	X	X	X	X	-
Betsy	X	X	X	-	-
Charlotte	X	X	X	-	-
Dennis	X	X	X	X	-
Hugh	X	X	X	X	-
Melissa	X	X	X	-	-

Table 4-3. Topics explored through the use of NIMM as reported by teachers

Topic	Teachers with topic focus in state standards for course	No. of references to NIMM use	Type of media used to explore topic*
Life_Environmental	Amanda; Hugh; Melissa	29	All
Physical_Chemical	Betsy; Dennis	3	All
Earth_Space	Charlotte	10	All except trade books
Scientists_Applications of Science	All	10	All
Controversial Issues	Not required in standards	9	All except trade books

*possible types include digital, newspapers or magazines, films or television shows, and trade books.

Table 4-4. Strategies for using media as reported by the teachers

Orientation	Strategy	Teachers	Representative Evidence
Student Centered	Student Creation	Charlotte; Hugh	We had 5 or 6 different programs because they know all these things. Some used Flash which I have no idea how to use. Some used Pivot which I know a little bit. I used PowerPoint and made my slides flip so fast it was like a flipbook. Um, someone else used Scratch or something. I mean, they have so many different ways. (HI1.326)
	Independent Exploration	Amanda; Betsy; Hugh; Melissa	*Jurassic Park …* I've used once and a while and I don't have them do anything with it. (MI1.354) They just got done doing a research paper where one of their sources had to be a news article. All of their sources had to be relatively current but they wrote about what's currently happening in the United States with alternative energy and energy in general and where they think we should be going. (BI1.32)
	Engaging in scientific practices	Amanda; Hugh	So we played a video game called Raft Wars which is this silly game where you're knocking bullies off of rafts with tennis balls but you have to measure the angle and the way that we did that is we actually used protractors and held them up to the screen. And we became really good at the game because normal people playing don't use a tool. (HI1.154)
Teacher Directed	Note-taking	Amanda; Betsy; Charlotte; Dennis; Hugh; Melissa	So what I told them to do during the video was to supplement their notes. They have three column notes, one for each of the molecules and I asked them as they were watching the video to see how many things they already had in their notes and to be adding things as he was discussing things like omega-3 fatty acids for example. (DI1.52)
	Teacher-led discussion	Amanda; Charlotte; Hugh; Melissa	R: So when you bring it to the classroom, what do you do with it? What do you do with them? C: I use them mostly as openers like I project it with, using the document camera so when they come into the classroom, they always look and they're already oh, look at what happened, or what is that? So that's what I mostly use and then I talk over. We discuss it and then we go with the lesson. (CI1.13)

Table 4-4. Continued

Orientation	Strategy	Teachers	Representative Evidence
	Identifying Fact or Fiction	Charlotte; Hugh; Melissa	I used Journey to the Center of the Earth. So I did that when we did the rock units and they had to find facts and fiction – what was fact and what was fiction in the movie. (CI1.142)
	Critical Evaluation of Media	Amanda; Betsy; Hugh	R: So what type of questions are they answering when they're watching those videos? H: Well, you know, there's like hierarchy of questions. So some of them are analytical like what are some things you think were left out of the video that should have been there to make it better and some are really straight forward. (HI1.251)
	Practicing Reading Strategies	Amanda; Dennis	I use our written text as a jumping point for using reading strategies that we're supposed to be using so things like reciprocal teaching or column notes or something like that. I tend to use those strategies more than with a print-based article that with a video. (DI1.178)

Table 4-5. Rationale for using media as reported by teachers

Rationale	Properties	Teachers	Representative Evidence
Preferred Medium	Less time consuming	Amanda; Charlotte; Hugh	Well I used videogames one other time when we talked about how to do a scientific paper. You know, I was a little short on time, I didn't have a month to do a long drawn out experiment. (HI1.151)
	More timely	Ama nda	But I like to share with them what's really going on in the world and I think you have to have media to do that. You can't do that with the text because the text came out a while ago and even the year it came out it was kind of old because it had so much review and all of that before that process. Books take a long time. There are a lot of types of media that are a lot more immediate. (AI1.257)
	More effective presentation style	Amanda; Betsy; Charlotte; Dennis	I think – well, for me, that's the way my brain works and I know at this age level they're probably a mix of all of those like auditory, visual, and there's a lot of kinesthetic because they like to move so I try to mix all of them. (CI1.404) If you're looking at say, science is repeatable, I mean you can read in the textbook science must be repeatable [said in a voice as if she were bored] but you can also go and look at this scientist – a video – that tells you this scientist did this and this scientist built on his work and if they presented it in an interesting way, it kind of gets the point across better. (AI1.486)
	Inaccessible Accessible	Amanda; Betsy; Charlotte	It allows you to take kids places you couldn't take them otherwise. (AI1.595) It shows them the inside of a wind turbine and the workers who work in the lab stations overseeing those turbines. That's not something I can do in a class without a video. That's why I try to use videos. (BI1.134)
	Access	Dennis; Hugh; Melissa	I use [media] a lot because it's cheap and it's easy. (HI1.495) Well a major advantage I've found of the online media is that when students are absent, they don't have to rely on me to get them the material that they miss. I'll email them a website link and say 'Here's the video we watched. Go watch it on your own at home.'(DI1.473)

Table 4-5. Continued

Rationale	Properties	Teachers	Representative Evidence
Science	New Content	Amanda; Betsy; Charlotte; Dennis; Hugh	I found a clip that is just amazing. They showed the layers and they kind of detach the layers. Like the lithosphere, the asthenosphere, the crust. So I used that for notes and they have to just follow through the movie and take them. (CI1.219)
	Prior Content	Amanda; Betsy; Charlotte; Dennis; Hugh; Melissa	C: Um. I've done. Let me see – yes. I used Journey to the Center of the Earth.… It was more like a review. We had talked about a few like the different rocks and we – yeah, we had talked about fossils. So they mention they had to travel right at the beginning of the movie so yes, it was more- that was at the end. It was a review. (CI1.142) Sometimes if they're watching a video, they just have to write down – if it's a 15 minute video – we did taxonomy one time when there was a sub and they had to write down every time they saw something from a different kingdom and they try to go to phylum maybe and down to class in terms of their taxonomic level. So we did some taxonomy practice with that. (HI1. 262)
	People in Science	Amanda; Betsy; Dennis; Melissa	If in a video they're talking about some phenol, they may have no idea what a phenol is but the pictures they see up on the screen, they can see that it's a molecule and they're putting things together and taking things apart and they can see who that chemist is and the lab that they worked in and to be able to have something to draw on when someone talks to them about a chemist later on, they have the background knowledge now to say I know who a chemist is or I remember seeing what a chemistry lab looked like. (BI1.150)

Table 4-5. Continued

Rationale	Properties	Teachers	Representative Evidence
	Prevalence of Science	Amanda; Betsy; Dennis; Melissa	But I like to share with them what's really going on in the world and I think you have to have media to do that. (AI1.246)
	Scientific Practices	Amanda; Betsy; Dennis; Hugh; Charlotte	I was like, where can I do something where we gather data, make a hypothesis and do all these things that scientists do? And I was like, let's just play videogames for a period. (HI1.153)
Interdisciplinary	Mode of presentation	Amanda; Dennis	At our school we have quite a reputation being a reading initiative school. Part of the Florida reading initiative, so we have people coming through and observing our classrooms so I use our written text as a jumping point for using reading strategies (DI1.176)
Classroom Management	Engagement	Amanda; Betsy; Dennis; Charlotte; Hugh	I do occasionally, believe it or not, show a Bill Nye video. If I'm introducing a topic because they love Bill Nye. They just think Bill Nye is awesome so even though it's below their level it kind of introduces it. It's like ok we're going to do plants and it's like oh, oh, what are plants (mimicking Bill Nye's voice here). He gets all excited and does all this music and this and that and they pay attention. (AI1.329)
	Entertainment	Amanda; Betsy; Dennis; Hugh; Melissa	And that book had a lot – that book was really colorful and big and beautiful book. If you just put one on the desk you could help but look through it. It's amazing so they really like that. (HI1.310) I only showed that K19. It's kind of an end of the year treat. (DI1.489)
	Management Tool	Charlotte; Hugh; Melissa	And I'll be honest, if I'm going to show the whole movie like that it's because I'm really behind in class and I've gotta get some other stuff done. (MI1.62)

Table 4-6. How to choose media as reported by teachers

Strategy	Properties	Teachers	Representative Evidence
Locating Media	Internet Search	Betsy; Dennis; Hugh; Melissa	I went onto the internet and searched for - this is through Google – searched for Good Eats episode descriptions and found a website that was some fan-based website that had every episode from every season of the show and you could search for episodes by certain key terms and carbohydrates and fats and proteins were one of them. So I found an episode that hit all three of them then I went to YouTube and typed in the title of the episode and sure enough I had the whole 20 something minute long episode was there. (DI1.23)
	Membership	Amanda; Charlotte; Dennis; Hugh; Melissa	This is from a – you see USAA – I'm a member. It's an insurance company we use and it was there and every month they send like a magazine and I guess they do members that have done different good things and I didn't know all astronauts have military training so in the magazine they portray that. (CI1.102)
	Word of Mouth	Amanda; Dennis; Hugh	A student in one of my college class was reading it one day and I asked her about it and then I went to Barnes and Noble and bought myself a copy and I'm not a very avid reader, but this book, to me, reminded me why I personally had fell in love with the subject of chemistry. (DI1.385)
	Inadvertent Exposure	Amanda; Betsy; Charlotte	Every once and a while I'll be watching something on TV like PBS – that's how I got the Percy Julian video. I saw it on PBS and I thought this is the greatest thing ever so I was able to get a video in to tape half of it and then I just decided it was worth the school purchasing the whole video. (BI1.258)
Selection Criteria (Science)	Related to class content	Amanda; Betsy; Charlotte; Dennis; Hugh; Melissa	The movies are more specific to whatever we're studying. (MI1.259)
	Scientifically accurate	Amanda	I use a lot of NOVA because I really respect them. I think they do a good job and I think the science behind it is good. (AI1.38)

Table 4-6. Continued

Strategy	Properties	Teachers	Representative Evidence
	Scientific Language	Dennis	So I think that's kind of the reason why I have these favorites is the language of them is similar to the language of their textbook and similar to the language I use in class. (DI1.114)
Selection Criteria (Media)	Author	Amanda; Hugh	I take New Yorker because they have a couple of great science reporters that I just love to read. You know, I like Malcolm Gladwell and some of these other guys – it's just fun to read them. (AI1.240)
	Balanced perspectives	Charlotte; Dennis	So I like the whole idea of controversial subject matter so I found some good articles in the past that present both sides of the debate (DI1.98)
	Length	Betsy	I prefer newspapers over trade books because I can get short news articles that I can do in 20 minutes in class (BI1.382)
	Timeliness	Amanda; Betsy; Charlotte; Dennis	They're just something that's newsworthy right now and if it's something that they're going to say "Yeah, but that was a year ago" then it's not, it's lost its value – its punch. (AI1.222)
	Quality visuals	Amanda; Hugh	The Eyewitness video … has like a white screen and shows like and animal and stuff whereas like Life on Earth, the footage is just so much better. The really good camera people that take the footage they can tell. I think that the footage is really good. (HI1.271)
Selection Criteria (Relevant to Teachers and Students)	Match to student reading level	Amanda; Charlotte; Hugh	R: So when you're choosing, let's say, a magazine article or newspaper article you come across, what criteria do you try to use? Or how do you pick that? A: It has to be – I want it to be as relevant to what we're studying as possible. I look at reading level. I look at appropriate language. You know obviously I don't want stuff that has a lot of words that are going to be either suggestive or totally inappropriate. (AI1.208)
	Student interest	Amanda; Betsy; Charlotte; Hugh; Melissa	B: Empathy. You gotta know what the kids will respond to. R: What they like? B: Not just what they like but what they'll be able to learn. Put yourself in their shoes. (BI1.438)
	Teacher interest	Charlotte; Dennis; Hugh	R: So when you're choosing those videos, how do you choose which ones you're going to show when the substitute is here? H: How awesome I think they are. Like, engaging in general.(HI1.263)

Table 4-7. Barriers to using media as reported by teachers

Barrier	Properties	Teachers	Representative Evidence
Features of Media	Incomplete representations of science	Betsy	There's so much stuff out there. And there's a lot of bad stuff out there. They were writing their research papers and using phrases like 'energy crisis' and 'going to war for oil' and 'global warming caused by pollution' and just very general phrases that people don't all agree on because they read it on a page (BI1.169)
	Dated	Amanda; Dennis	I don't think it's very updated because I don't see very many new comics and I know that I used to be into comic books in high school and not so much anymore but I know that there's a new reference to elements in these comic books – they're out there but no one has really complied them lately. I don't know when the last time that website has been updated. (DI1.432)
	Length	Betsy	This year I started at the beginning and by the time I got to that place in the video where I'd gotten to before, they didn't care, they were done. It was too much. I had given them too much of a chunk of video to look at. (BI1.121)
	Distracting elements	Amanda	I mean, if they're totally distracted by the fact there's these people that look really weird and there's these old cars driving down the street, you know, they're not going to be paying attention to the message that *you* want them to pay attention to so see, you have to be aware of that. Yeah. All those sorts of things are things that you have to think about. (AI1.627)
	Availability	Amanda; Dennis; Hugh; Melissa	I'm so cognizant of copyright that I don't do perhaps as much as I might. If I think it's ok. You know and I realize you can copy one strip from this. You know, I've read the copyright law and I try to abide by it fairly well. I don't use anything for profit and make a class set and you know, etc, etc. but it does make me feel limited because I don't want to step on anyone's toes. (AI1.141) M: Yeah. Just because I don't have very many magazines that are science – well I have Discovery but it's way too above the kids' heads most of the time. (MI1.141)

Table 4-7. Continued

Barrier	Properties	Teachers	Representative Evidence
Features of Context	Time	Betsy; Charlotte; Dennis; Melissa	I've used some, but I felt pressure to do the unit this year and I was out for different reasons – trainings and all during May when I was doing the unit – so I couldn't do more (CI1.37)
Features of Students	Too difficult for students to use	Amanda; Betsy; Dennis; Melissa	I mean, sometimes journal articles , they can be obtuse. I mean, they're trying to sound very important and so on and so forth and they use a lot of terminology and you know, there's jargon in every little bit of every little area of biology so if you're not really into ichthyology you might not know all the jargon so just cutting through all that stuff. (AI1.557)
	Lack of student interest	Amanda; Charlotte; Dennis; Hugh	Well some aren't as interesting to them as they were to me [laughs]. That happens every now and then. Like sometimes we were watching little clips from the Planet Earth series and they were like, on some things they were bored, but I found it very interesting because I'm a teacher. (HI1.503)
Features of Teacher	Other preferable methods	Amanda; Betsy; Dennis; Hugh	I think they can learn more science by doing science than by reading about someone doing the science. (BI1.390)
	Lack of content knowledge	Melissa	I'm not really strong with space and it's always the end of the year and it's like ok, what are we going to do? It's going to be quick and it's like – yeah – don't use much with it. (MI1.205)
	Locating media	Amanda; Betsy; Melissa	You know, ATP is a good storage molecule, etcetera. The basic stuff because they're going to get it again in college if they're going to go into the sciences. But finding the media is very difficult with those sorts of topics. (AI1.449)
	Unsure how to use	Melissa	I just don't know how to fit them in timewise and making sure that all the kids are accountable so maybe not all the kids would need to do it, but, I don't know. (MI1.485)

Table 4-8. Number of episodes identified as reported by teacher

Teacher	Newspapers/ magazines	TV/films	Trade books	Digital	Total No. episodes
Amanda	2	2		1	5
Betsy	1	2		2	5
Charlotte	3	3			6
Dennis		2	1	1	4
Hugh		2	1	2	5
Melissa	1	2			4

Table 4-9. Teachers using mass media identified by affordance

Affordance	Teacher
Emulating the Style of Scientists (ESS)	Amanda; Hugh
Assessing Scientific Knowledge (ASK)	Charlotte; Dennis; Melissa
Delivering Scientific Content Knowledge (DSK)	Amanda; Charlotte; Dennis; Hugh
Illustrating Real Science (IRS)	Amanda; Betsy; Charlotte; Dennis; Melissa
Managing the Classroom Environment (MCE)	Amanda; Charlotte; Melissa

CHAPTER 5
TEACHER CASES

I chose to conduct intensive investigation of three teachers during the remainder of my study to determine the extent to which non-instructional mass media (NIMM) played a role in their science classrooms. I chose to study Amanda, Charlotte, and Hugh based upon their availability, variety of NIMM use, and the diversity of their reasons for using media (referred to as *affordances* in this and previous chapters). The goal of this chapter is not to provide interpretive or evaluative statements on teachers' media use, but rather offer a rich description of the three teachers' classrooms, their views and goals for teaching science, patterns of mass media use, reasons for using mass media in their science classrooms, and knowledge of mass media construction. It is hoped that through these descriptions the reader will form a better understanding of the context of my research and the factors influencing my interpretation of the data which led to the development of theory to explain teachers' use of NIMM as reported in the following chapter.

Whereas the previous chapter only explored teachers' reported (both applied and hypothetical) uses of NIMM, this chapter includes observations and discussions of teachers' actual NIMM use. Given the large amount of data available to me, I chose to adhere to the construct of an *episode;* the raw observation and final interview data reflected this choice. Observation notes were taken with an emphasis on understanding episodes of media use and in the final interview I specifically probed teachers about episodes of NIMM use I observed in their classrooms during the observation period to further explore this phenomenon.

I present my descriptions and supporting evidence in this chapter using the same abbreviation scheme used in the previous chapter. In addition to the use of the initial interview, data for this chapter include classroom observations over a nine week period and a final interview. The abbreviation scheme is used to identify the original source and location of quotes or notes from interview transcripts and observation field notes. For example, AI1.132 indicates interview 1 with Amanda, line 132 in the transcript; HI2.104 indicates interview 2 with Hugh, line 104; and CO2.P3 indicates observation 2 with Charlotte, page three in the expanded field notes. The expanded field notes were kept as a running log within one document, therefore the page number indicates the location of the note or quote within that document. In several instances quotes from teacher dialogue recorded during the 9-week observation period are used to support researcher claims. When an interview or observation quote contains more than one voice, R stands for my voice, A stands for Amanda, C stands for Charlotte, and H stands for Hugh.

The remainder of this chapter details each teacher case, highlighting one teacher at a time. Within each case, I describe the teacher's context, goals for teaching science, patterns of NIMM use, conceptions of media literacy, and perceptions of the media literacy skills of their students. I also make comparisons between teachers' reported NIMM use (as detailed in the previous chapter) and their actual NIMM use. I rely on the emergent categories presented in the previous chapter to guide the discussion.

Amanda

Context

Amanda has been teaching for nineteen years. She has a Master's degree in science education as well as a Master's degree in architecture. In addition to her career as a teacher, Amanda worked as an architectural preservation consultant for a couple of years while she stayed at home to raise her son. Before making the transition to public schools, Amanda taught in a private school for two years. She has worked at Creekside School for nine years and holds certifications in both art and biology.

During the 2009-2010 school year Amanda taught two sections of marine science and two sections of AP environmental science. In addition to serving as Creekside's science department chair, Amanda served as faculty advisor for the school's key club and marine science club.

I only observed Amanda during her fourth period AP environmental science class. As an observer in Amanda's class, I sat in the back of the classroom and had limited interaction with the students.

The AP environmental class consisted primarily of 11^{th} and 12^{th} graders who were granted permission to take the course by satisfactory performance on standardized tests, previous success in science coursework, and teacher recommendation. Amanda has taught environmental science for several years, but this was the first year Amanda taught an AP course. In fact, this course was the first AP science course offered at Creekside. To prepare for the course, Amanda attended a professional development workshop on teaching the AP environmental science course during the previous summer and submitted her syllabus to the AP review board for approval prior to the start of the school year.

Amanda's classroom could be described as a science laboratory classroom with a whiteboard mounted on the front wall, a teacher demonstration bench at the front of the class, student tables in the middle of the room, and six lab bench stations in the back of the classroom. The countertops around the perimeter of the room were lined with tanks to hold marine life for the marine science class. Amanda had a TV, VCR, DVD player, and a computer cart housing an overhead projector that connected to her personal computer.

The beginning of class began the same way each day for Amanda, reflecting the consistency in routines across Creekside. When students entered the classroom, they took their seats, read and copied the agenda on the board, and began working on a warmup assignment that was also written on the board. During this time, Amanda worked at her computer at the front of the classroom accomplishing administrative tasks such as taking attendance and speaking with students individually as needed about previous or upcoming assignments. Most of Amanda's class periods consisted of a laboratory exercise or activity, lecture, and some interaction with media. Amanda's class also ended in a routine manner by reminding students of their homework assignment, which usually consisted of a short writing assignment and reading and outlining a chapter from the textbook, and dismissing them when the bell rang.

Role as a Teacher

Developing critical thinkers. Amanda described her role as a teacher as in terms of goals for her students. Amanda said she wanted to develop critical thinkers. Critical thinkers, by Amanda's definition, were students capable of questioning the world around them and the information they processed, and then applying their knowledge to new situations. In the science classroom, Amanda considered these abilities a part of what it means to be scientifically literate:

> I want them to get to the point where they're scientifically literate. Where they can ask questions and perform on their own eventually … I want them to be a little bit critical. I want them to be skeptical. I want them to think. (AI2.10)

During my observations of her class, it was apparent that developing critical thinkers was one of Amanda's goals. Amanda frequently required her students to read scientific articles and editorials. After reading the articles, she asked students to formulate their own opinions about what they read using evidence from the articles to support their position. She also had students identify what they would do differently in a scientific experiment if given the opportunity (AO9.P22).

Amanda felt it was her responsibility to develop critical thinkers in order to prepare her students for the future. She had felt unprepared in her ability to think critically when she went to college, and did not want that same experience for her students:

> It takes a while to really learn how to do that [think critically] and I don't think I really figured it out until college. But I want them to be good to go in college *(AI2.127)*

Developing awareness. Amanda also spoke of her role as a teacher as developing awareness in her students. Amanda believed that awareness of science and of environmental issues, specifically, was crucial to being a good citizen. She discussed using articles from the local newspaper to develop local awareness:

> I think it's important that they see the relevance to their own community as participating citizens and adults, you know, because it is – it's going on here. This isn't something you just study that happens somewhere else in the world. It's something that happens everywhere. (AI2.242)

Awareness for Amanda extended beyond local and current events in science and included understanding how science could influence society's decision making. During my observations of her classroom, it was clear that Amanda advocated awareness of historical issues because she believed understanding the past allowed individuals to navigate the future. During one observation, Amanda had her students read excerpts from five trade books that are considered important from an environmental science perspective. When Amanda introduced the book to her students, they wanted to know if they needed to know the authors' names as well as the main ideas. Amanda said,

> The point is not just to know the names of the books and people. These were pretty important books in environmental science and it's important to know their main ideas and how they impacted environmental science. (AO5.P13)

She then gave the example of Rachel Carson's *Silent Spring.* Amanda discussed the book's impact on the use of pesticides and drawing awareness to environmental issues of the time. Amanda discussed how one individual, through her writing, influenced how environmental issues are approached today.

Amanda felt that awareness was essential for her students, particularly for her students who were eighteen or older. In one class I observed, Amanda assigned her students to read two articles about off-shore oil drilling in Florida. After reading the articles, one of her students asked her what he could do to make a difference. She directed him to the Governor's website and encouraged him to contact state representatives with his opinions. She wanted her students to be aware of whom to contact. In response to this episode, Amanda said, "And these are kids are 18 so they should know that. They should know that they need to participate in their democracy because it works better if everybody pays attention" (AI2.136).

Patterns of Mass Media Use

Types of media. As can be seen in Table 5-1, I observed Amanda's use of newspapers, magazines, television shows, films, and trade books. Amanda mostly relied on the use of newspaper and magazine articles, followed by trade books and television shows or films. A comparison of Amanda's report and actual use of NIMM (see Table 5-2) shows that except for digital media, I observed Amanda using the types of NIMM she reported using. I did not observe Amanda using digital media as she reported during the initial interview; however, during the final interview with Amanda, she brought up her lack of digital media use and said the following:

> There's this new filter and it's really hard to get everything … it's just so hard to get around on the internet with all the filters and screens.… If you had [the students] looking for websites, they get blocked out of so much stuff that they get frustrated because they can't find anything. So I'm finding myself using more print media perhaps more than I would even normally use to make up for [the lack of digital media use]. (AI2.17)

The internet filter the school installed was a challenge for all teachers in the school and was also a topic of informal conversations between me and the other two teachers in my study. It is my belief that Amanda would have used more digital media had access and usability been easier.

Topics. During the observation period I observed Amanda engage her students in two complete units of instruction (see Table 5-3); each unit lasted approximately four calendar weeks. Amanda covered both life science topics and controversial issues through the use of NIMM. Examples of life science topics she covered were ecology, sustainability, and biodiversity; while off shore drilling and the banning of snake ownership were sample controversial issues. Also, while Amanda's two units of instruction focused on general topics related to environmental history and the biosphere, she explored several local and national issues related to environmental science. She used media created by both local and international authors and emphasized the importance of highlighting local environmental science connections to me during our informal conversation. More details about the specific topics addressed in each piece of media Amanda used can be seen in Appendix D.

Frequency of NIMM use. As discussed in the previous chapter, Amanda reported using media at least once during an instructional unit and in some units, every day. I observed twelve out of a possible twenty-four of Amanda's classes during the nine week observation period. Over the course of nine weeks, Amanda used NIMM in approximately 46% of those class periods (see Table 5-4). I observed Amanda use media at least once during each instructional unit (see Table 5-3). Through weekly emails, Amanda communicated with me in advance as to which days she planned to and not to use NIMM. I made every attempt to visit the class periods in which she planned to use NIMM in addition to those days I observed to maintain a constant presence in the classroom.

Strategies for using NIMM. Amanda employed a variety of strategies when she used NIMM in her classroom. All of the strategies I observed were teacher directed in that Amanda provided probing questions or specific prompts to direct students' attention to specific aspects of the media. Her expectations for how and what students were to attend to in the media were made explicit prior to student interaction with the media.

During the initial interview, Amanda discussed having her students explore media independently; however, in my observations of Amanda's classroom, she provided students with focus questions or specific tasks associated with reading the article even if students interacted with media on their own. This wasn't the same as note-taking, but more of a response to a series of questions to track student thinking during their use of media. This new variation of independent exploration of media led me to create a new category for strategies for using NIMM called "independent exploration with focus" as seen in Table 5-5.

An example of this new strategy was observed when Amanda used the book *Spineless Wonders* (AO7.P16). *Spineless Wonders* is a non-fiction trade book about the unique features of invertebrates. Amanda chose to use a chapter about moths after administering the first unit test. Amanda asked her students to read the chapter and identify any and all ecological relationships they could in the reading. Ecological relationships were not clearly stated in the book. The students had to read about the moths, determine what would be considered an ecological relationship, and then record that information. One student mentioned she was having difficulty finding ecological relationships. The student said she didn't know if she was having difficulty because they weren't in the book or if she didn't know what she was looking for. Amanda responded as follows, "It's getting the practice of looking for the relationships. There are a bunch of them in there. It's just a matter of learning how to read for them" (AO7.P18).

This was unlike when Amanda had her students complete a worksheet that accompanied the *Voyage to Galapagos* video documentary (AO10.P23) in that the worksheet served as a pacing guide for the students to keep track of main ideas as they watched the video. This was classified as a note taking strategy in the same way that a reader of text may highlight and record the main ideas as they read the text. When

Amanda had her students identify ecological relationships in *Spineless Wonders*, she was asking them to explore the book chapter independently, but with a specific focus in mind.

Another way Amanda used NIMM that resembled but departed from note-taking and independent exploration was her use of student opinion pieces to explore NIMM. On three occasions I observed Amanda using this strategy. Amanda prompted her students to read a selected text and form a personal opinion about the controversial issue discussed in the article. For example, Amanda assigned her students to read an article and an editorial about off-shore drilling from the local newspaper. Amanda instructed her students to “read the article and form an opinion and write a paragraph after you read the article discussing what you think” (AO5.P14). Amanda didn’t ask her students to write a summary of the article or to take notes on its main points, but rather wanted students to read the article for their own information and form an opinion on the issue. This was a new strategy that Amanda did not report using in the initial interview, but that I observed on more than one occasion.

In addition to the two new strategies I observed in Amanda’s classroom, she engaged students in reading strategies through the use of media, note-taking, and teacher led discussions as previously reported. Amanda’s students didn’t engage in scientific practices with media, independent exploration of media, or critical evaluation of media as previously reported by her. Students were asked to evaluate aspects of science from articles, but I did not observe Amanda engaging her students in the critical evaluation of media. While she had her students form opinions about topics discussed in the media, the credibility of information or the presentation of information in a source was not discussed.

Although I did not observe Amanda engaging her students in the critical evaluation of media, given my previous and subsequent conversations with Amanda, I am confident conversations about credibility do occur in her classroom later in the year. As a culminating project in AP environmental science, Amanda has her students seek out NIMM resources, evaluate their credibility, and report their findings to others. Becuase this was something I did not observe during my nine week observation period; however, it is not included as strategy on Table 5-5.

Affordances. I chose affordances, rather than rationales, as a means to discuss teachers' purposes for using NIMM because of the dependence of these results on observation data. A teacher may have an idea of why he or she plans to use NIMM and the potential of that media in the classroom (rationale), but once the media is actually used, its purpose becomes interwoven with teachers' strategies for using NIMM, thereby describing the affordances of media, or the specific actions a piece of media makes available to the teachers.

Table 5-6 illustrates the affordances I observed in Amanda's classroom and the frequency at which I observed Amanda using NIMM for each affordance during the seventeen episodes of NIMM use I observed in her classroom. I most frequently observed Amanda using NIMM to illustrate real science (IRS), followed by using media to manage the classroom environment (MCE) and deliver scientific content knowledge (DSK).

For example, Amanda required her students to read excerpts from five environmental non-fiction trade books (AO3.P10). In a follow up email discussion with Amanda, she informed me that the trade books allowed her to illustrate real science by giving them exposure to groundbreaking books in environmental science, a “local angle” because three of the authors were local authors, and a handle on the importance of biodiversity.

As shown in Table 5-6, a new affordance emerged through the observation process that was not reported by any of the original six teachers in the study during their discussions of episodes of NIMM use in the initial interview. Amanda was seen using media to apply science to students’ personal lives.

During episodes of NIMM use, Amanda applied science to students’ personal lives (ASP) by eliciting personal opinions and actions from students in response to reading or watching NIMM. In order to ASP through media, Amanda chose media that was controversial in nature and contained multiple perspectives so that her students could debate the merits of each perspective to develop their own personal opinions on the issue. This took students beyond evaluating the claims of each perspective and required them to make science personal by including their own perspective.
For example, when Amanda elicited student opinions about off-shore drilling (AO5.P14), she emphasized that she would not grade them on their opinions, but on how well they supported their arguments. Additionally, she encouraged individual students of voting age to take action by contacting their governor on the issue. This personally involved students in the issue.

Figure 5.7 illustrates the comparison between Amanda’s reported and actual use of media for its affordances. I observed Amanda using media for all but one of the affordances she discussed in her initial interview; Amanda did not use media to assess scientific knowledge (ASK). Assessing scientific knowledge may have been an implicit part of soliciting student opinions or note-taking, but it was not the focus of her NIMM use.

While my observations revealed the addition of a new affordance, each affordance previously identified and discussed as a part of the initial interviews were clearly observed in Amanda’s classroom. Comparison between Amanda’s reported and actual use of NIMM helped me strengthen the construct of an affordance and see how affordances materialize in actual classroom practice.

Knowledge of Media Construction

During my interviews with Amanda and my observations of her class, it became apparent that Amanda was aware of the tenets of media literacy as described in previous chapters. Amanda also utilized several tenets of media literacy in her instruction. Through our discussions, it was clear that Amanda understood the authors and intended audiences of media, the creative techniques media uses to deliver messages, and the values and perspectives included and omitted in media. While she articulated her understanding of media, I only observed her explicitly addressing the authors of media with her students.

When Amanda discussed her classroom use of media, she talked about the importance of screening the media before showing it to her students. Amanda felt it was absolutely necessary to know who was creating the media she selected for the classroom and make her selection process transparent to her students. Amanda recognized that all media was created for a purpose and underlying factors such as which group funded research could influence what was reported through media. Amanda discussed the subjective nature of news reporting when I asked her about her classroom use of newspapers to highlight the off-shore drilling controversy in Florida:

> And I talk to the kids too again about who's funding the study. Because you know if it's being funded by a drug company and it's about drugs, you've gotta think about that. If it's being funded by the oil companies and it's about ocean pollution, hmmm, I wonder if there's some conflict of interest here in terms of the way the data would be presented. So I did talk about that too. (AI2.445)

On multiple occasions I observed Amanda explicitly addressing the authors of media with her students. When she introduced readings from newspaper articles or trade books, Amanda would discuss the author's background and purpose for writing the text. For example, Amanda had her students read an excerpt from *The Everglades, River of Grass* by Marjory Stoneman Douglas. When she introduced the book she discussed Douglas' background as a local journalist from the early 1900s. Amanda discussed how the language may be challenging for the students because of when the book was written and how Douglas included information on the history of Florida in an anecdotal format influenced by her background as a newspaper reporter (AO3.P11).

Addressing the authors of media was not limited to print media in Amanda's classroom. In two episodes in which Amanda showed her students a film, I observed Amanda discussing the authors and key figures in the films. For example, Alan Alda was the narrator in the *Voyage to Galapagos* film. Amanda introduced the film with a description of Alda and how he was great at interviewing individuals. Later in the film Amanda stopped the tape and told her students about the professor in the film that was highlighted for researching booby chicks. She said he was a professor of biology at

Wake Forest and that he was still there in case any of the seniors considering going to college there wanted to contact him (AO10.P25).

Amanda also acknowledged that media uses creative techniques to capture and hold an audience's attention. Amanda talked about the use of intriguing and slanted headlines and "gritty reality" by newspapers to capture a reader's attention. She also discussed how different types of media present information differently highlighting the difference between narrative and expository texts. While Amanda talked about the creative techniques used by media, I did not observer her incorporating this in her instruction.

Amanda understood that specific values and perspectives were included and omitted in media, which is in turn was heavily dependent upon the author of the media and its purpose. Drawing on her prior experiences as a writer for a gardening magazine, Amanda shared the following anecdote about how space limitations restrict representations of science in media:

> I've written for *Horticultural* a little bit and what I found is that I got ticked because they would put it into – they would edit me so heavily sometimes that it's like – that isn't what I was trying to say at all. That wasn't what the science is saying, you know, but ok, it fits your space a lot better now, doesn't it? But it just wasn't – you know, to me it wasn't good anymore. So a lot of it – it's not just the authors. It's the editors. (AI2.88)

Similarly, Amanda noted that as articles were written and space limitations restricted the amount of information that could be shared, the accuracy of the science presented was compromised:

> So what I did is I presented [a science journal article and a newspaper article] side by side [to my students] and I said, This is the science and this is what came out of it. This is what it was distilled to for the public to read. So it's kind of like going primary, secondary source, you know? It's like if you look at history. Are you going to read the letter from the Civil War soldier or are you going to read the account of the Civil War here.…

> So I try to have a conversation with them about the fact that the popular literature is definitely different than the article and that it may take this information and it may make good use of it or it may twist it. And whoever read it and distilled it and turned it into a popular article may not have understood all the data and so they need to know that too and if they're really interested then they need to go back to the source. (AI2.479)

Amanda also recognized that there was a lack of diversity presented in popular media about science and she attributed more generally to a lack of diversity in science:

> I try to make sure that scientists aren't just some nerdy guys that you would never want to be like. I like to see diversity and unfortunately a lot of times it is a white male. If there is an African American or a woman that's great, you know. So I like to use diversity when I can find it and it's in the appropriate topic and so on. But I'm not going to go and find an African American woman that's off topic just to have an African American woman. She has to be somebody that's doing something that's in the area that I'm trying to talk about which can be challenging. So diversity happens when it does and it doesn't sometimes. (AI2.292)

Amanda did not talk about how different students might interpret the same media messages differently depending upon their background experiences and knowledge; however, she did discuss the importance of reading level to comprehending print media. While Amanda demonstrated her understanding of the attention-getting elements of media and the selective content of media, I did not observe Amanda explicitly teaching about either of these tenets.

Perceptions of Students' Media Literacy Capabilities

Throughout my conversations with Amanda, it was apparent that she equates her students to a college level audience. In her opinion, her students mirror the general population more than other secondary school students. Amanda feels her students are very capable of accessing media on their own and are varied in their ability to analyze and evaluate media, but would be unlikely to demonstrate their knowledge of media construction without being prompted:

> I think these kids are highly intelligent, capable students and I think that they're also - from the conversations I've had with them - thinking people. You know? Like one student who sits over there and he'll have a conversation with me about, well now, is this slanted? Or is this straight on? Because I think this is slanted a little bit. And so we have these conversations … but it's interesting because he's open but … he's analyzing it every step of the way. I think a lot of my kids do that. I think to really do who's the author, what's the author's purpose, the whole spiel of the intent of the article on a deep level, you know, you pretty much have to make them do that because they have so much to do that they're not going to sit down and spend a lot of time thinking about that. I think they do to a level, to a degree, on a more superficial level they think about that. (AI2.406)

Amanda attributes her students' ability to access, analyze, and evaluate media to one of three factors: an interest in science, an interest in reading, or an ability to comprehend text. She did not discuss her students' ability to create media. Overall, Amanda does not spend an extended period of time addressing the construction of media because of her already packed curriculum and her students' natural ability to critically evaluate media, but she says media is "definitely it's part of the conversation" (AI2.433) in her classroom.

Charlotte

Context

Charlotte entered the teaching profession as a second career. Originally from Puerto Rico, Charlotte received her doctorate in pharmacology before turning to the science classroom. She has been teaching for three years, all of which have been at Creekside School. Charlotte is certified to teach science grades 5-9.

During the 2009-2010 school year, Charlotte taught five sections of 6th grade earth science (the same class she has always taught at Creekside) and served as the sixth grade team leader. Charlotte mentioned on several occasions that she enjoyed working with sixth graders and recognized the unique transition between elementary and middle school facing her students. For this reason, Charlotte emphasized the use of routines and organization with her students. Before several of my observations and before both interviews, Charlotte met in her classroom with other sixth grade teachers in team planning sessions. While I was not privy to the contents of those conversations, through discussions with Charlotte, it was clear that she valued those planning sessions and the collaboration between team members at Creekside.

I observed Charlotte's fifth period class per Charlotte's request. My role in Charlotte's classroom was as participant observer. I sat in the back of the room to conduct most of my observations; however, I also interacted with the students by answering their questions, circulating the classroom to help during activities, and assisting Charlotte in the preparation of classroom materials when needed. This arrangement was agreed upon by me and Charlotte prior to beginning my observations and resulted in ongoing collaborations beyond the duration of my study.

Charlotte's classroom was oriented so that most of the student's attention was focused on two of the four classroom walls. Six student tables (each capable of seating four students) were positioned in the center of the classroom. One of the main focus walls contained a series of sliding white boards and the teacher's desk, while the other focus wall had a retractable screen used to project the contents of the teacher's computer or document camera which were located on a computer cart behind the student tables. Along the third wall were storage cabinets, lab counter space with one sink, and safety equipment. Along the fourth wall were six computers and benches for student use. Charlotte's classroom had two closed-circuit televisions (one mounted on the first focus wall and one stored in a storage cabinet along the third wall) allowing clear visibility to all students. Charlotte also had a VCR and DVD player for classroom use.

Similar to Amanda's class, Charlotte's use of routines and procedures provided a predictable pattern to each class period. Upon entering the classroom, Charlotte's students copied the agenda from the board into their planners and then completed the warm-up assignment also posted on the board. While students worked on their planners and warm-ups, Charlotte took attendance on her computer and walked around the room either checking homework or answering individual student questions. This was typically followed by a brief discussion led by Charlotte of the prior class period and any upcoming events or assignments. Each class period consisted of several opportunities for individual and group work, as well as teacher-led discussions and hands-on activities. Each class concluded with students turning in their class work, writing any additional homework in their planners, and cleaning up their tables. Charlotte dismissed student tables one at a time to get their backpacks and line up at the door. Charlotte then walked the entire class to the lunchroom.

Role as Teacher

Facilitating student learning. When I asked Charlotte about her role as a science teacher, she said, "I think my role is to facilitate the information for them" (CI2.4). Charlotte facilitated student learning of science by demonstrating the thinking process to her students and helping students develop strategies for organizing their thoughts.

During my observations I witnessed how Charlotte facilitated student learning of science by teaching her students how to access information about science and use that information to improve their learning. For example, Charlotte assigned her students the task of finding articles or images about earth science in newspapers and magazines. After collecting the artifacts, Charlotte had students share what they found and worked with them to compile a list of earth science topics on the board. One of their previous assignments was to list vocabulary words from the first chapter in the textbook and define them. Charlotte discussed how the articles and images they found in the newspapers and magazines could help them with completing that assignment:

> All of these are examples you can use in your homework for three column notes in the box of earth science, right? Because you have the definition of earth science is the study of earth and space. That's just – does that help you remember it? Now you have examples of all of this [pointing to the list on the board] that will help you learn that vocabulary. So you see how much information you have in the newspaper? And not only from science, but other topics in the newspapers. So if you want to read something and you don't have a book, you can read the newspaper. (CO2.P8)

Charlotte also called herself the "queen of charts" (CO3.P11). She told her students they would frequently see her use charts to organize information. For example, in one observation, Charlotte used a chart to help students organize their thoughts around a *Mythbusters* segment to identify the scientific method. In order to facilitate student learning and their use of the charts, Charlotte projected a copy of the two column chart on the overhead projector and demonstrated for her students how to fill in each section with an example. During the video, she stopped and discussed with the students what they could put in another cell of the chart before moving on. For Charlotte, this process was about demonstrating the thinking process and having students learning to organize their thoughts.

Developing student interest in science. Charlotte also spoke about her responsibility as a teacher to develop student interest in science. For Charlotte, developing student interest in science was important so that students would be motivated to learn about science and see the usefulness of science to their personal lives:

> I have to keep the students motivated or at least interested in the subject. I don't want them coming to 6th grade and right away design a curriculum that they'll be so bored to death and that's the end of science.… So what I want is to keep them motivated and to have them learn the science concepts but in a way that it relates to their lives as much as I can or they don't have a lot of knowledge still but to make it relevant so they are interested and they say, oh yes, this can serve a purpose later. (CI2.75)

Charlotte fulfilled this role by choosing media containing characters that students would find interesting (e.g., Bill Nye) and media that was easy or fun to look at and use (e.g., comic strips). She also deliberately chose resources that were "silly" to keep students interested. For example, she used a *Mythbusters* episode about cows, methane gas, and flatulence to stimulate student interest:

> So I showed one [Mythbusters episode]. There's one that I like about methane gas and the cows. It's quite funny and a little gross, but they love it. You know, sixth grade is funny. It's like if, um, you know, cows are the main producers of methane, where does it come from and they test it? (CI1.193)

Patterns of Media Use

Types of media. During my observations of Charlotte's classroom, she used newspapers, magazines, television shows, films, and the internet (see Table 5-1). Charlotte used articles, pictures, and comic strips from the newspapers and magazines; she showed an excerpt from a popular television show, *Mythbusters,* and one film from the Bill Nye the Science Guy series; and she had her students use the internet to locate pictures and create PowerPoint presentations.

Charlotte and I frequently discussed her plans for upcoming class periods. Charlotte mentioned that a new computerized state test limited her access to computers. On one occasion, Charlotte planned to visit the computer lab, but found out that morning that the lab was being used for testing (CO3.P13). When she tried to access the mobile laptop cart, it was also being used. From those conversations, I believe she would have used the internet more often if access to computers was more consistent.

A comparison of Charlotte's reported and actual use of NIMM (see Table 5-2) shows that Charlotte actually used each media type she reported using; however, a more detailed comparison of her reported and actual use revealed less variation on the types of television and film media Charlotte used within each category. For example, in the initial interview with Charlotte, she mentioned using popular fiction films such as *Journey to the Center of the Earth*. Charlotte did not show this type of film during the nine week observation period. I believe this was due to the timing of my observations rather than an inconsistency between Charlotte's reported and intended use. Charlotte told her students early in the nine weeks that she planned to show them that film later in the year (CO1.P2). In fact, "Journey to the Center of the Earth" was Charlotte's theme for her earth science course as shown on her course syllabus distributed on the first full day of class.

Topics. I observed Charlotte engaging her students in two full units and beginning a third unit of instruction during the nine weeks (see Table 5-3). Each unit lasted approximately four calendar weeks. Through the use of NIMM, Charlotte covered topics related to the following themes in science: applications of science, physical science, earth science, and space science. The scientific method was the main focus of the applications of science in Charlotte's classroom, while physical science topics included the laws of motion and atomic structure. Charlotte introduced her students to the breadth of earth and space science topics (the focus of Charlotte's course) through the use of NIMM. Charlotte did not explore controversial issues in her classroom using NIMM. More details about the specific topics addressed in each piece of media Charlotte used can be seen in Appendix D.

Frequency. I observed eleven of Charlotte's twenty-four class periods during the first nine weeks. Charlotte used media in less than 1/3 of her classes (see Table 5-4); however, I observed eight episodes of NIMM use. In one class period Charlotte used a film and a comic strip in two different parts of a lesson. Charlotte did not use media in class periods I did not observe. Charlotte's class agenda was available online and I received weekly confirmation of the plans posted online via email. As the observation log illustrates (see Appendix D), I observed all accounts of Charlotte's NIMM use during the nine week period.

Charlotte reported using NIMM at least once during each instructional unit. Table 5-3 shows that Charlotte actually used media as frequently as reported. This was also true for the space unit that began but was not completed during my observation period.

I was concerned that my presence in Charlotte's classroom influenced her use of NIMM because on two occasions Charlotte verbalized concern over whether or not she was doing something correctly. However, after additional conversations related to the purpose of my observations (to see what teachers do - not whether a lesson is successful), I concluded my presence did not influence the frequency at which Charlotte used NIMM. Moreover, at the conclusion of my observation period, I was able to explore the potential impact of my presence more objectively. Following the observation period, and during my ongoing analysis, I periodically visited Charlotte's online class agenda. She continued to use NIMM at least once each instructional unit during the second nine week period. This led me to conclude that my presence had little impact on the frequency at which she used NIMM in her science classroom.

Strategies for using media. I observed Charlotte using four teacher-directed strategies when she used NIMM in her science classroom: note-taking, teacher led discussion, identifying fact or fiction, and independent exploration with focus (see Appendix D for more details). As discussed in Chapter 4, these strategies were teacher-directed because Charlotte explicitly provided probing questions or specific prompts to direct students' attention to specific aspects of the media prior to student interaction.

Charlotte employed a note-taking strategy during three episodes of NIMM use. As an example, she used this strategy during her use of an excerpt from the television show *Mythbusters*. Charlotte first prompted her students to create a chart outlining the steps of the scientific method. Before watching the excerpt, Charlotte reviewed with her students the steps of the scientific method and introduced the purpose of watching the *Mythbusters* episode. She worked with the students through the course of the excerpt to identify how the scientists on the television show were using the scientific method and directed students to document their discussion in the chart in their notes (CO3.P11).

I only observed Charlotte using a teacher led discussion once during the nine week observation period. In that lesson, Charlotte introduced the course syllabus and outline to her students. She then showed her students pictures from the local and national newspapers and led a discussion of whether or not those pictures illustrated topics they might discuss in her course that school year. For example, she showed a picture of a space shuttle and asked, “Are we going to study the space shuttle program and going to space?” She and the students then discussed how over the course of the year, they will cover both earth and space science topics (CO2.P3).

During two episodes, Charlotte required her students to identify fact and fiction in comic strips as a strategy for using NIMM in her classroom. When she used this strategy, she had students identify the inaccurate scientific statements in a comic strip and then correct the inaccuracy in an explanation below the comic strip. One comic strip Charlotte used was a *For Better or Worse* strip about a wife who is missing socks in the laundry. The character in the comic strip said,

> I’ve decided there can only be one explanation for this phenomenon. The speed of the rotating dryer … plus the forced, heated air sends them into another time dimension! Somebody on this very spot in the year 2050 is going to suddenly acquire dozens of unmatched socks!! You’ve got to admit it’s possible. Trouble with most brilliant theories is nobody takes you seriously. (CO6.P17)

Charlotte then asked her students on the accompanying worksheet to identify what was wrong in the comic strip based on the definition of scientific theory.

During my observations of her teaching, however, I noticed that she also employed the strategy of independent exploration with a focus. I observed Charlotte using this strategy during two different class periods. In one episode, Charlotte had over twenty magazines and newspapers lying on a counter in her classroom for her students to explore. She directed her students to pull a piece of media and search for pictures or articles that illustrated topics related to earth science. She provided students with a specific prompt for looking through the media:

> You are going to get either a magazine or a newspaper part. If you have magazine … you need to look for articles or images that are topics that

> are studied in earth science. If you have a newspaper … you are going to read the headings of each article and decide if it's something related to earth science topics or earth science.… Then we are going to share that so you need to be prepared (CO2.P8).

Affordances. Table 5-6 illustrates the affordances I observed in Charlotte's classroom and the frequency at which I observed Charlotte using NIMM for each affordance. Charlotte used media to assess scientific knowledge (ASK), illustrate real science (IRS), and deliver scientific content knowledge (DSK). I most frequently observed Charlotte using media to ASK and DSK (three episodes each).

Charlotte used media to ASK when she had students identify the scientific facts and scientific inaccuracies in comic strips. For example, in the episode in which she asked students to identify the inaccurate use of the term "theory" in the *For Better or Worse* comic strip, she did this to assess students' understandings of a vocabulary word they learned during a previous lesson. She presented students with a new context for using the word, and attempted to assess if they were able to apply their understanding to new contexts (CO6.P17).

Charlotte used media to DSK during three episodes of NIMM use. During two of those episodes, she used NIMM to DSK by engaging students in a note-taking strategy to accompany a film or except from a television show. During the third episode, I observed Charlotte use digital media to DSK. This was the only instance in which I observed Charlotte using digital NIMM. In that episode Charlotte directed students to use the internet to locate images and information about planets. Their task was to locate scientific information about the planets and create a PowerPoint presentation to share with their classmates. Charlotte suggested a website for the students to use, but allowed her students explore other websites if they preferred. Charlotte mentioned that she felt their ability to use the internet to gather scientific information was dependent upon students' prior knowledge:

> They will interact with the [internet], but what they get out of it - it depends on their prior knowledge. And I can see it even when they synthesize things from websites to create a PowerPoint with the planets … I'm not sure they still - not all of them are at the level, you know, they need more [prior knowledge]. (CI2.205)

I also observed Charlotte's use of NIMM to IRS. In one episode, Charlotte tasked her students with collecting images and articles from newspapers and magazines related to earth science. After her students located the images and articles, she led a discussion with her students about the prevalence of earth science in everyday life and the types of topics that constitute earth science. One student located information about adventure treks that visitors to Alaska can take around Mt. McKinley. Charlotte took that opportunity to highlight the prevalence of science. She also discussed how science appears in all sections of the newspaper:

> Actually this is quite interesting. It's just in the section of traveling in the newspaper so you wouldn't even think there's a connection to earth science in this section. (CO2.P8)

As Table 5-7 shows, Charlotte reported using NIMM to MCE, ASK, IRS, and DSK in her initial interview. I did not observe any episodes in which Charlotte actually used NIMM to MCE. In her initial interview, her use of NIMM to MCE emerged during her discussion of her use of films to manage her students' behavior when a substitute was present. In my observations, Charlotte did assign a film when a substitute was present, but she had students complete an accompanying worksheet to take notes on the scientific content addressed in the film. Therefore, she was using the film to DSK; there was no evidence that the film was used to MCE.

Knowledge of Media Construction

Charlotte articulated a limited understanding of media construction during my study. When she discussed the authors, intended audiences, or representations of science in media, her views on media and its potential use as a science classroom resource highlighted her naïve conceptions of media. Additionally, I only observed one, brief episode in which Charlotte hinted at any understanding of the tenets of media literacy.

After observing Charlotte's NIMM use, I asked her who creates the media she uses and if the author matters when selecting NIMM. She did not identify any authors and said that if "it's good, it doesn't matter" (CI2.148). Charlotte was able to identify that media is meant for a general audience but did not offer any insight into how the general audience might compare to her student audience. In my observations of her teaching, Charlotte did not discuss the authors of media, their purposes, or intended audiences with her students thereby confirming that the author of media is not a significant factor to her selection and use of NIMM.

I also asked Charlotte about the creative techniques media uses to attract users' attention. Charlotte responded by discussing the content within the media she uses and its connection to the content she covers in her class. Charlotte even reported that if she were to make media for someone else, she would include robust content matter to make it interesting.

Despite her limited articulation of what makes media attractive and engaging, I observed one episode in which Charlotte recognized how the media uses creative techniques to convey a message. When Charlotte assigned her students to identify earth science topics in newspapers and magazines, one group selected a page from a magazine that had the title of the accompanying article and a picture of an outline of lung filled in with drawings of trees. Charlotte said,

> OK, they chose quite an interesting image. They're talking about deforestation and if we cut trees – the picture is in the shape of the lungs – and if we cut trees then it is related to the lungs – this is in the shape of the lungs [pointing to the image] because it will affect the amount of oxygen we have. (CO2.P9)

In this episode, Charlotte's discussion of the image and its unique portrayal of a concept in earth science (deforestation) illustrated that her understanding of how media uses creative techniques to convey a message was slightly more developed than she had articulated during her interview.

Charlotte also discussed that her students' prior knowledge and experiences influences their ability to understand the media they encounter. For Charlotte, prior knowledge included content knowledge and knowledge of the vehicles through which media is transmitted (i.e., the internet). Charlotte said the following about her students, "They will interact with the media, but what they get out of it, it depends on the prior knowledge" (CI2.205).

In my discussions with Charlotte, it was also evident that she recognizes that not all sources of scientific information are credible. Specifically, the internet was a troublesome resource for Charlotte. I probed Charlotte about representations of science in media and whether she feels media accurately represents science and scientist. She responded with the following:

> I'm not sure about the word accurate but I would say maybe non-traditional because like most – but I think we're getting better at portraying a different view of a scientist – and especially I start here like sometimes I'm like I'm a woman, I don't wear glasses, you know. (CI2.335)

Charlotte said she wanted to stay away from portraying scientists as one type of male like Albert Einstein, so I probed her about her use of Bill Nye videos and how Bill Nye compares to Albert Einstein. Charlotte said the following, "Bill Nye kind of looks like Albert Einstein with the coat that he wears, but he is loud and you know, doing crazy things so I'm not sure if it represents it accurately but definitely in another view of what a scientist could be" (CI2.343). I then asked her if she considered the representations of science and scientists when selecting media. Charlotte responded as follows:

> No. Like the magazines I try to make it cheap … whatever I had that was appropriate, I brought a couple. So I try. You know, I – in that - I don't discriminate. (CI2.324)

Charlotte did not explicitly discuss representations of science in media with her students during my observations, nor did she discuss the credibility of sources with her students. In fact, during one lesson students were encouraged to use the internet to collect information about the planets. Charlotte did not talk about the credibility of sources. She instead suggested a few websites for the students to access, which most of them did without straying too far from her suggestion. In a subsequent conversation with Charlotte, she noted that the credibility of sources is not the focus of her course because she knows that that tenet is a large part of the seventh grade curriculum. In her class, her focus is on acquiring the content from the sources and compiling them into a presentation.

Perceptions of Students' Media Literacy Capabilities

Charlotte felt her students were not capable of independently accessing or evaluating different types of media, but were developing in their ability to create media. Charlotte recounted a time in which her students used the internet to gather background information on why ships float. Charlotte said that the students all just copied and pasted the text from the same internet site. Most of the students in her class clicked on the first link that resulted from a basic search on sinking and floating and then could not decipher the information on the website. This led me to conclude that Charlotte did not believe her students could access or evaluate media sources. However, Charlotte felt that with practice her students could become better consumers and creators of media.

Charlotte also felt her students were limited but developing in their ability to create media. Charlotte described her students as silly and lacking focus when creating their ownvideos using equipment such as flip cameras. She acknowledged that she wanted their films to be fun, but felt they “still didn’t get all the content” (CI2.366). While my discussions with Charlotte about her perceptions of her students’ ability to access, analyze, evaluate, and create media were limited by Charlotte’s own media literacy, I got a sense that Charlotte believed that her students had the potential to become critical consumers of media.   Charlotte said she wished she had the time demonstrate how to do an internet search with her whole class to learn how to evaluate sources of scientific information: “They need a little more guidance and I think we’re getting better at it. I see the kids that are getting to me and they come and do a little better. They are more able” (CI2.359).

I asked Charlotte about her students’ abilities to analyze media (or identify how media captures an audience’s attention), but given Charlotte’s own lack of familiarity with this tenet of media literacy, she was unable to speak to her students’ capabilities. When asked, Charlotte did not think that there are any defining characteristics of students who are more or less capable of using media.

Hugh

Context

Hugh has been teaching for ten years; however, Hugh has not always been a secondary science teacher. Before teaching middle school, Hugh taught fourth grade. Hugh has been teaching 7th grade science and music because he arrived at Creekside eight years ago. He is certified to teach science, technology, and music grades 1-10.

During the 2009-2010 school year, Hugh taught five periods of 7th grade life science and one period of music ensemble. Hugh also served as the faculty advisor for the middle school herpetological society at Creekside (which he created) and as Creekside's cross country coach. While Hugh described himself as an avid scientist and comes from a family of scientists, his love for running was evident in his classroom and in discussions with his students. Trophies and ribbons won by his teams lined the countertops, and his players stopped by his classroom throughout the day.

After selecting Hugh as a participant to observe for the first nine weeks of the 2009 school year, Hugh notified me that another researcher would be in his classroom during the same observation period. A second graduate student (referred to as "Debbie" in this study) received permission to work with Hugh and conduct her dissertation research in his classroom. Debbie's project focused on the development of an online presence in the secondary science classroom. Her role was to identify online tools Hugh could use in his classroom to facilitate student learning. While she was familiar with technology and online work spaces, the decision of what tools to use or how to use those tools resided with Hugh. Hugh accessed and used the online resources as he saw fit in his classroom, therefore I reasoned her presence would not adversely affect my research. Instead, her presence increased the frequency at which I saw the internet used as a vehicle for NIMM use.

It was agreed that both Debbie and I would take on the role of participant observers in Hugh's classroom and serve as a second set of hands for interacting with the students during individual or group work, and for troubleshooting technology issues. I initially observed Hugh's second period life science class, but then switched to his first period class after the first two class periods per Hugh's request. Because Debbie had to commute two hours each morning to observe Hugh's second period class and Hugh felt he would benefit from additional help in first period, I made the transition to accommodate Hugh's needs. There was no noticeable difference between Hugh's first and second period classes as all classes at Creekside were scheduled with heterogeneous groups of students.

Hugh's classroom was unique when compared to Amanda's and Charlotte's classrooms in that each student had access to a laptop computer. Six sets of student tables (each seating four students) were positioned in the center of the classroom. A laptop cart resided at the front of the classroom containing the charged student laptops. Two walls of the classroom were lined with storage cabinets and countertops. All countertop space in the classroom was filled with aquariums of various sizes housing animals such as tarantulas, bearded dragons, axolotls, and chameleons; and trophies and ribbons won by Hugh's cross country team. The main focus wall contained a white board and a retractable overhead projector screen, which remained down during the entire observation period. In fact, nothing was ever written on the white board in Hugh's classroom as all class work was recorded and maintained online. Hugh's computer was located in the back of the classroom along the remaining wall which also contained windows leading to a common planning room shared by Hugh and his neighboring teacher.

Hugh's class started similar to Amanda's and Charlotte's classes in that students entered the classroom, accessed the class agenda, and began working on a warm-up assignment. The difference was that Hugh's students had to turn on computers and log into the school's server to access their agendas. The remainder of the class period consisted of students following the agenda individually by accomplishing assigned tasks online, with the occasional interruption by Hugh to hold class discussions or engage in offline activities.

Hugh had a software program loaded on his computer and all of the student laptops that allowed him to control the student computers from his own computer. When he wanted his students' attention, he could black out their screens with a message saying "Mr. H's turn." Blacking out student computer screens kept the students from being able to do any other work on their computers until Hugh released the control. With five minutes remaining in the class period, Hugh would always remind his students to save their work and log off of their computers. When the bell rang, Hugh alternated between dismissing his students by table and letting individual students leave when they were ready.

Role as Teacher

Coaching. When I asked Hugh to define his role was as a science teacher, he quickly responded that his role was to coach his students. Coaching, for Hugh, meant coaching students to monitor and extend their own learning and coaching students on how to be scientists.

In my initial interview with Hugh, he discussed his role of coaching students to monitor their own learning in terms of what coaching was not. Coaching was the antithesis of being the holder and deliverer of all knowledge:

> I'm just their coach … because they're the ones with the knowledge. I have some life science knowledge but it almost, in this day and age, that's not even completely necessary.… They can Google, you know, some species that I don't know about so it takes me – I don't know – it doesn't take me out of the picture, but it puts me in a different position as a teacher rather than the disseminator of ultimate knowledge. Instead I coach to make sure we're on task, we're doing the scientific process and that kind of stuff. (HI1.184)

In observations of Hugh's classrooms, his use of online organizational tools such as Evernote, Symbaloo, and Google Docs demonstrated his desire to teach his students how to monitor their own learning. Through the use of these online learning and communication tools, students could document and track their learning while simultaneously providing Hugh access to their work.

Hugh also took on the role of coaching students on how to be scientists. What scientists do and how they identify and evaluate evidence was a repeated topic of discussion in Hugh's classroom. For example, during one observation Hugh directed students to a website about the Pacific Tree Octopus, a fictional species presented online as a factual species. Hugh encouraged his students to evaluate the credibility of the website and the author's claims, but did so within the discussion of what scientists do to evaluate evidence when he told them, "You can search other things. There are many other links on there. What would a scientist do if they are trying to find information about it?" (HO2.P9) He then engaged his students in a debate about the authenticity of the website and told his students that that's what scientists do; they debate over and over again and present evidence to defend their arguments (HO2.P10).

In my observations it was evident that Hugh's class was set up for Hugh to serve a coaching role. When students entered the classroom, they independently accessed the class agenda online and began working. Hugh circulated through the classroom or watched student activity from his control computer and talked to students individually as they came to his seat. He occasionally interjected with some brief whole class discussions, but the learning and the demonstration of knowledge was created by the students.

Outside of the classroom structure, I asked how Hugh sets up the classroom atmosphere for coaching. Hugh said,

> I think one is the way that maybe I talk to the students. I don't give a lot of direct answers. I usually – I prefer to show them how to figure out the problem and coach them in that than give them a direct answer. I leave a lot of room if I can for them to be creative in like the projects that they're doing. (HI2.22)

Hugh's goal was to reduce his students' dependence upon him for learning:

> I'd say in general my philosophies are to make sure that concepts are being introduced that students are supposed to know in 7th grade, but to sort of guide them and give them - even if sometimes the illusion of - as much free choice and own responsibility for their learning as possible. (HI2.1)

Developing student interest in science. Like Charlotte, Hugh felt one of his roles as a science teacher was to develop student interest in science. During an interview with Hugh, he recounted his initial concerns about becoming a secondary science teacher and how he ultimately realized that his role was to keep the students interested in learning and develop their interest in science:

> I still remember when I got interviewed basically to do middle school. I was moving up from 4th grade and I was kind of like, well, yeah, I've been doing science for my whole life but you know this is weird. It's all content based and the person talking to me had said, "Well, now wait a minute. This is middle school. What we really, really want is for the students to still enjoy coming to school, to do good work, but to really come away with the sense – a sense of pride is good – but a sense of that this is really fun, that learning is really an enjoyable thing as a person. That kind of thing would be important." So that's what they told me. I said, "Well, I can do that. I can do that." So when I first started teaching … I remember reminding myself everyday - remember the goal. They should be enjoying this. (HI2.102)

The reason science needed to be interesting, according to Hugh, was so that his students engaged to the point that they want to learn, be successful, and pursue science:

> You really just have to find things that are interesting …. There's a bit of a pied piper approach with middle schoolers that's effective, I think. If you're really into it, you can kind of pull them along. You know, you give them a lot of encouragement, tell them they're doing a great job and they just kind of – they want to be a part of it too. And anyone wants to be a part of something successful. So when you're having success and people are learning things then, you know, they want to be in that. (HI1.410)

Patterns of Media Use

Types of media. During my observations of Hugh's classroom, Hugh used newspapers, video clips from television shows and films, the internet, and one video game to teach science (see Table 5-1). With the exception of one *Planet Earth* film, all of the media Hugh used was delivered through the Internet. All videos and television excerpts were shown through YouTube or United Streaming (an online video streaming service paid for by the school). The newspaper articles were also all accessed in their electronic format.

Because Hugh's classroom was infused with technology and he and his students maintained an online presence, it was not surprising to me that most of his NIMM use would be delivered electronically. However, as shown in Table 5-1, episodes of NIMM use in Hugh's classroom were heavily concentrated around the use of digital media and films (which were delivered electronically) with only one episode of newspaper use. This is in contrast to Hugh's reported NIMM in which he discussed using video games, but also more print materials such as trade books and magazines. A comparison of Hugh's reported and actual NIMM use (see Table 5-2) shows that with the exception of trade books, Hugh actually used each type of media he reported using.

Topics. I observed Hugh engaging his students in two full units of instruction and beginning a third unit of instruction on adaptations (see Table 5-3). Each unit lasted approximately three weeks, with topics discussed in the first unit continuing through the second and third unit. It was as though the questions "What is science?" and "What do scientists do?" drove instruction for Hugh and served as a common thread through all of his units of instruction.

Through the use of NIMM, Hugh covered topics related to the following themes in science: applications of science and life science. The practices of scientists were the main focus of applications of science in Hugh's classroom with an emphasis on how scientists communicate their work. I did not observe Hugh using NIMM to discuss controversial issues during the nine week observation period, which is in contrast to his reported use of NIMM ; however, like Amanda, Hugh used NIMM to discuss both national and local issues related to life science. A more detailed description of the types of NIMM Hugh used can be seen in Appendix D.

Frequency. As discussed in Chapter 4, Hugh reported using NIMM everyday regardless of the instructional unit. I observed twelve out of a possible twenty-four of

Hugh's class periods, and as he reported, he used NIMM in every class period (see Table 5-4). Hugh also used NIMM in every class period I did not observe (see Appendix D) as indicated by his online agenda and email communications with me.

As shown in Table 5-4, Hugh not only used NIMM in every class period, but he often used NIMM more than once per class. Of the twelve class periods I observed, Hugh used NIMM on twenty-eight separate occasions. In one class period, for example, Hugh showed a YouTube video clip on animal adaptations and had his students read a newspaper article about Cuban tree frogs (HO11.P47).

I believe Hugh's NIMM use was influenced to some extent by the presence of the research associate, Debbie; however, I do not believe his *frequency* of NIMM use was influenced by her presence. Debbie provided new ideas for the types of online technology Hugh could use in his classroom, and her presence influenced his daily use of some organizational tools (e.g., Symbaloo, Twiddla, etc.). However, Debbie did not provide any suggestions for the types and frequency of NIMM Hugh used outside of those tools. In every instance that I recorded Hugh using the internet, I noted whether the purpose of that internet use was to use online organizational and communication tools suggested by Debbie or if it was to do student searching, note-taking, or some other strategy. At least once per class period, Hugh used a type of NIMM that was different than the online tools suggested by Debbie.

Strategies for using media. In my observations of Hugh's classroom, Hugh used both student centered and teacher-directed strategies (see Table 5-9). Among the three teachers I observed, Hugh had the most equal use of strategies between student centered and teacher directed. I observed Hugh using all three student-centered strategies (student creation, independent exploration of media, and engaging in scientific practices) and four of the teacher directed strategies (note-taking, teacher led discussions, critical evaluation of media, and independent exploration with a focus).

Hugh was unique in that he was the only teacher to use student centered strategies during the observation period. This meant that students were in control of what they focused on while using or creating NIMM. For example, Hugh had students create a video that captured their scientific experiments on Cuban and green tree frogs. The students were expected to research information on the internet about tree frogs and read a local article about the impacts of introducing the non-native Cuban tree frog species into the local area. Then, as a class, Hugh had his students conduct an experiment to compare the physical and behavioral characteristics of tree frogs and come to a conclusion about why Cuban tree frogs are a threat to the native species of tree frog. Students filmed the experiment and then compiled their videos, notes, and scientific paper into an online presentation available to the public (HO11.P47). The students had control over what to film, how to edit the film, and then how to present it on a public space online.

Hugh also used independent exploration strategies to interact with NIMM. Hugh posted short YouTube video clips on the online daily class agenda to get student's attention and engage them in the lesson for the day. When Hugh posted the videos and assigned students to watch them on their own, he did not always provide a focus question. Nor did he always provide specific prompts to direct students' attention to specific aspects of the media. Hugh would sometimes put on his agenda "Check this out!" or "Awesome video here!" (HO7.P30) but would provide a link to the video as the first item on the day's agenda without any other specific directions for what students were supposed to do with that video.

Hugh was also the only teacher that I observed engaging in scientific practices with NIMM. Once during the observation period Hugh had his students play an online video game, *Pocket Tanks*, and record measurements and outcomes from the game. Students were asked to consider if the angle of attack or the power of attack had a greater impact on the players' success. Students recorded measurements from the game and drew conclusions from their data tables about what made a player successful (HO33.P34). In this instance, students were engaging in the scientific practices of data collection, analysis, and reporting.

Hugh also had students engage in scientific practices when he encouraged students to seek out more information on a topic via the internet. For example, in one lesson students were exploring the authenticity of the fictional Pacific Tree Octopus. When a student couldn't find any more information on the creature, Hugh said, "You can search other things. There are many other links on [that page]. What would a scientist do if they are trying to find information about it?" (HO2.P9)

Student centered strategies did not monopolize Hugh's repertoire of strategies for using NIMM. Like Amanda and Charlotte, he used student note-taking and teacher led discussions when using NIMM. Unlike Amanda and Charlotte, I actually observed him using critical evaluation of media strategies with NIMM. Early in the semester, Hugh engaged his students in a conversation about how to determine the authors of websites and the sites' credibility. He asked his students, "How can something be fake and be on the internet?" (HO1.P6) Hugh then directed his students to a website and discussed the meaning of URL extensions as a whole class. Hugh prompted students to consider what the extensions on a URL tell them about the author and credibility of a website (HO2.P11). Hugh also had students critically evaluate media when he had them consider what about a video makes it seem credible. Hugh asked his students, “It all looks pretty authentic, right? What makes it look authentic to you?” (HO2.P10)

Hugh also used the newly identified teacher directed strategy- independent exploration with focus. In most class periods, students were given a considerable amount of class time to explore the internet for information about an animal, adaptations, or vocabulary words. Students independently explored the internet but were given a specific topic to research. How students used the internet and the specific searches they did were up to them, but they were given a purpose for using the internet before interacting with the media thereby making it a teacher directed strategy.

Hugh actually used every strategy he reported using except for identifying fact and fiction (see Table 5-9). He did not explicitly ask his students to identify scientific fact and fiction in NIMM although the comparison between fact and fiction was implicit when he used the critical evaluation of media strategy. As reported, Hugh did not use reading strategies or opinion pieces to interact with NIMM.

Affordances. Table 5-6 illustrates the affordances I observed in Hugh’s classroom and the frequency at which I observed Hugh using NIMM for each affordance. Hugh used media for each of its affordances, except applying science to students’ personal lives (ASP). I most frequently observed Hugh using media to ESS (15 episodes) followed by DSK (9 episodes) and then ASK and IRS (3 episodes each).

Emulating the style of scientists (ESS) took on many forms in Hugh's classroom, and as the most observed affordance of media used by Hugh, my observations revealed a subtle difference between the way Hugh talked about this affordance and the way it actually occurred in this classroom.

As discussed in Chapter 4, Hugh discussed using media to first show and then to engage his students in the processes of science - including experimentation and communicating findings. Hugh reported using the media to encourage students to engage as scientists, use process skills to collect and analyze data, and communicate their findings. In my observations of Hugh's classroom, outside of using the videogame *Pocket Tanks*, Hugh did not emphasize the affordance of media to collect and analyze data, but rather used NIMM to emphasize the importance of communication to emulating the style of scientists. While data collection and analysis were certainly valued by Hugh, those skills were primarily done outside of the use of media and were later incorporated into a report or other mode of communication in Hugh's classroom. Hugh encouraged his students to participate as scientists in a community and emphasized the social aspects of science through NIMM. Hugh discussed the importance of stepping back from conversations among his students after using media so those communication skills and communities can be developed:

> I want the conversation to go in a certain way, but they're not letting it go that way and I have to really step back and leave it be for a while because what they're really doing is the scientific process and getting all the answers right is never a goal for me. (HI2.L257)

In my observations of Hugh's classroom, I also noticed that delivering science content (DSK) as an affordance of media took on a different emphasis than Hugh initially reported. Initially, consistent with the other teachers, Hugh discussed this affordance in terms of the ability of NIMM to supplement information students would otherwise collect from traditional science textbooks. In Hugh's classroom, because of its online presence, the internet completely replaced textbooks. Moreover, to use media to deliver science content, according to the teachers in their initial interview, the topic of the media needed to be related to the content being covered in class, the information in the media should be "up to date" to contribute to new content learning, and it must contain enough new information for students to contribute to new learning. However, because the internet lacks a filter that textbooks inherently have through the editing process, Hugh had to be explicit about what science content he wanted his students to get from the vast internet and how he was holding them accountable for acquiring that information. Hugh struggled with this balance at times. For example, when the students were supposed to be reading and collecting information about the Cuban tree frog, Hugh found that his students were not ready for a discussion because they were having difficultly sorting through the abundance of information they found online (HO11.P48).

As Table 5-7 shows, Hugh reported using NIMM to ESS and DSK, but during my observations I saw Hugh use NIMM for a wider range of affordances. In addition to using media to ESS and DSK, I observed Hugh using NIMM to MCE, ASK, and IRS. Hugh used a video when he was absent to hold students' attention for a class period (MCE) and he used a variety of short video clips to illustrate real science (IRS). Hugh also used digital NIMM to ASK. Specifically, Hugh had students create blogs and glogs (similar to a blog but in a poster format) to demonstrate their learning which allowed him to assess their scientific knowledge. The blogs and glogs were initially used by students to communicate their findings and research which allowed them to emulate the style of scientists (ESS); however, the affordance of this particular medium was shown to be more dynamic and allowed for multiple affordances as Hugh's use of the medium changed.

Knowledge of Media Construction

During my interviews with Hugh and my observations of his class, he articulated his awareness of the tenets of media literacy as described in previous chapters. Through our discussions, it was clear that Hugh understood the authors and intended audiences of media, the creative techniques media uses to deliver messages, and the values and perspectives included in and omitted from media. Hugh not only articulated his understanding of media; I observed him explicitly addressing the tenets of media literacy in his instruction.

Hugh was able to identify the author of all of the media he selected to use in his class except for the internet sites which his students selected and about which he had little information. He was also able to identify the intended audience as being the general public. Hugh emphasized that he chose media that was intended for a general audience rather than for his students because he believed that the authors of media had to work harder on interest when they are targeted to a general audience. In turn, the media would be more appealing to his students. Hugh described this as the capitalistic control of media that drove its production and quality:

> I think students are more interested because [the media] are designed to be interesting.… I think that the only reason that media makes it to the surface is because it's interesting and it's unique or maybe it's really persuasive or possibly controversial.… It's like that media, before it gets to the students, has already risen to the top somehow. It's not the bottom of the barrel stuff and so it's already just really good quality. Whereas in a textbook there's no capitalistic control choosing the fittest and most

> interesting information kind of thing.… So the competition of making your media more interesting creates better media for the students. (HI2.307)

While Hugh articulated a clear understanding of the authors and audiences of media, I also observed him explicitly teaching this tenet in his classroom. Early in the semester, Hugh discussed the meaning of URL extensions on internet websites. Hugh taught his students how to determine if a website is credible or accurate using the URL extension and by identifying the author of the webpage (HO2.P11). Throughout the observation period, I observed Hugh questioning his students and encouraging them to look critically at videos, newspaper articles, and internet websites and examine the authors of media. In one episode, a student found a website that piqued his interest. Hugh fired the following series of questions at the student to facilitate his critical evaluation of the website:

> What is this kind of site? What kind of site is it though? Are they trying to sell something? Who are they? Are they scientists or regular people? What do you think? You can scroll down and read some more and see what you think. (HO2.P10)

Hugh also articulated his understanding of the creative techniques media use to attract users' attention. For example, when I asked Hugh why he chose the *Planet Earth* documentary series to show in his classroom, he discussed the use of high quality images and pacing to engage audiences and deliver a message:

> So alright, [the] videos – they're colorful. They're really high quality. Um, there's like things that you have in good story telling. It's got good tensions. It's got good pacing, good building up.…They always have really, really good pacing. Like [the authors] must have these formulas that they sit down with and say, ok, we're only going to let you have 7 minutes of this scene so that we go to an action scene or something.… So those things have this pretty good pacing and I actually pay attention to those sort of things. You know, if I, in my other life, I might make these sorts of media someday. (HI2.203)

Hugh also noted that the length of a film and the attention span of a middle school student must be aligned to keep students engaged:

> These 45 seconds, a minute and half videos is like a new concept in the last 10 years. And that's right up middle school brain alley because it first of all tells you how long you have to go. If you have a video and you can see it's 90 seconds long, you'll watch the whole thing from beginning to end because that's no problem. But if you never knew how long the video was, sometimes you would kind of shut it off so that the fact that you can – those two new things – short videos and seeing how long they are – we take that for granted. That's just what we expect now with these videos. It's so interesting. (HI2.214)

Despite his knowledge and discussion of the technical aspects of media, Hugh did not explicitly teach this in his classroom. Hugh would probe his students for their understanding of the creative techniques used by media to capture their attention instead of directly instructing students on this tenet. For example, when his class was investigating the Pacific Tree Octopus and a student was exploring the bogus website, Hugh said to his students, "Teacher to another student "It all looks pretty authentic, right? What makes it look authentic to you?"(HO2.P9)

In Hugh's opinion, the interaction between the age of his students and the attention getting techniques used by media influenced his students' interest in the messages transmitted through media. However, their prior knowledge influenced their ability to interact and evaluate the messages. When Hugh showed a faked video of a chameleon changing colors, he was impressed with their ability to determine it was fake. Hugh came to me during the lesson and said, "See if they didn't have the background knowledge, they totally would have thought that was true" (HO3.P17). On the day prior, Hugh's students went to different websites and talked about what made them valid websites and read about chameleons.

Hugh felt it was his responsibility to encourage his students to have a critical stance towards media:

> So what I think is a really important thing with media is I'd like them to be really critical about it. I'd like them to look at it and say, well that might be true, but where is the evidence behind it and - I'm not saying they're going to go and spend weeks looking up the media and trying to find if it's valid or not, but I would hope that maybe they could like get in the mindset that these things aren't always what they seem to be. (HI2.237)

He frequently discussed the abundance of inaccurate and incomplete representations of science in media and reported using those limitations of media as conversations starters with his students. For example, in his discussion of playing *Spore*, a videogame he used to cover the topic of evolution, Hugh talked about its inaccuracies and inaccurate representations of science and how he used them to deepen students' understandings of evolution:

> H: And then one teacher said, "Oh I heard about that but isn't that like not accurate with evolution" and that's kind of the point. What's not accurate? That's a great way to learn too. Learn how things don't work.
>
> R: So did you have any of those accuracy conversations at all?
>
> H: Oh. Absolutely, because we talked about how you can't have one creature just change.… There's probably a million steps you have to take to change from not having legs to having legs and so that's why it doesn't happen instantaneously. So there again is another concept, you know, that evolution caused from natural selection can't happen instantaneously. (HI1.85)

His discussions of the values and perspectives included in and omitted from media articulated his understanding of the representations and reality tenet of media literacy.

Perceptions of Students' Media Literacy Capabilities

Hugh believed his students were capable of accessing, analyzing, evaluating, and creating media; however, he thought his students were not likely to demonstrate their abilities without being prompted. In the case of accessing media, Hugh felt his students are capable but unlikely to seek out the resources themselves because the media was created to appeal to a different audience:

> They're different than the general audience because the general audience is probably adult or young adults that just find these sort of things interesting. Whereas, these are students that wouldn't look for it on their own. (HI2.313)

Hugh felt this was the same reason for why his students would be able but unlikely to demonstrate their ability to analyze media:

> I bet if we had them explain it they'd probably be able to explain, you know, the purpose of what the author's trying to get across or maybe the intended audience. There's some science that's clearly intended for young people which they don't like very much to be honest. And then there's some that are intended to be interesting to adults which they seem to enjoy a lot more. (HI2.400)

When I asked Hugh how capable he felt his students were at evaluating media, he felt confident that regardless of the level of the student, they had the ability. Hugh discussed how two students of different abilities both found inconsistencies in information they found in two different sources and engaged in a conversation with Hugh about what information they should trust. The level of the student did not seem to matter. Hugh felt his students had an innate ability to critically evaluate media.

Even with evaluating media, Hugh thought his students were unlikely to demonstrate their ability without prompting. During one observation, Hugh told me that he noticed that if the students entered the wrong web address for the Pacific Tree Octopus website, they went to a website authored by the individual who created similar spoof websites. He said the students did not notice because if they pulled it up and it was not the tree octopus, they quickly returned to the navigation bar and retyped the URL. They did not notice the author's website because, as Hugh inferred, it was not what his students were looking for. His students did not stay long enough to look (HO2.P8).

Hugh said that creating media was one of the class' strengths this year. During my observations I saw Hugh's students creating media on multiple occasions. Hugh provided minimal instruction or guidance to his students on how to create media. Through his limited instruction, Hugh demonstrated his confidence in his students' ability to independently create media.

Hugh said that he was the main impetus for bringing popular media to his students' attention. The NIMM Hugh used was geared towards a general audience which he felt his students would not seek on their own because they would not be interested in media that appeals to the general audience. In Hugh's opinion, his students' abilities to critically examine media stem from an innate ability associated with their age. He said his students are naturally interested in media and therefore are naturally inclined to access, analyze, evaluate, and create it as long as a teacher brings media to the students' attention.

Summary

The goal of this chapter was not to make evaluative statements about teachers' NIMM use, but to provide a rich description of each teacher's classroom and practices. The presentation of this chapter was as case reports to provide the reader with a foundational knowledge of the teachers' classrooms that were used to develop a grounded theory of NIMM use as presented in the next chapter. Immediately following is a summary of the major findings from this chapter as they relate to my initial research questions.

Types, Topics, Frequency, Strategies, and Affordances

Amanda, Charlotte, and Hugh each reported and actually used a variety of media in their classrooms. Amanda favored print media such as newspapers and magazines. Charlotte favored visual media attributing her use to her own preference for visual resources. Hugh favored digital media and through his class' online presence utilized a variety of media types accessed on the internet. The actual digital NIMM use by Amanda and Charlotte was less than they reported, but both teachers attributed the disparity to insufficient internet access and the school's unpredictable internet filter for protecting student privacy and safety.

All three teachers used NIMM to address topics aligned to their courses including life science, earth science, space science, and physical science. Despite all three teachers reporting using NIMM to explore controversial issues in their classrooms, I only observed Amanda using NIMM for this purpose. All three teachers used NIMM to explore the work of scientists, with a specific emphasis on what scientists do.

All three teachers used NIMM at least once during each instructional unit as they initially reported with Hugh utilizing the most NIMM. Amanda used NIMM in 46% of her lessons; Charlotte used NIMM in 30% of her lessons; and Hugh used NIMM in 96% of his lessons. In some instances, Hugh used more than one type of NIMM in a given instructional lesson.

The teachers reported using both student-centered and teacher-directed instructional strategies with NIMM. I observed Amanda and Charlotte using teacher-directed strategies only; Hugh used both student-centered and teacher-directed strategies during my observation period. Two new instructional strategies relative to how teachers reported using NIMM during the initial interview emerged through observations: independent exploration with focus and opinion piece. Independent exploration with a focus was categorized as a teacher-directed strategy because when using the strategy, teachers would identify a focus question or prompt for the students to use when interacting with the media thereby drawing their attention to specific aspects of the media. This was in contrast to teachers' reported use of independent exploration of media in which students explored media without explicit directions on what to focus. All three teachers utilized this newly identified strategy. In the opinion piece strategy, students were asked to form a personal reaction or opinion while interacting with the media. Amanda was the only teacher I observed that used this strategy, and she did so on multiple occasions.

I observed Amanda using teacher-directed strategies to the point of giving the affordances of media to her students up front. Amanda was very transparent with her students about her purposes for teaching and using NIMM resources. Charlotte also used teacher-directed strategies but was not as transparent about her purposes for using media. Hugh balanced his use of student-centered and teacher-directed strategies and only occasionally made his purposes for using the NIMM explicit to his students.

The teachers' reported and actual uses of NIMM were closely matched. If anything, teachers under-reported their use of NIMM in the classroom in terms of the variety of strategies they employed and the affordances for which they used media. The teachers may not have been cognizant of all of the ways and reasons they use media, or else they did not articulate their understanding fully in the initial interview. However, contrary to prior research that suggests teachers over-estimate their teaching practices, my research showed teachers were quite reflective and accurately assessed their teaching practices.

Knowledge of Media Construction and NIMM Use

A comparison of the teachers' knowledge of media construction and their actual NIMM use revealed that teachers' personal knowledge of media construction does not always translate to explicit teaching with media or about media. In contrast, I observed several instances in which a teacher's knowledge of media construction (or lack thereof) translated to explicit instruction around the use of NIMM and class discussions of the tenets of media literacy.

For example, the authors and intended audiences of media were well articulated by Amanda and Hugh and both teachers explicitly addressed this tenet of media literacy in their classes. Amanda and Hugh also articulated a detailed knowledge of media construction, more generally, and frequently used a variety of media in their classrooms. Charlotte neither articulated an understanding of the authors of media nor explicitly discussed it with her students. Her limited shared knowledge of media construction aligned with her relatively limited use of media in her science classroom.

However, Amanda and Hugh also articulated personal knowledge of the messages and meanings of media, but did not explicitly discuss this tenet with their students. Representations and reality were also discussed by Hugh and Amanda, but the tenet was only explicitly taught in Hugh's class. This disparity between teacher's knowledge and their teaching practices may, among other possibilities, reveal that teachers: 1) assume students already understand media and do not need explicit instruction as was the case of Hugh's classroom, 2) assume the construction of media is not complex and therefore does not need special attention in the classroom, or 3) the teachers may lack the pedagogical knowledge to translate their personal knowledge to classroom instruction.

My research also revealed that teachers may discuss elements of media literacy with their students but may be unable to articulate their understanding in an interview. During an interview with Charlotte after observing her class, she was unable to articulate the creative techniques media uses to engage users or to deliver messages; however, I had just observed her discuss those elements of media with her students. This left me wondering why Charlotte was able to teach about media but could not articulate her own knowledge. Was the inconsistency a result of my interview or did Charlotte lack the vocabulary needed to discuss those elements? Is media literacy something each of us encounters at some point but because it is not made explicit to us as learners we are not able to make our understandings explicit?

Perceptions of Student Capabilities and NIMM Use

In light of this occasional mismatch between teachers' knowledge of media construction and their classroom use of NIMM, I compared the teachers' perceptions of student media literacy skills and the teachers' classroom NIMM use. In my study, the teachers' perceptions of student capabilities mapped on their classroom NIMM use. Hugh and Amanda used NIMM more frequently and employed more strategies for using media than Charlotte. They also used media for a wider variety of affordances. Hugh and Amanda also thought students are capable of accessing, analyzing, evaluating, and creating media. In comparison, Charlotte used NIMM less frequently and felt her students were not capable of independently accessing, analyzing, evaluation, or creating media successfully.

Charlotte said her students needed to be taught how to interact with media because they lacked the necessary knowledge to do so independently. In contrast, Hugh and Amanda felt students were capable; they thought their students just needed prompting to demonstrate their knowledge. The difference between Hugh and Amanda was that Hugh thought his students are capable *by virtue of their age.* Amanda said that her students were already capable because of past instruction they had received.

In this study, the teachers' perceptions of their students' media literacy skills varied from students having innate abilities (Hugh) to learned abilities (Amanda) to relatively limited abilities (Charlotte). The frequency at which the teachers used media and the variety of NIMM resources they chose to use in their classrooms aligned with their perceptions of their students' media literacy skills.

From Cases to Theory

This chapter has highlighted the context and NIMM practices of three secondary science teachers. The goal of this chapter was to offer a rich description of three teacher cases to orient the reader to the unique settings in which I conducted my study. While rich description in itself is valuable and offers insight into situations and phenomena that might otherwise go unnoticed, in grounded theory research, rich description falls short of developing theory to explain a phenomenon. In the next chapter, I will move to a discussion of the theory generated as a result of these cases, to explain the factors influencing secondary science teachers' NIMM use.

Table 5-1. Types of media used during observations

Teacher	Types	No. Used
Amanda	Newspapers/Magazines	8
	Trade Books	6
	Television/Films	3
	Digital	
	Internet	0
	Videogames	0
Charlotte	Newspapers/Magazines	5
	Trade Books	0
	Television/Films	2
	Digital	
	Internet	1
	Videogames	0
Hugh	Newspapers/Magazines	1
	Trade Books	0
	Television/Films	10
	Digital	
	Internet	16
	Videogames	1

Table 5-2. Comparison of the types of NIMM teachers reported and actually used

Media Type	Teacher	Reported Types of Media Used	Actual Types of Media Used
Newspapers/Magazines	Amanda	X	X
	Charlotte	X	X
	Hugh	X	X
Trade books	Amanda	X	X
	Charlotte	-	-
	Hugh	X	-
Television and Films	Amanda	X	X
	Charlotte	X	X
	Hugh	X	X
Digital Media	Amanda	X	-
	Charlotte	X	X
	Hugh	X	X
Radio	Amanda	-	-
	Charlotte	-	-
	Hugh	-	-

Table 5-3. Units and topics explored through media during observations

Teacher	Unit	Topics	No. Episodes
Amanda	Unit I:	Studying the Environment	6
		Environmental History	6
	Unit II:	Biosphere	5
		Evolution and Biodiversity	3
		Community Ecology	2
Charlotte	Unit I:	What is Earth Science	2
		Scientific Method	1
	Unit II:	Matter	4
	Unit III:	Space*	1
Hugh	Unit I:	Life Science	3
		What is science?	5
		What do scientists do?	15
	Unit II:	Scary animals	1
		Venomous versus	2
	Unit III:	poisonous	2
		Adaptations	

*This unit of instruction continued beyond my observation period.

Table 5-4. Episodes of media use during classroom observations

Teacher	Class Periods Observed			Class Periods NOT Observed*			Frequency of Media Use
	Total (A)	With Media Use (A1)	Episodes of Media Use	Total (B)	With Media Use (B1)	Episodes of Media Use	= Total with Media Use/Total = (A1 + B1) / (A + B)
Amanda	12	9	17	12	2	2	=0.46
Charlotte	11	7	8	13	0	0	=0.29
Hugh	12	12	28	12	11	24	=0.96

Table 5-5. Comparison of strategies used by Amanda

Type of Strategy	Name of Strategy	Reported	Actual
Student-centered			
	Student creation	-	-
	Independent exploration	X	-
	Engaging in scientific practices	X	-
Teacher-directed			
	Note-taking	X	X
	Teacher led discussion	X	X
	Identifying fact or fiction	-	-
	Critical evaluation of media	X	-
	Practice reading strategies	X	X
	Independent exploration with focus*	-	X
	Opinion piece*	-	X

*Of the class periods NOT observed, approximately half were shortened periods as opposed to the regular 110 minute block class periods

*New strategies identified during observations

Table 5-6. Frequency of observed affordances

Teacher (no. episodes)	Affordances	Frequency *
Amanda (17)	Emulating the Style of Scientists (ESS)	0.06
	Managing the Classroom Environment (MCE)	0.35
	Assessing Scientific Knowledge (ASK)	0.06
	Illustrating Real Science (IRS)	0.59
	Delivering Scientific Content Knowledge (DSK)	0.24
	Applying Science to Students' Personal Lives (ASP)**	0.18
Charlotte (8)	Emulating the Style of Scientists (ESS)	0.00
	Managing the Classroom Environment (MCE)	0.00
	Assessing Scientific Knowledge (ASK)	0.375
	Illustrating Real Science (IRS)	0.25
	Delivering Scientific Content Knowledge (DSK)	0.375
	Applying Science to Students' Personal Lives (ASP)**	0.00
Hugh (28)	Emulating the Style of Scientists (ESS)	0.55
	Managing the Classroom Environment (MCE)	0.03
	Assessing Scientific Knowledge (ASK)	0.10
	Illustrating Real Science (IRS)	0.10
	Delivering Scientific Content Knowledge (DSK)	0.32
	Applying Science to Students' Personal Lives (ASP)**	0.00

*Does not total to 1.00 because some episodes mapped to multiple affordances.
** ASP was a new affordance that emerged through observations

Table 5-7. Comparison of reported affordances to actual affordances

Affordance	Teacher	Reported Media Used	Actual Media Used
Emulating the Style of Scientists (ESS)	Amanda	X	X
	Charlotte	-	-
	Hugh	X	X
Managing the Classroom Environment (MCE)	Amanda	X	X
	Charlotte	X	-
	Hugh	-	X
Assessing Scientific Knowledge (ASK)	Amanda	-	X
	Charlotte	X	X
	Hugh	-	X
Illustrating Real Science (IRS)	Amanda	X	X
	Charlotte	X	X
	Hugh	-	X
Delivering Scientific Content Knowledge (DSK)	Amanda	X	X
	Charlotte	X	X
	Hugh	X	X
Applying Science to Students' Personal Lives (ASP)*	Amanda	-	X
	Charlotte	-	-
	Hugh	-	-

* ASP was a new affordance that emerged through observation

Table 5-8. Comparison of strategies used by Charlotte

Type of Strategy	Name of Strategy	Reported	Actual
Student-centered			
	Student creation	-	-
	Independent exploration	-	-
	Engaging in scientific practices	-	-
Teacher-directed			
	Note-taking	X	X
	Teacher led discussion	X	X
	Identifying fact or fiction	X	X
	Critical evaluation of media	-	-
	Practice reading strategies	-	-
	Independent exploration with focus*	-	X
	Opinion piece*	-	-

*New strategies identified during observations
*New strategies identified during observations

Table 5-9. Comparison of strategies used by Hugh

Type of Strategy	Name of Strategy	Reported	Actual
Student -centered			
	Student creation	X	X
	Independent exploration	X	X
	Engaging in scientific practices	X	X
Teacher-directed			
	Note-taking	X	X
	Teacher led discussion	X	X
	Identifying fact or fiction	X	-
	Critical evaluation of media	X	X
	Practice reading strategies	-	-
	Independent exploration with focus*	-	X
	Opinion piece*	-	-

CHAPTER 6
THEORY OF MEDIA USE

> I have found that … researchers have placed more and more emphasis on the accuracy of collected data [and analysis] rather than concentrating on the developing theory. These researchers are in grave danger of developing a rich description of the social scene rather than a theoretical one. Description is important to our knowledge, but it's not theory. (Stern in Bryant & Charmez, 2007, p.118)

The caution in grounded theory research, as highlighted by Stern in the quote above, is that researchers using a grounded theory approach fall short of the goal of grounded theory when they stop at rich description of their cases and fail to abstract the data to another level in order to develop theory to explain what they have so thoroughly described. Following the tradition of grounded theory, this chapter presents a framework for explaining the factors influencing science teachers' use of NIMM.

As described in chapter three, the theory underlying this framework was generated through constant comparisons in which data from interviews, observations, artifacts, and informal conversations were analyzed and triangulated for common themes in order to describe teachers' NIMM use. The initial analysis provided me with the basis for the rich description of teacher cases presented in the previous chapter.

As I went through the study, I kept a series of memos that summarized what I was finding and pulled together my ideas for why I was "seeing" what I was seeing in the data. I attempted to integrate my codes, categories, and personal memos to identify how all of the categories fit together. Once I identified "teacher knowledges" as a framework for telling my story, I reviewed the data simultaneously for instances that supported my theory of secondary science teachers' NIMM use, as well as any instances that highlighted potential gaps in my theory. To validate the resulting theory, I discussed its development and shared the following report with two researchers and the participants in the study for their comments. My theory seemed to hold up to everyone's scrutiny and accounted for the lived experiences of the participants. Therefore, I present the following framework and subsequent discussions as a grounded theory that explains secondary science teachers' NIMM use.

Framework Overview

Figure 6-1 depicts the framework underlying the grounded theory that explains teachers' NIMM use. Called the "Six Knowledges," this framework illustrates the factors influencing science teachers' NIMM use. The framework also illustrates how each factor is related to the next based on the perceptions of the three teachers in my study and my interpretation of their practices.

The circles in the middle of the framework represent the six knowledges that teachers draw upon when choosing and using NIMM. As indicated by the linkages between the six knowledges, all of the knowledges are interdependent, each contributing to a unique profile of NIMM use when combined. Each knowledge contributes to only a piece of the profile and is dependent upon the other knowledges. To understand science teachers' NIMM, I contend that you must view each knowledge as belonging to a larger network of knowledges. As the arrows between prior experiences and knowledges, and knowledges and instructional decisions indicate, the framework also illustrates the role of prior experiences in shaping the Six Knowledges and in ultimately shaping science teachers' NIMM use.

In the following sections I will describe this framework in light of the evidence collected in this research study. Specifically, I will describe how I conceptualize each of the knowledges using a representative example from one teacher. I will then discuss the interdependent relationship between knowledges using an example from each teacher. Each component of the model will be discussed using evidence grounded in the data to support my assertions.

Instructional Decisions

In my study I specifically looked at secondary science teachers' NIMM use. The emerging theory for the factors influencing teachers' use of NIMM was developed as an explanation for why the teachers in my study did what they did in their classrooms. As shown in Figure 6-1, an interplay between the Six Knowledges drives teachers' instructional decisions. In this study, the specific instructional decisions under reference are science teachers' NIMM use. It should be noted that instructional decisions include the teachers' choices to use NIMM, their selection of the media, and the strategies they used once NIMM was in their classrooms. Instructional decisions, therefore, encompass the planning and implementation stages of instruction.

Knowledge of Learners

The first knowledge influencing a science teacher's NIMM use is his or her knowledge of learners. Knowledge of learners is frequently cited as an essential component of science teachers' instructional decision-making (Angeli & Valanides, 2009). Typically this knowledge of learners is referenced in the research literature as pertaining to students' prior knowledge. However, each of the three teachers in this study discussed or demonstrated the importance of knowledge of learners in specifically driving their use of NIMM. The teachers discussed their knowledge of learners as including knowledge of one or more of the following elements:

- student prior knowledge
- student reading and/or viewing comprehension abilities and how they do or do not align with representations of science in media

- student interest and familiarity with different types of media
- student learning styles and how they compare with the presentation styles of various media, and
- how students may or may not be impacted by teachers' use of media

For example, in her use and discussion of non-instructional videos, Charlotte highlighted the importance of her knowledge of learners to her use of NIMM. Charlotte recognized that student prior knowledge of science and of media were contributing factors to using NIMM in her science classroom. She noted that her students "will interact with the media, but what they get out of it, it depends on their prior knowledge" (CI2.205). She chose television shows like *Mythbusters* because they were unlike other media which present science in a way that is too complicated and requires a higher level of prior knowledge. Charlotte said that some media is too complicated because her students "don't have knowledge of the materials [they use in the video]" (CI2.199) or the videos are too long. To compensate for their lack of familiarity with the materials or procedures discussed in the media, Charlotte either "makes that [video] short … to reach them, or finds another one" (CI2.201). Charlotte chose the *Mythbusters* clip because it was short and clearly illustrated the scientific method at a level that was comprehensible to her students:

> Some [experiments] are silly things they do, but [in] a lot of them … it's so clear the scientific method is there. Like in this silly, easy, funny way they're doing it and … what they do is not complicated. So it's not like a fancy scientific lab that is testing all this. So the kids can see easily the lesson without having me, you know, explain it all to them. (CI2.187)

Charlotte's knowledge of her students' interest and familiarity with different types of media also influenced her use of NIMM. Charlotte knew that her students enjoyed and were familiar with television shows and films, thereby making them powerful instructional tools in her classroom. Specifically, Charlotte discussed her students' familiarity with the television show, *Mythbusters*. She said, "Well, again … it relates to them. Right away they know who the *Mythbusters* are. They know what they're looking for - if the myth is approved or busted" (CI2.181). Because the show was familiar to her students, Charlotte felt the *Mythbusters* television show "relates the science concept to them" (CI2.183).

Charlotte also attributed her use of television shows and films to the alignment between her students' learning styles and the visual and auditory presentation of those media. She knew her students learned through a variety of modes. Charlotte noted that "at [her student's] age level, they're probably a mix of all of those [learning styles] like auditory, visual, and there's a lot of kinesthetic because they like to move" (CI1.396). So she tried to "mix all of them" (CI1.398). In this way, Charlotte selected and used NIMM in ways that match her students' learning needs.

She specifically chose the *Mythbusters* clip because of its visual and auditory presentation of the scientific method. During her use of the clip, she engaged her students in documenting the steps of the scientific method to engage the kinesthetic learners. Charlotte had her students complete a chart outlining the steps of the scientific method. She then went through the chart with her students, showing brief excepts of the *Mythbusters* clip and engaging her students in a discussion of how each step of the scientific method was demonstrated in the clip. She asked her students to continue documenting the steps of the scientific method as they watched the remainder of the clip (CO3.P11). This allowed her kinesthetic learners to practice what they learned by writing down the information and processing the information in an organizational chart.

Charlotte's knowledge of how her students may or may not be impacted by media also influenced her NIMM use. Charlotte discussed how some NIMM contains language and topics that are inappropriate for her students. Charlotte selects NIMM by keeping her students' age and the potential negative impact of these sources in mind. In reference to her use of television shows, Charlotte said the following:

> C: Definitely, the TV shows would have to be screened.…
>
> R: What would you have to filter it for? What types of things would be – ?
>
> C: Comments and yeah, language. And my general feeling is TV puts a little bit of inappropriate things in everything. (CI2.418)

Knowledge of Context

The second knowledge influencing a science teacher's NIMM use is his or her knowledge of context. Knowledge of context has increasingly been cited in the research literature as influencing a teacher's instructional decisions (Abell, 2007). Recent research has emphasized the role of state and national mandates on teachers' instructional decision-making. Not unlike the current research, context in this study includes the immediate classrooms in which teachers work, as well as their school, local, state, or national contexts. The teachers in this study discussed or demonstrated the importance of knowledge of context in driving their instructional decisions and, specifically, their use of NIMM. The teachers discussed their knowledge of context as including knowledge of one or more of the following elements:

- Course objectives and requirements
- Available class time to use NIMM

- Access to NIMM
- School level initiatives
- School level instructional supports such as professional development opportunities and other teachers
- Curricular connections to other local, national, and international events, and
- State and national standards and testing requirements

For example, Amanda's knowledge of her context influenced her selection and use of the science journal article "Tragedy of the Commons" from the 1968 *Science* magazine. "Tragedy of the Commons" was written by Garrett Hardin who initially discussed the link between overpopulation and the scarcity of resources. Amanda's knowledge of her course objectives and requirements influenced her decision to use the article as an instructional tool. In her environmental science course, the topics of overpopulation and sustainability are key themes. Amanda said that she chooses NIMM that is "specific to what we're doing. It has to be appropriate for the subject" (AI2.166). The ideas discussed in Hardin's "Tragedy of the Commons" are centrally related to the key themes in environmental science.

Amanda also felt that as a part of AP environmental science, her students should read "real" science articles to see how science is written so they too can engage in science:

> And I also – particularly in AP –I use some journal articles … because I really think that [my students] need to read real science from the horse's mouth and see … how it's written and this is how it's done. If [my students] are going to do science, they need to understand true science writing, not watered down stuff. So they need to see some of that too. (AI2.277)

Amanda's NIMM use was also influenced by the amount of class time she had available to use NIMM. She assigned her students to read "Tragedy of the Commons" in class but was unable to engage in a discussion of the article during that class period. To compensate for this time limitation, Amanda continued to reference the article throughout her unit of instruction, assigning homework that elicited student reactions to the article and connecting the themes in the article to themes in other NIMM resources such as the movie *The Lorax* (AO2.P5). Amanda did not have enough time to discuss the article the day she assigned her students to read it, but drew on her knowledge of her context (and ongoing discussions of the article in reference to other class activities) to maximize the likelihood that her students would comprehend the article and apply it to new situations.

Through email correspondence, Amanda shared that she felt her students should read the article, but may not have access to the article as students. Amanda accessed the article through the university's science library and because she was using it for educational purposes, could distribute a copy to each of her students. Amanda mentioned on several occasions that copyright and access was also a product of her context that influenced whether or not she used NIMM.

It was clear when Amanda introduced the article to her students, that she had knowledge of school level initiatives, specifically related to reading initiatives. Her choice to use print NIMM resources such as science journal articles was influenced by her mandated need to incorporate reading in her classes. Amanda chose articles that lent themselves to using reading comprehension strategies like reciprocal teaching. She told her students they were using the particular strategy with "Tragedy of the Commons" because "it's pretty meaty material" (AO1.P3).

Even when reading strategies are encouraged or mandated by a school or state, the choice of which print material to use is usually up to the teacher. However, Amanda's knowledge of school level instructional support such as collaboration with other teachers influenced her use of "The Tragedy of the Commons." The economics teacher at Amanda's school talked about cost-benefits analyses with his students and discussed the article with his students as well. Amanda felt that this type of interdisciplinary use of NIMM influenced her ability to use the article in a way that her students would understand the concepts and relate them to other situations:

> [Our students] read the article. They knew what I was talking about. We talk about cost-benefit analysis and it was really pretty neat because they were right there with me. They knew what the commons were and so it worked out really well in terms of having an interdisciplinary connection too. (AI2.282)

Amanda was also aware of local, national, and international events and discussed "Tragedy of the Commons" with her students in light of those events. How she used the article was dependent upon its connection to themes outside of class. For example, when she assigned her students to read an editorial article about off-shore oil drilling, she asked students to consider if off-shore oil drilling was an "economic boom, tragedy of the commons, or both" (AO5.P13).

As shown in previous research, state and national standards and testing requirements influence instructional decisions. Amanda's use of "Tragedy of the Commons" was no exception. Amanda was aware of this contextual factor, and in response, assigned her students extended writing assignments around the article to practice their persuasive writing skills. She assigned students to complete a three paragraph essay that summarized the article, discussed the relevance of the article to environmental science, and highlighted arguments in support of and in opposition to

Hardin's position. Amanda's knowledge of state and national testing requirements influenced how she used "Tragedy of the Commons" in her classroom.

Knowledge of Self

The third knowledge influencing a science teacher's NIMM use is his or her knowledge of self. A knowledge of self as presented in this study includes what has been referred to in previous research as a teacher's knowledge of his or her science teaching orientations or teaching philosophies (Friedrichsen & Dana, 2005). However, knowledge of self is unique from previous literature in that it includes knowledge of who the teacher is as a learner and a teacher's personal media preferences. The teachers in this study discussed or demonstrated the importance of knowledge of self in driving their instructional decisions, and specifically, their use of NIMM. The teachers discussed their knowledge of self as including knowledge of one or more of the following elements:

- Role as teacher
- Personal media preferences; and
- Personal learning style

For example, Charlotte drew on her knowledge of self when she assigned her students to use images and articles from newspapers and magazines to identify topics related to earth science and illustrate definitions of earth science vocabulary. Charlotte felt her role as a science teacher was to facilitate student learning by providing her students with strategies for organizing their thoughts. Drawing on her knowledge of her role as a science teacher, Charlotte had her students both verbally and visually illustrate earth science vocabulary to provide multiple modes for students to organize and assimilate new information (CO5.P8).

Charlotte also drew on her knowledge of her own personal media preferences to select NIMM for use in her science classroom. Charlotte described herself as an avid newspaper and magazine reader. Charlotte reported that she read the newspaper every morning and consistently looked through the newspaper and magazines for articles and images related to her curriculum. Her own personal preference for print media influenced her selection of that type of media for use in her classroom. Moreover, Charlotte drew on her personal collection of newspapers and magazines in her classroom use of NIMM. She knew her students may have difficulty finding images that illustrated topics in earth science or the meaning of some vocabulary words like heterogeneous mixtures, for example, so she used her own personal collection to add to the classroom resources

Charlotte's knowledge of her personal learning style also influenced her NIMM use. When I asked Charlotte if there is anything within the school or administratively that dictates she use NIMM, she responded as follows:

> Um. I'm visual. I'm very, very, completely visual – a visual person so I think for me, when I study and I read and I'm trying to plan a lesson, and I see their faces and I now I understand, you know, I need to show this. (CI1.370)

Charlotte noted that her own personal learning style influenced her NIMM use. Because Charlotte is a visual learner, she thinks her students may also need visual representations of science to remember key science concepts, which she refers to as "stories":

> So I think all those resources help, and if I just do a piece of paper sitting there reading – you need other resources to have some, to keep some like story in your memory. That's how I keep it in my memory. I need a visual or something that I see. (CI1.405)

Knowledge of Pedagogy

The fourth knowledge influencing a science teacher's NIMM use is his or her knowledge of pedagogy. Typically this knowledge of pedagogy is referenced in the research literature as pertaining to knowing different teaching methods and/or methods for teaching science in general (Lee & Luft, 2008). However, the three teachers in this study discussed or demonstrated the importance of knowledge of pedagogy in specifically driving their use of NIMM to teach science. The teachers discussed their knowledge of pedagogy as including knowledge of one or more of the following elements:

- Methods for science teaching
- Methods for teaching with media; and
- Methods for teaching science through media

Hugh demonstrated his knowledge of methods for science teaching through his use of the internet to support classroom instruction. On multiple occasions Hugh discussed how he strives to engage his students in the practices of science through interactive work and class discussions. Hugh also encouraged his students to cite evidence from websites to support their scientific explanations. To Hugh, collaboration and inquiry-based instructional practices are essential features of science teaching and learning. Hugh also believed that to teach science, teachers need to offer their students choices and hold them responsible for their own learning. By allowing his students to use the internet, Hugh was able to "make sure that concepts are being introduced that students are supposed to know in 7th grade, but sort of guide them and give them … as much free choice and own responsibility for their learning as possible" (HI2.13).

Hugh recognized that his knowledge of methods for teaching with media also influenced his instructional decisions. Through observations of his class, I was able to see that although Hugh has his students explore the internet independently, he often provided a focus for their searching. This narrowed the students' searches, which Hugh felt was necessary for his students as they used the internet. The internet, as a media source, is vast and contains both accurate and inaccurate information. Hugh prepared his students to use the internet effectively by instructing them to consider who creates different websites and how to determine the authenticity of the information. He explicitly taught his students about the socially constructed nature of media before allowing his students to use the internet on their own. (HO2.P11). He also taught them how to use social bookmarking applications to reference each other's links and find out information searched by their classmates to reduce the amount of searching time they would need to do individually (HO4.P21). This was part of teaching his students how to use media. Hugh also showed his students different search engines that he preferred (e.g., Search Cube) and shared that he thought the search engines would help students search for information more efficiently (HO10.P43). Hugh noted that he wouldn't be comfortable with his students completely doing internet searches on their own because "They're still 7th graders. There's a lot of adults that can't do that" (HI2.383).

Lastly, Hugh's knowledge of methods for teaching science through media influenced his instructional decisions around student use of the internet. Hugh was aware that he could allow his students access to the internet without guidance. He knew his students would have some questions or issues with "scientific" information they found online. Therefore, he integrated teaching strategies *about* media with strategies for teaching science *through* the media. In the following excerpt, Hugh discusses an encounter with a student who questioned the scientific information he found online:

> I was with another student … and he found some pretty big inconsistencies in articles that he found online. One was Wikipedia, one was another article. He found a forum with people talking – another source of media – and he just didn't find a lot of consistency about cobra fangs, like how long they were and how they work. He found a drawing of them with giant fangs like a rattlesnake and then he read one where they had these little tiny fangs and he really didn't know what was going on. So in that case, we resorted to the cell phone and speaker and we called a guy … and he works with venomous snakes … about 70 miles from here. He was able to tell him exactly what he knew about cobras and the fangs from personal experience, so we put that into the [student's report] which was nice. (HI2.350)

In this example, Hugh leveraged the use of media to engage his student in a comparison of "scientific" information found on the internet. Hugh tasked his student with initially seeking the scientific information and then actively involved him in contacting a scientist for additional information to make a comparison between the sources of information. In this example, Hugh was facilitating student learning about scientific content and practices while using the internet. This required Hugh to draw on his knowledge of how to teach about science, how to teach about media, and how to teach science through media.

Knowledge of Science Content

The fifth knowledge influencing a science teacher's NIMM use is his or her knowledge of science content. The teachers discussed their knowledge of science content as including knowledge of one or both of the following elements:

- The substantive structures of science; and
- The syntactic structures of science

The notions of substantive and syntactic structures are aligned with Shulman's view of subject matter knowledge (SMK). As Abell summarizes, "substantive structures include the organization of concepts, facts, principles, and theories, whereas syntactic structure are the rules of evidence and proof used to generate and justify knowledge claims in the discipline" (Abell, 2007, p.1107).

Amanda drew on her knowledge of both the substantive and syntactic structures of science when she used a *Smithsonian Magazine* article titled "Return of the Sandpiper." Prior to using the article in class, Amanda engaged her students in a discussion of the ecological roles of species in an ecosystem. She talked about how different species have different reproductive rates and how that combined with the size of a species gene pool can limit a species' chance of survival. Amanda used the case of the sandpiper birds and horseshoe crabs as an example. She told her students "You're going to read an article about sandpipers and horseshoe crabs later" (AO8.P21).

After completing her discussion of the ecological roles of species, Amanda introduced the magazine article to her students. She gave her students a brief summary of the article and highlighted what the ornithologists and bird watchers were trying to learn about the sandpiper birds – why their populations were declining – in the Chesapeake Bay. Amanda then provided the following instructions for her students:

> What I want you to do is put yourself in the role of the researcher. I want you to tell me a null hypothesis for what's going on and an experimental hypothesis for what's going on with these birds. I want you to tell me how you would design an experiment to test those. You can use all the information in the article. By reading this article, you can see what these people are doing. If you were there, what questions would you have? How would you test your question? How would you get an idea if you hypothesis was upheld or refuted?" (AO8.P22)

Amanda demonstrated her knowledge of content, and specifically the substantive structures of science, through her understanding of the ecological relationships in an ecosystem and factors influencing species population size. Her use of sandpipers and horseshoe crabs demonstrated her ability to extrapolate her knowledge of ecological relationships to real life examples. Moreover, Amanda demonstrated her syntactic structures of science when she instructed her students to put themselves in the role of the researcher while reading the article. By having her students consider the evidence presented in the article and how they might alter the experimental design, Amanda demonstrated her understanding of how evidence is used to justify knowledge claims in science.

Although Amanda demonstrated an understanding of science, it is important to emphasize that a teacher's knowledge of the substantive and syntactic structures of science may differ from "the" substantive or syntactic structures of a discipline. A teacher develops his or her own subject matter knowledge base, which may contain complete, naïve, or inaccurate understandings of science content. Amanda's use of the sandpiper article highlighted her complete understanding of the substantive and syntactic structures of science. In contrast, Charlotte's use of the *Mythbusters* video was influenced by her complete understanding of the substantive structures of science, but also by her naïve understandings of the syntactic structures of science.

As previously discussed, Charlotte had her students complete a chart outlining the steps of the scientific method. She then showed her students brief excerpts from a *Mythbusters* episode while going through the chart with her students. Her goal was to engage her students in a discussion of how each step of the scientific method was demonstrated in the clip (CO3.P11). While Charlotte's knowledge of learners influenced her selection and use of the *Mythbusters* clip, her use was also influenced by her naïve understanding of science content. While the scientific method presented as a series of steps for doing science is often used in science classrooms, it has widely been accepted as a naïve and limited representation of how science is actually done. Charlotte engaged her students in a discussion of independent and dependent variables, controls, and experimental design, thereby indicating her knowledge of substantive structures of science. However, by introducing the scientific method as "the" process for doing science, Charlotte presented a naïve representation of how science is done and highlighted her limited knowledge of the syntactic structures of science.

Knowledge of Media

The sixth knowledge influencing a science teacher's NIMM use is his or her knowledge of media. Knowledge of media is frequently cited as an essential component of instructional decision-making when the goal is media literacy education (Hobbs, 2008). However, no research has examined how a science teacher's knowledge of media influences his or her NIMM use. The three teachers in this study discussed or demonstrated the importance of knowledge of media in specifically driving their use of NIMM. The teachers discussed their knowledge of media as including knowledge of one or more of the following elements:

- The constructed nature of media; and
- How science is portrayed in media

Hugh's knowledge of media influenced his use of a YouTube video titled "Big Slip." In the twenty-five second video clip, a plastic slip and slide was oriented down a steep hill. A man is then shown sliding on the dampened slip and slide and landing in a baby pool several meters away. When Hugh used the video in his classroom, he told me that he wanted to have his students think like scientists and hopefully come to the conclusion that the video was impossible.

Hugh drew on his knowledge of the constructed nature of media to choose the clip and encourage his students to question its credibility. Hugh recognized the clip was scientifically improbable, but that its short length would increase the likelihood that his students would pay attention to the clip and task at hand:

> These 45 seconds, a minute and half, videos are like a new concept in the last 10 years. And that's right up middle school brain alley because it, first of all, tells you how long you have to go. If you have a video and you can see it's 90 seconds long, you'll watch the whole thing from beginning to end because that's no problem.… That's just what we expect now with these videos. It's so interesting. (HI2.214)

Hugh also felt the video would be well received by his students because the YouTube video was an "outlandish video", and was "attention grabbing" (HI2.240). However, Hugh also wanted his students to question the credibility of the video:

> So what I think is a really important thing with media is I'd like them to be really critical about it. I'd like them to look at it and say, well that might be true, but where is the evidence behind it and - I'm not saying they're going to go and spend weeks looking up the media and trying to find if it's valid or not, but I would hope that maybe they could like get in the mindset that these things aren't always what they seem to be. As somebody thinking with the scientific process we need to questions the validity of these findings. (HI2.237)

Hugh recognized from using the video that his students had little doubt as to the credibility of the video. He wanted to instill a culture of doubt into his students and drew on his own knowledge of the constructed nature of media to justify the use of the video for this purpose:

> H: You saw the one time we had the slip and slide video –

> R: Right.
>
> H: It's just so insane that it's gonna grab their attention. But it just brings up so many questions about whether or not that can be true. Can you really edit a video to do that? What about all the other trials and the person landing and all the piles of dead people before they got the landing right? And so all these things are like – there's a couple of things with that. One, it really does get them thinking like scientists and it's gonna take me a year I think before I get them to understand the culture of doubt of science. (HI2.125)

But Hugh also knew that different audiences would reflect on the video differently depending upon their background knowledge and understanding of the culture of doubt in science:

> It's a meaty concept and it is tough to look at something and doubt it and then look for empirical evidence and then validate it. But those are all so important and that's such a big picture, but doing things like that I think, um, you know, you had two or three [students] that were skeptical about [the clip] and everyone else just accepted it as fact that the person was launching a quarter mile. (HI2.135)

Hugh ultimately used the video to engage his students in a discussion of what scientists do. To do this, Hugh had to use his knowledge of how science is portrayed in media to determine how the video clip would be applicable to his students and his classroom. He showed the video twice; once to get the students engaged and a second time so students can process what was happening in the video clip. He then asked his students, "Does that [video] have anything to do with what scientists do?" (HO5.P25) Hugh took student comments and when a student referenced something in the film that made the other students doubt the clip's authenticity, Hugh showed the video again. Hugh asked his students if scientists doubt things. Hugh's conversation then transitioned to what scientists do, how the students were acting like scientists while watching and questioning the film, and whether the people in the film were behaving like scientists. Specifically, Hugh asked, "What are you doing that scientists do?" Hugh's students said they were questioning, experimenting, and communicating. Through his interactions with his students, Hugh demonstrated how he used his knowledge of how science is portrayed in media to choose and use the YouTube video in his classroom.

Interplay Among the Knowledges

In the previous sections, I used one descriptive example from a single teacher case to highlight the nuances of teacher knowledges that influence a science teachers' NIMM use. All of the supporting evidence came from interview and observation data and therefore were grounded in the data. There were certainly more examples from the larger data set that I could have used to highlight the influence of the six knowledges on science teachers NIMM use; however, I chose to highlight only one for conciseness of reporting.

While presenting only one example achieved the goal of conciseness, as seen in the highlighted examples, the distinction between individual knowledges was occasionally blurred. For example, when Hugh discussed his instructional decisions around the use of the internet, his use was discussed in light of a teacher's knowledge of pedagogy. However, Hugh also drew on his knowledge of content (what his students already knew and needed to know) and context (the course goals and objectives, and local relatedness of the topics students researched on the internet) when using the internet. In the examples provided, one could argue that any of those knowleges influenced Hugh's use of the internet in his classroom. It is difficult to parcel out individual knowledges because they are inevitably linked as illustrated by the links between all six knowledges in Figure 6-1. In the following paragraphs, I will discuss one episode of NIMM use for each teacher in light of the linked nature of the six knowledges.

Amanda and trade books. All six knowledges influenced Amanda's decision on whether or not to use trade books, which books to use, and how to use them in her classroom. In one class period, I observed Amanda using excerpts from five non-fiction trade books (Rachel Carson's *Silent Spring,* Aldo Leopold's *A Sand County Almanac,* E. O. Wilson's *The Diversity of Life,* Archie Carr's *The Windward Road* and Marjory Stoneman Douglas' *The Everglades: River of Grass).* She introduced the books as significant contributions to environmental science and instructed her students to use a jigsaw activity to familiarize themselves with each of the books. In the jigsaw activity, student groups read one of the excerpts, summarized the excerpt, and then shared the information with other groups responsible for the other readings.

Immediately after I observed Amanda using the five trade books, I emailed to ask her what prompted her choice to use the books. Her response was as follows:

> The five environmental readings all touched on major topics in the curriculum: Carson: pesticide use and the case against DDT; Leopold: ecosystem connections, sustainability and environmental ethics; Wilson: the importance of biodiversity; Carr: how species become endangered (due to human impact) and the ethics involved; Douglas: the impact of making major changes to an ecosystem without adequate study (effect of man on natural systems). The curriculum does not require any books in particular, but does address all of those topics (and they would do well to know Carson, Leopold and Wilson due to their impact on environmental science as a whole)…. Both Rachel Carson's *Silent Spring* and Aldo Leopold's *A Sand County Almanac* were used in the environmental science text as examples of groundbreaking books … and are referred to often throughout numerous sections of the text. E. O. Wilson is also referred to often in the text, and I felt that his reading would give them a "handle" on the importance of biodiversity. Archie Carr (*The Windward Road*) and Marjory Stoneman Douglas (*The Everglades: River of Grass*) were both influential Florida environmental authors (whose writings and work spurred an interest in major environmental "causes"). I wanted to give them a "local angle" as well…. The standards in the [environmental science] curriculum deal with things that these [books] deal with … the five books were simply vehicles, if you will, to carry that information. (email communication, 9/29/09)

Her response indicated that her knowledge of what students needed to know in the environmental science curriculum, how those five trade books addressed those topics in the curriculum, their contribution to the line of evidence used to justify current environmental policy, and the “local angle” the books offered drove her choice to select those five books. She also indicated that outside of the environmental science curriculum, she felt her students would benefit from knowing about the authors more generally because of their impact on environmental science and that the trade books were vehicles for carrying information. This one email communication illustrates how Amanda’s combined knowledge of context (the course objectives and curricular connections to local events/authors), content (how/how well the environmental topics are illustrated in the trade books and their contribution to the development of scientific knowledge in environmental science), self (her role as a teacher to develop awareness) and media (the constructed nature of media) influenced her selection of the books.

In my later conversations with Amanda, it was also clear that her combined knowledge of her learners, knowledge of media, and knowledge of pedagogy influenced her selection and use of the trade books. Amanda felt her students were an appropriate audience for the trade books and that the jigsaw activity was essential to their comprehension of the excerpts. She informally discussed with me during my observation of the trade book episode that she was excited that her students “got it.” She remarked that she was so excited to have a class of high ability students because she could use the jigsaw activity and “more difficult” print materials with them (AO3.P11). However, she recognized that the author of media influences the message being delivered and that her learners needed support to understand her purpose for using the trade books and support on how to read the excerpts. The following is a discussion which highlights the role of her knowledge of media and of learners in driving her choice to use one of the trade books:

> A: I tried to preface, for example, the Marjorie Stoneman Douglass book. This was written a long time ago because she talks about negros and she talks about, you know, she was in a different world and the social setting was much different. And she talks about things in a way that you don't talk about them today so you really have to preface it with that and make sure that they understand and hopefully are not offended, but just realize that they're dealing with a period piece. But that it was important because she raised awareness of the Everglades so much and it was considered a seminal book in terms of beginning the process of taking care of the Everglades as an ecosystem. So if you have something like that that's an important work, then you have to make sure the students understand why you're sharing it with them and that it's an important work too I think.
>
> R: So some of the messages in it may not be relevant to today but the other messages are?
>
> A: Right. Exactly. And they have to be able to sort them out and then understand that. And sometimes it takes some work with them to get them to that point but I think with these kids at least – and I don't think I would give that, necessarily, to a general class because it's got a lot of dialect. It's got – it's not the sort of book that they would necessarily "get." You know what I mean? And if I'm going to give them something I want them to "get" it and I want them to understand why I'm giving it to them and why it's important and why they should care. (AI2.206)

To offer the reading support, Amanda's knowledge of pedagogy combined with her knowledge of learners and media influenced her choice to use the jigsaw activity with the trade books. She felt the jigsaw activity was an essential component to student comprehension of the trade book excerpts:

> You can't give them something in isolation and expect them to get it. You have to prepare them for it. You have to have something to make them pay attention to it and you have to follow up on it. That's true of labs. That's true of anything. I mean, really you want to do everything you can to get it into their schema and they hate that word because [another teacher] uses it too. I say you know, it's going to get into your scheme a lot better. They go don't tell me about my schema. [laughs]. (AI2.339)

Charlotte and comic strips. All six knowledges also influenced Charlotte's decision on whether or not to use comic strips, which comic strip to use, and how to use it in her classroom. In one class period, I observed Charlotte using a comic strip from the local newspaper to assess student's prior knowledge of the atomic model. Charlotte distributed a worksheet to the students at the start of class requiring students to agree or disagree with a series of statements that embedded the recent chapter vocabulary. At the bottom of the worksheet was a photocopied comic strip about atoms. The comic strip inaccurately used the word "crouton" in place of "neutron." The instructions on the worksheet were as follows, "Read the following comic strip. Based on your knowledge about matter, explain what is wrong in this comic strip. Circle what is a fact and cross out what is fiction – what is a mistake" (CO8.P24). That week in Charlotte's class was the start of a new chapter on chemistry, so the comic strip was used to assess students' prior knowledge. Some students had already completed their chapter vocabulary and thereby had more recent experience with the words proton, neutrons, and electrons. Other students relied on what they learned in previous years to complete the worksheet. Once students had time to complete the worksheet, Charlotte had three students act out the three characters' roles in the comic strip before discussing the mistake in the comic strip. She then told her students that they were going to learn the charge of the subatomic particles in future lessons.

When I asked Charlotte about her decision to use comic strips, she talked about her own personal preference for using newspapers. She said, "I can't move through my day without reading the newspaper" (CI1.56). She also mentioned that she chose to use comic strips because they are relevant to her students:

> It's silly and they love it. Sixth graders are really silly and I think that you also gain their – they like you – they want to learn because it's cool – oh – you're using cartoons. So anything that they use on a daily basis and they're related to, you're gonna get them easier I think." (CI1.510)

When asked how she chose which comic strip to use, she talked about her knowledge of context and media influencing her choice:

> Now every Sunday I read the newspaper and I'm looking for comic strips to see if I can get something for them. I was lucky on that one. I really liked it, you know. Like it went along with that benchmark along with the comic strip…. I usually try like for the movies or videos that I choose, I try to browse and browse which one is the best one, short, that it has all the information, that it's precise, concise, you know, not too long. (CI2.40)

In this excerpt Charlotte discussed how she used her knowledge of context (the course objectives or benchmarks) and media (the length of the media) to choose which comic strip to use in her classroom.

It was Charlotte's use of her knowledge of self and her learners as demonstrated in the prior quotes that influenced her choice to use comic strips, but it was her knowledge of context and media that influenced her choice of which comic strip to use. However, it was these knowledges combined with her knowledge of pedagogy and content that influenced how she used the comic strip in the classroom. The following is an excerpt from my discussion with Charlotte about her comic strip use:

> R: So when you're choosing the [comic strip] from the [local newspaper], how do you choose that? Is it because [the comic strip] is there? Do you have a choice of [comic strips]?
>
> C: No. I just read but I'm always looking for my curriculum and how to tie it up. Like this cartoon. Like I went to a training last summer and they brought up the cartoons and I don't consider myself funny at all [laughs]. And I'm like, oh, cartoons. So I would throw away right away the cartoon section from the newspaper. But after that training … every single Sunday I check. I go through all the cartoons quickly to see if there's any. And there's the coolest thing. How in the world? I never thought that and this one – the cartoons for the atoms – this one I use as a warm up too but they had to correct and find and they read it, we had fun, and then I'm like

> – now you have to, there are some mistakes, so what are the mistakes. And it was at the beginning of the chapter, of the matter – really simple. And I was surprised because right away I knew they had already read. That they were already aware of protons, neutrons, electrons. They knew the mistakes so then I just have to move on.
>
> R: So it helped you know what their prior knowledge was?
>
> C: Exactly. Yes. (CI1.75)

In this one dialogue, Charlotte discussed how she used the comic strip to assess her students' prior knowledge by asking them to identify the incorrect scientific statements in the comic strip. This required Charlotte to know the substantive structures of science content in that she understood subatomic molecules (knowledge of content). She also used her knowledge of pedagogy to determine how she could use the comic strip to assess student prior knowledge.

Hugh and newspapers. All six knowledges also influenced Hugh's decision on whether or not to use newspaper articles, which article to use, and how to use it in his classroom. In one class period, I observed Hugh using a local newspaper article on Cuban tree frogs with his students. When the students entered Hugh's classroom and started up their computers, the online agenda prompted them to follow a link to the newspaper article online. The second task posted on the online agenda was to make a list of physical adaptations for Cuban tree frogs in their notes. When I entered the classroom that day, Hugh explained that over the previous few days, students brought in living tree frogs – some Cuban and some green tree frogs. He wanted his students to read about the Cuban tree frog through an online article, listen to a video of the noise it makes, and then measure the jumping distance of the tree frogs brought to class and compare them to their own jumping distances. Once the data was collected, Hugh said the goal for the lesson was to have students write a scientific report on the difference between them and the frogs in terms of physical and behavior adaptations (HO11.P47).

In deciding whether or not to use newspaper articles like the Cuban tree frog article, Hugh said he makes a conscious decision to teach his students to think critically rather than to prepare them solely for state standardized tests:

> Do I teach them on the surface, use a textbook, and prepare them for FCAT? Or do I teach them to think like scientists? People would say – well, you can do both. And actually, I'm not even sure you can do that. I think you can give them the culture of doubt [and] teach them the scientific process, but I don't think it prepares them really well for answering straight-forward questions that really aren't correct, but you have to answer them correct anyway. It's weird. (HI2.269)

Hugh felt newspaper articles were an ideal vehicle for preparing his students to think critically, but not necessarily ideal for preparing test-takers. However, Hugh defended his choice to use newspapers because he thinks "the job of the teacher is to provide [students] with those sorts of things. It's kind of like that's how you coach them" (HI2.313). He also believed that the reading abilities of his students matched the reading level of the intended audience of newspaper articles making them an ideal resource in his classroom:

> Interestingly enough, things written in like the [local newspaper], for example, are written to such a general audience that middle school is perfectly fine with it. I look at the words and the way that it's written – there's nothing really, really hard about it. I think it's easier than the textbook! (HI2.191)

Although Hugh's knowledge of context (in terms of standardized testing requirements) clearly factored into his instructional decision-making, his knowledge of self (in terms of his role as a teacher to develop critical thinkers and coach his students), his learners (students' reading levels), and media (in terms of the intended audience of media) took precedent in his choice to use newspapers.

In deciding which newspaper article to use, Hugh's knowledge of his content, context, and media all influenced this instructional decision. When I asked Hugh why he chose the Cuban tree frog article, he mentioned in an email communication that the article discussed how the physical and behavioral adaptations of Cuban tree frogs made them an invasive species in our local area, which was causing the decline of native green tree frogs. Because his curriculum focus at that point in time was on physical and behavioral adaptations, the information in the article was linked to the course topics. Understanding the difference between behavioral and physical adaptations and how different frogs illustrated those concepts required Hugh to use his knowledge of substantive science structures (knowledge of content). In his decision to use an experiment to compare frog and student jumping distances alongside the value of adaptations, Hugh used his knowledge of how lines of evidence justify knowledge claims in science. In this aspect, Hugh used his knowledge of syntactic science structures (knowledge of content). Also, Hugh said, "The article was short, easy to understand, and relatively local." This further illustrated the influence of his knowledge of both media and content on his instructional decisions.

Lastly, Hugh's knowledge of his pedagogy, self, and context drove his instructional decisions on how to use the newspaper article in his classroom. Because Hugh's classroom had a strong online presence, accessing the article from a link on his class agenda was a frequent pedagogical strategy of Hugh's. However, during my observation of Hugh's newspaper use, I noticed that Hugh's students did a considerable amount of collaborative work and Hugh appeared to function as a secondary level of support for his students while they read the newspaper article. In fact, Hugh said to his students,

> If you ever find something that doesn't make sense, then find me. I am your coach. Education is different now. You have answers right in front of you at your finger tips. I am your coach and will help you if you get stuck. But you have access to a lot of stuff now. (HO11.P48)

In this episode, Hugh had his students engage with newspapers independently with a focus, but then also engaged them in conversations with their peers about the physical and behavioral adaptations of tree frogs. This combination of strategies used by Hugh demonstrated the influence of knowledge of pedagogy on instructional decisions. The point in Hugh's classroom was not to learn about tree frogs, specifically, but to explore real life examples of adaptations. The comparison activity between humans and frogs following reading the article brought the local angle of the newspaper article to life. This illustrated how Hugh's knowledge of context, mixed with his knowledge of pedagogy and self created an episode of newspaper use in his classroom.

The Role of Prior Experience in Driving Knowledges

As seen in Figure 6-1, prior experiences, which included both prior instructional and non-instructional experiences, were found to influence the development of the six knowledges previously discussed. Prior teaching experiences, professional development, collaboration with peers, and personal experiences were mentioned by the teachers as impacting one or more of their knowledges.

For example, Amanda spoke of the impact of her personal experience as a science writer on her knowledge of how media is created, edited, and ultimately presented to the public. Amanda also discussed how her prior professional development experiences such training in reading comprehension strategies drove her knowledge of how to use print media in the classroom. Her collaborations with peers also drove her knowledge of her context such as in the case of her collaborations with the economics teacher when she used *Tragedy of the Commons* and her collaborations with the technology coordinator to access and use the internet with her students.

Similarly, Hugh spoke of how his prior teaching and personal experiences drove his knowledge of self and pedagogy. His personal experiences as a cross country coach and experience as an elementary teacher drove how he perceived his role as a teacher. Collaboration with his peers also drove Hugh's knowledge of how to diversity his pedagogical practices and access media (context).

For Charlotte, professional development and prior personal experiences were the major factors driving her knowledges. Professional development on the use of reading comprehension strategies drove her knowledge of pedagogy and learners, while her personal subscriptions to newspapers and magazines drove her knowledge of media, context, and self.

While prior experiences were mentioned by the teachers to influence one or more of their six knowledges, the extent to which they influence the knowledges or the nature of that influence was not explored in this study. Therefore the model only claims that a relationship between prior experiences and the six knowlegdges exists. No claims can be made about the relationship between individual knowledges and types of prior experiences or types of prior experiences and the collective knowledges.

Summary

According to Glaser and Strauss (as discussed in Corbin & Strauss, 2008), theories may be substantive, middle-range, or formal. Substantive theories are those derived within a specific context and under specific conditions. Middle range and formal theories, on the other hand, focus on multiple cases and investigations of broader concepts developed as part of an initial substantive theory. This study attempts to develop a substantive theory to describe the factors influencing a science teachers NIMM use by considering the three teacher cases as one collective substantive area.

My research has shown that teachers have ideas about what media can do for them. Those ideas are influenced by their personal ideologies and the ideas they hold about media. They are also influenced by the perceived priorities of their context and the content discipline in which they work. As a framework in which these factors are interdependent and interact in a way to provide a profile of a NIMM user, the Six Knowledges model seeks to provide an explanatory framework for science teachers' NIMM use.

For explanatory purposes it was necessary in this report to identify and delineate individual knowledges; however, as previously stated and shown in Figure 6-1, all six knowledges are interdependent, each contributing to a unique profile of NIMM use when combined. The three episodes discussed as examples of the interplay between knowledges were chosen because, through observations or discussions with teachers, the six knowledges were best illustrated through those examples.

The influence of the six knowledges may not have been explicitly articulated by the teachers; however, all were present in each episode of teacher's NIMM use. Additionally, prolonged engagement in the teachers' classrooms allowed me to observe multiple instances of NIMM use over time. It should be noted that the model presented is based both upon interviews with the teachers and upon classroom observations, which by nature are based on my own interpretation of what was happening in the classroom. And while it is true that in some episodes of NIMM use, the interplay between two or three knowledges was emphasized more in a particular interview transcript or classroom observation than the interplay between other knowledges, over the course of the entire study, evidence suggested that each episode was influenced by the interplay between all six of the knowledges.

I artificially parceled out the knowledges to discuss each one individually, but it cannot be emphasized enough that my study found that the six knowledges work together as a whole to influence NIMM use. They should be thought of as a collection rather than as individual and then overlapping pieces. They work together in synergy. This interplay between the knowledges is not represented by the use of overlapping diagrams as presented in some teacher knowledge models like PCK (Abell, 2007) or TPCK (Mishra & Koehler, 2006), but rather as an interconnected network of knowledges. While overlapping diagrams show the individual components and then overlapping nature of teacher knowledge, I think it misrepresents what I found in my study.

Also, no claims are made by Figure 6-1 as to which knowledge influenced a teacher's NIMM use the most. One or more knowledges may have been emphasized for parts of what I called instructional decisions. For example, a teacher may have drawn more on their knowledge of content when initially selecting the media, but more on their pedagogical knowledge when actually using it in the classroom. To understand the full inclinations and capacity of science teachers' NIMM use, I did not take a reductionist view to parcel out when or to what extent knowledges were used specifically in the selection or use stages of instructional decision-making. The theory outlined in Figure 6-1 avoids such a reductionist view and rather considers teachers' NIMM use as being influenced by the interplay among all six knowledges. Each knowledge plays a significant role in influencing a science teacher's NIMM use. All six knowledges work synergistically and at varying levels to influence science teachers' use of NIMM.

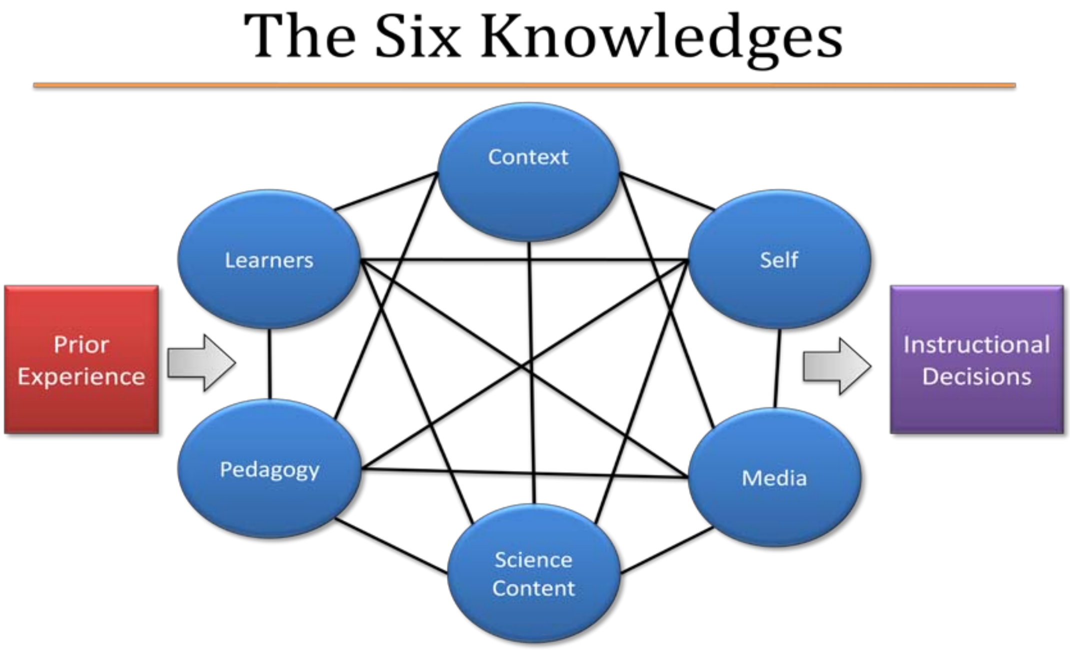

Figure 6-1. The six knowledges framework

CHAPTER 7
DISCUSSION

Overview of Study

Although results of previous surveys suggest that science teachers are using mass media, and in some cases NIMM (or mass media that was not initially intended to be used in the classroom), little is known about how or why science teachers are using the media. When studies of science teachers' use of NIMM have been conducted, they have focused on either teachers' use of one type of media such as newspapers (e.g., Jarman & McClune, 2002), consisted of researcher interventions on teacher or student evaluation of media texts (e.g., Klemm, 2001), involved researcher selection of media texts for classrooms use (e.g., Fang, Lamme, Pringle, et al., 2008), or have relied exclusively on teachers' reported use of NIMM (e.g., Kachan, Guilbert, & Bisanz, 2006). Until this study, naturalistic research on the diverse possible uses of NIMM by secondary science teachers has not been attempted. Prior research has not considered how and why science teachers select NIMM for classroom use, or how their reported use compares with their actual use. While considering the many forms of NIMM a teacher may use and the variety of ways they use them is a considerable undertaking, without such an attempt our understanding of science classroom use of NIMM and how to best support teachers in their efforts to use NIMM would remain unknown.

The purpose of this study was to explore how and why secondary science teachers use NIMM. This study attempted to investigate the factors influencing science teachers' use of NIMM in order to deepen our understanding of the complex nature of science teaching and instructional decision-making. It is my goal that this research will open conversations in the science education community as to what the use of NIMM in the science classroom looks like and what that use means for teachers and students.

To understand how and why science teachers use NIMM in their science classrooms, as well as the factors influencing teachers' instructional decision-making around the use of NIMM, grounded theory methods were employed in this study. An initial set of six secondary science teachers from one K-12 university research school participated in the study and were formally interviewed at the beginning of the study to determine a subset of teachers to follow for the remainder of the study. The subset of three teachers who were classified as frequent users of NIMM were observed for nine weeks and participated in one additional formal interview.

The goal of the interviews and observations was to elucidate the complex nature of science teachers' instructional practices around the use of NIMM. Beginning with the initial set of six teachers, data collection and analysis occurred simultaneously and in a cyclical process. Ongoing member checks, peer debriefing, and detailed logs served to ensure the trustworthiness of data collection and analysis. Identification and comparisons of themes and patterns in the data were used to develop an initial understanding of secondary science teachers' NIMM use.

There were several general findings. First, I found that secondary science teachers use a variety of NIMM types and in a variety of ways. Teachers select NIMM based on specific selection criteria, and several factors serve as supports and barriers to science teachers' NIMM use. Also, the affordances of NIMM, or the actions that media make available to teachers in the secondary science classroom, are influenced both by a science teacher's reasons for using the media as well as the strategies they use to interact with that media. I also found that teachers' stated use of NIMM was, for the most part, consistent with their actual use of media.

In addition to these general findings, comparisons of three teachers' practices, while they were each rich and unique cases, resulted in the development of theory to explain the factors influencing a science teachers' use of NIMM. Secondary science teachers draw on six different knowledges (knowledge of learners, context, self, content, pedagogy, and media) which work together synergistically, to make instructional decisions around their use of NIMM. These six knowledges are in turn influenced by the teacher's prior professional and personal experiences.

In this chapter, I discuss how the findings from my study extend the existing literature base on secondary science classroom use of NIMM and science teachers' instructional-decision making. I then present implications for science teacher education and for research in media literacy education and science education.

Secondary Science Classroom Use of NIMM

Types of NIMM Used

Prior survey research suggested that teachers across the curriculum, and science teachers particularly, use newspapers, magazines, television shows, films, radio, and the internet as classroom instructional resources (Kachan, Guilbert, & Bisanz, 2006; Yates, 2002). While teachers in this study both reported and were observed using most of the before-mentioned media types, no teachers were observed using radio broadcasts in the science classroom. Despite suggestions by Piecka, Studnicki, and Zuckerman-Parker (2008) that investigations of radio (and specifically podcast use) should be pursued, the lack of science teacher use of this type of media leaves a researcher to wonder how and in which contexts such research should be pursued.

In contrast, despite widespread suggestions for how to use *non-instructional* television shows, films, trade books, and videogames in anecdotal and other practitioner-based articles (Broemmel & Rearden, 2006; Dubeck, 1993; Ensminger; 1990; Fredericks, 2003; Pringle & Lamme, 2005), prior empirical research has neglected to examine science teachers' selection and actual classroom use of these *non-instructional* media types. All six teachers in this study reported using one or more these types of NIMM, thereby expanding our understanding of teachers' diverse media selection and use patterns. During my observations, I noticed that while each of the teachers used a variety of media types, they each appeared to favor one type of media. This "teacher preference" has not otherwise been noted in the literature.

Science Topics Teachers Address through NIMM

In their study of science teachers' newspaper use, Jarman and McClune (2002) found that science teachers used newspapers primarily to explore environmental, human biology, health, or genetics related themes. Similarly, Wellington's (1991) content analysis of science-related news articles revealed that most news articles are highly "issue-based" covering topics of current concern, and focus primarily on the biological sciences. However, outside of newspaper use, prior research has not examined the relationship between NIMM use and science topics. Because this study was open to more types of NIMM beyond newspapers, I was unsure what correlations, if any, I might find between the topics teachers explore through NIMM, the types of media they use, and the content covered in their courses. This study found that no patterns existed between these variables. The teachers both reported and used media to cover topics in life and environmental, physical, chemical, earth, and space science as well as topics related to the applications of science and controversial issues. The diverse coverage of science topics in NIMM indicates the pervasive possibility for using NIMM in the science classroom.

Frequency of Teachers' NIMM Use

The science teachers in this study reported and were observed using NIMM at least once each instructional unit, which supports earlier research by Kachan and colleagues (2006) who found that 74% of the science teachers in their study classified themselves as "frequent" users of NIMM. This research also supports findings of Kachan and colleagues in that no distinct patterns were found between teachers' frequency of use and the type of media they used. This research is distinct in that, unlike Kachan and colleagues, it examined three teachers' actual use of NIMM in addition to their reported use, thereby adding a layer of examination that provides additional support for claims on science teachers' NIMM use.

Strategies for Using NIMM

Prior research on how teachers use NIMM is also missing. Research interventions such as Perales-Palaciosa & Vilchez-Gonzalezb (2005) engaged students in the identification of fictional science content in a television series; Dhingra (2003) asked students to critically evaluate different television genres and their portrayal of science; and Watts, Alsop, Zyibersztajn, and de Silva (1997) examined how students approached creating a television program. However, no one study has investigated teachers' strategies for using NIMM, nor has strategies for use been investigated in an actual science classroom in the absence of interventions. Some research in education, more generally, has gone so far as to offer pedagogical suggestions for how to integrate off-the-shelf video games in the classroom. Such suggestions are synonymous with suggestions made by scholars of media literacy education suggestions who contend that teachers should help students “focus on analysis of game events and how they are similar or different from the ‘real’ content” (Charsky & Mims, 2008, p.41).

While these suggestions exist, classroom observations of this critical evaluation strategy are missing in the literature. This study found that science teachers use both student-centered and teacher-directed strategies when using NIMM in the classroom. Teachers engaged students with media by asking them to identify fact and fiction, create media, and critically evaluate media as discussed in previous literature. This research expands on prior findings in that it looked at these strategies as they naturally occurred from a teacher’s perspective. The strategies were not designed or implemented by researchers with specific ideas on how to interact with the media. As seen in this study, science teachers draw on a broad range of instructional strategies to interact with NIMM.

Choosing NIMM for the Classroom

While not the original foci of the research, how teachers choose NIMM, the supports they draw upon to use NIMM, and the barriers to their use of NIMM were ongoing themes of this research study. For example, the teachers in this study used specific selection criteria when choosing NIMM for their classrooms. Similar to the studies by Halkia (2003), Halkia & Mantzouridis (2005), and Jarman & McClune (2002), the teachers in this study chose print NIMM (i.e., trade books, newspapers, and magazines) based upon its narrative style and non-technical presentation of science. The teachers also chose media that matched students’ reading levels or interests. Amanda was especially cognizant of the match between presentation style and student abilities as demonstrated in her repeated discussion of student reading levels. Teachers also chose media for its relatedness to the content being covered in class. All six teachers noted this essential link, which echoes the content connection desire of the teachers in Fang and colleagues' (2008) trade book study.

The findings of this study differed from prior research in that although teachers considered how well the presentation style of media paralleled students' interests during the selection process, the type of media teachers chose was based upon their own personal preferences for specific types of media. For example, Hugh personally preferred to use digital media as a source of scientific information and pleasure. Therefore, Hugh primarily used digital media in his classroom. However, the video, article, or videogame Hugh chose for his students to access or use in his classroom was dependent upon how interested he felt his students would be in that piece of media or how well matched that piece of media would be to his students' abilities. Selection on the type of media began with the teachers' interests; however, the selection of a specific piece of media within a collection of the same type was made in consideration of student interests and abilities.

Supports for Using NIMM

Previous research has suggested that in order to make new technology or digital instructional resources successful platforms for learning in the science classroom, training on how to use such resources is required (Kirriemuir & McFarlane, 2006). While NIMM use was not found to require formal teacher training in this study, prior experience was found to influence a teacher's digital media use. Although there has been little to no prior discussion on the role of supports for using NIMM resources beyond digital media types, in this study the role of other teachers and professional development in supporting science teachers' use of NIMM, more generally, cannot be understated.

Professional development opportunities and other teachers were considered invaluable supports to science teachers' NIMM use by the participants in this study. For example, Amanda and Charlotte drew on their professional development activities around reading comprehension strategies and print media to support their NIMM use. Also, all six teachers noted other teachers as supporting their NIMM use. Science teachers relied on the support of other teachers either by discussing ideas on the types of NIMM they could use or ways to use specific NIMM, such as in the case of Hugh's collaboration with the school's technology specialist.

Barriers to Using NIMM

Previous research that has explored barriers to using mass media have found that teachers cite a lack of materials, time, training, administrative and parental support, and limited student abilities as common constraints to incorporating mass media in the classroom (Hobbs, 2003; Hobbs, 2005; Kubey, 2004; Paradise, 2004; Yates, 2002). This study echoes previous findings in that access, time, and limited student abilities constrain a science teachers' use of NIMM. This study expands on previous research in that it reclassified the types of barriers science teachers encounter.

Interviews and observations revealed that using media requires being aware of one's surroundings as much as it requires an awareness of the media itself. Both external features of one's surroundings (i.e., access and learner abilities) and internal features of media (i.e., its socially constructed nature) can constrain a science teacher's NIMM use.

As an example of an external factor, Hobbs (2003) found that media use was seen by teachers as a “subversive” (p.104) instructional practice. Teachers in Hobbs’ studies were concerned with how administrators and parents would view their classroom media use because media is often deemed a controversial source of information. Teachers felt they needed to "fly below the radar" if they used media in the classroom. In contrast, the teachers in this study did not feel they needed to be subversive at all. Although external barriers existed, the teachers in this study were united in determining ways to incorporate NIMM. As a result of the school’s technology and reading initiatives, the teachers collectively found NIMM to be a useful resource for science teaching and learning and overcame the barriers often presented by increased requirements associated with such initiatives.

This study also deviates from earlier research in that while teachers considered students’ abilities as compared to the NIMM they used, the teachers in this study did not feel constrained by their students’ ability to interact with NIMM. As discussed in the teachers’ perceptions of their students’ media literacy skills, on average, the teachers believed their students had at least a basic ability to read and interpret media messages. Even in Charlotte’s classroom where the teacher had less confidence in her students’ abilities, I observed ongoing use of NIMM. While something may be said about her limited use relative to Hugh or Amanda, her perceptions of her students’ limited media literacy skills did not impede her media use to the level reported by prior research. Charlotte felt her use of NIMM was essential to her science classroom despite her students’ limited abilities.

Student Impact

No previous research has looked at the potential impacts of science teachers' NIMM use on student inclinations to use media or on student attitudes or learning as a result of teacher media use. While this study did not attempt to examine students' use of NIMM or students' media literacy skills, in their discussion of NIMM use, teachers acknowledged the potential impact of using NIMM on their students. Just as Daniels (2001) discussed the impact of teachers' pedagogical choices to the development of student conceptual knowledge, the teachers in this study recognized the impact of their instructional decisions on student learning and their students' future use of NIMM. Three teachers discussed how their use either empowered students or encouraged their students to use NIMM in the future.

Affordances of NIMM

In the three prior research studies that have looked at science teachers' reported or actual NIMM use in the absence of researcher intervention, NIMM was used to stimulate student interest in a science topic, provide real-life connections to science, provide students access to technology, develop student critical thinking ability, reinforce literacy instruction, and deliver science content (Jarman & McClune, 2002; Kachan, Guilbert, & Bisanz, 2006; Wallace, 2004). In these studies, this list of rationales was stated in terms of how teachers perceived the *potential* of NIMM resources. Wallace's (2004) study on science teachers' use of the internet was the only study that investigated how the potential of NIMM actually materialized in science classrooms.

Wallace (2004) used the term *affordances* similar to the manner in which I have used it in this study. Wallace noted that she did not describe affordances of the internet as characteristics of the internet because "they are a product of the use of the [internet], not necessarily a designed feature" (p.476). So similar to my findings, affordances in Wallace's study depended on the resources teacher use, their purposes for using them, and the strategies they use to interact with the medium.

Wallace (2004) identified five affordances of the internet: boundaries, authority, stability, pedagogical context, and disciplinary context; and said that how a teacher chooses to engage with the internet determines how available or unavailable the five affordances are to a teacher. However, while Wallace only looked at teachers' use of the internet, a unique interactive form of media, this study investigated science teachers' use of a broad range of media types. When Bucy and Affe (2006) advanced the idea of affordances of internet use by defining an affordance as "the possible actions that the properties of a medium make available to users" (p.228), they argued that the dual nature of affordances, which depends on both the users and the medium, is a powerful one for new technologies "because it focuses on the interaction between technology and users" (p.229). Although prior research has looked at affordances in terms of technology and more contemporary 21st century instructional tools like the internet, this current study highlights that even instructional resources that may be considered "dated" by some such as newspapers or magazines or movies can contribute to the science classroom in unique ways, offering affordances to the science teacher that may not otherwise be available with other instructional resources.

Additionally, while Wallace (2004) and Bucy and Affe (2006) advanced the idea of affordances as being dependent upon the interaction between the user and medium, affordances are discussed as static entities that do not change unless the medium, or deliverer of the affordances, itself changes. Through examination of a teacher's purposes for using NIMM and the ways in which they use them, it became clear in this research that affordances, as previously considered, are not static entities, but are in fact dynamic.

In addition to finding that multiple types of media can yield similar affordances, this study found that one type of media yielded very different affordances depending on how the teacher used the medium in the classroom over time. For example, Amanda uses the local newspaper to illustrate local applications of concepts covered in class. She therefore used newspapers to illustrate real science (IRS). However, Amanda also had her students write their own opinion piece after reading editorials to solicit their own thoughts and to consider the application of science to their own lives. In this way she used newspapers to apply science to students' personal lives (ASP). While the medium used was the newspaper, different affordances of newspapers materialized as Amanda's strategy for using the medium changed.

It was also found the affordance of a medium can transition as teachers' purposes transition within one episode of media use. For example, Hugh used the internet as a tool for students to communicate their findings and report on their classroom experiments, thereby using the internet to emulate the style of scientists. However, at the same time, Hugh used the students' communications on the internet as a means for assessing student understanding of science (ASK) by evaluating the content and patterns of their communications. The medium and the activity did not change, but as Hugh's purposes for using the medium transitioned, the affordances of that medium also transitioned.

This research suggests that affordances can be used as a framework for looking at the unique possibilities NIMM makes available to science teachers as an instructional tool. However, if affordances are used as a framework for looking at science teachers' NIMM, the dynamic nature of affordances needs to be considered.

Teachers Stated Versus Actual Use

Self-reporting behaviors is a useful means of investigating what happens in a classroom in a very quick and easy manner. The challenge to self-reporting is that researchers relying on this method must consider whether teachers fairly represent themselves and their classroom behaviors. The discrepancy between teacher talk and teacher action has been widely investigated from traditional K-12 classrooms to medical school classrooms, and research cautions that additional measures of classroom practice (i.e., observations or student feedback) should be used to gain an accurate picture of a classroom (Alvermann, O'Brien, & Dillon, 1990; Hartman & Nelson, 1992; Hood & Rosenshie, 1978; King, Shumow & Lietz, 2001; Koziol & Burns, 1986).

Alternatively, Koziol and Burns (1986) caution from their review of literature that "the likelihood of making accurate determinations of teachers' classroom practices based upon observer reports is reduced when there are too few observations and when the instructional context for the observations is inconsistent or undefined" (p.205). In their observation of nine English teachers to determine if length of observations improved correlations between accuracy of teacher self-reporting and actual practice, Koziol and Burns found that when the focus of the self-reporting instrument (e.g., survey or interview) is focused on one particular area within the broader dimensions of teaching, teachers' accuracy of reporting is greater. However, they found no definitive information to conclude if length of observations improves correlations between teacher and observer claims.

Through observations of teacher practice, this study found that teachers used more media types and strategies for NIMM use than teachers initially reported. At the start of the study, the teachers were informed of my research focus. According to Koziol and Burns, this should have helped them tailor their discussions to their use of NIMM and therefore more accurately discuss their NIMM use. However, I found that it took observations of teacher practice to uncover the true diversity of teachers' NIMM uses. Unlike research that has compared teachers' self-reported inquiry practices and their actual practice (King, Shumow, & Lietz, 2001), in general, the teachers in my study *under*stated their instructional practices specific to their use of NIMM.

This is not to say that I believe the teachers were intentionally falsifying what happened in their classrooms or selectively omitted information during the interviews. Instead, I believe that the teachers may have lacked the reflective ability to talk about what they did or lack the means to accurately express their classroom behaviors. Additionally, the social desirability of responses may have influenced the accuracy of a teacher's self-reporting. As cautioned by Newfield (1980) who found a significant correlation between teachers' self-reports and observations of their practice but whose correlations "left something to be desired" (p.80), more inquiry needs to be done on what influences a teacher's self-reporting accuracy.

Teacher Knowledge and Instructional Decisions

Role of Teacher Knowledge in Decision-making

Several models of teacher knowledge and its influence on classroom practice have been proposed, extensively discussed, and researched. Models such as PCK, LPCK, TPCK, and even ICT-TPCK have sought to explain teachers' classroom practices and the knowledge needed to be an effective classroom teacher. While some of these models have been discussed in terms of general classroom theory (Shulman, 1986) or in the use of language (Love, 2009) or technology (Mishra & Koehler, 2006), an increasing number of studies have been conducted in the last decade as to the applicability of teacher knowledge models in the science classroom (e.g., Abell, 2007; Abell, 2008; Abell, Rogers, Hanuscin, et al., 2009; Gess-Newsome, 1999).

Despite differing definitions of what constitutes a teacher's knowledge base, all models include a knowledge of subject matter and a knowledge of learners; they recognize that teacher knowledge is subject specific; and they state that knowing how to teach in specific subject contexts is unique from a general knowledge of pedagogy, contexts, and learners (Angeli & Valanides, 2009). However, how researchers talk about teacher knowledge in terms of its individual components, how those components work together to make up a teachers' total knowledge base, and what influences or is influenced by teacher knowledge differs.

For example, Abell and colleagues (2009) say the following about the components of science teachers' pedagogical content knowledge, or PCK:

> According to the PCK framework, knowing science is a necessary, but not sufficient condition for teaching. Science teachers must also have knowledge about science learners, curriculum, instructional strategies, and assessment through which they transform their science knowledge into effective teaching and learning. These types of knowledge, or PCK, are filtered through a teacher's orientation to science teaching as they are put into action. (p.79)

Similarly, Lee and Luft (2008) and Sánchez and Valcárcel (1999) found that content, student knowledge, teaching strategies, and assessment influenced teacher instructional decision-making.

Gess-Newsome (1999) distinguished how researchers discussed PCK in terms of how the components of PCK work together to make up a teachers' total knowledge base. She identified previous research as falling into one of two discussions about science teacher's PCK. PCK was either integrative (in which individual components of a teacher's knowledge are individually drawn upon and add up to a teacher's total PCK) or transformative (in which individual components cannot be isolated but are collectively drawn upon during instruction).

Lastly, Abell (2008) says that "teachers not only possess PCK, they employ the components of PCK in an integrated fashion as they plan and carry out instruction" and that the varying views of PCK "shapes the questions researchers ask and the ways they design their studies" (p.1407). The transformation of individual types of knowledge makes a teacher's collective PCK viable for instruction.

This study echoed prior sentiments that teachers draw collectively on multiple knowledges to drive their instructional decisions. This study found that a teacher's collective knowledges influence future instructional decisions, and specifically their NIMM use. Additionally, more in line with the transformative model of PCK, individual components of teacher knowledge are identifiable, but exist in combination with other knowledges.

Like prior studies, this study found that knowledge of subject matter, knowledge of learners, knowledge of context, and knowledge of science pedagogy were integral to a teacher's instructional decision making around the use of NIMM. However, this study found that knowledge of self and knowledge of media were also important.

Knowledge of self resembled what Friedrichesen and Dana (2005) refer to as science teaching orientations, which considers the role of teacher beliefs and goals for teaching in driving instructional decisions. Friedrichsen and Dana talked about a teacher's "means" or "the purposeful selection and use of curricula, as well as instructional and assessment strategies" (p.228) as influencing and being influenced by secondary science teachers' teaching orientations, or their goals for science teaching. Similar to Friedrichsen and Dana, this study found a match between teachers' instructional goals and methods. This study differed, however, in that the prior research missed a discussion of how teachers' personal preferences influence their selection of instructional materials and how an understanding of those materials may or may not influence their use by teachers.

While Abell (2008) and others note that PCK considers multiple elements, including knowledge of instructional strategies, models such as Mishra and Koehler's TPCK, or technological pedagogical content knowledge (2006), contend that traditional PCK models fail to acknowledge the complexity of what it means to have knowledge of instructional strategies or materials. TPCK moves beyond PCK in that it says models of PCK make mention of teachers knowing about the instructional resources and materials available to them, but not necessarily knowing about how those resources are constructed or their limitations to and affordances for teaching. Technology educators see technology "as a tool invoked by its users to reconstruct the subject matter from the knowledge of the teacher into the content of instruction" (Angeli & Valanides, 2009, p.157), and the TPCK model recognizes that technology has its limitations and is uniquely situated as an educational tool with differing affordances for different environments. Teachers intending to use instructional resources such as technology, according to Mishra and Koehler, need to have knowledge of the resource's limitations and affordances to effectively integrate them in classroom instruction.

Similar to the current study, Lee and Luft (2008) in their attempt to elucidate the meaning and complex nature of PCK from the perspective of experienced science teachers, found that the teachers in their study specifically discussed a need for knowledge of resources in their teaching. According to Lee and Luft:

> Resources ultimately allowed these teachers to make their instruction relevant to their students, and provided instructional experiences that were outside the curriculum…. This suggests that knowledge of resources should be explored to determine whether it should be considered a component of PCK. (p.1361)

The teachers in Lee and Luft's study placed their knowledge of resources as equal in importance to their knowledge of teaching and assessment; they drew upon their knowledge of resources to determine what and how to teach; and they identified their knowledge of resources as a major factor in influencing how they organized their curriculum. Although Lee and Luft discussed resources in a limited sense as activities, materials, or locations teachers can reference to find materials and activities to use in the classroom, their recognition that resources play a more prominent role in teachers' instructional decision-making shows promise.

This study's finding that teachers draw on a knowledge of media construction (among other knowledges) to guide their selection and use of NIMM draws parallels to theories of teacher knowledge in technology education. This finding combined with the recent recognition of the prominence of knowledge of resources in science education research offers potential to add to the discussion of the types of knowledge science teachers use, how those knowledges interact, and the effect of those knowledges on instructional decision-making.

Role of Prior Experiences

My study extends the current literature base in that it describes the complexity of teacher practice as depending on the interplay among teacher knowledges. A teacher's knowledges work together, synergistically, to drive instructional decision-making. Specifically, it considers the prominent role of teacher knowledge of media. In this first aspect, it resembles discussions of TPCK, LPCK, and even more specific forms of TPCK such as ICT-TPCK (Angeli & Valanides, 2009).

My study also extends the current literature base by describing how a teacher's knowledges are situated within his or her larger teaching context and are driven by his or her own teaching and non-teaching prior experiences. The fact that prior experiences, such as professional development workshops or institutes, influence a teacher's instructional decision-making is documented (Supovitz & Turner, 2000). Moreover, it is also documented that both classroom and non-classroom experiences influence a science teacher's orientations and instructional practices (Friedrichsen & Dana, 2005; Hargreaves, 1984). But prior research in science education has failed to explicitly make the link between prior experiences and a teacher's knowledge base and their instructional decision-making around the use of resources such as NIMM explicit. The role of prior experiences in driving instructional decisions has been made, as has the role of prior experiences in building a teacher's knowledge base. However, a connection between the three, as proposed in the theory developed in this study, has not been addressed.

Implications

Implications for Perspectives on Scientific Literacy

Earlier in this manuscript, perspectives on scientific literacy were introduced and discussed in light of a more superordinate definition of Literacy. Definitions of scientific literacy are commonly classified as belonging to one of two visions. Vision I definitions of scientific literacy emphasize the domain-specific knowledge of science while Vision II definitions emphasize scientific skill sets and the personal relevance of science to citizens and sociopolitical decision-making.

If you assume that science teachers teach to develop the scientific literacy of students, then the teachers in this study demonstrated that their definition of scientific literacy not only addresses Vision I and Vision II definitions, but also includes a new perspective on scientific literacy that considers the vehicles that transfer scientific knowledge between individuals. As the results of this study highlighted, teachers draw upon their knowledge of media (among other knowledges) when choosing and using NIMM in the science classroom. Through conversations with the teachers and observations of teacher practice, teachers' views of scientific literacy expand on the prior two visions of scientific literacy in that their "new" perspective allows for the possibility to include media literacy in science education. In light of this new perspective, the following sections offer suggestions for how to include media literacy in science education and how this new perspective and the results of this study impact future research in media literacy and science education.

Implications for Teacher Education

The findings of this study agree with prior research that suggests knowledge of content is not enough to be an effective science teacher (Abell, 2007) or to understand the constructed nature of mass media (Alverman, 1990; Kolsto, 2006; Norris & Phillips, 2003). Teachers draw upon multiple knowledges to make instructional decisions around the use of NIMM. Therefore, if we plan to prepare effective and reflective science teachers, preservice and inservice teacher education programs need to address all of a teacher's knowledges. Furthermore, knowledge of media needs to be developed if teachers intend to use NIMM resources in their classroom. But how can we, as teacher educators, develop the multiple knowledges of our preservice and inservice teachers? And in an already compact teacher education curriculum, where does instruction on the constructed nature of media fit in science teacher education programs?

One possibility is to consider a model for science teacher education as suggested by Clough, Berg, and Olsen (2009). Their model includes a framework that helps science teachers understand the rationale for, interpret the findings of, and incorporate the suggestions of science education research into their practice. They suggest that research from a variety of fields can broaden the repertoire of strategies science teachers are aware of and can use in their classrooms. As indicated by the influence of professional development activities in disciplines outside of science education (such as reading comprehension and technology initiatives) on the science teachers in this study, exposing preservice and inservice teachers to practice-based research from a variety of disciplines (including media literacy education) may improve their reflection and practice, and specifically their NIMM use. However, science educators need to realize that the research they use needs to refrain from being an isolated set of findings, and needs to appreciate (and consider) the multi-faceted nature of teaching and the multiple factors that influence teachers' instructional decision-making.

Another possible suggestion for incorporating media literacy education in science teacher education programs is through the development and use of materials similar to Schneider and Krajcik's (2002) educative curriculum materials. Educative curriculum materials provide support for teachers on both how to use curriculum materials and on the content covered in those materials. Research by Lim, Norris, and Hedberg (2006) on the use of instructional videogames shows promise for such materials and accompanying professional development. They found that by scaffolding activities for teachers and students, including explicit instruction on software and its functionalities, the amount of work needed by teachers and students to *learn a game* before actually *learning from a game* was reduced. In a sense, Lim and colleagues advocated for media literacy education, which emphasizes increased reflection on the media rather than just on its content. Although Lim and colleagues researched materials and instruction around the use of instructional mass media, educative curriculum materials such as *Science Newswise* (Jarman & McClune, 2005), which is used to support science teachers' use of newspapers, is an educative curriculum resource around the use of another type of NIMM that may prove valuable to science educators.

Additionally, the results of this study revealed that inservice science teachers use a variety of NIMM types, strategies for interacting with NIMM in classrooms, and use NIMM for multiple affordances. The repertoire of teaching strategies preservice and inservice teachers draw from can be enhanced if teacher educators consider the results from this study as adding to the list of possible methods for teaching science.

Specifically, the episodes of NIMM use discussed in this study could be used by teacher educators to highlight the multiple ways science teachers can integrate media in the science classroom.

As indicated in this study, teachers under-reported their instructional diversity. This may have been due to a lack in their reflective abilities, their media literacy skills, or lack of a common language for talking about their media literacy skills and the influence of media literacy on their selection and use of NIMM. Materials and curricula such as the ones proposed have the potential to open lines of communication between teachers and teacher educators and provide them with a common language for talking about instructional practices. As Beyer, Delgado, Davis, and Krajcik (n.d.) warn, “promoting teachers’ learning through curriculum materials might best be supported if the materials are embedded within a professional development program aimed at helping teachers become more effective science instructors” (p.50). By encouraging preservice and inservice teachers to read and talk about their practice, teacher educators might be able to develop teachers’ reflective abilities and better understand the impact of their various knowledges on their instructional decision-making.

Implications for Research in Media Literacy Education

There are practical, methodological, and theoretical implications for research in media literacy education based upon the findings of this research. First, this study showed that science teachers are using NIMM in their classroom. Moreover, a science teacher’s knowledge of media was found to influence his or her instructional decisions around the use of NIMM. This presents an exciting challenge for media literacy education researchers. While prior research has looked at the use of mass media in language arts and social studies classrooms, little attention has been paid by the field to the use of mass media in science classrooms. A new set of questions emerges for media literacy education researchers as a result of this missing link. How can media literacy education be incorporated in science classrooms? What affect does media literacy education have on science teachers' understanding of media construction? What affect does media literacy education have on students' understanding of media construction and how science is represented in media?

Second, the results of this study have methodological implications for research in media literacy education. This study presented science teachers' media literacy as I interpreted or as the teachers reported based upon my own understanding of media literacy. Therefore, I cannot say that a teacher's media literacy skills, as reported in this study, are reflective of the sum total of their knowledge about media construction. While I would have liked to have a more precise means of determining a science teacher's media literacy skills, because there are currently no developed assessments to look at teachers' media knowledge more generally, or at *science* teachers' media knowledge, more specifically, I have accepted this as a limitation of my study. However, future research in media literacy education needs to move beyond discussions of theory and suggestions for teaching about media to practical suggestions for how to assess a teacher's (or student's) knowledge of media. There also needs to be some discussion as to how a teacher's media literacy can be assessed outside of in-depth interviews. Interviews proved to be limiting in this study because of the lack of common language around media literacy between the participants and the researcher. If teachers do not have a vocabulary for discussing media literacy, how do we assess their knowledge?

Third, the results of this study have theoretical implications for research in media literacy education. The media literacy framework that was described in chapter two (and used to evaluate the literature) was also tried as an analysis framework in this study. As discussed previously, the framework, while useful for delineating between research studies, was not useful as an analytical tool. Data consistently fell in multiple categories (i.e., authors and audiences AND messages and meanings) indicating an overlap between categories. Future research in media literacy education should look at new ways for analyzing what a teacher does in the classroom in terms of the tenets of media literacy education. In addition to exploring interventions that put media literacy education programs in science classrooms, media literacy educators need to explore new frameworks and analysis techniques that account for the complexity of teacher practice and student learning.

Implications for Research in Science Education

There are also practical, methodological, and theoretical implications for research in science education based on the findings of this research. Practical considerations include the American context of the study, the role of professional development on a teacher's knowledge, and the teacher's perceived impact of media on students.

First, this research has expanded upon prior studies by providing a lens into science classrooms in the United States. Prior research on teachers' mass media use was conducted in Canada (Kachan et al., 2006) and Northern Ireland (Jarman & McClune, 2002), but the current study provides new information into American teachers' NIMM use in an age of accountability and science education reform. More research needs to be done on American science teachers' NIMM use given the significant role NIMM played in the American science classrooms of this study.

This study also highlighted the complexity of teachers' practices, especially in regards to their instructional resource use. The research did not, however, anticipate prior professional development (PD) and non-classroom experiences to be recognized as such a significant factor in shaping teachers' knowledges. The results of this study suggest that we need to probe deeper about the specific elements of PD experiences that influence teachers' future actions, rather than accepting general statements about the merits of different PD designs. Future research needs to explore what it is about PD experiences that specifically prompt science teachers' use of NIMM and then needs to draw on those elements to help improve and sustain teacher use.

Moreover, the teachers in this study believed that their classroom use of NIMM impacted their students in terms of making them more critical thinkers and users of media, and encouraging their everyday use of mass media at home. This study did not explore the merits of these teacher claims; however, one of Amanda's students talked about writing his governor after reading a newspaper article in class on off-shore oil drilling, and as such, was searching for outlets for his knowledge garnered from his use of newspapers. This was just one anecdote but was a powerful one in that it indicates the potential impact of a teachers' NIMM use on students. Future research in science education needs to explore the actual impacts of science teachers' NIMM use on student use, understandings of science, and understandings of media. This may be accomplished by looking at various media affects models developed by scholars in mass communication studies and investigating their applicability to secondary science classroom and students.

Second, methodological implications as a result of this study include considerations of the naturalistic design and data collection methods used. Many research studies in science education rush into classrooms and implement an intervention to see if it “works” before taking a look at how the classroom naturally runs. This research shows that teachers are using media and that a survey of the land was necessary before deciding upon next steps for exploring the factors influencing a science teachers’ NIMM use. Researchers should recognize that interventions are not always necessary; it is important that we try to explore what teachers do well in their classrooms rather than relying on a deficit model of education. It is important that we, as researchers, do not underestimate the toolkit teachers already have when we enter their classrooms. Naturalistic designs accomplish this task.

Also, as King, Shumow, & Lietz (2001) have shown in their investigation of teachers’ inquiry practices, “given the great disparity between what teachers stated were their practice and the reality of the situation, the value of self-reported program documentation and evaluation must be called into question” (p.106). However, observations alone are also insufficient to account for classroom practices (Koziol & Burns, 1986). The use of interviews and length of observations need to be considered in light of available time, resources, and return of time investment.

In my review of the literature, I found comparisons between teachers’ reported and actual practices very limited in science education research. When comparisons were made, they were most commonly done in the context of teachers’ use of inquiry-based teaching practices. Beyond teachers’ reported and actual use of inquiry-based teaching practices, we have a very limited understanding of how science teachers’ reported behaviors compare to their actual classroom practices. Given the strengths and limitations of interviews and observations in this study in elucidating these comparisons, more research needs to be done in science education on the individual and combined merits of data collection methods to accurately identify what teachers are doing in their classrooms.

Third, theoretical implications as a result of this study include considerations of how the resulting knowledges framework aligns with the sociocultural theory which drove the research design and the extensibility of the study's findings to other contexts. The knowledeges framework developed in this study considers the social and cultural environment in which teaching and learning occurred (Brown, Collins, & Duguid, 1989). Similarly, it considered how individuals within a learning environment interacted with each other and with their available resources to make meaning of their environment. This meaning-making process was dependent upon the participants, their prior background and knowledge, their current location in time and space, their use of available resources, and their collective intentions (Alverman, Moon, & Hagood, 1999). As such, the framework illustrates that secondary science teachers' NIMM use is situated and cannot be removed from its social or cultural context. This parallel between sociocultural theories of teaching and learning and the knowledges framework which resulted from this study indicates that future research needs to continue to look at the broader cultural and environmental factors influencing science teachers' instructional decision-making. Factors external to the teacher, and even outside of the classroom, influenced their NIMM use and were essential to an explanation of the factors influencing science teachers' NIMM use.

Lastly, the design of the study was limited in that it included a small sample of participants from one school. While ideal for developing rich cases of secondary science teachers' NIMM use, the results are not generalizable to other classroom contexts. More research is needed to examine if the knowledges framework developed in this study is applicable to other secondary science classrooms. The extensibility of these results can be explored by looking at different kinds of teachers in different kinds of settings. The role of NIMM in urban or rural science classrooms, for example, could be a fruitful line of research. Similarly, the role of NIMM in technology infused classrooms, similar to Hugh's, compared with classrooms lacking technology could also be explored. This latter suggestion may highlight the strengths and limitations of the digital divide theory posited by scholars in media literacy education.

Conclusion

When we consider the role of mass media in today's society, we often picture media as conveying important information for consumption by the general citizenry. While some may recognize the potential bias of media reports, other citizens accept what they read as factual information and essential to their own decision-making. This disparate understanding of mass media and the information it shares presents a considerable challenge to developing media literacy in the larger population.

Now consider a science classroom. By its nature, science is complex, represents multiple perspectives, and is laden with scientific uncertainty. Science teachers must first understand this multifaceted nature of science and then must know how to teach students about science to develop students' scientific literacy. So what do teachers use to develop students' understanding of science? In this study, I found that NIMM was one such resource.

As this study has shown, many factors influence a teachers' ability to use mass media in the science classroom – both factors related to the media itself and to the teachers' context. Knowing why and how teachers use mass media in the science classroom and understanding the factors that influence their use can help us as science educators determine ways to support teachers' future use of such resources. This is especially true when teachers use *non-instructional* mass media resources as they rarely come with instructions for how to use the materials in the classroom and are created independent of consideration for students' background knowledge and experiences. Therefore, secondary science classroom use of NIMM requires teachers to make decisions about which media to use and how to use them without ancillary support.

When researchers look at science classrooms, it is not enough to assume that teachers are using every instructional resource effectively. Similarly, it is not fair to assume that teachers have the knowledge or experiences to use them effectively. Just like educators would not expect science teachers to enter the science classroom and use inquiry practices without instruction in inquiry-based teaching, they should not expect teachers to be able effectively use media in the science classroom if they have never had exposure to media literacy education. Because of its multiple layers and the nature of message construction and interpretation through media, we should not use media in the science classroom if we are unwilling to give attention to how to use it effectively.

This study expands on what we currently know about NIMM in the secondary science classroom in that it provides a more detailed inspection of how teachers actually use NIMM in the classroom. Although the findings from this study cannot be generalized to all secondary science teachers, nor can it be generalized to teachers' use of all forms of mass media, as seen in the lack of prior research on teachers' understandings of media and their reasons for using media to teach science, this study addresses several facets of science teaching that we, as a science education research community, have neglected to investigate. The hope is that this research will open conversations in the science education community on the potential impact of science teachers' NIMM use and that the findings of this initial study will lead to better understandings of the type of future research needed to truly uncover the complexity of the science classroom and teachers' instructional choices.

APPENDIX A
INFORMED CONSENT

Protocol Title: Secondary Science Teachers' Use of Mass Media in the Classroom

Please read this consent document carefully before you decide to participate in this study.

Dear Teacher:

I am a doctoral student at the University of Florida. As part of my dissertation I am trying to learn how secondary science teachers use media resources in their classrooms for instructional purposes. I am asking you to participate in a series of interviews and observations because you have been identified as a secondary science teacher.

Should you agree to participate, questions during the interviews will ask you to discuss your teaching practices with a specific focus on your use of media resources. The first interview should last no longer than 45 minutes. The second interview should last no longer than 90 minutes. Both interviews will be conducted in your classroom or on your school's campus at a time that is most convenient for you. Observations of your teaching will occur during the first grading period of the 2009-2010 school year. I would like to observe your classroom teaching at least once weekly and any additional times you intend to use media resources as a teaching tool. With your permission I would like to audiotape the interviews. You will not have to answer any question you do not wish to answer. Only I will have access to the tape which I will personally transcribe, removing any identifiers during transcription. The tape will then be erased. Your identity will be kept confidential to the extent provided by law and your identity will not be revealed in the final manuscript.

With your permission, I would also like to videotape the classroom observations. The focus of the videotape will be on your classroom teaching, therefore student images will not be captured or included in the study. Only I will have access to the videotape which I will use to check the handwritten notes I take during the observation. I might also use excerpts from the videotape during the second interview to help you reflect on your practice and your choice of media use during that particular lesson.

There are no anticipated risks, compensation or other direct benefits to you as a participant in this interview beyond providing you with the opportunity to discuss and reflect upon your own teaching practices. You are free to withdraw your consent to participate and may discontinue your participation in the study at any time without consequence.

If you have any questions about this research protocol, please contact me via email at klosteml@ufl.edu or via phone at 219-7837. You may also contact my faculty supervisor, Dr. Troy Sadler, at 273-4222. Questions or concerns about your rights as a research participant may be directed to the IRB02 office, University of Florida, Box 112250, Gainesville, FL 32611; (352) 392-0433.

Please sign and return this copy of the letter in the enclosed envelope. A second copy is enclosed for your records.

By signing this letter, you give me permission to report your responses anonymously in the final manuscript to be submitted to my supervisory committee as part of my dissertation. You will be offered access to all transcriptions, notes, and my interpretations of the interviews and observations to determine if your perspective was adequately captured before the final manuscript for my dissertation is submitted.

Sincerely,
Michelle L. Klosterman, M.Ed
Graduate Student
School of Teaching and Learning
2423 Norman Hall
Gainesville FL 32611

I have read the procedure described above. I voluntarily agree to participate in the procedure and I have received a copy of this description.

Participant: ____ Date: __________

Principal Investigator: ____________________________________ Date: __________

APPENDIX B
SAMPLE INTERVIEW QUESTIONS

Interview #1: Reported Media Use Interview

1. How frequently would you say you use these forms of media in the classroom? Times per week/times per month/times per unit?
2. What types of media do you use in the classroom?
3. Why do you choose to use (or not to use) media in the classroom?
4. What types of media do you feel most comfortable working with and why?
5. What science topics do you usually explore through media?
6. Are there any topics in science that you feel are more appropriate to explore through the use of media? If so, why?
7. Are there any school-wide suggestions or requirements for using media in the classroom?
8. Have you ever discussed using media with another teacher in your department or school?
9. Are you aware of any related Sunshine State Standards that would promote the use of media?
10. How do you typically use media in the classroom?
11. How does it occur in the course of a lesson or unit?
12. What are the teachers' and students' roles when using media?
13. How are students expected to interact with the media?
14. Are there any differences in the way you choose which type of media to use in the classroom? Why or why not? How would you characterize those differences?
15. Are there any differences in the way you use different types media in the classroom? Why or why not? How would you characterize those differences?
16. What do you think are the advantages of using media in the classroom?
17. What are the disadvantages of using media in the classroom?

Interview #2: Media Literacy Interview
Conceptions of Mass Media

1. In your opinion, does non-instructional mass media differ significantly from instructional forms of mass media? If yes, how? If not, why not?
2. Do you think your use of media in the classroom is influenced by your own views about mass media or society? Why or why not?

Media Literacy Skills (Teacher)

3. What were your learning objectives for this lesson?
4. Why do you consider those objectives important?

5. Why did you choose to use (XXX media) during that lesson?
6. How did you select (XXX media) for that lesson?
7. How did you go about locating that specific source?
8. Are there any criteria you used for determining whether or not to use that piece of media?
9. Was there anything specific about that particular medium that made it better to use during that lesson than another medium?
10. What type of background knowledge would be needed to interact with that medium?
11. Some people suggest that media are constructed with a specific audience in mind. Would you agree or disagree with that statement for (XXX media)? Why?
12. What impact would that have on how students interact with media?
13. Was (XXX media) typical in terms of how it compares to other media of the same type?
14. What types of creative techniques does (XXX media) use to get your attention?
15. What types of creative techniques does (XXX media) use to convey its message?
16. What impact would that have on how students interact with media?
17. How well do you think (XXX media) accurately reflected how science is done? Explain.
18. How well do you think (XXX media) accurately reflected what scientists do? Explain.
19. Overall, how successful do you feel (XXX media) was in helping you accomplish your objectives for this lesson?

Media Literacy Skills (Students)

20. How do your students react to the use of media in your classroom?
21. How capable do you feel your students are at using media for the purposes you outline in class?
22. Are there any defining characteristics of students that you notice that tend to prefer using media?
23. Are there any defining characteristics of students that you notice are more capable of interacting with media?
24. Media literacy education is being considered in some schools as a way to teach students how to access, analyze, critically evaluate, and even create new media. To what extent do you feel your students are able to accomplish these goals?
25. Consider the preparation of students you are teaching today. Do you feel that students at the level you are teaching are prepared to use non-instructional media in science? If yes, why do you think so? If no, what would it take to prepare them?

APPENDIX C
EXCERPT OF CODED INTERVIEW TRANSCRIPT

R: Ok, so I'm going to ask you about your use of media resources and this is – I'm specifically looking at your use as a teacher so your choices you make to use media, how you use them, and kind of your role and your students' role when you do use them. But first, how frequently would you say you use media in the classroom?
D: I would say, on average, twice a month.
R: Twice a month?
D: Which comes out to probably – I usually as a hook for a unit (opener) will do some form of media other than the traditional textbook or something and usually my units are a few weeks long so that's why I say twice a month. It's kind of – it tends to be at the beginning of the unit for me.
R: Alright. And is there, um, can you give me an example of one you may have used that was using one of these media resources that are not traditionally classroom –
D: Yes. Like for example, yesterday we started a unit of food chemistry and so I showed them an episode of Good Eats from the Food Network on – I just found it on YouTube (how to choose)– and it was one called something, I forget what it was called, but it was about protein bars and energy bars and how to make your own but he went into defining carbohydrates, fats and proteins and molecular structure and everything. So that was an example, I guess, of media that I use as kind of an intro to a unit and many of the kids were familiar with the show. So the Food Network logo was on it.
R: Right. So how did you find that episode?
D: Um, I had to go online because I've seen Good Eats on TV before and I've always thought it was cool because the science teacher in me – it goes into the science behind nutrition, um, and so I went onto the internet and searched for - this is through Google – searched for Good Eats episode descriptions (how to choose) and found a website that was some fan-based website that had every episode from every season of the show and you could search for episodes by certain key terms and carbohydrates and fats and proteins were one of them. So I found an episode that hit all three of them then I went to YouTube and typed in the title of the episode and sure enough I had the whole 20 something minute long episode was there.
R: On YouTube?
D. Uh huh. Yeah. So that's how I found out.
R: Wow that's a nice fan [laugh]
D: Yeah. It was kind of cool. I loved that website – that fan-based thing. I was like wow that's really detailed search engine for a show.
R: Have you found, have you ever used anything else like that or come across anything else like that to find –
D: That was the most in depth, ease of searching a show that I've found. I'm sure there's stuff like that for major shows like MythBusters and stuff like that. I haven't shown MythBusters but I would.
R: You would? So you chose this, um, you chose Good Eats because you were familiar with it and you knew the science. When you did that with your students, you used that as a hook. Can you describe how you introduced it to them or how you set it up a little bit?

D: Yeah. Well, um, I guess I talked about my everyday life and how the Food Network is always on so I just gave them a story about how I hate it when my wife's always watching the Food Network when I want to watch ESPN or something like that, so I guess we had a little bit of a media discussion then and then I said, but there's this one show that I actually like and I asked if they'd heard of the show, Good Eats, and some of them had and some hadn't. We had already – I had already kind of introduced carbohydrates, fats and proteins – they built structures of the three molecules and we did some, a jigsaw activity where everybody taught a different section so they already had some notes and so what I told them to do during the video was to supplement their notes. They have three column notes, one for each of the molecules and (notes) I asked them as they were watching the video to see how many things they already had in their notes (review) and to be adding things as he was discussing things like omega-3 fatty acids for example. (content)
R: So he got into some pretty good content detail?
D: Oh yeah. Very detailed content. Yeah.
R: I wonder.
D: I wish I had had ovens and stuff. We would have made our own granola bars or whatever.
R: Yeah. That's cool. So other than videos like the Good Eats, have you used any other type of media that's not made for classrooms that you can think of?
D: Yeah. I do a lot of YouTube. I know that's video too but whenever I think of a topic or something – even if it doesn't have anything to do with chemistry – um, for example we're learning about equilibrium – I had seen these which is balancing out both sides and I'd seen these indi- indo boards I think they're called which are these training devices for snowboarders and skateboarders and stuff and it's just somebody standing on a board with this tube and balancing and so I found a YouTube video of a bunch of people wiping out on it and talked about as an analogy to balancing and equilibrium in a system. So I do lots of – I supplement media almost, like I said, almost like a hook a lot. (engagement) As far as text, um, I use a lot of current event newspaper articles.
[phone rings, D answers, stop tape – new file]
R: So newspapers or magazines.
D: Yeah, so I actually don't have any magazine subscriptions per se so I usually do everything electronically (gaining access)and then I run copies of it because our school is very lenient in that we don't have a required number of copies so I can go through as much paper as I want. That's how environmentally friendly we are [laugh] here.
R: but supportive of the teachers.
D: Yes. Sure. So I can find any article I want online and run off as many copies as I want for the kids so that's easier for me I think than having a subscription. The thing is that I do that I would work on personally is I find my favorite article and then I use it each year when I get to a certain topic and so I'll have an article from like 2004 on a certain topic from – and usually I tend to like just Associated Press articles, um, rather than something from a specific slant. Those seem to be the least biased (criteria – neutral) to me so I'll usually find some associated press article but then I usually use it over and over again and it's the laziness of me not wanting to search for something more current but I'll have the kids do – for homework assignments often – I'll have them bring in a current event and talk to them about how an informative encyclopedia entry

from something like Wikipedia is not classified as a current event. (evaluating media) I'll ask them to bring in something from a website that is either a newspaper or a source like MSNBC or something like that. I'll tell them, "Don't search in Google, go to one of these sites first and see what article you can find then." I've done that with recently with this year we had a current even project search on climate change and then also one on nuclear power and it was neat to see the kids bring in stuff that was much more current than the articles that I had made copies of and had them read. (empowerment)
R: Yeah. So when you made the copies of your article, you said you like kind of had your favorites. What makes them your favorite?
D: That they were written – like so I like the whole idea of controversial subject matter so I found some good articles in the past that present both sides of the debate (criteria – both sides/neutral) or maybe are interviewing two different people like someone who is – like in the case of nuclear power – one was a nuclear physicist who was arguing for the use of nuclear power and another one was an environmental agency spokesperson who was arguing against the use of that but the format of the article was such that led to a nice discussion prompting of the debate. (real science)
[student enters classroom, tape stops, new file]

APPENDIX D
OBSERVATION LOG

Amanda: Classes Observed

Date	Topic	Media Used?	Type of Media
8/26/2009 W	Current Issues	YES	*Garden Gate* magazine editorial ; *Science* journal article
8/28/2009 F	Sustainability	YES	*The Lorax* video
9/2/2009 W	History of ES	YES	Leopold *Sand County Almanac*; Carson *Silent Spring;* Carr *The Windward Road;* Douglas *The Everglades*; Wilson *The Diversity of Life*
9/9/09 W	Current Issues	YES	*Gainesville Sun* article (gulf drilling); *Gainesville Sun* editorial (drilling)
9/11/09 F	Relationships	YES	Ant video (substitute)
9/16/09 W	Relationships	YES	*Spineless Wonders* book
9/23/09 W	Relationships	NO	
9/25/09 F	Ecosystems	YES	*Smithsonian* article (Sandpiper)
9/30/09 W	Ecosystems	YES	*Voyage to Galapagos* video
10/2/09 F	Current Issues; Relationships	YES	*Gainesville Sun* article (snakes); *Gainesville Sun* editorial (snakes); *Nature Conservatory* article (starfish)
10/7/2009 M	Biomes	NO	
10/21/2009 W	Water	NO	

Amanda: Classes Not Observed

Date	Topic	Media Used?	Type of Media
8/24/2009 M	Welcome	NO	
8/31/2009 M	Environmental History	NO	
9/4/2009 F	Atom review	NO	
9/15/2009 M	Cycles	NO	
9/18/2009 F	Biodiversity	NO	
9/22/2009 M	Biodiversity	NO	
9/28/2009 M	Adaptations	NO	
10/5/2009 M	Biomes	NO	
10/9/2009F	Biomes	NO	
10/12/2009 M	Water	NO	
10/14/2009 W	Water	YES	*Gainesville Sun* article (St.John water)
10/19/2009 M	Water	YES	Internet (webquest on Snow)

Charlotte: Classes Observed

Date	Topic	Media Used?	Type of Media
8/26/2009 W	Class overview; Earth science topics	YES	Newspaper (images)
9/2/2009 W	Earth science topics	YES	Newspaper (titles and

			images)
9/4/2009 F	Scientific Method	YES	*Mythbusters* clip (Sharks)
9/9/2009 W	Scientific method	NO	
9/16/2009 W	Newton's Laws of Motion	YES	*Gainesville Sun* comic strip; *Bill Nye* video
9/23/2009 W	Telescopes	NO	
9/25/2009 F	Matter	YES	Magazines (images)
9/30/2009 W	Matter	YES	*Gainesville Sun* comic strip
10/7/2009 W	Measurement	NO	
10/21/2009 W	Space	YES	*Internet (webquest)*
10/19/2009 M	Space	YES	Internet (NASA pictures)

Charlotte: Classes not observed

Date	Topic	Media Used?	Type of Media
8/24/2009 M	Introductions	NO	
8/28/2009 F	What is Science	NO	
8/31/2009 M	Scientific Method	NO	
9/11/2009 F	Scientific method	NO	
9/14/2009 M	Scientific Method	NO	
9/18/2009 F	Scientific Method	NO	
9/21/2009 M	Meteorology	NO	
9/28/2009 M	Matter	NO	
10/1/2009 F	Forms of matter	NO	
10/5/2009 M	Measurement	NO	
10/9/2009 F	Matter	NO	
10/12/2009 M	Matter	NO	
10/14/2009 W	Matter	NO	

Hugh: Classes Observed

Date	Topic	Media Used?	Type of Media
8/25/09 T	What is Science?	YES	YouTube; Internet
8/27/09 R	What is Science?	YES	Internet
9/1/09 T	What do scientists do?	YES	Internet; YouTube; Animal Planet video
9/3/09 R	What do scientists do?	YES	Internet
9/8/09 T	What do scientists	YES	YouTube; Internet

	do?		
9/10/09 R	What do scientists do?	YES	Internet
9/15/09 T	What do scientists do?	YES	YouTube; Internet
9/22/09 T	General Life Science	YES	Planet Earth video
9/24/09 R	Scientific Method	YES	Pocket Tanks video game
10/6/2009 T	Adaptations	YES	Discovery Streaming clip; Internet
10/13/2009 T	Adaptations	YES	Gainesville Sun article; YouTube
10/20/2009 T	Adaptations	YES	Internet

Hugh: Classes Not Observed

Date	Topic	Media Used?	Type of Media
8/24/2009 M	Welcome	YES	YouTube video
8/31/2009 M	What is science?	YES	YouTube Video; Internet
9/14/2009 M	What do scientists do?	YES	YouTube National Geographic clip
9/17/2009 R	Scary animals	YES	WildClassroom clip; Internet
9/21/2009 M	Scary animals	YES	YouTube; Internet
9/28/2009 M	Adaptations	YES	Gainesville Sun article; Internet
9/29/2009 T	What do scientists do?	YES	Internet
10/1/2009 R	Adaptations	YES	YouTube; Internet
10/5/2009 M	Adaptations	YES	Discover Education clip; Internet
10/8/2009 R	Adaptations	YES	YouTube; Internet
10/15/2009 R	Adaptations	YES	Internet
0/22/2009 R	Adaptations	YES	YouTube; Internet

APPENDIX E
SAMPLE EXPANDED FIELD NOTES

Charlotte. September 9, 2009

10:45 Students begin entering the classroom. The teacher has the warmup sentence written on the left hand side of the board. The agenda is written on the right hand side of the board. The last time I was in the class the students did not have assigned seats. Today they enter and walk to an assigned seat. The teacher asks students to copy the agenda in their planners and begin the warmup in their composition notebooks. The teacher goes to the board and goes over the warm up sentence. “What you’re doing here is comparing and contrasting.” “I underlined the words that you need.” The teacher approaches me and tells me that if I ever wanted to help, the table at the front of the class needs a little bit of extra help sometimes. I tell her OK. She also tells me that today is going to go a little slower than usual. Because classes are on block scheduling, and the other two classes that meet the next day will be on a field trip, she is taking her time to keep them all on track together.

10:58 The teacher instructs students to turn to their shoulder partners to share the answer to their warmup. She says that partner “B” will share first. She reminds the students that partner “A” shouldn’t be talking yet – they should just be listening.

11:01 The teacher moves to the OHC and works to turn on the projector. The teacher pulls up an electronic spinner that when you click on the button it spins an electronic spinner and randomly stops at a number. The students have numbers (1-4) on their table. The teacher says that the # matching the spinner’s choice should stand up. The spinner lands on #4 and the respective students stand up. She has each student share their response to the warm up statement. The teacher tells the students to check their answers to see if they say something that can be added to their own responses in their notebooks. As each student shares his/her response, the teacher notes words that she “likes” about the student responses. The teacher goes to the board and draws a pie graph to illustrate how earth science is one slice of the larger topic of science. The teacher then fills in the warmup on the board using some of the student examples shared. “Please check your notebooks now. I just gave you a more complete answer.”

11:11 The teacher turns on the OHC. “Now what your doing. In your notebook, you’re making two columns.” The teacher passes out Ziploc baggies with cut out slips of paper containing phrases on them such as “observable” and “certain.” The teacher instructs the students that they are to look at each phrase and put it in the “Science Is” or the “Science is Not” column in their notebooks. Each student pair gets a baggies with the phrases. Students are instructed to work with their shoulder buddies.

11:20 The students are working to sort their phrases in two columns. The teacher projects a 2 column chart on the OHC. The teacher approaches me and says that she’s short a Ziploc baggie. She mentions that she won’t have enough for her last class. I offer to make two new sets. I make sure the video camera is rolling and then follow the teacher to get paper, a pen, and scissors to make two new sets. At three tables, students are asking the teacher what some words mean such as "certain." The teacher tells the students that there are dictionaries on the shelf if they don't know the meaning of a word.

11:30 The teacher raises her hand to get the students' attention. This is the universal "sign" at this school for getting quiet. The teacher raises his/her hand and then as students see the teacher's hand raised, they raise their hands. The idea is that once you see a hand up, you follow their lead, and get quiet. Like a wave, the class eventually gets quiet. The teacher instructs students that they are going to play agree and disagree. She assigns one side of the classroom as "agree" and the other as "disagree." She tells the students that she's doing this because she read some research that said that you remember more when you move around and learn something than if you're sitting still. She instructs the students to stand up and then she reads a statement. The students move if they agree or disagree with the statement. The statements are all "Science is" statements from the phrases. Examples: certain, observable, based on belief, can solve all problems, based on experimentation, cannot be changed. After the students move to a side of the room, the teacher discusses the correct response.

11:35 The teacher sends students back to their seats. "I'm not sure about your answers, so I'm going to project them here. So please check your answers." Teacher projects a completed 2 column notes using the phrases on the OHC.

11:38 The teacher exits the OHC 2 column. "We just said science cannot answer all questions." The teacher then projects a page out of a textbook resource workbook on the ELMO. The direction are "Can science answer these questions? Yes or no." The teacher directs students to read the first question. "Is it ethical to use animals in medical experimentation?" Teacher says this question cannot be answered by science; it's an ethical question. The next question is "What is the distance to the nearest star?" Students say science can answer that and the teacher says yes – that's a testable question.

NEWSPAPER EARTH SCIENCE TOPICS EPISODE

Before	During	After
11:40 Teacher turns off OHC. "We talked about science, now we're going to talk about topics that earth science studies." "I'm going to give you either a magazine or a newspaper part." Teacher says	11:42 The teacher passes out the magazines and newspapers to each group. At a table of two groups (four students), one group is given a magazine and the other group is given a newspaper. The magazines are National Geographic magazines. The newspapers are the local Gainesville Sun. The student groups begin working together. The teacher circulates through the classroom helping other tables. *This teacher mentioned to me before	12:16 The teacher walks to the front of the classroom and raises her hand to get student attention and quiet. "Do you see just through newspapers and magazines we got a list of earth science topics we

she's going to give a newspaper or magazine to each pair of students. She tells students they are to decide if something they read is related to a topic in earth science. "If you have a magazine … you need to look for articles or images that are topics that are studied in earth science." "If you have a newspaper … you are going to read the headings of each article and decide if it's something related to earth science topics or earth science." The teacher gives an example. She opens a newspaper. "For example … [reads title] … .it has this image. Does this have to do with earth science?" The students respond no. The teacher says "So you go to the next one." The teacher says they can check in the textbooks on the tables if they aren't sure if it's an earth science topic. "If	beginning my research that she would like me to assist in the classroom. I decide to circulate to help the students with the instructions of the assignment and ask them about what they found. This does not alter how the teacher is using the media sources – I'm mimicking her behavior here. I made sure my videocamera was turned on. While we are circulating around the students, the teacher walks around and gives each student pair a yellow sticky note. She tells them to write the earth science topics they found and a short summary or prediction about the article on the sticky note. "Ok guys, time's up. I want each group to stand up and come up here and show your news article or pictures because many of your articles have images and they are good pictures." The teacher says that after they share, she's going to make a list of the earth science topics they found on the board. The first table brings their article to the teacher. The teacher puts the article under the ELMO and projects the article for others to see. The student stands to share her prediction and the related earth science topic. *I offer to volunteer to write the topics on the board so the teacher can collect and put the articles on the ELMO. Again, I make sure the video camera is on so that I can review the tape later to get observation notes. The third group stands to share an article about Mt.McKinley in Alaska and adventure treks you can take. "Alaska's mountain majesty. Actually this is quite interesting. It's just in the section of traveling in the newspaper so you wouldn't even think there's a connection to earth science in this section." The teacher asks the student to share their prediction. The student instead	came up with." The teacher then lists the topics found (space exploration, hurricanes and wind, maps and weather, mountains, water, rivers, glaciers, global warming, volcanoes, planets, stars and star life cycles, water, gases in ocean floor, wildfires, deforestation). "All of these are examples you can use in your homework for three column notes in the box of earth science, right? Because you have the definition of earth science is the study of earth and space. That's just - does that help you remember it? Now you have examples – all of this [pointing to board] – that will - help you learn that vocabulary. So you see how much information you have in the newspaper? And not only from science, but other topics in the newspaper so if

you have time you can read it and summarize it or make a prediction about that article is going to be about." "Then we are going to share that so you need to be prepared as a team what that's about."	gives a summary. The teacher says, "So what earth science topic does this article show?" After each group presents, the teacher talks a little bit about the article and asks the students to identify the earth science topic. I write what the student says on the board. The last group puts up a magazine article that has the title of the article and a picture of a lung outline filled with trees. Teacher, "OK, they chose quite an interesting image. "They're talking about deforestation and if we cut trees – the picture is in the shape of the lungs – and if we cut trees then it is related to the lungs – this is in the shape of the lungs [pointing to image] because it will affect the amount of oxygen we have." 11:53 The teacher tells me that she asked one group what they found. She said one student pair picked out an article about the category three hurricane currently in the pacific and approaching the mexico coast. The student told her that his prediction was that there is going to be a lot of damage in mexico. She asked why he predicted that. He said "because it's a category 3." The teacher said she was excited to see that they knew that and could pull that out of the newspaper.	you want to read something and you don't have a book, you can read the newspaper. The library always has the newspaper."

12:25 A student asks a question about the homework assignment on vocabulary. The teacher shows an example of what the students should have for homework in terms of the 3 column notes. Teacher says they need to pack up. Students pack bags and walk to door. Bell rings, teacher opens door, students walk out.

I had a conversation with the teacher after class about how she felt about the lesson. She thought it went well. She said it went a little too long for them, they were getting restless, but that she thinks they found a lot of good topics. She said that the next class they will do the safety rules which they didn't get to today. She also said she plans to show a Discovery Streaming video clip on Friday. I plan to attend.

APPENDIX F
SAMPLE OBSERVATION SUMMARY CHART

Media	Access	Purpose	Student/Teacher Directed – Independent/ Coached Use	Interactions BEFORE (class, groups, individual)	Interactions DURING (class, groups, individual)	Interactions AFTER (class, groups, individual)
Garden Gate magazine editorial	Member of Florida Botanical Society	Management of class; Reinforce “need to appreciate environmental science, not just learn about it”	T-I	Test (I); instruct to pick up article and consider relevance to ES while reading	Silent reading (I)	Discussion of relevance to environmental science (C)
Tragedy of Commons Science research journal article	Marston Science Library	Background on theory explaining class activity ”Fishing in the Commons”; management of class while teacher assigns textbooks	T-I	Fishing in the Commons lab activity (G); assignment for discussing relevance posted on board	Reciprocal teaching (G)	Discussion of relevance (C); 3 paragraph summary (I); personal reaction in warmup next class (I)
Lorax children’s fable movie	Personal copy … originally purchased for my son	Management; relevance to what is being studied; “captivate my audience”	T-I	Discussion of tragedy of commons (C)	worksheet (I)	Discussion of relevance to Tragedy of Commons (C); Worksheet finish for HW (I); test questions on unit test (I)
Historical non-fiction Trade books	Personal or library copies	“exposure to groundbreaking books in environmental science”; “give them a ‘local angle’”; “give them a ‘handle’ on the importance of biodiversity”	T-I	Discussion of authors and hometowns (C); discuss jigsaw reading and task to find relevance to environmental science (C)	Jigsaw reading (G)	Summary and written relevance to environmental science (I); test questions on unit test (I)

APPENDIX G
CATEGORICAL CODES

Types of media

- Newspapers/Magazines
- Video/Television
- Videogames/Internet
- Trade Books

Topics

- Life/Environmental
- Physical/Chemical
- Earth/Space
- Science Application
- Controversial Issues

Frequency

- Daily
- Weekly
- At least once each unit

Support for Using Media

- Other teachers
- Professional development

Rationale

- Preferred Medium
  - Less time consuming
  - More timely
  - More effective presentation style
  - Inaccessible accessible
  - Access
- Science
  - New content
  - Prior content
  - People in science
  - Prevalence of science
  - Scientific practices
- Interdisciplinary
- Classroom management
  - Engagement
  - Entertainment
  - Management tool

Strategy for Using Media

- Student-Centered
  - Student creation
  - Independent exploration
  - Engage in scientific practices
- Teacher-Directed
  - Note-taking
  - Teacher-led discussion
  - Identifying fact and fiction
  - Critical evaluation of media
  - Practice reading strategies

Choosing Media

- Locating Media
  - Internet searching
  - Membership
  - Word of mouth
  - Inadvertent exposure
- Selection criteria (Science)
  - Related to class content
  - Scientifically accurate
  - Use of scientific language
- Selection criteria (Media)
  - Author
  - Balanced perspectives
  - Length
  - Timeliness
  - Quality visuals
- Selection criteria (Relevant to student and teachers)
  - Match student reading level
  - Teacher interest
  - Student interest

Barriers to Using Media

- Features of Media
  - Incomplete representations of science
  - Dated
  - Length
  - Distracting elements
  - Availability
- Features of Context
  - Time
- Features of Students
  - Too difficult to use
  - Lack of interest
- Features of Teacher
  - Other preferable methods
  - Lack of content knowledge
  - Locating media

Student Impact

- Empowerment
- Increase out-of-classroom use

LIST OF REFERENCES

Abell, S.K. (2007). Research on science teacher knowledge. In S.K. Abell & N.G. Lederman (Eds.), *Handbook of research on science education* (pp. 1105–1149). Mahwah, NJ: Lawrence Erlbaum.

Abell, S. (2008). Twenty years later: Does pedagogical content knowledge remain a useful idea? *International Journal of Science Education, 30*(10), 1405–1416.

Abell, S., Rogers, M., Hanuscin, D., Lee, M., & Gagnon, M. (2009). Preparing the next generaion of science teacher educators: A model for developing PCK for teaching science teachers. *Journal of Science Teacher Education, 20*(1), 77–93.

Aikenhead, G. (1984). Teacher decision making: The case of prairie high. *Journal of Research in Science Teaching, 21*(2), 167–186.

Almqvist, J., & Ostman, L. (2006). Privileging and artifacts: On the use of information technology in science education. *Interchange, 37*(3), 225–250.

Alvermann, D., O'Brien, D., & Dillon, D. (1990). What teachers do when they say they're having discussions of content area reading assignments: A qualitative analysis. *Reading Research Quarterly*, *25*(4), 296–322.

Alvermann, D., Mood, J., & Hagood, M. (1999). *Popular culture in the classroom: Teaching and researching critical media literacy.* Newark, DE: International Reading Association.

American Association for the Advancement of Science (AAAS) (1990). *Science for All Americans*. New York: Oxford University Press.

American Association for the Advancement of Science (AAAS) (1993). *Benchmarks for scientific literacy.* New York: Oxford University Press.

Anderman, E., & Johnston, J. (1998). Television news in the classroom: What are adolescents learning? *Journal of Adolescent Research, 13*(1), 73–100.

Angeli, C., & Valanides, N. (2009). Epistemological and methodological issues for the conceptualization, development, and assessment of ICT-TPCK: Advances in technological pedagogical content knowledge (TPCK). *Computers & Education, 52*(1), 154–168.

Annetta, L., & Murray, M. (2008). Investigating student attitudes toward a synchronous, online graduate course in a multi-user virtual learning environment. *Journal of Technology and Teacher Education, 16*(1), 5–34.

Aufderheide, P. (1993). Media literacy: A report of the national leadership conference on media literacy. Aspen , CO: Aspen Institute.

Austria, J.L. (2007). Developing evaluation criteria for podcasts. *LIBRI, 57*(4), 179–208.

Ayres, L., Kavanaugh, K., & Knafl, K. (2003). Within-case and across-case approaches to qualitative data analysis. *Qualitative Health Research, 13*(6), 871–883.

Baram-Tsabari, A., & Yarden, A. (2005). Text genre as a factor in formation of scientific literacy. *Journal of Research in Science Teaching, 42*(4), 403–428.

Barnett, M., Wagner, H., Gatling, A., Anderson, J., Houle, M., & Kafka, A. (2006). The impact of science fiction film on student understanding of science. *Journal of Science Education and Technology, 15*(2), 179–199.

Barrilleaux, L. (1967). An experiment on the effects of multiple library sources as compared to the use of basic textbook in junior high school science. *The Journal of Experimental Education, 35*(3), 27–35.

Barthes, R. (1972) Text. New York, NY: Hill and Wang.

Berger, P., & Kellner, H. (1981). *Sociology Reinterpreted.* New York: Anchor Books.

Beyer, C. J.,Delgado, C.,Davis, E. A.,& Krajcik, J. (n.d.). Investigating high school biology texts as educative curriculum materials: Curriculum review process. Manuscript submitted for publication.

Brier, S. (2006). Ficta: Remixing generalized symbolic media in the new scientific novel. *Public Understanding of Science*, *15*(2), 153–174.

Broemmel, A., & Rearden, K. (2006). *Should teachers use the Teachers' Choice books in science class?* The Reading Teacher, *60*(3), *254–265.*

Brown, J. S., Collins, A., & Duguid, R. (1989). Situated cognition and the culture of learning. *Educational Researcher, 18*: 32–42.

Broz, S. (2001, August). Media literacy: A review and critical assessment of its diverse literature. Paper presented at the annual meeting of the Association for Education in Journalism and Mass Communication, Washington, DC.

Buckingham, D. (2003). *Media education: Literacy, learning and contemporary culture*. Cambridge: Polity Press.

Bucy, E., & Affe, R. (2006). The contributions of net news to cyber democracy: Civic affordances of major metropolitan newspaper sites. In Xigen Li (Ed.), *Internet newspapers: The making of mainstream media* (pp. 227–242). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.

Calabrese Barton, A. (2007). Science learning in urban settings. In S.K. Abell & N.G.Lederman (Eds.), *Handbook of research on science education* (pp. 319–344)*.* Mahwah, NJ: Lawrence Erlbaum Associates.

Carlsen, W. (2007). Language and science learning. In S. K. Abell & N. G. Lederman (Eds.), *Handbook of research on science education* (pp. 57–74). Mahwah, NJ: Lawrence Erlbaum Associates.

Cavanaugh, T., & Cavanaugh, C. (2004). *Teach science with science fiction films: A guide for teachers and library media specialists*. Worthington, OH: Linworth Publishing.

Charsky, D., & Mims, C. (2008). Integrating commercial off-the-shelf videogames into school curriculums. *TechTrends, 52*(5), 38–44.

Chinn, C.A., & Malhotra, B. (2002). Epistemologically authentic inquiry in schools: A theoretical framework for evaluating inquiry tasks. *Science Education, 86*(2), 175–218.

Clark, D.B. & Slotta, J.D. (2000). Evaluating media-enhancement and source authority on the internet: The knowledge integration environment. *International Journal of Science Education, 22*(8), 859–871.

Clough, M., Berg, C. & Olson, J. (2009). Promoting effective science teacher education and science teaching: A framework for teacher decision-making. *International Journal of Science and Mathematics Education, 7*(4), 821–847.

Corbin, J., & Strauss, A. (2008). *Basics of qualitative research* (3rd ed.). Los Angeles, CA: Sage Publications.

Crotty, M. (1998). *The foundations of social research: Meaning and perspective in the research process.* London: Sage Publications.

Daisey, P. (1994). The value of trade books in secondary science and mathematics instruction: A rationale*.* *School Science and Mathematics*, *94*(3), 30–137.

Daniels, H. (2001). *Vygotsky and Pedagogy.* London: RoutledgeFalmer.

Dawson, C. (2000). Upper primary girls' and boys' interest in science. *International Journal of Science Education, 22*(6), 557–570.

Delwiche, A. (2006). Massively multiplayer online games (MMOs) in the new media classroom. *Educational Technology and Society, 9*(3), 160–172.

Dewalt, K., & Dewalt, B. (2002). *Participant observation: A guide for field workers.* Lanham, MA: Rowman & Littlefield Publishers, Inc.

Dhingra, K. (2003). Thinking about television science: How students understand the nature of science from different program genres. *Journal of Research in Science Teaching, 40*(2), 234–256.

Dimopoulos, K., & Koulaidis, V. (2003). Science and technology education for citizenship: The potential role of the press. *Science Education, 87*(2), 241–256.

Dingwall, R., & Aldridge, M. (2006). Television wildlife programming as a source of popular scientific information: A case study of evolution. *Public Understanding of Science, 15*(2), 131–152.

Dubeck, L.W. (1993). Finding the facts in science fiction films. *The Science Teacher, 60*(4), 46–48.

Dubeck, L., Moshier, S., & Boss, J. (1994). *Fantastic Voyages: Learning Science Through Science Fiction Films*. Woodbury NY: AIP Press.

Duncan, B., Pungente J., & Andersen, N. (2002). Media Education in Canada. Retreived January, 28, 2009, from http://www.aml.ca/articles/articles.php?articleID=272.

Duschl, R. (2008). Science education in three-part harmony: Balancing conceptual, episitemic, and social learning goals. *Review of Research in Education, 32*, 268.

Educational Research (2009). Retrieved March 25, 2009, from http://www.pky.ufl.edu/aboutPK/research.php.

Elliott, P. (2006). Reviewing newspaper articles as a technique for enhancing the scientific literacy of student-teachers. *International Journal of Science Education, 28*(11), 1245–1265.

Ensminger, B. (1990). Television lesson. *The Science Teacher, 57*(6), 77–79.

Erlandson, D., Harris, E., Skipper, B, & Allen, S. (1993). *Doing naturalistic inquiry: A guide to methods.* Newbury Park, CA: Sage Publications.

Fang, Z., Lamme, L., Pringle, R., Patrick, J., Sanders, J., Zmach, C., et al. (2008). Integrating reading into middle school science: What we did, found and learned. *International Journal of Science Education*, *30*(15), 2067–2089.

Fisher, B. (1980). Using literature to teach science. *Journal of Research in Science Teaching, 17*(2), 173–177.

Flagg, B. (1994). Learning science from children's radio: Summative evaluation of Kinetic City Super Crew. *Educational Technology Research and Development*, *42*(3), 29–43.

Ford (2006). Representations of science within children's trade books. *Journal of Research in Science Teaching*, *43*, 214–235.

Fredericks, A. (2003). Evaluting and using nonfiction literature in the science curriculum. In R. Bamford, & J. Kristo (Eds.), *Making facts come alive: Choosing and using nonfiction literature K–8* (2nd ed.) (pp. 141–156). Norwood, MA: Christopher-Gordon.

Friedrichsen, P., & Dana, T. (2005). Substantive-level theory of highly regarded secondary biology teachers' science teaching orientations. *Journal of Research in Science Teaching, 42*(2), 218–244.

Freudenrich, C. (2000). Sci-fi science. *The Science Teacher, 67*(8), 42–45.

Furman, M., & Calabrese Barton, A. (2006). Capturing urban student voices in the creation of a science mini-documentary. *Journal of Research in Science Teaching, 43*(7), 667–694.

Gess-Newsome, J. (1999). Pedagogical content knowledge : An introduction and orientation. In J. Gess-Newsome & N. Lederman (Eds.), *Examining pedagogical content knowledge: The construct and its implications for science education* (pp.3–17). Netherlands: Kluwere Academic Publishers.

Glasser, B., & Strauss, A. (1967). *The discovery of grounded theory: Strategies of qualitative research.* London: Wiedenfeld and Nicholson.

Glesne, C. (2006). *Becoming qualitative researchers: An introduction* (3rd ed.). Boston, MA: Pearson Education, Inc.

Guba, E., & Lincolon, Y. (1989). *Fourth generation evaluation.* Newbury Park, CA: Sage Publications.

Guba, E., & Lincoln, Y. (1994). Competing paradigms in qualitative research. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 105–117). London: Sage.

Halkia, K. (2003) Teachers' views and attitudes towards the communication code and the rhetoric used in press science articles. In D. Psillos, P. Kariotoglou, V. Tselfes, E. Hatzikraniotis, G Fassoulopoulos, & M. Kallery (Eds.), *Science education research in the knowledge –based society* (pp. 415–423). Netherlands: Kluwer Academic Publishers.

Halkia, K., & Mantzouridis, D. (2005). Students' views and attitudes towards the communication code used in press articles about science. *International Journal of Science Education, 27*(12), 1395–1411.

Halliday, M. (1993). Towards a language-based theory of learning. *Linguistics and Education, 5*(2), 93–116.

Hargreaves, A. (1984). Experience counts, theory doesn't: How teachers talk about their work. *Sociology of Education, 57*(4), 244–254.

Hart, A., & Suss, D. (Eds.) (2002). *Media education in 12 European countries.* Zurich: The Swiss Federal Institute of Technology.

Hartz, J., & R. Chappell (1997) *Worlds apart: How the distance between science and journalism threatens America's future.* Nashville, TN: First Amendment Center, Freedom Forum.

Hatch, A. (2002). *Doing qualitative research in education settings.* New York: SUNY Press.

Hand, B., Alverman, D., Gee, J., Guzzetti, B.J., Norris, S., Phillips, L., et al. (2003). Message from the ''Island Group'': What Is literacy in science literacy? *Journal of Research in Science Teaching, 40*(7), 607–615.

Hartman, S., & Nelson, M. (1992). What we say and what we do: Self-reported teaching behavior versus performances in written simulations among medical school faculty. *Academic Medicine, 67*(8), 522–527.

Henderson, M., & Bradey, S. (2008). Shaping online teaching practices: The influence of professional and academic identities. *Campus-wide information systems, 25*(2), 85–92.

Hobbs, R. (2003). Understanding teachers' experiences with media literacy in the classroom. In B. Duncan and K. Tyner (Eds.), *Visions/Revisions: moving forward with media education* (pp. 100–108). Madison, WI: National Telemedia Council.

Hobbs, R. (2005). The state of media literacy education. *Journal of Communication, 55*(4), 865–871.

Hobbs, R. (2006a). Non-optimal uses of video in the classroom. *Learning, media and technology, 31*(1), 35–50.

Hobbs, R. (2006b). Multiple visions of multimedia literacy: Emerging areas of synthesis. In M.C. McKenna, L.D. Labbo, R.D. Kieffer, & D. Reinking (Eds.), *International handbook of literacy and technology* (pp. 15–28). Mahwah, NJ: Lawrence Erlbaum Associates.

Hoffman, J., Wu, H.-K., Krajcik, J., & Soloway, E. (2003). The nature of middle school learners' science content understandings with the use of on-line resources. *Journal of Research in Science Teaching, 40*(3), 323–346.

Holstein, J., & Gubrium, J. (2003). *Inside interviewing: New lenses, new concerns.* Thousand Oaks, CA: Sage Publications.

Hook, C., & Rosenshine, B. (1979). Accuracy of teacher reports of their classroom behavior. *Review of Educational Research, 49*(1), 1–11.

Hsieh, H., & Shannon, S. (2005). Three approaches to qualitative content analysis. *Qualitative Health Research, 15*(9), 1277–1288.

Jarman, R., & McClune, B. (2002). A survey of the use of newspapers in science instruction by secondary teachers in Northern Ireland. *International Journal of Science Education, 24*(10), 997–1020.

Jarman, R., & McClune, B. (2005). *Science Newswise.* Belfast: Queen's University.

Jenkins, H., Purushotma, K., Weigel, M., Robison, A. (2006). Confronting the challenges of participatory culture: Media education for the 21st century. Retrieved August 25, 2008, from http://www.projectnml.org/files/working/NMLWhitePaper.pdf.

Jewitt, C. (2008). What counts as knowledge in educational settings: Disciplinary knowledge, assessment, and curriculum. *Review of Research in Education, 32*(1), 241–267.

Kachan, M., Guilbert, S., & Bisanz, G. (2006). Do teachers ask students to read news in secondary science?: Evidence from the Canadian context. *Science Education, 90*(3), 496–531.

Kellner, D. (2001). New technologies/new literacies: Reconstructing education for the new millennium. *International Journal of Technology and Design Education, 11*(1), 67–81.

Kind, V. (2009). Pedagogical content knowledge in science education: Perspectives and potential for progress. *Studies in Science Education, 45*(2), 169–204.

King, K., Shumow, L., & Lietz, S. (2001). Science education in an urban elementary school: Case studies of teacher beliefs and classroom practices, *Science Education*, *85*(2), 89–110.

Kirby, D. (2003). Science consultants, fictional films, and scientific practice. *Social Studies of Science*, *33*(2), 231–268.

Kirriemuir, J., & McFarlane, A. (2006). Literature Review in Games and Learning. Retrieved January 12, 2009, from http://www.futurelab.org.uk/resources/documents/lit_reviews/Games_Review.pdf.

Klemm, E.B., Iding, M.K., & Speitel, T.W. (2001). Do scientists and teachers agree on the credibility of media information sources? *International Journal of Instructional Media, 28*(1), 83–91.

Kolsto, S. (2001). Scientific literacy for citizenship: Tools for dealing with the science dimension of controversial socioscientific issues. *Science Education, 85*, 281–310.

Kolsto, S. D. (2006). Patterns in students' argumentation confronted with a risk-focused socio-scientific issue. *International Journal of Science Education, 28*(14), 1689–1716.

Korpan, C., Bisanz, G., & Bisanz, L. (1997). Assessing literacy in science: Evaluation of scientific news briefs. *Science Education, 81*, 515–532.

Koziol, S., & Burns, P. (1986). Teachers' accuracy in self-reporting about instructional practices using a focused self-report inventory. *Journal of Educational Research, 79*(4), 205–209.

Kozulin, A., Gindis, B., Ageyev, V.S., & Miller, S. (2003). *Vygotsky's educational theory in cultural context.* New York, NY: Cambridge University Press.

Kress, G. (2000). Multimodality: Challenges to thinking about language. *TESOL Quarterly*, *34*(2), 337–340.

Kubey, R. (2004). What is media education and why is it important? *Television Quarterly*, *34*(4), 21–27.

Laugksch, R. (2000). Scientific literacy: A conceptual overview. *Science Education, 84*, 71–94.

LeCompte, M., Preissle, G., & Tesch, R. (1993). *Ethnography and qualitative design in educational research.* New York, NY: Academic.

Lee, E., & Luft, J. (2008). Experienced secondary science teachers' representation of pedagogical content knowledge. *International Journal of Science Education, 30*(10), 1343–1363.

Lemke, J. (1990). *Talking science: Language, learning, and values.* Norwood: Ablex Publishing Corporation.

Lemke, J. (2001). Articulating communities: Sociocultural perspectives on science education. *Journal of Research in Science Teaching, 38*(3), 296–316.

Lemke, J. (2004). The literacies of science. In E.W. Saul (Eds.), *Crossing borders in literacy and science instruction* (pp. 33–47). Newark, DE: International Reading Association, Inc.

Lewis, A. (2003). *The effect of trade books on the environmental literacy of 11th and 12th graders in aquatic science*. Unpublished doctoral dissertation, University of North Texas.

Lim, C.P., Nonis, D., & Hedberg, J. (2006). Gaming in a 3D multiuser virtual environment: Engaging students in science lessons. *British Journal of Educational Technology, 37*(2), 211–231.

Lin, C., & Tsai, C. (2008). Exploring the structural relationships between high school students' scientific epistemological views and their utilization of information commitments toward online science information. *International Journal of Science Education, 30*(15), 2001–2022.

Lincoln, Y., & Guba, E. (1985). *Naturalistic Inquiry.* Newbury, CA: Sage Publications.

Love, K. (2009). Literacy pedagogical content knowledge in secondary teacher education: Reflecting on oral language and learning across the disciplines. *Language and Education, 23*(6), 541–560.

Lucasa, P., Martinez, R., & Mendez, L. (2008). Developing new literacies using commercial videogames as educational tools. *Linguistics and Education, 19*, 85–106.

McSherry, G. (2002). Television programming and advertisements: Help or hindrance to effective science education? *International Journal of Science Education, 24*(5), 487–497.

Matthews, S.B., & Davies, D. (1999). Changing children's images of scientists: Can teachers make a difference? *School Science Review, 80*(293), 79–85.

Mares, M., Cantor, J., & Steinbach, J. (1999). Using television to foster children's interest in science. *Science Communication, 20*(3), 283–297.

Marks, L., Kalaitzandonakes, N., Wilkins, L., & Zakharova, L. (2007) Mass media framing of biotechnology news. *Public Understanding of Science*, *16*(2), 183–203.

Martinson, D.L. (2004). Media literacy education: No longer a curriculum option. *Educational Forum, 68*(2), 154–160.

Mayoh, K., & Knutton, S. (1997). Using out-of-school experience in science lessons: Reality or rhetoric? *International Journal of Science Education, 19*(7), 849–867.

Merriam, S. (1998). *Qualitative research and case study applications in education.* San Francisco, CA: Jossey-Bass Publishers.

Meyer, J. (2004). *The Vanishing Newspaper: Saving journalism in the information age.* Columbia, MO: University of Missouri Press.

Mishra, P., & Koehler, M. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record*, *108*(6), 1017–1054.

National Association for Media Literacy Education (NAMLE). Core Principles of Media Literacy Education. Retrieved August 25, 2008, from http://www.amlainfo.org/core-principles.

National Science Foundation (NSF) (2000). *Science and Engineering Indicators 2000* Retrieved August 28, 2008, from http://www.nsf.gov/statistics/seind00/frames.htm.

Nathanson, S. (2006). Harnessing the power of story: Using narrative reading and writing across content areas. *Reading Horizons, 47*(1), 1–23.

Nelson, B.C., & Erlandson, B.E. (2008). Managing cognitive load in educational multi-user virtual environments: Reflection on design practice. *Educational Technology Research and Development, 56*(5–6), 619–641.

Newfield, J. (1980). Accuracy of teacher self-reports: Reports and observations of specific classroom behaviors. *Journal of Educational Research, 74*(2), 78–82.

New London Group (1996). A pedagogy of multiliteracies: Designing social futures. *Harvard Educational Review, 66*(1), 60–92.

Nisbet, M. C., & Mooney, C. (2007). Framing science. *Science,* 316, 56.

Norris, S., & Phillips, L. (2003). How literacy in its fundamental sense is central to scientific literacy. *Science Education, 87*, 224–240.

Norris, S., Phillips, L., & Korpan, C. A. (2003). University students' interpretation of media reports of science and its relationship to background knowledge, interest, and reading difficulty. *Public Understanding of Science,* 12(2), 123–145.

Osborne, J., Simon, S., & Collins, S. (2003). Attitudes towards science: A review of the literature and its implications. *International Journal of Science Education, 25*(9), 1049–1079.

Paradise, A., & Bergstrom, A. (2004, August). Reaching beyond the academy: Introducing elementary school students to media literacy and critical thinking. Paper presented at the meeting for the Association for Education in Journalism and Mass Communication, Toronto, Canada.

Patton, M. (2002). *Qualitative evaluation and research methods* (3rd ed.). Thousand Oaks, CA: Sage Publications.

Perales-Palaciosa, F.J., & Vilchez-Gonzalezb, J.M. (2005). The teaching of physics and cartoons: Can they be interrelated in secondary education? *International Journal of Science Education, 27*(14), 1647–1670.

Peters, J.M., & Stout D.L. (2006). *Concepts and inquiries for teaching elementary school science.* Upper Saddle River, NJ: Pearson Merrill Prentice Hall.

Phillips, L., & Norris, S. (1999). Interpreting popular reports of science: What happens when the reader's world meets the world on paper? *International Journal of Science Education, 21*(3), 317–327.

Piecka, D., Studnicki, E, & Zuckerman-Parker, M. (2008). A proposal for ozone science podcasting in a middle school classroom. *Association for the Advancement of Computing in Education Journal, 16*(2), 203–233.

Pramling, N., & Saljo, R. (2007). Scientific knowledge, popularization, and the use of metaphors: Modern genetics in popular science magazines. *Scandinavian Journal of Educational Research, 51*(3), 275–295.

Pringle, R., & Lamme, L. (2005). Using picture storybooks to support young children's science learning. *Reading Horizons, 46*(1), 1–15.

Ratcliffe, M. (1999). Evaluation of abilities in interpreting media reports of scientific research. *International Journal of Science Education, 21*(10), 1085–1099.

Reis, P., & Galvao, C. (2004). Socio-scientific controversies and students' conceptions about scientists. *International Journal of Science Education, 26*(13), 1621–1633.

Roberts, D. A. (2007). Scientific literacy/science literacy. In S. K. Abell & N. G. Lederman (Eds.), *Handbook of research on science education* (pp. 729–780). Mahwah, NJ: Lawrence Erlbaum Associates.

Rose, C. (2003). How to teach biology using the movie science of cloning people, resurrecting the dead, and combining flies and humans. *Public Understanding of Science, 12*, 289–296.

Ryder, J. (2002). School science education for citizenship: Strategies for teaching about the epistemology of science. *Journal of Curriculum Studies, 34*(6), 637–658.

Sánchez , G., & Valcárcel, V. (1999). Science teachers' views and practices in planning for teaching. *Journal of Research in Science Teaching*, *36*(4), 493–513.

Scheibe, C.L. (2004). A deeper sense of literacy: Curriculum-driven approaches to media literacy in the K–12 classroom. *American Behavioral Scientist, 48*(1), 60–68.

Schneider, R., & Krajcik, J. (2002). Supporting science teacher learning: The role of educative curriculum materials. *Journal of Science Teacher Education, 13*(3), 221–245.

Schussler, E. (2008). From flowers to fruits: How children's books represent plant reproduction. *International Journal of Science Education, 30*(12), 1677–1696.

Share, J., Jolls, T., & Thoman, E. (2009). *Five key questions that can change the world: Deconstruction.* Retrieved January 10, 2009, from http://www.medialit.org/reading_room/article661.html.

Sherman, R., & Webb, R. (1988). *Qualitative research in education: Focus and methods.* London: RoutledgeFalmer.

Shulman, L. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher, 15*(2), 4–14.

Shulman, L. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review,* 57(1), 1–22.

Sorensen, P., Twidle, J., Childs, A., & Godwin, J. (2007). The use of the internet in science teaching: A longitudinal study of developments in use by student-teachers in England. *International Journal of Science Education, 13*(22), 1605–1627.

Srinivasan, S., & Crooks, S. (2005). Multimedia in a science learning environment. *Journal of Educational Multimedia and Hypermedia, 14*(2), 151–167.

Steinkuehler, C., & Duncan, S. (2008). Scientific habits of mind in virtual worlds. *Journal of Science Education and Technology, 17*(6), 530–543.

Stern, P. (2008). On solid ground: Essential properties for growing grounded theory. In A. Bryant & K. Charmaz (Eds.), *The SAGE Handbook of Grounded Theory* (pp. 114–126). Thousand Oaks, CA: SAGE Publications, Inc.

Squire, K.D., & Jan, M. (2007). Mad City Mystery: Developing scientific argumentation skills with a place-based augmented reality game on handheld computers. *Journal of Science Education and Technology, 16*(1), 5–29.

Taasoobshirazi, G., Zuiker, S.J., Anderson, K.T., & Hickey, D.T. (2006). Enhancing inquiry, understanding, and achievement in an astronomy multimedia learning environment. *Journal of Science Education and Technology, 15*(5), 382–395.

Thoman, E., & Jolls, T. (2004). Media literacy – A national priority for a changing world. *American Behavioral Scientist, 48*(1), 18–28.

Tuggle, C.A., Sneed, D., & Wulfemeyer, K.T. (2000). Teaching media studies as high school social science. *Journalism and Mass Communication Educator, 54*(4), 67–76.

Tyner, K. (2004). Beyond boxes and wires: Literacy in transition. *Television and New Media*, *4*(4), 371–388.

Unsworth, L. (2001). *Teaching multiliteracies across the curriculum: Changing contexts of text and image in classroom practice.* Buckingham: Open University Press.

van den Akker, J. (1998). The science curriculum: Between ideals and outcomes. In B. J. Fraser & K. G. Tobin (Eds.), *The international handbook of science education* (pp. 421–448). Dordrecht, The Netherlands: Kluwer.

Wallace, R.M. (2004). A framework for understanding teaching with the internet. *American Educational Research Journal, 41*(2), 447–488.

Wang, M.M., Wu, K., & Huang, T.I. (2007). A study on the factors affecting biological concept learning of junior high school students. *International Journal of Science Education, 29*(4), 453–464.

Weitkamp, E., & Burnet, F. (2007). The Chemidian brings laughter to the chemistry classroom. *International Journal of Science Education, 29*(15), 1911–1929.

Wellington, J. (1991). Newspaper science, school science: Friends or enemies? *International Journal of Science Education, 13*(4), 363–372.

Wells, G., & Claxton, G. (2002). *Learning for life in the 21st century*. Oxford: Blackwell Publishers Ltd.

Westbrook, L. (1994). Qualitative research methods: A review of major stages, data analysis techniques, and quality controls. *Library & Information Science Research, 16*, 241-254.

Wynne, B. (1992). Public understanding of science research: New horizons or hall of mirrors? *Public Understanding of Science*, *1*(1), 37–43.

Yates, B. (2002). Media education's present and future: A survey of teachers. *Studies in media & information literacy education, 2*(3), N.PAG.

BIOGRAPHICAL SKETCH

Michelle Leigh Carlsen was born in Memphis, Tennessee to Richard and Jane Carlsen. After moving north at the age of twelve to live in Pennsylvania, Michelle decided to return to the south to pursue her collegiate education in 1996. Michelle received a Bachelor of Engineering degree in biomedical engineering and a Master of Education degree in science education from Vanderbilt University in 2000 and 2002, respectively. In 2000, Michelle also married Brad A. Klosterman, with whom she has three children: Carstyn, Chase, and Rae. Michelle has taught both middle school and high school science in Ohio, Tennessee, and Florida.

Michelle entered the science education Ph.D. program at the University of Florida in 2005. While pursuing her doctoral degree, Michelle participated in a number of state and nationally funded grants aimed to improve science teaching and learning in K–12 classrooms. She also maintained a constant presence in K–12 classrooms assisting teachers with planning and implementing science instruction. Michelle's research publications and presentations are primarily focused on the infusion of popular media and technology in secondary science classrooms, and on professional development activities to support inquiry-based teaching and learning. In the summer of 2010, Michelle will join the faculty at Wake Forest University as an Assistant Professor of Science Education.