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Using Novels In The Science Classroom To Increase Literacy In Middle School Students

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USING NOVELS IN THE SCIENCE CLASSROOM TO INCREASE LITERACY IN MIDDLE SCHOOL STUDENTS

by

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INTRODUCTION

Introduction

Reading has always been a passion of mine but I never wanted to be a language arts teacher. I do not like writing, reading classics, or poetry, enough to be able to teach it. I have always had an interest in science and you could say it comes naturally. I went into science in school and still continue to pursue it though not in the way I had initially expected. Throughout my journey in becoming a science teacher, I have seen some students be passionate about reading in the form of choice novels, but when it comes to reading about science, the majority of students are downright bored and/or do not understand the text that they are reading. Based on my personal experience and what I have observed in science classrooms, reading a science textbook is notoriously difficult and requires a completely different skill set than reading a choice book. This is the reason why the many students hate it and come to hate science in the long-run. I want to see students be excited by science and be ready and willing to learn about it, including reading about it. This is why I have chosen to research the question: *How does the use of novels in the middle school science classroom impact student reading and literacy skills among ELL students?*

My Beginning

For me school has always come naturally, however many find it surprising that I repeated first grade. Since then, school has always been exceedingly easy. Additionally, I did not go to public school, instead I went to highly competitive private preparatory school in Minnesota which I absolutely loved. As an adult, I know that I was incredibly fortunate to attend this school and I also know that this school is not for everyone. For example, my three other siblings did much better at other schools later than they did at this school. As a result of being in this school I was constantly challenged and I came away with an excellent education and a passion for reading thanks to my English teachers there. In particular, my eighth grade English teacher was the one who led me to favorite genre of science fiction/fantasy when we read *Dragonsong* by Anne McCaffrey. After that I was hooked on the genre.

Ever since third grade I have been reading voraciously on my own, my first passion in life. Prior to that I was read to by my parents. I can clearly remember my mother reading the Ramona books to me or my father reading Berenstain Bear books to myself and younger siblings. After I became a confident, independent reader I read all of the Babysitter Club books, Animorphs, and many other series. My father still read to us occasionally, particularly when he wanted to make sure we read a book and we were not going to read it on our own, so even when I was in fifth and sixth grade my father would sometimes read aloud to us. He read us *The Giver* (almost right after it was published) and *A Wrinkle in Time*. Sometimes I would read more of the books in the series. After *A Wrinkle in Time* I went on to read every other Madeleine L'Engle book I could get. Not

easy when some were out of print already even in the 1990s. In seventh grade, I started looking for some other types of books to read and thanks to my middle school English teacher I got into reading a number of classics, such as *Wuthering Heights* and *To Kill a Mockingbird*. In eighth grade I discovered a new genre of novels, science fiction and fantasy written by female authors. I had been exposed this genre before but it was always male authors and I was unable to identify with the male protagonists. Since eighth grade I have pretty much stuck with this genre in various forms. I will reread my favorite books, such as *Arrows of the Queen* by Mercedes Lackey, *Wild Magic* by Tamora Pierce, *The Blue Sword* by Robin McKinley, to name a few, many times. Even after having read a particular book already 15 times, I will still read it again a year or two later.

My second passion in life is science. One could possibly say that I came by it naturally. My father has a PhD in biochemistry, with a bachelor's and master's of science in botany. My mother also has a bachelor's of science in zoology. My parents have never pushed their goals on any of their children but they were there if we needed help, particularly when it came to topics like science.

When I finished high school and went to college I knew going in that I wanted to major in biology. I graduated with a bachelor's of science in four years and immediately went to graduate school because I knew that I would not be able to get a job in a science field without at least a master's degree. I finished a master's of science in biology in two years, unheard of in science, but I had the unfortunate timing of graduating in the spring of 2009 during the height of the recession, so years later I decided to go back to school

for a PhD. However, I decided the leave the program after two years due to a lack of funding.

During graduate school, I did a lot of graduate student teaching. I discovered I liked teaching, however I did not decide to make it a career until a year after leaving my PhD program. I really liked getting to share my love of science with students and being able to give advice to students about their future science careers. I also noticed at this time that even undergraduate students had a difficult time reading science textbooks, but it did not really become an issue for me until I started teaching middle school students. Not even undergraduate students could read a textbook and effectively summarize it due to the difficulty level from the vocabulary and the complex sentences. Oftentimes students would skip reading the textbook all together in favor of getting their information exclusively from lectures and to a lesser extent the lab manual. Personally, as an undergraduate student, I never read my textbook either. I believe that some of this is due to a lack of preparation in schools for reading textbooks and learning how to take notes on what was just read (Moje, 2008; Ness, 2007), and the other reason was not having the time in which to actually read it.

When I started the teacher licensure program at Hamline, I only needed to take the education classes because of my background in biology. After two semesters, I decided to expand my licensure to include middle school science, which required I pick up three content classes. This is one of the best decisions I made, as I was able to pursue other areas of science and increase my knowledge base. In the end, I got my license and I have been teaching middle school science ever since. I have been working in charter

schools with very different styles (project-based versus traditional), which is where I came across my research question and purpose for my capstone.

The Purpose

There are two purposes to my research question. The first is that there is a literacy crisis among students in the United States. Children spend vast amounts of time on screens such as computers, phones, tablets, televisions, and gaming systems (Ofcom, 2014). When children are on a screen, as long as they are not watching something, they are reading constantly, but because they are not spending time reading anything of quality or reading increasingly difficult texts, they are not progressing as readers (Bohme & Barton, 2013; Duusrsma, Smith, & Jones, 2017). This is addressed in the schools where there is a push for literacy among all students, however it is mostly reflected through their language arts classes and somewhat in their social studies classes through readings other than those from a textbook. It is generally not reflected in any of their other classes.

The second purpose of my research question has to do with getting students excited about science and being excited about reading in science. I have noticed that there are basically two types of science classrooms currently in schools-the textbook-heavy and the lecture-heavy classroom. The textbook-heavy classroom does what its name implies. It is heavy on textbooks with some labs and lectures thrown in. Science textbooks require a specific skill when reading them (Ness, 2007). If students are not trained in how to read a science textbook, then they have a lot of difficulty with it and it tends to destroy their confidence in both reading and in the subject of science (Biancorosa & Snow, 2004). Many times, students are simply told to read a specific set of pages in their textbook and

then are expected to somehow know the information that they read about. They are not taught how to read a science textbook or how to take notes from one (Ness, 2007). Newer teachers are starting to do more of the teaching of reading science textbooks, but in many classrooms this often gets left behind because the teacher feels that there is too much information to cover to waste time on teaching students to read a book when they already know how to read (Jacobs, 2008).

On the other end is lecture and activity/lab-heavy curriculum, where students never touch a science textbook or any other book for that matter and instead read lecture slides and activity sheets without really increasing their science literacy. This type of classroom is designed specifically so that students will be more interested in science because most of the time is spent doing labs and activities (Huerta & Spies, 2016). However, these are the classrooms where there are no science textbooks. Teachers are ultimately doing a great disservice to students in the future because when they get to college, they will not have any experience with reading science texts and will have no idea how to use a textbook (Smith, Holliday, & Austin, 2010). This will make the science class(es) that they have to take more difficult than it needs to be. Leaving all the literacy up to social studies and language arts will not prepare students for life after they finish high school. Those classes may cover non-fiction texts but they are not in the form of a science textbook.

What I propose is to meet somewhere in the middle. My guiding question is *How does the use of novels in the middle school science classroom impact student reading and literacy skills among ELL students?* I want to not only do my part in helping with the

literacy crisis in the United States but also keep students interested in science. Students need to increase their science literacy but they also do not need to spend all their time reading science textbooks either. Science textbooks have a purpose in science classes but students need to be taught how to read one and use it effectively as a learning tool (Biancorosa & Snow, 2004; Ness 2007). The literacy from reading can easily come from non-fiction and fiction novels that surround a science-related topic and are far more of a high-interest read for the majority of students than reading a textbook (Anderson & Hite, 2010; Batchelor, 2017; Coiro, 2012; Freudenrich, 2000). Using other sources of text than science textbooks could have similar results to using science textbooks effectively and my goal with this project is to increase literacy in middle school grades by adding additional reading sources in the science curriculum than just textbooks.

Through this capstone project I plan to create a curriculum for use in the middle school science classroom by adding novels to the existing curriculum. I will be creating 8th grade curriculum with a fiction novel for use within the mega-unit on space. This whole class novel is meant to supplement the curriculum and get students reading about science, showing students through fiction that science does not have to be "dry and boring."

Chapter Two of my capstone will be a literature review of science and literacy in the secondary classroom. I will focus on literacy using science textbooks as well as literacy using novels to teach content. I will also include a section on literacy in ELL students as the majority of my current student population is ELL learners. Chapter Three will be a project description where I will give an overview of how I created the

curriculum for the fiction novel as well as how I adapted the curriculum to fit my target audience of largely ELL students. Chapter Four will be a reflection on the capstone project delineating the parts of the literature review which were most useful to my project and some implications for the project. I will also discuss how the project can be utilized in other schools and why it is a benefit to the profession of teaching science.

CHAPTER TWO

LITERATURE REVIEW

Introduction

Science can be a tricky subject to teach in terms of the literacy demand of students. Science teachers need to teach a large number of new vocabulary words every year which students are unlikely to see again outside of science. Students also need to be able to read a science text which is very different and more difficult than a non-fiction text from English language arts (ELA) or social studies (Moje, 2008). Students need special instruction in reading a science text in order to retain the information (Biancarosa & Snow, 2004). Additionally, an increasing number of students are English language learners (ELL). As of a survey in 2015, the national average was about 10% of students were ELL and in Minnesota the percentage of ELL students in public schools was 8.2% (National Center for Education Statistics, 2018). My guiding question is *How does the use of novels in the middle school science classroom impact student reading and literacy skills among ELL students?* This chapter discusses the challenges students face in the science classroom with regards to literacy, best practices for teaching science literacy, and other options for text in the science classroom with an emphasis on ELL students. I will also go into other texts and their uses in the science classroom and discuss the place

that novels have in the science classroom and how they may increase science literacy in students.

Science Literacy and Its Difficulties

The expectations for literacy and reading skills changes as students move from elementary school and into middle and high school. In science texts between grade levels this is no different. For example, comparing text on the same topic in three different grade level textbooks (fourth, seventh, and tenth), Biancorosa (2010) stated that at a fourth grade level the vocabulary has words no more complex than *reproduce* and *example*. When one gets to seventh grade, the textbook introduced words like *ancestors* and *characteristics* while by tenth grade students need to be to handle the word *psilophytes* in addition to the other technical words from previous grades. Additionally, there is a dramatic increase in the need of students to be able to synthesize information across multiple texts and formats which include graphs, tables, pictures, and figures (Biancorosa, 2010). Sentences in these textbooks get longer and more complex as the structural devices, readily found in elementary texts, meant to support comprehension become fewer (van den Broek, 2010). It is no wonder that students have problems reading science texts. When one adds in the factor of also being an ELL student as well, these students have great difficulty reading and understanding science texts.

In order for students to get through a subject area text and understand it, the student needs to have an understanding for what "counts" within each discipline (Biancorosa, 2010). For example, asking a student about the *characteristics* of an object or organism in science equates to asking about the object's or organism's physical

properties. Whereas in an English Language Arts class, if a student is asked to describe the *characteristics* of a character the student needs to recognize that they need to state things about the character's personality in addition to any physical properties. In order to support students in literacy in any subject it requires "…simultaneous attention to the needs of the students who have not mastered basic reading skills and to the common need of all students to master ever-more-challenging texts in ever-changing contexts for increasingly divergent goals" (Biancorosa, 2010, p. 26). When considering what is required of students in the science classroom and other classrooms, it no wonder that ELL students have great difficulty with scientific literacy in the middle and upper grades. When investigating science literacy in relation to ELLs, it is important to understand the difficulties that are faced by all students when it comes to the typical science text. ELL students will have an even more challenging time with these texts as they do not yet have the technical language necessary to decipher these texts. In the next section, I will discuss specific problem areas for ELL students and strategies that can be used to help them as well as other non-ELL students.

ELL Students-Literacy in the Science Classroom

ELL students often end up behind in school in all subjects, particularly when it comes to literacy and reading skills as it takes many years for a student to become proficient in English (Bautista & Casteñeda, 2011). These students have to learn English and simultaneously are expected to keep up in each content area no matter their grade level. In 1983, Chall described that after a student is in grade three they are no longer learning to read but reading to learn (as cited in Biancarosa, 2010). For students who

come into the country later, this makes their job harder because they have to be able to read and understand English in order to master content. Students who start in kindergarten with no English are similarly behind, however at this point they are learning to read and are not mastering content through reading (Chall, 1983; as cited in Biancarosa, 2012). The next section I will describe ELL students and the challenges they face with a particular emphasis on the science classroom. The different subtopics in this section will be ELLs and science literacy, and several science literacy strategies that can be used to help ELLs in the science classroom.

ELLs and inquiry-based science. Science is a great way to engage students of all backgrounds, ELL students are no exception (Capitelli, Hooper, Rankin, Austin, & Caven, 2016). Using inquiry-based science not only leads to better engagement among students, but also is an effective way for students to understand science ideas and practices (National Research Council, 2012). Students who are discovering phenomena for themselves, investigating how it works, and then learning more about it from a trusted source, such as a teacher, are more likely to remember the main idea. ELL students benefit greatly from inquiry-based science because they are engaged enough in the topic that they want to be able to talk and write about what they are doing, witnessing, or discovering for themselves (Capitelli et al., 2016).

Inquiry-based lessons are excellent at engaging students and encouraging them to learn more about natural phenomenon. They also provide many opportunities for students to improve their language skills through discussion with peers and writing (Grooms, Enderle, Hutner, Murphy, & Sampson, 2016). There is a lot of value for ELL students in

lessons that include opportunities for students to write (Lee, Maerten-Rivera, Penfield, LeRoy, & Secada, 2008; Shaw & Nagashima, 2009; Tong, Irby, Lara-Alecio, Guerra, Fan, & Huerta, 2014). Science notebooks are a great way to increase writing in ELL students and are highly useful in inquiry-based science lessons when used correctly. Entries can include pictures, schematics, labels, and diagrams as a way to scaffold students' academic language acquisition and understanding of the concepts (Huerta & Spies, 2016).

As noted by Weinburgh, Silva, Smith, Groulx, and Nettles (2014), ELL students are highly engaged when in inquiry-based science lessons. But these lessons were not originally built with ELL students in mind, so Weinburgh et al. (2014) created two inquiry-based science units which included specific language goals for the students. The units showed a clear growth in ELLs supporting their claim that ELLs would grow in their understanding of topics and they also used more language to communicate their knowledge. The model that Weinburgh et al. (2014) used included repeating, revealing, repositioning, replacing, and reloading language. For example, Weinburgh et al. weaved vocabulary throughout the lessons, words were then added to strips of paper as they came up and placed on a word wall for a later return when they came up again.

Language acquisition and science. There is considerable research showing connections between language acquisition and science (Fradd & Lee, 1999; Pearson, Moje, & Greenleaf, 2010; Stoddart, Pinal, Latzke, & Canaday, 2002). Students who are engaged and want to share their learnings are more motivated to learn new language and phrases in order to be able to share those ideas. At the same time, the language demands

in science show that explicit teaching of language is necessary in order to for students to succeed (Quinn, Lee, & Valdés, 2012). In order for teachers to effectively teach and enhance ELL student literacy skills, they need to develop their views to what is current in language acquisition and then fit it to their curriculum (Capitelli et al., 2016).

Of particular difficulty for ELL students in science are nominalizations and connecting words (Román, Briceño, & Basaraba, 2018). Nominalizations are words that get their origins as a verb or adverb (e.g. *evolve* and *radioactive*) but are also used as nouns (e.g. *evolution* and *radioactivity*) (Fang, 2008). Connecting words are words used to show relationships between phrases and sentences (Román et al., 2018). These words help ELL students and others understand texts, however they are often left out to shorten sentences in upper grade level textbooks. Both nominalizations and connecting words are important because they help students understand that science texts are coherent units and not a collection of technical words (Román, Briceño, Rohde, & Hironaka, 2016). As students progress through the grades, textbooks start to leave out more and more of the connecting words that appear so often in texts in the lower grades, reiterating important points and connecting ideas together. These get left out in the upper grades and so ELL students, as well as students who have difficulty with reading comprehension, are less able to understand texts. There are many strategies that can be used by teachers to help ELLs in the classroom which have the added bonus of being able to help additional students. The next section will discuss the science textbooks, literacy, and the problems faced by all students when confronted with this type of reading.

Science Textbooks and Literacy

Until recently, the burden for learning from text in science classrooms was placed on the student (Jacobs, 2008). As reported by Kamil, secondary content-area textbooks are notoriously difficult not only to read but to recall information from after reading and in secondary school the ability of students to be able read and understand this type of text is critical to student success (as cited by Ness, 2007, p. 229). These textbooks are also often written at a level that is above the grade they claim to serve (Walton, 2006). Explicit instruction is needed in how to read and recall information from a science textbook (Biancorosa & Snow, 2004, as cited by Boardman et al., 2015). This section will detail the pros and cons of the use of science textbooks in the classroom as well as the methods that result in the best results for reading and understanding a science textbook.

Content-area literacy. Chauvin and Theodore (2015) defined content-area literacy as "the ability to use reading and writing to learn a subject matter in a particular disciple" and it "emphasizes a set of study skills that can be used across content-areas" (p. 2). Students need to be taught to think about what they read and to come up with meaning of what they read (Harvey & Goudvis, 2007). When it is used correctly, the strategies should not take extra time away from teaching but should be used as a vehicle to teach content material (McGlynn & Kelly, 2018).

As recently as 2007, teachers were not instructing students in reading comprehension for science textbooks (Ness, 2007). Ness saw on average only 3% of instructional time being devoted to reading comprehension. Strategies for reading

comprehension should include asking and answering questions, summarizing, using fix-it strategies when comprehension broke down, examining text structures, using graphic organizers, predicting, and clarifying. However, Ness only observed very limited strategies, such as literal questions and writing summaries, when teachers actually devoted some class time to textbook reading comprehension. Several studies have shown that teachers need to spend time teaching students how to read their textbooks (Biancarosa & Snow, 2004; Boardman et al., 2015; Brown & Concannon, 2015; Yore et al., 2003). For example, Boardman et al. (2015) found that students who had explicit strategy instruction in reading a textbook combined with student-led discussions of the text performed better on tests compared to students who did not receive this instruction. Brown & Concannon (2015) found a similar result to Boardman et al., however they used multiple literacy strategies with a group of eighth grade students and found their reading comprehension scores increased from anywhere between 10% to 90% depending on the terminology being used.

With the amount of vocabulary in textbooks it is quite common for students to have problems reading textbooks. Groves (2016) found the average number of vocabulary terms per page in science textbooks to be between four to seven depending on the publisher. When one considers that those learning a foreign language average about 300 words or less per year, over a seven year time span that is less than 2,100 words (Milton, 2006). However, in one year a Pearson biology textbook potentially introduces 2,900 science terms and McGraw-Hill Interactive Science has over 1,900 words (Groves,

2016). Learning science is similar to a foreign language because of the emphasis on vocabulary, particularly low frequency terms. It is a source of difficulty for students who struggle with comprehension (Kelley, Lesaux, Kiefer, & Faller, 2010). It is no wonder that science students may have low motivation if they see the reading and vocabulary tasks as either not worthwhile or too difficult. Groves stated that "…science classrooms can be viewed as a type of discourse commonly found with its own language that is heavily mediated by textbooks, … " (p. 321).

With so few teachers teaching students how to read textbooks combined with the massive vocabulary load that is expected of students, many students feel overwhelmed by textbooks, leading teachers to reduce or completely eliminate the number of readings students get in school from textbooks and instead focus on high interest activities and labs (Stoddart, 2016; Yore, 2012). This is a great disservice to students as they need to be able to decipher these texts and will have problems when they reach college. In fact, Smith, Holliday, and Austin (2010) found that first year college students are not proficient at comprehending informational text. However, when students were assigned a questioning strategy for use with these texts, comprehension by students increased by approximately 6%. Reading comprehension strategies for textbooks work quite well and teach students how to be critical of the texts that they read (Boardman et al., 2015; Brown & Concannon, 2015; McGlynn & Kelly, 2018), a necessary life skill. Next, I will discuss other text options besides textbooks in the science classroom.

Other Texts in the Science Classroom

Outside of the standard science textbook, there are many other types of texts that can be used in the science classroom to supplement what students are learning. For example, science news articles are a common resource for teachers to use (Jarman & McClune, 2001). Additionally, when students are doing a project they will likely access the internet for their research and will be reading information on websites, which will likely be of an informational form but oftentimes is not a news article. Less used in the science classroom are books or novels, though science fiction has been used in the form of television shows and movies (Freidenrich, 2000). Picture books are used more often in grade school but they can have a place in secondary school as well (Batchelor, 2017). This section will discuss the different types of texts that are not textbooks that can be found in the science classroom and how they are currently used.

Picture Books. When one thinks of using picture books in the classroom, one tends to think of their use in elementary classrooms only. However, picture books can have a place in the secondary content classroom as well. Batchelor (2017) discussed the role of picture books in a social studies classroom. Picture books provide more information than a textbook (Vacca, Vacca, Gove, Burkey, Lenhart, & McKeon, 2009). They allow students to draw more meaning from a text through the addition of illustrations which set a tone for the story, clarify concepts, and generally enhance the story (Vacca & Vacca, 2002). Many content area teachers focus almost exclusively on information from textbooks (Levstik, 2008), however they have a place in content-area classrooms as they are excellent at adding interest to the topic at hand. Introducing a unit with picture books can often stimulate curiosity and interest in students (Batchelor,

2017). Students have more conversations around the text because of the pictures. They are also very helpful to ELL students as they provide a frame of reference for what the text is about (Batchelor, 2017). While, this is a social studies classroom, students in a science classroom would benefit in the same manner.

Internet reading. Using the internet as a resource has become increasingly popular with teachers in recent years. Students generally think the internet makes learning more interesting and as a result they work harder and are happier (Coiro, 2009; as cited by Coiro, 2012, p. 646). However, students also feel that it's is easy to "get lost" and that the internet can make it more difficult to find useful information (Coiro, 2012). Despite this, adolescents still want to use the internet because they believe the internet is more valuable than researching information from a book (Coiro, 2012).

This desire of adolescents to use the internet can be easily combined with the use of news articles. While this type of research is most common in biology classrooms, it can be used in other classrooms as well (Jarman & McClune, 2001). The common intention of teachers is to highlight links between school science and science in everyday life. It can be used to critically evaluate science reports in the media (Jarman & McClune, 2001). Online reading benefits include sources of material for projects, information search, debate, extended writing, etc.

Science fiction. Science fiction has a place in the science classroom as well. Freudenrich (2000) uses science fiction works, such as television shows, novels, and movies, as a jumping off point for topics to explore in science. Students can explore basic principles and ideas in fields such as physics, astronomy, biology, chemistry, space

exploration, and Earth science. Freudenrich starts by having students watch or read a work of science fiction, such as watching an episode of Star Trek. Afterwards, students and teacher make a list of relevant topics and the students conduct a relevant inquiry investigation.

Novels in Non-English Language Arts (ELA) Classrooms

Reading across content areas has been shown to be one of the more effective ways to increase literacy and reading skills in students (Rainey & Moje, 2012). Novels are used frequently in the English language arts classroom (Santoli & Wagner, 2004) and it is part of the Minnesota state standards (Minnesota Department of Education, 2010). However, that is not the only classroom where novels can and should show up in the curriculum. Other content areas, will add to their course texts with outside material such as from news articles and internet web pages, however most do not use novels. This section will discuss the benefits of using novels in other classrooms and how they can be implemented within the curriculum.

Literacy among adolescent students has been falling for years (as cited in Rainey & Moje, 2012). It is "…critical for the improvement of students' academic literacy development and overall learning that all teachers and literacy researchers attend to the teaching of disciplinary literacy in every subject" (Rainey & Moje, 2012, p. 73). Students must be taught in every discipline content-area literacy and have it be reiterated in other disciplines in order for literacy skills to improve. However, there exists a common problem to literacy among the content-areas and that is that the texts are often dull and boring. For example, students in the ELA classroom often balk, complain, become

impassive, and/or fall asleep when faced with the classics (Santoli & Wagner, 2004). The same can easily be said for the reading of science textbooks. However, some ELA teachers have started to integrate young adult literature into their curriculum as it allows the teachers a way to still present the necessary literary elements found in classics but engage adolescent students (Santoli & Wagner, 2004).

Novels in the science classroom. Novels are traditionally not used in the science classroom, however they are quite common in the ELA classroom. The use of young adult literature makes novels even more engaging, unlike the typical textbook. Science fiction novels are an excellent way to engage students in science ideas while also helping students improve their literacy skills. Creech and Hale (2006) used fiction novels in one of their quarterly reading projects, where students select a fiction book from a list and participate in a book group. As part of their quarterly reading projects, students are asked to write questions, short summaries, or personal connections to what they are reading. Kilby-Goodwin (2010) has a "Putting the Science in Science Fiction" project that she does with her classes. Students select a book from a list. They read the book and write a short critique of the book. Then students select a research topic based on a scientific idea in the book. Students must find five credible sources and link them to quotes from the book. At the end students write a short report on their research topic.

One suggested reading strategy for novels comes from Anderson and Hite (2010). They stated that if readers have little or no prior knowledge of a book's subject, comprehension and enjoyment are impaired. They suggested that the teacher go through a pre-reading schema with students in order to peak their interest in the book. The first step

is to “Begin at the End.” This involves having students start on the last page of text and look at each page following that until they reach the back cover. Sometimes books have an afterward, glossary, maps, and/or other critical information. The second step is “Cover to Cover.” This step has students reading author biographical information and the back cover or inside cover book summary. The last step “Finish at the Front,” has students reviewing all front material up to the first page of text, including any illustrations on the front cover. Even the publication date can be important for students as it can give a time frame for what they are about to read. The teacher can model this as a “think aloud” and students may write the information down in a graphic organizer for later perusal. In the next section I discuss the reading and literacy strategies that have been shown to be effective with ELL students as well as other students in the science classroom.

Strategies for Teaching Reading to ELLs in Science

There are a large number of researched strategies that have been used with ELL students as well as with students who are not ELL. These strategies have been used in research and have been shown to increase reading skills and comprehension in students who are taught to use them effectively. This section begins with planning for ELL students in the classroom and then discusses strategies for reading and literacy skills to aid students in their understanding of science.

Planning strategies for teachers with ELL students. Baustista and Casteñeda (2011) gave a list of strategies for teachers when it comes to planning for classes containing ELL students. The first of these is to be sure one knows the ELLs’ language proficiency levels. A teacher will have a difficult time with instruction if they planned for

ELL students with a WIDA level of four (WIDA, 2018; see Appendix A: WIDA-Overview of WIDA Framework and Appendix B: WIDA-Can Do Descriptors for Grades 6-8) but in actuality have a range of students with levels ranging from two to three. For example, students at a level four should be able to write a multiple paragraph essay and justify their ideas but a student at a level two would only be able to write short, simple sentences (WIDA, 2018; see Appendix B: WIDA-Can Do Descriptors for Grades 6-8).

The second step in planning described by Bautista and Casteñeda (2011) is to align content and language objectives. The language objectives should focus on the specific vocabulary, grammar, rhetorical, and discourse structures that are needed to learn the science content. The third step is to create a link between background knowledge and science instruction. Good teachers do this naturally, but for ELLs this step is especially important as it helps the students to connect phenomenon they already know about to the concepts being taught and connect new vocabulary to these topics.

Bautista and Cateñeda (2011) also gave advice for planning instruction with ELL students in mind. The first of these tips is to make sure to provide opportunities for input and output. The input needs to be comprehensible, using language that is within the realm of understanding for ELLs but is just beyond their current level of competence. Examples of activities which will help with this facet are simulation activities with visuals and poster presentations. Another item to include when planning for instruction is opportunities for interaction. An excellent way to do this is small group work. The third tip is to use performance-based assessment when possible.

Providing visuals. Using visuals is a common and recommended practice for ELLs (Wright, Eslami, McTigue, & Reynolds, 2015). However, not all textbook visuals are equally useful to students and ELL students in particular. In fact, one study found the typical visuals normally found in textbooks to have no advantage for ELL students in science text comprehension (Ardasheva, Wang, Roo, Adesope, & Morrison, 2018). Visual aids are popular because they support vocabulary development however as students advance through the grades, the difficulty and importance of content vocabulary increases and so students need more support in understanding their texts (Wright et al., 2015). Many graphics in textbooks are less than ideal when it comes to providing useful visuals with appropriate captions.

Wright et al. (2015) gives a list for teachers to use when checking their texts for appropriate graphics and visual aids. The first of these is whether the graphic models a system. The more useful visual is the system as a whole, however most U.S. science textbooks only show an isolated unit of the complex idea. The next tip is to make sure the graphic is near relevant text. Graphics are not always located near the text to which they are referring, sometimes they are even located on the next page. The third tip is to note whether the text references the graphic. Students will often neglect to look at a graphic in favor of continuing to read the text in order to get it over with. They are more likely to look at a graphic when the text says something to the effect of "…pause now and look at …" versus "see Figure 1" (Wright et al., 2015). The next tip is to closely examine the captions used by the text. Captions can have too little information or too much. Very few have the right amount of information (see Figure 1) (Wright et al., 2015). ELL students

have difficulty picking out the relevant information from the caption when there is too much information and it tends to confuse them.

FIGURE 3

Sample text, corresponding graphic, and possible captions.

Text and visual from a seventh-grade science lesson on cells

"Robert Hooke was the first person to describe ***cells***. In 1665, he built a ***microscope*** to look at tiny objects. One day, he looked at a thin slice of cork. Cork is found in the bark of cork trees. The cork looked like it was made of little boxes." (Supreme Education Council, 2010)

Simplistic Caption	Caption with Superfluous information	Ideal Caption
An early microscope	Figure 3: In the 11th century, the Arab Alhazan was the 1st to describe the use and the characteristics of glass lenses. Around 1600, the microscope was invented, possibly by Hans and Zacharias Jansen	Figure 3: A microscope similar to the one Robert Hooke may have used when he first described cork cells.

Microscope © Alan.hawk / Wikimedia Commons/ CC-BY-SA.3.0

Figure 1. Text from a textbook and accompanying graphic with several captions. The caption with superfluous information was found with the original graphic (Printed with permission: Wright et al., 2015).

Vocabulary and language acquisition strategies. Capitelli et al. (2016) described a few strategies that work well with ELL students regarding vocabulary and language acquisition. The first is to have students talk while they write down words. This works especially well with younger children but can also be useful with older students.

Another strategy is to allow ample opportunity for student experiences with phenomenon as it is more than just an opportunity for language learning but also supports the development of new language. The last important strategy to remember is to keep ideas in science complex, as it is better for ELL students' language development.

Textbook literacy strategies. Strategies for ELLs involving a textbook are important as well. Science textbooks are difficult for everyone, not just ELL students (as cited by Ness, 2007). Román at al. (2018) described two useful strategies for ELLs. The first of these strategies is called interactive editing. This is when the teacher picks a meaningful paragraph or chapter section to summarize. It is done by starting with a choral read of the selected text so that ELL students can hear the correct pronunciation of unfamiliar words. Next, the teacher and students pick out keywords or phrases, focusing on nominalizations and connecting words. Sometimes the teacher will need to define words and model explanations of why these words and/or phrases are important. Finally, the teacher and students use the keywords and phrases to collaboratively rewrite the text in the students' own language being sure to underline the keywords and phrases. The strategy is particularly useful for key paragraphs and chapter sections. It is also possible to use this strategy on large sections by having students split into groups and giving each group a different section to use the strategy with. At the end, each group shares their new paragraph.

The second strategy from Román et al. 2018 is called "Translation Charts." In this strategy, students create a T-chart where one column has "What the Textbook Says" and the other column has "Whole-Group Translation." The former column has exact sentence

quotes from the textbook while the latter column is a translation of the sentence into words that are easier to understand. This strategy can also be adapted for note-taking from textbook. Like the previous strategy, the teacher should lead the use of the strategy until students are sufficiently comfortable with it to be able to do it in small groups and then on their own.

Another type of textbook strategy that can be used with students involves the graphics and their captions found in the text. ELL students can have a difficult time deciphering the caption and graphic, therefore one strategy for teachers to use with students is to lead students through writing a better caption for the graphic (Wright et al., 2015). Often these captions have unnecessary information, so one option is to lead students through writing a summary of the caption. Another option is to have students underline or highlight information that directly supports the idea. This teaches students to identify the purpose of a visual and to be critical of it (Wright et al., 2015).

Assessment for ELLs. When it comes to assessment for ELLs some accommodations should be made for their lack of language skills but still assess their content knowledge. Casteñeda and Bautista (2011) offered several ideas for assessing ELLs appropriately according to their content knowledge. Some of these include providing a word bank, allowing students to use pictures rather than words, using yes or no questions instead of true or false, limiting choices, providing examples, and creating matching items. Additional ideas are highlighting key vocabulary, avoiding reduced or embedded clauses and passive voice, using shorter sentences, and using high frequency

words and questions rather than sentence completions (Flaitz, 2009; as cited by Casteñeda & Bautista, 2011).

Collaborative Strategic Reading (CSR). Boardman et al. (2015) used Collaborative Strategic Reading, or CSR, to increase student test scores. CSR uses a combination of explicit instruction, scaffolding, peer-mediated learning, and embedded supports for struggling readers and ELLs. The explicit instruction provides students with the knowledge and self-regulation skills needed in order to be able to read independently and successfully. Students are taught how to use the strategy, when to use it, and why it is important. The strategies used in CSR activate prior knowledge and set a purpose for reading; monitor understanding and take steps to fix comprehension when it breaks down; find the main idea of short sections of text; and generate questions and review key ideas. Sweetman and Sabella (2018) used a very similar strategy called the strategic research cycle which teaches students how to decide whether information in the text is important to the purpose.

Other text reading strategies. Martin (2006) provides several strategies with different purposes in mind for students that are meant to improve reading comprehension and writing. Strategies for understanding the text include: encouraging note taking to clarify ideas, challenging or questioning the text, stopping occasionally to evaluate comprehension, rereading and revising understanding, and predicting what will come next. Martin also suggests predicting answers such as posing True or False statements from the text prior to reading (see also McGlynn & Kelly, 2018), followed by reading and then a follow-up by the teacher. KWL (What I Know, What I Want to Learn, What I

Learned) charts, SQ3R (survey, question, read, recite, review), and agree or disagree for controversial topics are also good strategies for student comprehension (Martin, 2006).

McGlynn and Kelly (2018) have many strategy suggestions for teachers trying to increase textbook reading comprehension. Prior to reading they suggest the use of anticipation guides, admit slips, list-group-label, FLIP (Flip, Look, Information, Predict), text feature outline, and examining visuals. Examining visuals is especially useful because it helps point out text features and draws attention to useful information that is not part of the text (Batchelor, 2017). Examining visuals can also be used as a during reading strategy which encourages students to pause in reading and look at diagrams, tables, graphs, and pictures (McGlynn & Kelly, 2018). Marking up text and double-entry journals are both suggested strategies for during reading and after reading. ABC books are suggested as an after reading or unit strategy to help tie all the terms and content together for one unit (McGlynn & Kelly, 2018).

Accardi, Chesbro, and Donovan (2018) delineate a strategy called outlining informational text. This strategy allows students to analyze and evaluate information, then creatively organize it in a hierarchically structured framework. This strategy will need to be taught to students on several occasions, each time giving the students more independence, until they are able to do it on their own.

Taken in context, textbooks can be read and understood by students when given proper instruction in how to do it. Unfortunately, many teachers do not give instruction and instead assume students can read and comprehend the textbook or do not give any reading. As long as teachers use text comprehension strategies, textbooks still have a

place in the science classroom but there are other choices out there than focusing all content-area reading on a textbook. The next section will discuss strategies for reading texts other than science textbooks and their potential role in the science classroom.

Strategies for reading. Strategies suggested in this section on textbooks and ELL students will work for any readings. An additional strategy for reading other texts comes from Brown (2016) who uses a somewhat different approach to having students read. The primary difference is that students first learn about the topic prior to reading through a variety of lab activities. This is different from most teachers who often introduce topics through readings and then they do the lab activities. For Brown, student experiences are important for developing science vocabulary and conceptual understanding. After this, students were asked to read an article which challenged them because of complex academic and discipline-specific vocabulary and needing extensive knowledge of science concepts. Students then used the 5S strategy, analyzing the structure, speaker, situation, shifts, and summary statements (as described by Brown, 2016), to evaluate the article.

Students find reading other texts than textbooks to be more engaging and oftentimes less difficult. Students need instruction in these texts but mostly they need opportunities to negotiate real texts for real purposes (Ivey & Fisher, 2005). They can find curriculum-based topics interesting, and comprehend what they are reading, but unfortunately teachers do not always use texts and methods that highlight what is interesting about the subjects that are taught (Ivey & Fisher, 2005). I believe that this is why we should incorporate more novels in science curriculum instead of simply focusing on textbooks.

Conclusion

Reading and literacy skills in the science classroom can be addressed in many ways with regards to all students and in particular ELL students. ELL specific strategies are great for any type of reading in the science classroom and help other struggling readers as well. Textbooks have their place in the science classroom and it is critical that students be able to read a textbook for later in life (Biancarosa & Snow, 2004), however that is not and should not be the only type of reading that students do in the science classroom. My research question *how does the use of novels in the 6-8 science classroom impact student reading and literacy skills among ELL students* aims to get readings in the science classroom away from the strict adherence to the textbook. Textbooks can be very difficult for students to comprehend. For the ELL student, textbooks contain so many content specific vocabulary words (Groves, 2016) that ELL students have very little hope of being able to read and comprehend what they are reading. Teachers can add in other readings from the internet and news articles which brings the reading level down to a more manageable level, however students are more willing to learn and spend the time to learn new vocabulary when highly engaged in what they are reading (Weinbugh et al., 2014). I argue that using fiction and non-fiction novels in the science classroom will aid in student engagement while helping to increase student literacy and reading skills. The following chapter will discuss how I created supplementary curriculum around this topic for a population of ELL students.

CHAPTER THREE

PROJECT DESCRIPTION

Introduction

Reading in science can be extremely difficult for students. There is very high vocabulary content in science textbooks, up to 4-7 terms per page (Groves, 2016). English language learners (ELLs) have even more difficulty with science text reading as not only are there the usual vocabulary for students but they are also learning a language at the same time and therefore there are even more terms per page that they will need to learn in order to understand any given text (Bautista & Casteñeda, 2011; Biancorosa, 2010). Due to the difficulty of reading science texts, many students get discouraged and frequently give up (Capitelli et al., 2016). Therefore, I decided to investigate ways that could increase literacy in the science classroom and also encourage students to read, namely through the use of high-interest novels.

For this project, I created a supplementary curricular unit for use within the large space unit in an eighth grade science classroom. The reasoning for this topic came from a combination of sources. One was witnessing the use of novels with middle school students in classrooms other than an ELA (English Language Arts) classroom and the effect one could have on students with them. The second reason was my personal experience with students and the difficulty that all students face when reading a science

textbook, as well as the apathy from students that comes with reading a textbook. The last was the schoolwide goal at the school where I teach to increase reading scores and literacy in the student population. The majority of students at the school are not reading at grade level, particularly among the middle school students. Therefore, I designed the central research question of *How does the use of novels in the middle school science classroom impact student reading and literacy skills among ELL students?* The intended outcome of this project is to aid in the schoolwide goal of increasing reading and literacy among students by implementing a few novels at each grade level in the middle school science classroom throughout the school year.

For the purpose of this project, I started with one novel for eighth grade students and then I intend to add sixth and seventh grade over the course of the next few years. I created a supplementary unit around the central research question with a focus on adapting the methodology for ELL students. The eighth grade students read *The Martian: Young Reader's Edition* by Andy Weir as a class and completed various assignments with the novel along the way. Each assignment was designed to aid students in developing literacy skills as well as science specific content related to the space unit.

The focus of this chapter is the design and premise for the supplementary curriculum intended for implementation in the eighth grade science classroom. The chapter begins with an overview and project description. Next, research and theories that support the project are discussed. Finally, the chapter concludes with a description of the project setting and timeline for the project.

Project Description

For this project, I created curriculum to be used within other units to aid in students' science literacy and reading skills without overly taxing their vocabulary using a fiction novel. The curriculum is to be used within the large unit (made up of 3 smaller units) on space. Backwards design lesson planning using the lesson design template (Appendix C) from Wiggins and McTighe (2011) was used to plan mini-lessons throughout the larger space unit on *The Martian: Young Reader's Edition* by Andy Weir. I chose to use *The Martian* for a few reasons. One of these is that the novel is scientifically accurate. That is, the science that is described in the book and the situation that the main character, Mark Watney, lands himself in, as well as the process he goes through, is quite accurate and plausible as to what would actually happen (M. Edeen, personal communication with NASA scientist, January 2016). Another reason is that the portrayal of NASA in the novel is also very accurate in terms of the lengths that they would go through to get an astronaut back, the politics involved, and how scientists at NASA work together to solve problems and the process by which they give information to its astronauts (M. Edeen, personal communication with NASA scientist, October 11, 2018). The third reason for my choice of this novel is that it comes in a Young Reader's Edition. The edition is almost identical to the original but with the majority of the swearing removed from the book. My school has very conservative parents who would not want their student reading a book with so many swear words in it. The final reason for my choice in novel was that there is a film which is very well done and quite accurate

to the book which allowed students to be able to compare the novel to the film and also give the students more of a visualization for the novel.

The curriculum for *The Martian* is comprised of a number of different elements specific to ELL students and their needs. A combination of reading strategies, comprehension questions, entrance tickets, small group work, and whole class discussion were used in the supplementary unit. The unit begins with a NASA activity (NASA, n.d.) designed to get students thinking about Mars exploration and what it takes in order to carry out such a mission. Reading strategies are introduced throughout the unit to aid in student comprehension (Appendix C). Students are taught the reading strategies at the beginning of the unit and then are asked to use the different strategies throughout the unit with their reading of the novel.

At the end of the large space unit, students were able to watch the film (Producer Goddard, Producer Kinberg, & Director Scott, 2015) and write a critique on the similarities and differences between the book and film (ELA standard 8.4.7.7). The curriculum for use with the space mega-unit helps to fulfill science Minnesota standards 8.1.1.2.1, 8.1.3.3.1, 8.1.3.3.2, 8.1.3.3.3, 8.3.3.1.2, and 8.3.3.1.3 (Appendix D). The end of goal of curriculum using *The Martian* is to increase student awareness of what it takes to explore space and for humans to live out there. Students are able to live through this experience in *The Martian* while also increasing their scientific knowledge of space including the physics and chemistry necessary in order to live. Having students read the book as opposed to simply watching the movie also allows them to increase their literary

and reading skills as well as their scientific knowledge. In the next section, I will discuss the curriculum research and design that informed this project.

Curriculum Research and Design

The curriculum set surrounding *The Martian* was created using Wiggins and McTighe's (2011) backward design approach. The approach starts with deciding on the desired outcome of the curriculum being created or designed, then deciding on what the evidence of learning will be, and finally creating the learning plan. The essential part of using the backwards design is to begin with the end goal in mind. The primary goal of this design is to develop and deepen student understanding and to be able to transfer their learning to other ideas.

One of the major ideas of Wiggins and McTighe's (2011) backward design approach is that long-term achievement is more likely when teachers are teaching for understanding of concepts that can be transferred while at the same time giving learners multiple opportunities to use their learning in a meaningful way. In the science classroom, this would equate to students being able to transfer learned concepts to real-world phenomenon, for example through labs.

Using Wiggins and McTighe (2011), the end goal of this project was to increase literacy and reading skills as they pertain to the science in a group of eighth grade students. After deciding on this goal, I decided to grade based on a rubric that shows what proficient student work would look like (Appendix E). Finally, I decided on the method by which students would accomplish this work.

I created supplementary curriculum to be used with the units on space. For each lesson focused on reading the novel, students either learn a reading strategy designed to aid in comprehension or they discuss the book after having read assigned chapters using a particular strategy. Reading strategies were chosen specifically with ELL students in mind, however struggling readers would also benefit greatly as will all students. Additionally, the strategies I chose are adapted from science specific reading strategies which are more traditionally used with textbook readings. All students should benefit from these strategies as they can be used with textbook readings as well, an area where most students struggle (Biancarosa, 2010; Biancarosa & Snow, 2004; van den Broek, 2010; Moje, 2008).

This supplementary curriculum was designed as primarily mini-lessons with a few days of full lessons. Each mini-lesson is meant to take place at least 2-3 days after the previous lesson (see Appendix F for proposed schedule) to allow students time to read the novel and use one of three different reading strategies. Occasionally, students are also required to answer questions in one of the 3 reading packets.

Assessment

Students were assessed for *The Martian* curriculum both formatively and summatively. Students were assessed formatively on their reading through the completion of their reading questions, class discussions, homework checks, and questioning at the beginning of class time through entrance tickets. Students are assessed summatively using the end of book questions in the reading packet as these require longer, more complicated answers, as well as the critique on the book and movie

comparison after they watch the film, *The Martian*, starring Matt Damon (Producer Goddard, Producer Kinberg, & Director Scott, 2015). Students were graded according to a general rubric for all summative assessments (Appendix D).

Setting and Audience

The novel project was implemented at a small urban charter school in Minnesota. The school serves grades K-8 who are predominantly ELL students. Over 90% of the student body is ELL coming from Slavic speaking countries. Seventy-five percent of the students are on free and reduced-price lunch as well. Of the students who come into Kindergarten each year, over 50% speak no English despite being born in the United States. Parents wish that their children learn their language before English and thus are not exposed to very much English prior to beginning school in Kindergarten. Middle school at this school starts in grade 5 instead of traditional schools where it starts in grade 6. However, for the purpose of this project, I consider middle school to be grades 6-8.

Class sizes in the school are quite small allowing for more teacher one-on-one however, the school wishes to be larger. The entire school comprises 103 children ages 5-14. The middle school (grades 5-8) has a total of 32 students. The target audience for this project are the 8th grade students in the school. Of the three eighth grade students, one student has an eighth grade reading level. The other two students are below grade level reading between fifth and seventh grade. Students in sixth and seventh grade have a wide range of largely below grade level reading, ranging from as low as second grade level to sixth and seventh. Only one sixth grade student is above grade level reading at a seventh grade level. Almost all of the middle school students are ELLs with a few being relatively

new to the country. Middle school students performed at or above grade level in math but they have yet to catch up in reading and literacy skills. The school has implemented a school-wide literacy intervention for students in grades two through eight, receiving at least 30 minutes of small group instruction in reading in order to help improve literacy and reading. I chose to add to this by increasing the amount of reading in grades 6-8 in science and giving explicit instruction in how to read science texts. The Minnesota Comprehensive Assessment (MCA) science scores for the school are below state mandate as well.

The supplementary curricular project is intended to aid in increasing science literacy as well as reading skills in middle school students. I started with eighth grade students for this project, however, in following years, I intend to add at least one class novel to the sixth and seventh grade science curriculum as well as a choice novel project. It will take several years before measurable results are able to be seen. The curriculum discussed in this project can be used in any classroom. I created curriculum to be specific to an ELL student body, however, it would work well with any struggling readers and can be modified for students performing at a higher level. In the next section, I will discuss the timeline for the project.

Project Timeline

The instructional curriculum around *The Martian* is intended to be implemented during the large space unit, consisting of 3 units (The Solar System; Stars, Constellations, and Galaxies; and Moon Phases and Seasons). The curriculum is set up so that it can be largely used as reading outside of class time with small mini-lessons during class time. It

is the teacher's discretion as to how much to assign at one time to students and when to assign it. I organized it such that students started the book at the beginning of the Solar System unit and finished during the Moon Phases and Seasons unit. We watched the movie after we finished the unit on Moon Phases and Seasons but before we started the next unit.

In regards to the guidelines for the Capstone Project, Hamline University guidelines state that the Capstone Project is submitted at the end of GED 8490 Capstone Project cumulative course. I began the project in the spring semester of 2019 and finished in the final revisions in May of 2019.

Conclusion

The research question defining this project is *How does the use of novels in the middle school science classroom impact student reading and literacy skills among ELL students?* There is ample research out there that shows that students who are motivated are more likely to be willing to put in the extra effort needed to learn the vocabulary necessary to understand a topic (Biancorosa, 2010; Capitelli et al., 2016; Huerta & Spies, 2016; Lee & Spratley, 2010; Moje, 2008; Weinburgh et al., 2014). Additionally, my school is 90% ELL and ELLs have a particularly hard time in science where the vocabulary can be as much as 4-6 words a page for English speaking students (Groves, 2016). Adding in the ELL factor makes learning in the science classroom particularly difficult when students are required to read exclusively from textbooks (Ivey & Fisher, 2005; Ness, 2007). Therefore, I chose to incorporate a high-interest novel into the

curriculum to take some of weight from exclusive textbook reading and instead incorporate science concepts from fiction novels.

I chose to answer this question by creating curriculum for eighth grade students using a fiction novel. I created one curriculum set to be used within the large unit on space. The curriculum comprised the use of a whole class novel, *The Martian (Young Reader's Edition)* by Andy Weir. Students read the novel and answered questions in reading packets broken up into 3 sections (Appendix E) before culminating in a class viewing of the film, *The Martian*, starring Matt Damon (Producer Goddard, Producer Kinberg, & Director Scott, 2015) where students were required to write a 1-2 page critique of the film comparing the accuracy of the film to the novel.

The following chapter, chapter four: reflection, reflects on the curriculum sets in their creation, the project, and key learnings that were learned and informed the project. Learnings from the literature review and the process of the project and curriculum creation are all discussed.

CHAPTER FOUR

REFLECTION

Introduction

For this project I created a supplementary curriculum to be used in the science classroom with the express purpose of supporting literacy in middle school students. I decided on this project because reading and literacy in science is difficult for many students (Brown & Concannon, 2015; Groves, 2016). Oftentimes, students are not taught how to read science text after grade school and by the time the students get to middle school and high school, they have little idea as to how to read a science text, such as a textbook, but yet are expected to understand it (Ness, 2007). Reading a science text requires a different set of skills than reading in English Language Arts (ELA) or Social Studies (Biancorosa, 2010; Chauvin & Theodore, 2015). Yet, most teachers spend little time, if any, on teaching students how to read science (Biancorosa & Snow, 2004; Ness, 2007). The problem of reading science becomes even greater when considering the number of ELL students in Minnesota. Therefore my guiding question for this project was *How does the use of novels in the middle school science classroom impact student reading and literacy skills among ELL students?*

I decided to create supplementary curriculum to aid student literacy and reading in science by having students read a science novel and introducing students to three

different science reading strategies. I chose the novel *The Martian* by Andy Weir as it can be easily used during the units on space in eighth grade science and is quite scientifically accurate (M. Edeen, personal communication with NASA scientist, January 2016). I created 12 lessons surrounding the novel and included reading strategies in most of them using Wiggins and McTighe's (2011) Understanding by Design approach (Appendix C). Next, I will discuss the key learnings from my project.

Key Project Understandings

Through the capstone process I came away with two key learnings. The first is that there are many strategies out there for reading science texts. I had come across some of these while taking my content classes in education for teaching science but I had no idea just how many of these strategies there were or that there were so many specifically for ELL students. Reading through all these strategies opened up my eyes to how I could help the ELL students at my school in science and that I needed to use those strategies. Because I am not an ELL teacher, I did not much consider the reading level of my students in science class prior to this project. However, I am now far more aware of this and I will endeavor to add some reading strategies to my curriculum for students starting at the beginning of the school year in order to better set them up for success and help their literacy grow.

The second key learning I came away with is that while some science teachers may incorporate novels in their classroom, there is very little research on the benefits of using them in the classroom. It was extremely difficult to find peer-reviewed articles of novels being used in the science classroom or any classroom outside of ELA in middle or

high school.This was unexpected for me as I would have thought that with all the science fiction out there, someone may be using it in the classroom to help get students more interested in science. I have personally seen novels being used in the science classroom by another teacher and found a National Science Teacher Association (NSTA) article about a science novel project (Kilby-Goodwin, 2010), but there were no instances of it having been researched in the classroom and whether it had any effect on literacy in students. This not only shows a distinct lack in the literature but also a great opportunity for getting students interested in science and gently increasing their literacy without forcing highly technical textbook readings on them all the time. In the next section I will discuss the parts of the literature review that I found to be most important to my project.

Important Learnings from the Literature Review

There were two major parts of the literature review that I found to be the most important to my project. The first of these was the literature on the demands of reading science. For example, Biancarosa (2010) found that the vocabulary demand between fourth, seventh, and tenth grade greatly increases for students. Students in fourth grade had words such as *reproduce* and *example* while by the time students reached tenth grade they had to deal with words like *psilophytes*. The difference is absolutely incredible and adding in the factor of ELL students makes reading text like that found in high school next to impossible. Additionally, Biancarosa (2010) discussed the difference between knowing what counts in science versus other disciplines. For example, asking students to identify *characteristics* of a species or organism in science versus the *characteristics* of a

character in ELA. This type of knowledge is difficult for ordinary students, let alone ELL students who are trying to learn English.

I also found the comparison of popular textbooks by Groves (2016) to be highly informative as well. Groves found a Pearson biology textbook potentially introduced as many as 2,900 science terms and McGraw-Hill's *Interactive Science* introduced over 1,900 words. This far exceeds what is deemed typical when learning a foreign language where a student is expected to learn about 300 words per year, resulting in less 2,100 words over seven years (Milton, 2006). I have heard numerous people saying that learning science is like learning a foreign language, but reading this in the literature was absolutely astounding. And yet, somehow, teachers are expected to teach students using these textbooks. It is no surprise that in my personal experience I have seen a number of teachers simply stop using textbooks all together because students have too difficult a time reading them. However, this does students a disservice as when they get to college they will be expected to read a textbook and will not be taught any strategies for reading them.

The second major part of the literature review I found to be particularly useful was the section on reading strategies for science. It was this section that I drew from when deciding which reading strategies I should use in my curriculum for students. I found many strategies that were for struggling readers and/or ELL students in science; but in the end, the most useful strategies were from Martin (2006) and Román et al. (2018), who had several reading strategies for science specific to ELLs. The strategies from Romàn et al. are specific to textbooks, but I was able to use one of them to work

with a novel as well. It is called Interactive Editing, where a passage is chosen by the student or teacher, is read out loud so that students can hear what words sound like, and then is put into easier words and summarized. I felt this strategy would work well for a number of chapters in *The Martian* as there is some very technical jargon used in the book which ELL students and struggling readers may have a difficult time with. Using this strategy on those sections or chapters will help students put what Mark Watney (the main character of the novel) is doing into words that are easier to understand.

From Martin (2006), who had many strategies for reading science textbooks, I chose two that could be adapted to fit a novel. The first of these is SQ3R (survey, question, read, recite, review). In a textbook, students would be surveying a section looking at headings, bold text, and pictures, figures, or tables. Then they would formulate questions about what the section is about, read it, recite or summarize the section, and then review their questions and answer them. I adapted this strategy to fit the novel. This strategy will not work with all novels, but with *The Martian* it can be used as there is often text written in italics, the first and last sentence of sections where Watney is talking are often provocative making a reader curious about what is to happen or what will happen next, and there are numerous important acronyms interspersed throughout the text in all caps which stand out. Therefore the only adaptation I made to the strategy was to highlight what students should look for during their survey of the selected section, everything else regarding the strategy remained the same.

The second strategy from Martin (2006) that I adapted and then used was Understanding the Text. The sequence that I have students follow for this strategy is largely the same as that from Martin, however as there are no bold words or informative section titles, I removed that part from the strategy. Otherwise the strategy remains the same. Students read a selected section and take notes on the sequence of events to help clarify what is happening stopping periodically to question what is happening in the text and evaluate if they understand. In a textbook this would happen at the end of each sub-section. In a novel, the teacher will need to illustrate to the students when they should do this, such as at the end of one or two pages. Next, the student rereads the section to revise understanding. Lastly, the student predicts what will happen next. This strategy works particularly well for novels and textbooks without needing a lot of modification and can be easily transferred from one to another. In the next section I will talk about the implications of my project.

Project Implications and Limitations

The goal of this project is to increase literacy in science for sixth to eighth grade ELL students. It shows how novels can be used to aid literacy skills through the teaching of specific reading strategies, which can double as strategies for a textbook, and also still be relevant to the curriculum being taught in the classroom. In schools with a large population of ELLs, using texts other than textbooks is important. It gently aids students in increasing their literacy skills by using a high-interest text which is less challenging. Low-interest texts, such as a science textbook tend to be so challenging that it turns off

students from science permanently. ELL students are far more likely to put in effort into their literacy skills when they are given high-interest material (Capitelli et al., 2016; Huerta & Spies, 2016; Weinburgh et al., 2014). The same can be said of most students.

In order for this project to be implemented in schools, the science department would need some extra funding up to front to buy classroom copies of the chosen books, however, very little cost would be associated with implementing this project in schools. Additionally, teachers in other grades may wish to choose at least one novel for the whole class based on their subject matter and grade level after which the teacher will need to spend time to create the curriculum to go with it. Therefore, the only limitations on this project are the initial cost to buy copies of the books and the time necessary by teachers to create the curriculum for the book if it is not *The Martian*.

This project could easily be used by teachers and schools who wish increase literacy in all subject areas, not just in ELA. Many schools wish to encourage reading and yet it is largely left up to the ELA teachers to do that as opposed to having all teachers help in this goal. Incorporating other text sources in science, such as through novels, aids this goal and at the same time also aids in science literacy in a high-interest way for students. In the next section I will discuss future research and projects as they relate to this project.

Future Research and Communication of Results

My project highlights the need for more research into the usefulness that novels can play in classrooms outside of the ELA classroom and the potential aid to increasing

student literacy in general as well in different subject areas. There is very little research out there about the usefulness of using novels in classrooms other than ELA. Others have used novels and other types of formats to get students excited about science and science concepts (Batchelor, 2017; Coiro, 2012; Freudenrich, 2000; Ivey & Fisher, 2005; Jarman & McClune, 2001), but to my knowledge very few have used novels to teach science concepts and also try to increase literacy skills among students in the secondary classroom. Given the lack of science literacy among students due to a lack of teaching (Ness, 2007), this is an area which I believe could be explored to great effect. With this particular project, in the future I would like to gather some data on the effect of reading novels in the middle school science classroom from grades six to eight to see if the use of the novels is truly benefiting students in increasing their literacy skills.

I have shared this project with others through the capstone presentation and capstone online publication. I have also shared this project with the director of my school and middle school teachers at the school. While I am the only science teacher in my school, in the future I would like to take this project with me to other schools that I may teach at where hopefully there are other science teachers and administration who are interested in using this in the classroom.

Conclusion

This project sheds light on an area of science teaching that is largely unexplored. In my personal experience, it is well known among science teachers that students are finding it increasingly difficult to read science textbooks and so teachers have moved

away from using them in their classroom. If they are used, then students have very little, if any, time devoted to instruction in how read a textbook (Ness, 2007). Science teachers in secondary school have a lot of science standards to get through in any given class and so they feel that they do not have time to teach students how to read. Yet, students are expected to be able to read a science textbook from one year to the next or by the time they reach college (Ness, 2007; Smith et al., 2010). I believe that reading and literacy is important in all aspects of a student's school career, not just in ELA and yet that is largely the only place where it is taught. This project serves as a step to incorporating more reading and literacy in science which hopefully others will see and use in the future.

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APPENDIX A

WIDA-Overview of WIDA Framework

SECTION 1: The WIDA Standards Framework

Introduction

The WIDA Standards Framework, depicted in Figure A, consists of a set of interactive and interdependent components that exemplify WIDA's vision for academic language development. This framework is the foundation for WIDA's work on language development standards.

The WIDA Standards Framework describes WIDA's conceptualization of language learning in addition to the nature of academic language and its relation to language development. It is represented by the following components.

The **WIDA Can Do Philosophy** is based on the belief that all students bring to their learning cultural, experiential, and linguistic practices, skills, and ways of knowing from their homes and communities. WIDA believes that as educators, our role is to craft instruction that capitalizes on and builds upon these assets.

Figure A: WIDA Standards Framework

The **Guiding Principles of Language Development** represent WIDA's core beliefs about language development. They are derived from a synthesis of literature and research related to language development and effective instructional practices for language learners.

The **Features of Academic Language in Sociocultural Contexts** highlight academic language features across three dimensions: discourse, sentence, and word/phrase and six levels of language proficiency taking into consideration the various components of the learning environment (grade level content, purposes for language use, role relationships with others, and other factors)

The **Performance Definitions** delineate the criteria for receptive language (listening and reading) and productive language (speaking and writing) at six levels of language proficiency. They are informed by the Features of Academic Language.

The **Can Do Descriptors** illustrate what learners can do at each level of language proficiency across the five language development standards.

The **Standards Matrices** help educators envision what language development might look like in K–12 classrooms across levels of language proficiency for each of the five standards. The matrices are used in conjunction with the Performance Definitions to describe possible student trajectories for academic language development.

The components of the WIDA Standards Framework interact and influence each other in the design of curricula, language instruction, and assessment of language learners. Teachers and school leaders are encouraged to highlight specific components of the framework in their language education programs to fit the specific needs of individual students and contexts. In doing so, all stakeholders can participate in shaping the education of our increasingly rich and diverse student population.

The WIDA English Language Development Standards

The WIDA English Language Development (ELD) Standards represent the social, instructional, and academic language that students need to engage with peers, educators, and the curriculum in schools. Figure B shows the five standards and their abbreviations.

Figure B: The English Language Development Standards

	Standard	Abbreviation
English Language Development Standard 1	English language learners **communicate** for **Social** and **Instructional** purposes within the school setting	Social and Instructional language
English Language Development Standard 2	English language learners **communicate** information, ideas and concepts necessary for academic success in the content area of **Language Arts**	The language of Language Arts
English Language Development Standard 3	English language learners **communicate** information, ideas and concepts necessary for academic success in the content area of **Mathematics**	The language of Mathematics
English Language Development Standard 4	English language learners **communicate** information, ideas and concepts necessary for academic success in the content area of **Science**	The language of Science
English Language Development Standard 5	English language learners **communicate** information, ideas and concepts necessary for academic success in the content area of **Social Studies**	The language of Social Studies

Standard 1 draws on students' personal experiences as they interact with teachers and peers. It works in conjunction with Standards 2–5 that address the language of the content areas.

Grade Levels and Grade-Level Clusters

WIDA recognizes that English language development occurs over multiple years, is variable, and depends on many factors (e.g., age, maturation, classroom experiences, programming, motivation, and attitudes. With this in mind, WIDA has organized the ELD standards around individual grade levels from Kindergarten through 8th grade and for grade-level clusters 9–10 and 11–12. Having examples at the individual grade levels allows educators to recognize content topics pertaining to their grade and, most importantly, remind them that instruction for ELLs must be age and developmentally appropriate. As language development is a multi-year process, we encourage educators to look at examples of language development across a cluster of grades to get a fuller picture of the range of language development for their students. WIDA has a separate publication containing early language development standards for Pre-Kindergarteners (children ages 2.5–5.5), as language development for this age group is unique.

Developmentally Appropriate Academic Language in Sociocultural Contexts

WIDA illustrates social, instructional, and academic language as three dimensions: discourse dimension, sentence dimension, and word/phrase dimension. The **FEATURES OF ACADEMIC LANGUAGE** in Figure C delineate academic language in each of these dimensions and their corresponding criteria of

Linguistic Complexity, Language Forms and Conventions, and Vocabulary Usage. Notice that the criteria are framed within the sociocultural context that highlights the purpose of the communication and, most importantly, the considers the participants and their experiences.

Figure C: The Features of Academic Language

The Features of Academic Language operate within sociocultural contexts for language use.

Dimension	Performance Criteria	Features
Discourse	**Linguistic Complexity** *(Quantity and variety of oral and written text in communication)*	• Amount of speech/written text • Structure of speech/written text • Density of speech/written text • Coherence and cohesion of ideas • Variety of sentence types to form organized text
Sentence	**Language Forms and Conventions** *(Types, array, and use of language structures in communication)*	• Types and variety of grammatical constructions • Mechanics of sentence types • Fluency of expression • Match language forms to purposes/perspectives • Formulaic and idiomatic expressions
Word/Phrase	**Vocabulary Usage** *(Specificity of word or phrase choice in communication)*	• General, specific, and technical language • Multiple meanings of words and phrases • Nuances and shades of meaning • Collocations and idioms

The sociocultural contexts for language use involve the interaction between the student and the language environment, encompassing the…

- Register
- Genre/Text type
- Topic
- Task/Situation
- Participants' identities and social roles

Performance Definitions

The three dimensions used to define each level of language proficiency are displayed in two sets of **PERFORMANCE DEFINITIONS**. One set of Performance Definitions (shown in Figure D) is for receptive language and represents how ELLs process language to comprehend information, ideas, or concepts in either oral or written communication. The other set of Performance Definitions (see Figure E) is for productive language and shows how students use language to express information, ideas, or concepts in either oral or written communication.

Students do not follow one common process for language development. Language development is dependent on many factors (e.g., student personality, language exposure, instructional design, service delivery, scaffolding, models for language). Therefore, the Performance Definitions outline many possible pathways to students' language development.

APPENDIX B

WIDA-Can Do Descriptors for Grades 6-8

WIDA CONSORTIUM

Can Do Descriptors: Grade Level Cluster 6-8

For the given level of English language proficiency and with visual, graphic, or interactive support through Level 4, English language learners can process or produce the **language** needed to:

	Level 1 Entering	Level 2 Beginning	Level 3 Developing	Level 4 Expanding	Level 5 Bridging	Level 6 Reaching
LISTENING	• Follow one-step oral commands/instructions • Match social language to visual/graphic displays • Identify objects, people, or places from oral statements/ questions using gestures (e.g., pointing) • Match instructional language with visual representation (e.g., "Use a sharpened pencil.")	• Follow multi-step oral commands/instructions • Classify/sort content-related visuals per oral descriptions • Sequence visuals per oral directions • Identify information on charts or tables based on oral statements	• Categorize content-based examples from oral directions • Match main ideas of familiar text read aloud to visuals • Use learning strategies described orally • Identify everyday examples of content-based concepts described orally • Associate oral language with different time frames (e.g., past, present, future)	• Identify main ideas and details of oral discourse • Complete content-related tasks or assignments based on oral discourse • Apply learning strategies to new situations • Role play, dramatize, or re-enact scenarios from oral reading	• Use oral information to accomplish grade-level tasks • Evaluate intent of speech and act accordingly • Make inferences from grade-level text read aloud • Discriminate among multiple genres read orally	Write in grade-level Listening expectations below:
NAMES						

The Can Do Descriptors work in conjunction with the WIDA Performance Definitions of the English language proficiency standards. The Performance Definitions use three criteria (1. linguistic complexity; 2. vocabulary usage; and 3. language control) to describe the increasing quality and quantity of students' language processing and use across the levels of language proficiency.

WIDA CONSORTIUM

Can Do Descriptors: Grade Level Cluster 6-8

For the given level of English language proficiency and with visual, graphic, or interactive support through Level 4, English language learners can process or produce the **language** needed to:

	Level 1 Entering	Level 2 Beginning	Level 3 Developing	Level 4 Expanding	Level 5 Bridging	Level 6 Reaching
SPEAKING	• Answer yes/no and choice questions • Begin to use general and high frequency vocabulary • Repeat words, short phrases, memorized chunks • Answer select WH-questions (e.g., "who," "what," "when," "where") within context of lessons or personal experiences	• Convey content through high frequency words/ phrases • State big/main ideas of classroom conversation • Describe situations from modeled sentences • Describe routines and everyday events • Express everyday needs and wants • Communicate in social situations • Make requests	• Begin to express time through multiple tenses • Retell/rephrase ideas from speech • Give brief oral content-based presentations • State opinions • Connect ideas in discourse using transitions (e.g., "but," "then") • Use different registers inside and outside of class • State big/main ideas with some supporting details • Ask for clarification (e.g., self-monitor)	• Paraphrase and summarize ideas presented orally • Defend a point of view • Explain outcomes • Explain and compare content-based concepts • Connect ideas with supporting details/ evidence • Substantiate opinions with reasons and evidence	• Defend a point of view and give reasons • Use and explain metaphors and similes • Communicate with fluency in social and academic contexts • Negotiate meaning in group discussions • Discuss and give examples of abstract, content-based ideas (e.g., democracy, justice)	Write in grade-level Speaking expectations below:
NAMES						

The Can Do Descriptors work in conjunction with the WIDA Performance Definitions of the English language proficiency standards. The Performance Definitions use three criteria (1. linguistic complexity; 2. vocabulary usage; and 3. language control) to describe the increasing quality and quantity of students' language processing and use across the levels of language proficiency.

WIDA CONSORTIUM

Can Do Descriptors: Grade Level Cluster 6-8

For the given level of English language proficiency and with visual, graphic, or interactive support through Level 4, English language learners can process or produce the **language** needed to:

	Level 1 Entering	Level 2 Beginning	Level 3 Developing	Level 4 Expanding	Level 5 Bridging	Level 6 Reaching
READING	• Associate letters with sounds and objects • Match content-related objects/pictures to words • Identify common symbols, signs, and words • Recognize concepts of print • Find single word responses to WH-questions (e.g., "who," "what," "when," "where") related to illustrated text • Use picture dictionaries/ illustrated glossaries	• Sequence illustrated text of fictional and non-fictional events • Locate main ideas in a series of simple sentences • Find information from text structure (e.g., titles, graphs, glossary) • Follow text read aloud (e.g., tapes, teacher, paired-readings) • Sort/group pre-taught words/phrases • Use pre-taught vocabulary (e.g., word banks) to complete simple sentences • Use L1 to support L2 (e.g., cognates) • Use bilingual dictionaries and glossaries	• Identify topic sentences, main ideas, and details in paragraphs • Identify multiple meanings of words in context (e.g., "cell," "table") • Use context clues • Make predictions based on illustrated text • Identify frequently used affixes and root words to make/extract meaning (e.g., "un-," "re-," "-ed") • Differentiate between fact and opinion • Answer questions about explicit information in texts • Use English dictionaries and glossaries	• Order paragraphs • Identify summaries of passages • Identify figurative language (e.g., "dark as night") • Interpret adapted classics or modified text • Match cause to effect • Identify specific language of different genres and informational texts • Use an array of strategies (e.g., skim and scan for information)	• Differentiate and apply multiple meanings of words/phrases • Apply strategies to new situations • Infer meaning from modified grade-level text • Critique material and support argument • Sort grade-level text by genre	Write in grade-level Reading expectations below:
NAMES						

The Can Do Descriptors work in conjunction with the WIDA Performance Definitions of the English language proficiency standards. The Performance Definitions use three criteria (1. linguistic complexity; 2. vocabulary usage; and 3. language control) to describe the increasing quality and quantity of students' language processing and use across the levels of language proficiency.

WIDA CONSORTIUM

Can Do Descriptors: Grade Level Cluster 6-8

For the given level of English language proficiency and with visual, graphic, or interactive support through Level 4, English language learners can process or produce the **language** needed to:

	Level 1 Entering	Level 2 Beginning	Level 3 Developing	Level 4 Expanding	Level 5 Bridging	Level 6 Reaching
WRITING	• Draw content-related pictures • Produce high frequency words • Label pictures and graphs • Create vocabulary/ concept cards • Generate lists from pre-taught words/phrases and word banks (e.g., create menu from list of food groups)	• Complete pattern sentences • Extend "sentence starters" with original ideas • Connect simple sentences • Complete graphic organizers/forms with personal information • Respond to yes/no, choice, and some WH-questions	• Produce short paragraphs with main ideas and some details (e.g., column notes) • Create compound sentences (e.g., with conjunctions) • Explain steps in problem-solving • Compare/contrast information, events, characters • Give opinions, preferences, and reactions along with reasons	• Create multiple-paragraph essays • Justify ideas • Produce content-related reports • Use details/examples to support ideas • Use transition words to create cohesive passages • Compose intro/body/ conclusion • Paraphrase or summarize text • Take notes (e.g., for research)	• Create expository text to explain graphs/charts • Produce research reports using multiple sources/ citations • Begin using analogies • Critique literary essays or articles	Write in grade-level Writing expectations below:
NAMES						

The Can Do Descriptors work in conjunction with the WIDA Performance Definitions of the English language proficiency standards. The Performance Definitions use three criteria (1. linguistic complexity; 2. vocabulary usage; and 3. language control) to describe the increasing quality and quantity of students' language processing and use across the levels of language proficiency.

APPENDIX C

Reading Strategies

Strategy 1 (Román et al, 2018)-Interactive Editing

1. Select a section of meaningful paragraphs or small section.
2. Choral read the text-This allows students to hear what words sound like
3. With the help of students, select keywords or phrases (focus on nominalizations and connecting words)
4. Use keywords to collaboratively rewrite the text in the students' own language, underlining the keywords
5. Can be used later to jigsaw texts.

Strategy 2 (as illustrated by Martin, 2006)- SQ3R (Survey, Question, Read, Recite, Review)

*Adapted to fit a fiction novel

1. Students survey the chapter to be read, glancing through the text, noticing the headings and any changes in the text font
2. Students pose questions based on the survey and what they have read before about what will happen in the text
3. Students read the text
4. Students recite the main idea or summarize by writing
5. Students review the questions that they wrote and answer them if they can and/or write new questions based on what they read

Strategy 3 (Martin, 2006)-Understanding the Text

*Adapted to fit a fiction novel

1. Read the chapter and take notes on the sequence of events to help clarify what is happening
2. Stop periodically to question what is happening in the text and evaluate if the text is understood
3. Reread the chapter to revise understanding
4. Predict what will happen next

APPENDIX D

Backwards Design Template adapted from Wiggins & McTighe (2011)

Title of Supplementary Unit:	Novel Study-*The Martian* by Andy Weir	**Grade Level:**	8th Grade
Curriculum Area:	Space	**Time Frame:**	7-8 Weeks
Created by:	Elizabeth Das		
Stage 1-Desired Results			
Content Standards			
Science Standards: 8.1.1.2.1-Use logical reasoning and imagination to develop descriptions, explanations, predictions and models based on evidence (MN Dept. of Education, 2010, p.22) 8.1.3.3.1-Explain how scientific laws and engineering principles, as well as economic, political, social, and ethical expectations, must be taken into account in designing engineering solutions or conducting scientific investigations (MN Dept. of Education, 2010, p.22) 8.1.3.3.2-Understand that scientific knowledge is always changing as new technology and information enhance observations and analysis of data (MN Dept. of Education, 2010, p.22) 8.1.3.3.3-Provide examples of how advances in technology have impacted how people live, work, and interact (MN Dept. of Education, 2010, p.22) 8.3.3.1.2-Describe how gravity and inertia keep most objects in the solar system in regular and predictable motion (MN Dept. of Education, 2010, p.25) 8.3.3.1.3-Recognize that gravitational force exists between any two objects and describe how the masses of the objects and distance between them affect the force (MN Dept. of Education, 2010, p.25) English Language Arts Standards: 8.4.7.7-Analyze the extent to which a filmed or live production of a story or drama stays faithful to or departs from the text or script, evaluating the choices made by the			

director or actors (MN Dept. of Education, 2017, p. 51)	
Understandings *Students will understand...*	**Essential Questions**
-The difficulties of surviving in space and on a planet other than Earth -The ethics involved in space travel and colonization of a new planet -The politics involved in space travel and colonization of a new planet -The difficulty of planning and safely executing space travel	-Why do people want to explore our solar system? -What technology is needed for us to explore our system? -How does *The Martian* illustrate humanity's desire to explore other worlds? -What would it take for a person to survive on a planet different from Earth? -What scientific knowledge do we need in order to explore and colonize another planet? -What ethical considerations were taken into account or shown in *The Martian*? -What were the political ramifications of decisions made by NASA in *The Martian*?
Knowledge *Students will know...*	**Skills** *Students will be able to...*
-The scientific principles needed for accurate and safe space exploration (such as gravity, inertia, air chemistry, growing food, etc.) -The technology needed for a person to survive on a planet like Mars	-Use research skills to find out about technology used in current space travel and what is needed for future space travel -Express their thoughts about the reading in writing and orally
Stage 2-Assessment Evidence	
Evaluative Criteria	**Performance Tasks:**
-Clear and concise sentences -Good Detail -Informative -Accurate to novel -Accurate science	-Completion of reading question sets and chapter summaries -1 to 2 page critique of movie versus novel

	Other Evidence
-Well spoken -Clear and concise idea/structures	Formative Assessments: Participation in small group and class discussions, Marsbound! NASA activity questions, entrance tickets Summative Assessments: End of book question set, movie and novel critique
Stage 3-Learning Plan	
Summary of Key Learning Events and Instruction	
The importance of the novel *The Martian* lies in its connection to the 3 units on space that coincide with the reading of the novel. The novel is meant to aid student understanding in life on other planets and what that may look like as well as the need for technology and the difficulty of space travel. Pre-reading activity: Marsbound! NASA activity-Students will complete an activity taking approximately 135 minutes that simulates a mission to Mars and the problems that astronauts face as well as the job of astronauts. Successive Readings: Every 2-3 days students will spend approximately 15-20 minutes of class time discussing the latest reading and talking about reading strategies as they pertain to *The Martian* through small group and whole class work. Students will largely be assigned readings and writing components as homework, though extra class time may be devoted to these as deemed necessary by the teacher. After the book has been read: Students will complete several long answer questions regarding the entire book. Some questions may require some online research by the students depending on student knowledge base. Some additional class time will be devoted to the questions and discussion of the questions as well as for brainstorming ideas and creating outlines for question answers. Additionally, students will watch the film version of *The Martian* (Producer Goddard, Producer Kinberg, & Director Scott, 2015) and write a 1-2 page critique of the film versus the book.	

APPENDIX E

Grading Rubric

For: Question Responses in Reading Packets and Long-Answer Questions

	1	2	3	4
Scientific Accuracy	Science is not accurate and conclusions are not backed-up with evidence	Science in response is somewhat accurate; conclusions are not backed-up with evidence	Science in response is accurate and some conclusions are backed-up with evidence	Science in response is accurate and conclusions are well-backed up with evidence
Accuracy to Novel	Response is somewhat accurate to the novel	Response is accurate to the novel	Response is accurate to the novel with some evidence from the text	Response is accurate to the novel with evidence from the text
Information	Response has very little detail and is somewhat relevant to the question	Response has some detail and is mostly relevant to the question	Response has good detail and gives relevant information to the question	Response has a lot of detail and gives relevant information to the question
Grammar	Sentences are not quite clear, with many grammar and spelling mistakes	Sentences are clear, with some grammar and spelling mistakes	Sentences are clear, with accurate grammar and spelling	Sentences are clear and concise, with accurate grammar and spelling

APPENDIX F

Lesson Plan Calendar

*Note 1: Most lessons should be spaced 2-3 days apart to give students time to complete the homework.

*Note 2: On days where nothing is noted or time allocated is less than 45 min, material from the space unit is covered.

Week 1	Day 1 Lesson 1 (45 min)	Day 2 Lesson 1 (45 min)	Day 3 Lesson 1 (45 min)	Day 4 Lesson 2 (45 min)	Day 5
Week 2	Day 6	Day 7	Day 8 Lesson 3 (25 min)	Day 9	Day 10
Week 3	Day 11	Day 12 Lesson 4 (25 min)	Day 13	Day 14	Day 15
Week 4	Day 16 Lesson 5 (15 min)	Day 17	Day 18	Day 19 Lesson 6 (20 min)	Day 20
Week 5	Day 21	Day 22 Lesson 7 (15 min)	Day 23	Day 24	Day 25 Lesson 8 (25 min)
Week 6	Day 26	Day 27	Day 28 Lesson 9 (15-20 min)	Day 29	Day 30
Week 7	Day 31 Lesson 10 (45 min)	Day 32	Day 33 Lesson 11 (45 min)	Day 34 Lesson 11 (15 min)	Day 35

Week 8	Day 36 Lesson 12 (45 min)	Day 37 Lesson 12 (45 min)	Day 38 Lesson 12 (45 min)	Day 39	Day 40