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The Prevalence of Model-Based Reasoning in CSCOPE Curriculum for Sixth Grade Science

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The Prevalence of Model-Based Reasoning in CSCOPE Curriculum for Sixth Grade Science

by

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Report

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Dedication

This work is dedicated to my mother Blanca Gonzalez, daughter Sofia Gonzalez Lloreda, and my wife Raquel Lloreda Gonzalez. Without their guidance, support, patience and love this project would not have been possible.

Acknowledgements

I would like to acknowledge the UTeach Program faculty and staff, especially Dr. Petrosino, Dr. Allen, and Dr. Crawford, for the opportunity and their guidance in achieving this master's degree. I am deeply grateful to my wife Raquel, mother Blanca, siblings Cesar Armando and Maria Teresa, and Mother-in-law Dina for having faith in me and providing support at home. I would like to thank my parents for their encouragement and unconditional support.

Abstract

The Prevalence of Model-Based Reasoning in CSCOPE Curriculum for Sixth Grade Science

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This research was conducted on model-based reasoning and its prevalence in CSCOPE curriculum. Communications with seven CSCOPE representatives out of twenty regions revealed that CSCOPE is simply a name, not an acronym. The primary focus of CSCOPE is to impact instructional practices in the classroom to improve student performance. This report discusses the history of CSCOPE, its framework, and its exemplar lessons. It also looks at model-based reasoning, taxonomy of models, and model-eliciting activities. The research also aims to determine if the exemplar lessons in CSCOPE can be classified as model-based.

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CHAPTER I:

INTRODUCTION AND STATEMENT OF THE PROBLEM

The driving force in Texas public education is the idea of continuity of education across departments, schools, and districts in the state. This means that if a student transfers from one district, school, or class to another, the student will continue to get the same high level of education. The goal is for the student to not miss information that has been taught or to not be challenged because they have previously covered the material. To prevent this from occurring, 19 out of the 20 regions across Texas have implemented CSCOPE.

The Texas Education Service Center Curriculum Collaborative (TESCCC) developed CSCOPE, a comprehensive, customizable, user-friendly curriculum management system built on the most current research-based practices in the field, such as Concept Based Curriculum and Instruction (Erickson 2002) and Getting Results with Curriculum Mapping (Jacobs 2004). CSCOPE is a curriculum that provides sequence and lessons aligned with the Texas Essential Knowledge and Skills (TEKS) and includes support, resources, and an accountability process to ensure quality implementation. The decision to use CSCOPE, along with changes in TEKS, instruction time, and teacher-to-student ratio in public education, prompted a shift in the thinking about science instruction for some educators. Science instruction is transitioning from "pedagogical approaches based on learning facts and procedures to those oriented around constructing, evaluating, and revising models" (Petrosino, 2003).

This study focuses on the prevalence of model-based curriculum in CSCOPE at the sixth grade science level. If CSCOPE'S exemplar lessons are classified using a model-based criteria, then my hypothesis is that thirty-six percent or more of the lessons will qualify as model-based reasoning. The percent chosen is an educated guess based on my experience with the performance indicators from their previous lessons and my knowledge gained of model-based reasoning. This study is based on the framework for thinking about the use of models and model-based curriculum in K–12 education. It is supported by the work of Leona Schauble and Richard Lehrer, as well as research conducted by Anthony J. Petrosino. I will also determine if the exemplar lessons can be classified as model-eliciting activities. (Lesh, Hoover, Hole, Kelly, & Post, 2000) This research is intended to provide insight regarding the prevalence of model-based reasoning and the need to use models. The proposed study will potentially advance our knowledge of CSCOPE and whether it integrates modeling by utilizing the criteria, procedures, and methodology of Lehrer, Schauble, and Petrosino (2003) in the domain of science at the sixth grade level.

CHAPTER II:

REVIEW OF THE LITERATURE

The goal of this research is to determine the prevalence of model-based reasoning in CSCOPE curriculum. The first step is to understand the history and purpose of CSCOPE. The next step is to understand the framework of the CSCOPE curriculum for science at the sixth grade level. The curriculum has exemplar lessons which will be compared to five different model-based instructions criteria to determine if each lesson can be classified as one of the four model-based activity categories, a model-eliciting activity, or neither. In order to be able to categorize the previously mentioned CSCOPE curriculum exemplar lessons, the following research was done on CSCOPE, CSCOPE curriculum, model-based reasoning, taxonomy of models, and model-eliciting activities.

According to the Region XIII Education Service Center, the primary focus of CSCOPE is to impact instructional practices in the classroom in order to improve student performance. This multi-faceted system includes three key components operating seamlessly together: Curriculum and Assessment, Professional Development, and Innovative Technology. This research will focus on the curriculum and assessment facet. CSCOPE states that curriculum "involves the what, the when, and the why" ("A Guaranteed and Viable Curriculum," 2009). This is based on "What works in schools" research conducted by Robert Marzano, who concluded that a "guaranteed and viable curriculum is the most powerful school-level factor in determining overall student achievement" (Marzano, 2003). He defines a guaranteed and viable curriculum "as a combination of opportunity to learn and time to learn." CSCOPE suggests "Districts and schools must ensure that the intended curriculum (in Texas this is the TEKS and district curricula) is implemented consistently by all teachers. In turn, the attained curriculum—what students actually learn—should align with the intended and implemented curricula" ("A Guaranteed and Viable Curriculum," 2009). To achieve this, CSCOPE created a development team composed of Education Service Center personnel, and other content area experts. The team has done extensive work by adding specificity to the TEKS student expectations, thus ensuring that each standard from the TEKS framework includes specificity for each student expectation. Furthermore, CSCOPE created the Year at a Glance, a curriculum map and pacing guide for units of study. It ensures that the teacher has adequate instructional time to present the required content. Curriculum mapping "is a process for documenting the plan for curriculum delivery over a specified period of time" (Jacobs, 2004). The current curriculum-mapping model that CSCOPE uses is based on the work of Dr. Heidi Hayes Jacobs "Getting Results With Curriculum Mapping" (Jacobs, 2004). To be clear, the CSCOPE Curriculum is composed of The Vertical Alignment, Year at a Glance, and Instructional Focus Documents along with the TEKS Verification Matrix.

CSCOPE UNITS

CSCOPE curriculum for sixth grade science is 36 weeks in duration divided into four nine-week periods. The following are the specific units for each nine-week period.

FIRST NINE-WEEKS:

- Unit 01: Chemical and Physical Properties (09-10): This unit focuses on "the properties of a substance are those characteristics that are used to identify or describe it. Physical and chemical properties are used to classify matter. Physical properties refer to the state of matter. Chemical properties change the chemical nature of matter along with the chemical changes matter can undergo. The chemical and physical properties of a substance change when the substance undergoes a chemical change. Chemical changes are caused as a result of chemical reactions. The change results from a rearrangement of the atoms. After a chemical reaction, the properties of the new substances differ from the original substances" ("Instructional Focus Document," 2010).

- Unit 02: Force and Motion (09-10): In this unit, "students will be required to test and describe how forces are related to motion and describe what happens to the motion of an object as it accelerates. They must also create, interpret and analyze changes in motion that are represented graphically" ("Instructional Focus Document," 2010).

- Unit 03: Energy Transformations: Non-Living Systems (09-10): In this unit, "students will develop a clear understanding and be able to define the concept of energy. Students will also be able to define energy by noting that energy causes change in matter through an exploration of the different forms of energy and the changes they create. Students will enhance their understanding of systems through the development of understanding energy systems. Students will also observe and explain energy transformations used for human use by identifying the forms of energy before and after transformations. Ultimately students will be able to connect prior learning related to energy, energy transformations, and energy devices used by humans to the sources of energy (renewable, nonrenewable, inexhaustible)" ("Instructional Focus Document," 2010).

SECOND NINE-WEEKS

- Unit 04: Energy Transformation: Living Systems (09-10): In this unit, "students will study energy flow in food chains and food webs. Students will create food webs and track the flow of energy as it travels from one trophic level to another. Students will also construct a compost column and observe the interaction between matter and energy in the decay of biomass. Students will create an illustration of the flow of energy in the water cycle" ("Instructional Focus Document," 2010).

- Unit 05: Levels of Organization in Living Systems (09-10): In this unit, "students will learn about the structure and function of cells, scientists who led to the development of the cell theory, how to use a microscope to determine that organisms are composed of cells, and how the structure of the various parts of the cell (organelles) is related to their function. They will construct a model of a cell to identify the structures within the cell and the functions of those structures. Students will also explore parts of the plant to identify how structure and function complement each other in living systems. Students will also connect structure and function to the levels of organization in living systems" ("Instructional Focus

Document," 2010).

- Unit 06: Genes (09-10): In this unit, "students will witness a DNA extraction demonstration and explore traits of other students in order to interpret the role of genes in inheritance. Students will also observe and identify how changes occur over several generations through natural selection and selective breeding" ("Instructional Focus Document," 2010).

THIRD NINE-WEEKS:

- Unit 07: Organisms' Response to Stimuli (09-10): In this unit, "students will identify responses in organisms, plants, and animals, to internal and external stimuli. One lab on animals and one on plants will give students practice in observing responses. Students will identify components of an ecosystem to which organisms respond. Students will also connect how an organism's ability to respond affects its survival" ("Instructional Focus Document," 2010).

- Unit 08: Water Systems and Cycles (09-10): In this unit, "students will complete a variety of activities to illustrate how water moves through the water cycle using heat energy and gravity" ("Instructional Focus Document," 2010).

- Unit 09: Atmospheric Cycles and Systems (09-10): In this unit, "students will identify the components of the atmosphere that most influence weather change. They will also identify layers of the atmosphere" ("Instructional Focus Document," 2010).

FOURTH NINE WEEKS:

- Unit 10: Forces That Change the Earth (09-10): In this unit, "students will study the major processes involved in the rock cycle. Students will understand that the rock cycle has many paths and they will be able to create their own path in narrative form. They will also create a diagram demonstrating the various and changeable routes that are possible in the rock cycle. Students will predict what might happen if major components or events in the rock cycle were altered. Students will identify the primary forces within the Earth that drive the rock cycle including gravity, pressure, and heat. Students will be able to identify the forces that shape the Earth including uplifting, movement of water, and volcanic activity. This information will prepare students for future learning as they move through the middle and high school years. Students will become scientific investigators as they develop an understanding of the forces that shape the Earth" ("Instructional Focus Document," 2010).

- Unit 11: Properties of the Solar System (09-10): In this unit, "students will be able to identify characteristics of the Sun, meteorites, asteroids, moons, and comets. The students will also be able to identify characteristics of the planets and have a better understanding of the numerous systems found at the planetary level and how those systems interact with the larger systems found within the solar system" ("Instructional Focus Document," 2010).

- Unit 12: Space Travel (09-10): In this unit, "students will work in a modified jigsaw to form a design team for the Millennium Space Project Mission to Mars. Students will become space vehicle experts working together as a final design team that will compile research, build, describe and present information about the types of equipment and transportation needed for space travel" ("Instructional Focus Document," 2010).

Model-Based Reasoning

"Model-based reasoning can be thought of as a continuum in which the teacher begins with students' basic representational capacities and try to end up near the practices of mathematicians and scientists" (Petrosino, 2003). There are three types of model-based reasoning. First is *analogical modeling*, which represents what is common among the members of physical systems with respect to a problem context. The second type is *visual modeling*, which describes the use external of visual representations to provide support for the processes of constructing and reasoning with a mental model. "These representations can model phenomena in several ways, including providing idealized representations of aspects of phenomena and embodying aspects of theoretical models. Finally, *thought experimenting* is a specific form of model-based reasoning, which makes the intention clear that the situation is one that is to represent a potential real-world situation" (Nersessian, 1999).

MODEL	DESCRIPTION
Physical Microcosms (Gentner and Toupin, 1986)	Model the world via resemblance such as models of the solar system, planetarium models of the cosmos, terrarium models of ecosystems, model rockets.
Representational Systems (Gentner and Toupin, 1986)	Provide a resemblance between the model and the world such as maps, diagrams, and related display notations.
Syntactic Models (Gentner and Toupin, 1986)	Summarize the essential functioning of a system by exchanging similarity for analogy.
Hypothetical-Deductive Models (Gentner and Toupin, 1986)	Incorporate mechanisms that can produce previously unseen and often unpredicted behaviors. (Gas Model). These models move beyond the realm of describing the observable to embodying unseen hypothetical entities that interact to produce emergent behavior.

Table 1: Taxonomy of Models

Furthermore, “there are several key common ingredients to the various forms of model-based reasoning. They are systematic reasoning processes in that the models are intended as interpretations of a target domain. In the modeling process, various forms of abstractions, such as limiting case, idealization, generalization, generic modeling, are utilized. Evaluation and adaptation take place in light of structural, casual, and/or functional constraint satisfaction and enhanced understanding of the target problem through the modeling process. Simulation can be used to produce new states and enable evaluation of behaviors, constraint satisfaction, and other factors” (Nersessian, 1999). Finally, “an instance of model-based reasoning: 1) involves the construction or retrieval of a model, 2) derives inferences through manipulation of the model, and 3) those inferences can be specific or generic, that is, they can either apply to the particular model or to the model understood as a model-type, representing members of a class of phenomena” (Nersessian, 2009).

Model-Eliciting Activities

Model-eliciting activities were also used in the criteria. They were used to determine the prevalence of model-based reasoning in CSCOPE curriculum and to determine how many of the suggested activities titled Exemplar Lessons can be classified as model-based or model-eliciting activities. “Model-eliciting activities are designed to encourage students to make sense of meaningful situations, and to invent, extend, and refine their own mathematical constructs" (Lesh, Hoover, Hole, Kelly, & Post, 2000). Model-eliciting activities are guided by the following six principles (Lesh et al., 2000):

- *The Reality Principle. Will students make sense of the situation by extending their own knowledge and experiences?* (Lesh et al., 2000) Does the activity/lesson motivate or create a need to apply covariational reasoning by the student (Carlson, M., Larsen, S. & Lesh, R., 2002).
- *The Model Construction Principle. Does the task immerse students in a situation in which they are likely to confront the need to develop (or refine, modify, or extend) a mathematically significant construct?* (Lesh et al., 2000) Does the task involve constructing, explaining, manipulating, predicting, or controlling a structurally significant system? (Carlson, M., Larsen, S. & Lesh, R. 2002) This criteria can be met by the students creating two models, such as a graph and an instruction manual.
- *The Self-Evaluation Principle. Does the activity promote self-evaluation on the part of the students?* (Lesh et al., 2000) This can be accomplished by having the students create criteria for assessing the quality of their model.
- *The Construct Documentation Principle. Will the question require students to reveal their thinking about the situation?* (Lesh et al., 2000) This is the primary motivation for developing a model-eliciting activity (Carlson, M., Larsen, S. & Lesh, R. 2002) Therefore, creating a model allows the students to reveal how they think about the situation.
- *The Construct Generalization Principle. Does the model provide a general model*

for analyzing this type of dynamic situation? (Lesh et al., 2000)

- *The Simplicity Principle. Is the situation simple?* (Lesh et al., 2000) Is the activity/task/challenge simple enough to allow it to play the role of a prototypical problem?

As stated previously, the model-eliciting activities criterion is also used to determine if the exemplar lessons did not meet model-based reasoning. "Model-eliciting activities are designed to encourage students to make sense of meaningful situations, and to invent, extend, and refine their own mathematical constructs" (Lesh, Hoover, Hole, Kelly, & Post, 2000). Furthermore, I strongly agree that model-based reasoning is crucial in creating an environment in "which the teacher begins with students' basic representational capacities and tries to end up near the practices of mathematicians and scientists" (Petrosino, 2003). Especially now that I am teaching sixth grade I am aware of how important it is to be a facilitator in helping students identify and change misconceptions about STEM disciplines. I truly believe that by giving the students the opportunity to partake in using models, model-based reasoning, and model-eliciting activities students can achieve a deeper level of understanding. Students not only gain an understanding of the academic objective, the TEKS here in Texas, they also are able to understand the benefits and limitations of models.

CHAPTER III:

RESEARCH REPORT METHODS, RESULTS, AND ANALYSIS

METHODS

In order to determine the prevalence of model-based reasoning in CSCOPE curriculum, I narrowed my research to focus on Science. Next, I focused specifically on Intergraded Science and chose the sixth grade due to its significance and relevance to the work being done within practice. This analysis can be done for any grade and any discipline in K–12. I specifically focused on sixth grade because I am the lead teacher for sixth grade Science at my school. Once the specific curriculum is determined, the performance indicator for each exemplar lesson within each unit is compared to the criteria of the following five categories: Physical Microcosm, Representational System, Syntactic Models, Hypothetical-Deductive Models, Model-Eliciting Activities. The results for each unit, including all exemplar lessons for that unit, will be recorded separately in a data table that will indicate which performance indicator for each unit meets the criteria for a specific model type. Furthermore, to establish Inter-rater reliability, the rating system will be implemented and conducted by two educators, myself and another educator whose practice is in a different discipline, as well as a different grade level. The letter Y will represent the primary investigator and X will represent the secondary investigator.

RESULTS

CSCOPE UNIT EXEMPLAR LESSONS VS. TYPES OF MODELS DATA

UNIT 01: Chemical and Physical Properties

- Exemplar Lesson 01: Properties Matter (10 days)
- TEKS: 6.7B
- Performance Indicator(s): Students will identify mystery substances as being a solid, a liquid, or a gas. They will experiment, make observations, and collect data about the properties of the mystery substance to support their statement and organize the data in a chart. They will use the data to back up their original statement in a paragraph and end the paragraph with a concluding statement.
- Exemplar Lesson 02: Chemical Changes Create Change in Matter (4 days)
- TEKS: 6.7A
- Performance Indicator(s): Students will perform an experiment to evaluate if a chemical or physical reaction has taken place, then collect data, draw conclusions, and present the results to the class. Students will write a summary of each group's experiment and explain how they know when a chemical change has occurred.

CSCOPE Exemplar Lessons	Physical Microcosm	Representational System	Syntactic Models	Hypothetical-Deductive Models	Model-Eliciting Activities
01: Properties Matter				Y/X	
02: Chemical Changes Create Change in Matter				Y/X	

Table 2: Model Type vs. Unit 1 Exemplar Lessons

UNIT 02: Force and Motion (09-10)

- Exemplar Lesson 01: Relationship between Force and Motion (10 days)
- TEKS: 6.6 A,B
- Performance Indicator(s): Create a plotted graph from data and analyze distance vs. time. At certain points describe what activity was happening at that time.

CSCOPE Exemplar Lessons	Physical Microcosm	Representational System	Syntactic Models	Hypothetical-Deductive Models	Model-Eliciting Activities
01:Relationship between Force and Motion		Y/X			

Table 3: Model Types vs. Unit 2 Exemplar Lesson

UNIT 03: Energy Transformations: Non-Living Systems (09-10)

- Exemplar Lesson 01: Energy Causes Change (6 days)
- TEKS: 6.8A
- Performance Indicator(s): Students will work in pairs to formulate a definition for energy using class experiences to support the definition. They will display the final definition and class experience supports, including the different forms of energy, in PowerPoint or picture book format if PowerPoint is unavailable. Exemplar Lesson 02: Energy Transformation: Non-Living Systems (4 days)
- TEKS: 6.9A, B
- Performance Indicator(s): Students will work in groups to identify two common items that demonstrate energy transformation and compare methods used for transforming energy. These will be added to the previously created PowerPoint and presented to the class.
- Exemplar Lesson 03: Sources for Energy (3 days)
- TEKS: 6.9A, 6.9C)
- Performance Indicator(s): Students will research and describe energy types from their source to their use and determine if each type is renewable, nonrenewable, or inexhaustible. They will create PowerPoint slides to display their research and energy descriptions.

CSCOPE Exemplar Lessons	Physical Microcos m	Representation al System	Syntacti c Models	Hypothetica l-Deductive Models	Model-Eliciting Activitie s
01: Energy Causes Change		Y/X			
02: Energy Transformatio n		Y/X			
03: Sources for Energy		Y/X			

Table 4: Model Types vs. Unit 3 Exemplar Lessons

UNIT 04: Energy Transformation: Living Systems (09-10)

- Exemplar Lesson 01: Food Chains and Food Webs (6 days)
- TEKS: 6.8C
- Performance Indicator(s): Students will construct a food web demonstrating the flow of energy within the system.
- Exemplar Lesson 02: Decay of Biomass (Composting) (5 days)
- TEKS: 6.8B
- Performance Indicator(s): Students will illustrate and explain how matter and energy is transferred in a compost bin.

CSCOPE Exemplar Lessons	Physical Microcosm	Representational System	Syntactic Models	Hypothetical-Deductive Models	Model-Eliciting Activities
01: Food Chains and Food Webs		Y/X			
02: Decay of Biomass Composting		Y/X			

Table 5: Model Types vs. Unit 4 Exemplar Lessons

UNIT 05: Levels of Organization in Living Systems (09-10)

- Exemplar Lesson 01: Exploration of the Cell: Scientific Contributions, Parts, Structure, and Function (12 days)
- TEKS: 6.10A, B
- Performance Indicator(s): Students will construct a model of a plant or animal cell and complete a report that describes how the structure of the organelles is related to their function within the cell. The report will include a description of the organelles and relate their structure to the role they play in the functioning of the cell.
- Exemplar Lesson 02: In This Together: Structure, Function, and Levels of Organization in Living Systems (4 days)
- TEKS: 6.10C
- Performance Indicator(s): Students will complete a word wall manipulative identifying the levels of organization and the relationship between structure and function.

CSCOPE Exemplar Lessons	Physical Microcosm	Representational System	Syntactic Models	Hypothetical-Deductive Models	Model-Eliciting Activities
01:Exploration of the Cell	Y/X				
02: In This Together		Y/X			

Table 6: Model Types vs. Unit 5 Exemplar Lessons

UNIT 06: Genes (09-10)

- Exemplar Lesson 01: From Parents to Offspring (3 days)
- TEKS: 6.11B, C
- Performance Indicator(s): Students will interpret the role of genes in inheritance and use a graphic organizer to identify where DNA is located within a cell.
- Exemplar Lesson 02: Changes in Traits (5 days)
- TEKS: 6.11A
- Performance Indicator(s): Students will complete a main idea literature review of articles related to natural occurrence and selective breeding.

CSCOPE Exemplar Lessons	Physical Microcosm	Representational System	Syntactic Models	Hypothetical-Deductive Models	Model-Eliciting Activities
01: From Parents to Offspring		Y/X			
02:Changes in Traits			Y/X		

Table 7: Model Type vs. Unit 6 Exemplar Lessons

Unit 07: Organisms' Response to Stimuli (09-10)

- Exemplar Lesson 01: Characteristics, Needs, and Responses of Organisms (5 days)
- TEKS: 6.12A, B
- Performance Indicator(s): Students will identify responses in organisms as internal or external on a response evaluation.
- Exemplar Lesson 02: Responding to the Environment (5 days)
- TEKS: 6.12C
- Performance Indicator(s): Students will identify the components of an ecosystem to which an organism may respond by matching response cards to the appropriate stimuli.

CSCOPE Exemplar Lessons	Physical Microcosm	Representational System	Syntactic Models	Hypothetical-Deductive Models	Model-Eliciting Activities
01:Characteristics, Needs, and Responses of Organisms				Y/X	
02: Responding to the Environment				Y/X	

Table 8: Model Types vs. Unit 7 Exemplar Lessons

UNIT 08: Water Systems and Cycles (09-10)

- Exemplar Lesson 01: Water Cycle Interactions (12 days)
- TEKS: 6.8B
- Performance Indicator(s): Students will create an illustrated story of the life of a drop of water as it travels through the water cycle.

CSCOPE Exemplar Lessons	Physical Microcosm	Representational System	Syntactic Models	Hypothetical-Deductive Models	Model-Eliciting Activities
01: Water Cycle Interactions			Y/X		

Table 9: Model Types vs. Unit 8 Exemplar Lesson

UNIT 09: Atmospheric Cycles and Systems (09-10)

- Exemplar Lesson 01: Components of the Atmosphere and Weather (12 days)
- TEKS: 6.14C
- Performance Indicator(s): Students will design a book, poster, or other visual product describing and illustrating how the atmosphere interacts with the earth's surface to create weather changes. The project will include information about currents, cycles, energy, temperature, precipitation, humidity, clouds, and wind.

CSCOPE Exemplar Lessons	Physical Microcosm	Representational System	Syntactic Models	Hypothetical-Deductive Models	Model-Eliciting Activities
01:Components of the Atmosphere and Weather		Y/X			

Table 10: Model Type vs. Unit 9 Exemplar Lesson

UNIT 10: Forces That Change the Earth (09-10)

- Exemplar Lesson 01: The Rock Cycle (8 days)
- TEKS: 6.14A
- Performance Indicator(s): Students will create a story relating a path through the rock cycle and illustrate the various changeable possible routes.
- Exemplar Lesson 02: Forces that Shape the Earth (7 days)
- TEKS: 6.6C
- Performance Indicator(s): Students will design a class presentation that identifies the forces that shape the features of the Earth.

CSCOPE Exemplar Lessons	Physical Microcosm	Representational System	Syntactic Models	Hypothetical-Deductive Models	Model-Eliciting Activities
01: The Rock Cycle			Y/X		
02:Forces that Shape the Earth		Y/X			

Table 11: Model Types vs. Unit 10 Exemplar Lessons

UNIT 11: Properties of the Solar System (09-10)

- Exemplar Lesson 01: Overview of the Solar System (6 days)
- TEKS: 6.13A
- Performance Indicator(s): Students will create a comic strip detailing a trip through our solar system from the vantage point of a traveler from another system to ours for the first time. The comic strip will include a description of the sun, meteoroids, meteors, asteroids, moons, and comets.
- Exemplar Lesson 02: Solar System: Components and Properties (7 days)
- TEKS: 6.5A, B, 6.13A
- Performance Indicator(s): Students will create a visual that illustrates the numerous systems found on the planetary level and how those systems interact with the larger systems found within the solar system.

CSCOPE Exemplar Lessons	Physical Microcosm	Representational System	Syntactic Models	Hypothetical-Deductive Models	Model-Eliciting Activities
01: Overview of the Solar System			Y/X		
02: Solar System: Components and Properties		Y/X			

Table 12: Model Type vs. Unit 11 Exemplar Lessons

UNIT 12: Space Travel (09-10)

- Exemplar Lesson 01: Modeling Space Travel (10 days)
- TEKS: 6.13B
- Performance Indicator(s): Students will complete a group presentation and a one-page science journal reflection describing the types of equipment and transportation needed for space travel.

CSCOPE Exemplar Lessons	Physical Microcosm	Representational System	Syntactic Models	Hypothetical-Deductive Models	Model-Eliciting Activities
01: Modeling Space Travel		Y/X			

Table 13: Model Types vs. Unit 12 Exemplar Lesson

DATA ANALYSIS

Prevalence of Models: The criteria for each model type were used to determine how each exemplar lesson could be classified. The data showed that each exemplar lesson met a model criterion.

Model Type	Prevalence of Models
Physical Microcosm	One exemplar lesson met this criteria
Representational System	12 exemplar lessons met this criteria
Syntactic Models	Four exemplar lessons met this criteria
Hypothetical-Deductive Models	Four exemplar lessons met this criteria
Model-Eliciting Activities	All exemplar lessons met these criteria, but since all exemplar lessons met one of the previous models, none were allocated in this table.

Table 14: Model Type vs. Prevalence of Models

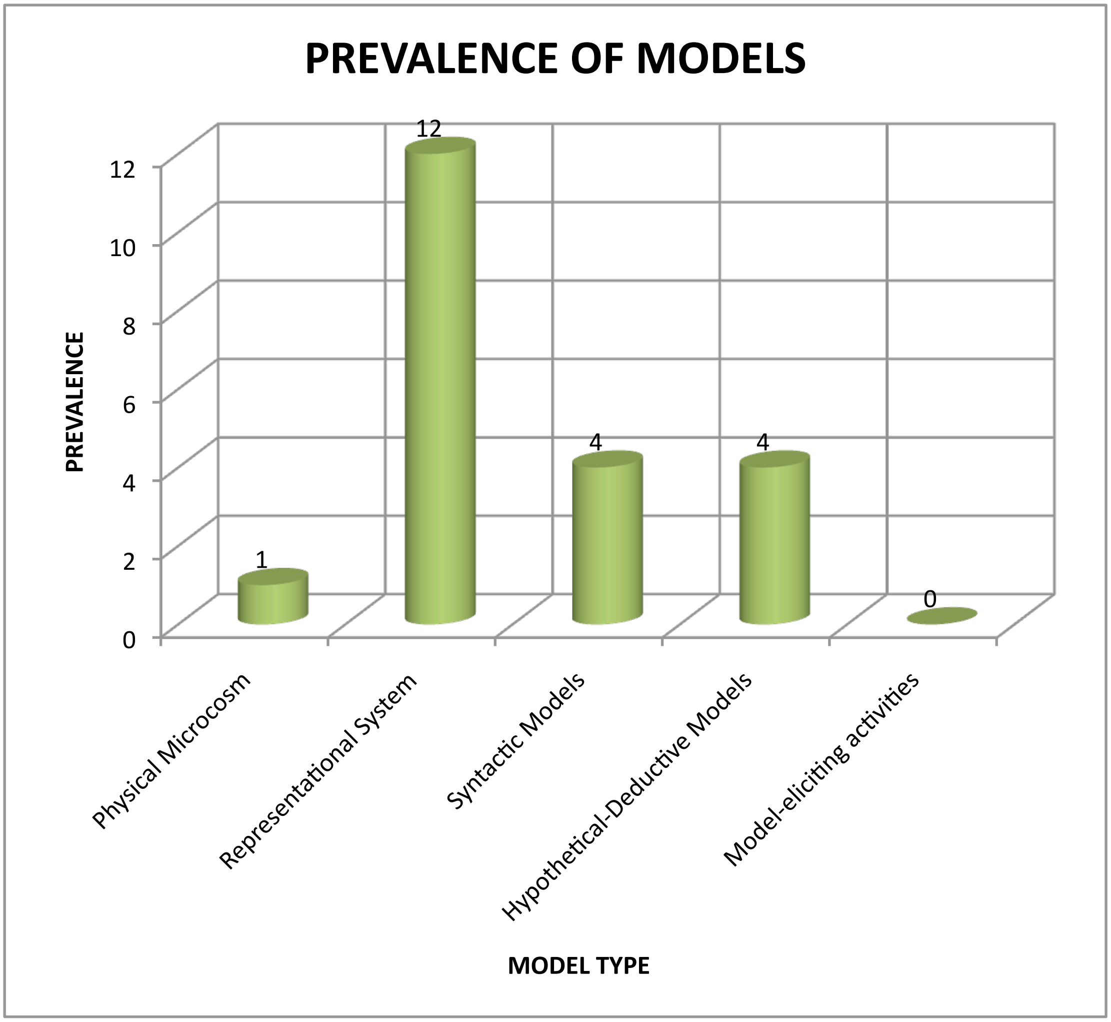

Figure 2: Prevalence of Models

Determining the percentage of model type in CSCOPE Curriculum

Model Type	Formula: MODEL TYPE IN CSCOPE CURRICULUM ___________________________ x 100 TOTAL # OF EXEMPLAR LESSONS IN CSCOPE	Percentage
Physical Microcosm	1/21 = 0.0476 x 100	4.76%
Representational System	12/21 = 0.5714 x 100	57.14%
Syntactic Models	4/21 = 0.1904 x 100	19.04%
Hypothetical-Deductive Models	4/21 = 0.1904 x 100	19.04%
Model-Eliciting Activities	0/21= 0 x 100	0%

Table 15: Percentage of Model Type in CSCOPE Curriculum.

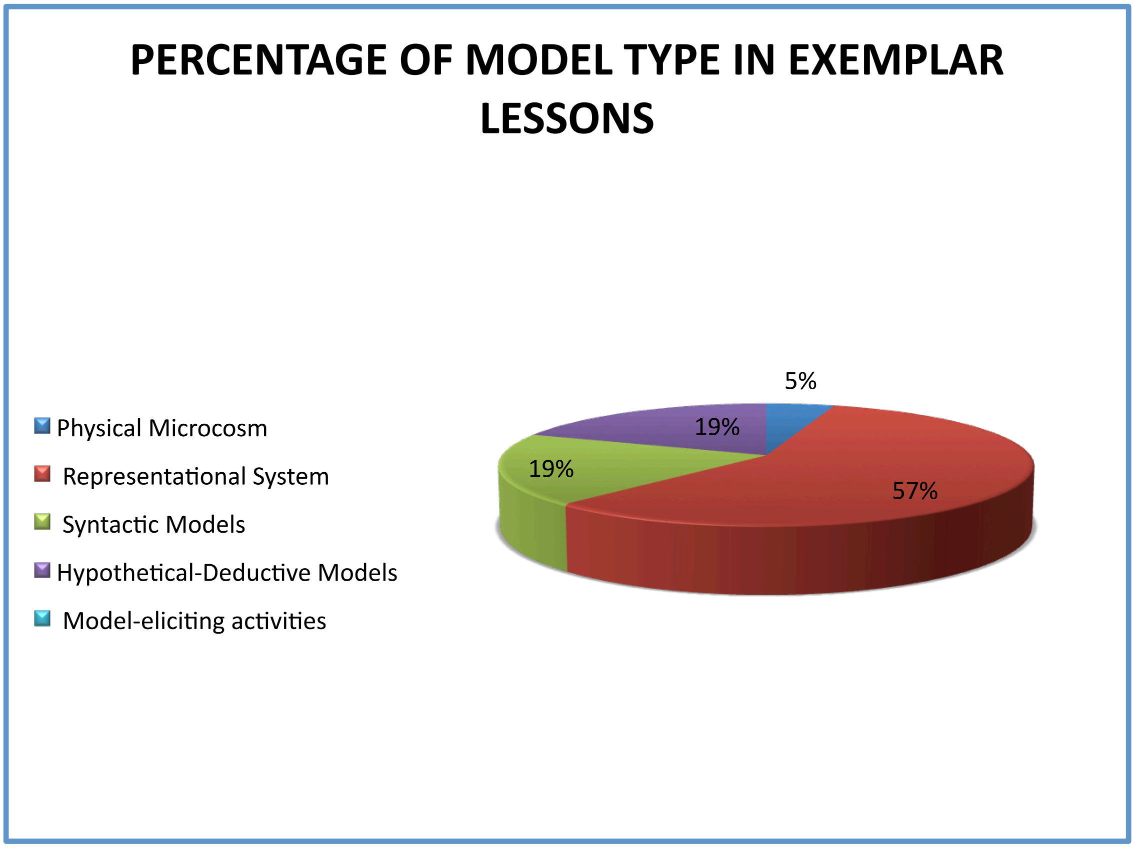

Figure 3: Percentage of Model Type in Exemplar Lessons

PREVALENCE OF MODEL-BASED REASONINGIN CSCOPE CURRICULUM

21 (NUMBER OF EXEMPLAR LESSONS CLASSIFIED AS MODEL-BASED REASONING)

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21 (TOTAL NUMBER OF EXEMPLAR LESSONS)

1 x 100 = 100% of exemplar lessons can be classified as model-based reasoning

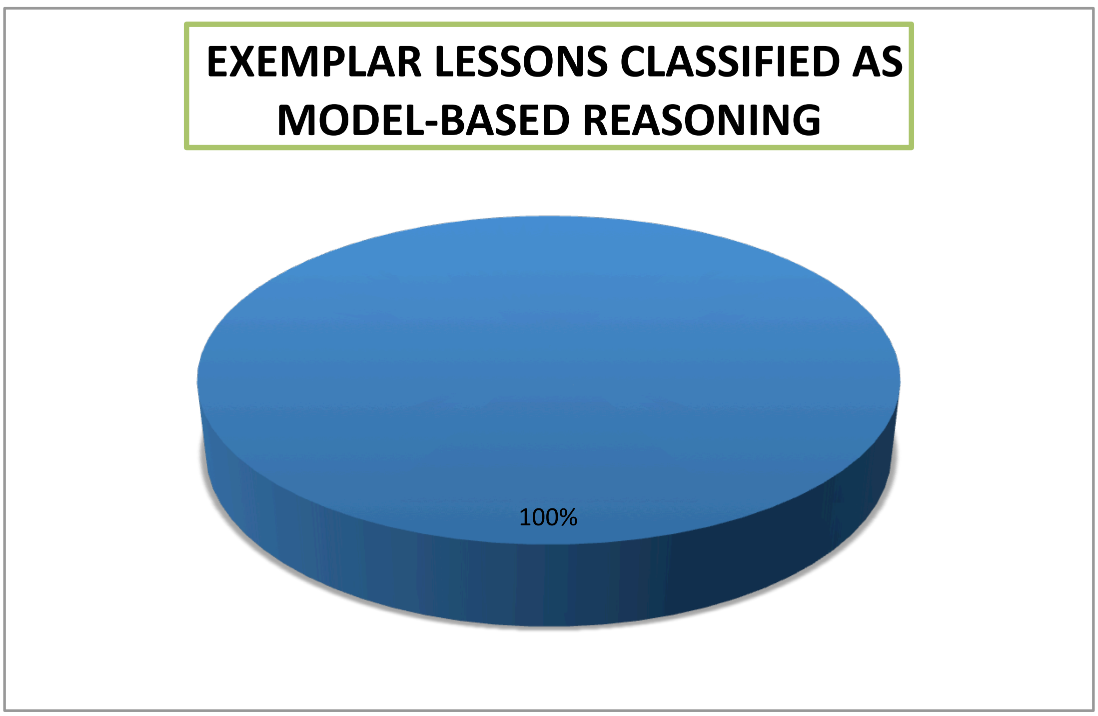

Figure 4: Exemplar Lessons Classified as Model-Based Reasoning

CHAPTER IV:

APPLICATIONS TO PRACTICE

The UTeach program has prepared me to present engineering careers and practices to my future students. Sixth grade science is the first time that most students take science as a discipline or step into a scientific classroom. With the budget crisis negatively impacting public education and the decrease in instructional time allotted to each student, we as educators must find solutions to cover the TEKS and help our students become more confident and excited about STEM topics. I believe that modeling engages students in complex forms of scientific and engineering thought and reasoning. Being able to use model-based reasoning will allow me to cover multiple TEKS and concepts, as well as allowing the students to understand the relevance of science, technology, engineering, and mathematics. My specific plans for increasing my students' exposure to STEM concepts is to maximize the benefits of the Professional Learning Communities that our school is implementing next year. Each grade level will divide its student body and core subject faculty into three Professional Learning Communities, which will allow the core teachers of each team to plan together. Furthermore, we are given 250 minutes a week to plan interdisciplinary lessons together. My curriculum design is CSCOPE, but as my data proves, the exemplar lessons that have been created by CSCOPE and the Professional Learning Communities will allow me to continue to present engineering, as well as the other STEM disciplines, through a multitude of model-based reasoning activities.

As a science teacher I have always taught the scientific method, but after taking the engineering courses determined by the program I now have a broader perspective of scientists and engineers. I will now be able to teach my students engineering principles along with scientific principles and explore their similarities and differences. I also have a greater toolbox to relate all STEM courses and show how they impact our daily lives. The program has allowed me to become well equipped to help students identify and change misconceptions about engineering. The engineering habit that I have employed most is the understanding that there are always trade-offs in life, in teaching, and in curriculum design. I am constantly sharing examples with my students where they have to consider trade-offs in their everyday life, from deciding what they will eat for breakfast to what assignment they will do first for homework, I point out that they are weighing their options and listing the trade-offs in the planning of their daily activities. The second engineering habit is the constant reminder to myself and to my students that there can be many solutions to one problem. I try to model and encourage my students to always attempt to come up with more that one solution when planning their projects and experiments. Ultimately, I believe that these engineering habits and my new understanding of my pedagogy, thanks to this program, will benefit my students.

My research did contribute to my understanding of the design process, specifically in the design of models. The design process is an integral part of models and model-based reasoning. I attained a clearer understanding of the design process due to the extensive time spent in the design of a fourth year high school science curriculum piloted in Austin ISD and now required by many districts. Furthermore, I now have my students design models and solve problems using both the scientific method and the design process. My research is not representative of the design process because I researched the prevalence of model-based reasoning in CSCOPE curriculum by analyzing the exemplar lessons against criteria to determine if the lessons can be classified as model-based.

Specifically, what I have learned in the MASEE program has and will continue to affect my practice in engineering education. I have and will be able to promote STEM in my classes. By understanding curriculum design, STEM, and engineering, I can help my students realize that the negative connotation of engineering is a misconception and that they can resolve many of the problems they face now and in the future by applying engineering habits. I am now better prepared and well versed to advocate and promote all aspects of STEM, especially engineering.

CHAPTER V:
CONCLUSION

The purpose of this research was to determine the prevalence of model-based reasoning in CSCOPE curriculum for sixth grade science. Specifically, the aim was to look at the performance indicators for each exemplar lesson and compare them to the criteria for model-based reasoning activities. My hypothesis stated that if CSCOPE's exemplar lessons are classified using model-based criterion, then thirty-six percent or more of the curriculum will qualify as model-based reasoning. I conclude that my hypothesis is correct based on data showing that one hundred percent of the exemplar lessons qualify as model-based reasoning activities under the criterion. Specifically, the most prevalent type of model used in CSCOPE science curriculum is the representational system. The second most prevalent types of models found in CSCOPE were syntactic models and hypothetical-deductive models. There was one lesson that qualified as physical microcosm. All exemplar lessons fall into one of the six principles that model-eliciting activities are based on; therefore, all exemplar lessons can be modified to qualify as model-eliciting activities. Inter-rater reliability was established due to the rating system being implemented and conducted by two educators who attained the same results.

In conclusion, using the model-based criteria to classify the exemplar lessons based on each lesson's performance indicators, I determined that all 21 exemplar lessons do meet the criteria for model-based reasoning activities. I feel confident that the curriculum will increase rigor in the classroom, help teachers implement a homogeneous curriculum across the state, and prepare students for STAAR, the new standardized test.

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Vita

Jose Ricardo Gonzalez was born in Guatemala City on July 25, 1977. After graduating in 1996 from the Science Academy at LBJ High School in Austin, Texas, he enrolled at Huston-Tillotson University in Austin in 1997. He received a Bachelor of Science degree in Biology in May, 2001. Since then, Jose has worked as a science teacher at Crockett High School in Austin and Lake Travis Middle School. In June, 2009, he began graduate studies at the University of Texas at Austin.

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