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The Impact Of Universal Design For Learning-representation Practices On Concept Maps And The Development Of Quality Scientific Explanations

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THE IMPACT OF UNIVERSAL DESIGN FOR LEARNING-REPRESENTATION PRACTICES ON CONCEPT MAPS AND THE DEVELOPMENT OF QUALITY SCIENTIFIC EXPLANATIONS

by

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ABSTRACT

The purpose of this action research project was to determine how my practice of implementing Universal Design for Learning-Representation (UDL-R) principles influenced my students' understanding of content and enhanced their ability to organize their knowledge using concept maps. A secondary purpose of this action research project was to determine if student created concept maps served as a useful tool to enrich students' written scientific explanations. Students in this study completed concept maps and wrote explanations about adaptations before and after participating in lessons enriched with UDL-R principles that included the use of multi-media sources, website searches, and trade books.

The processes used to collect data for this action research project were concept maps, written explanations, student notes, and videotaped accounts of learning from UDL-R principles. The themes that emerged were deeper content understanding for students and greater engagement in learning through UDL-R practices as evidenced through student notes, student discussions and videotaped accounts. The students in this study showed minimal change in the total average scores on concept maps with mixed results for males versus female students' scores. Although students' concept maps and written explanations indicated minimal improvement or change, their notes listing thirty to over one hundred facts and their comments indicated their interest and engagement in the learning process supported by UDL-R practices.

This research is dedicated in memory of Wallace and Janet Crockatt, two wonderfully supportive parents who have encouraged me from above and whose words of support are forever in my heart and mind.

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CHAPTER 1: INTRODUCTION

"The *National Science Education Standards* (1996) present a vision of a scientifically knowledgeable population in society. This document outlines what students need to know and understand so that they become scientifically literate at different grade levels. The *Standards* describe an educational system which incorporates students demonstrating high levels of performance, teachers empowered to make the decisions essential for effective learning, the interlocking of communities of teachers and students that are focused on learning science, and supportive educational programs and systems that nurture achievement. The *Standards* which are written intentionally in the present tense point toward a future that is challenging but attainable." (National Research Council, 1996, p.2). "The National Research Council's (NRC) intent of the *Standards* can be expressed in a single phrase: Science standards for all students. The phrase embodies both excellence and equity which means the standards apply to all students, regardless of age, gender, cultural or ethnic background, disabilities, aspirations, or interest and motivation in science. Understandably different students will achieve understanding in different ways and in different degrees of depth and breadth depending on interest, ability, and context however, all students can develop the knowledge and skills described in the *Standard*." (National Research Council, 1996, p.2). As students move towards deeper conceptual understanding and mastery of content, they move towards an ability to explain their knowledge. Many times this understanding can be observed in the classroom as students eagerly discuss, share, and communicate what they know. Another way for students to demonstrate their ability to express

their knowledge is through written explanations. In order for students to write about their knowledge of science, they need to understand and make connections to the material presented.

The Florida Sunshine State Standards in Science require explanations asking students to observe and explain; recognize and explain; investigate and explain; or simply explain a scientific concept. As science moves towards "Big Ideas" and understanding of the characteristics of scientific knowledge, students need to work towards explanations that are linked with evidence. (FLDOE, 2008) This deeper understanding and ability to make connections and write quality scientific explanations is the driving force of my research. After witnessing student explanations to be no more than verbatim definitions of science vocabulary or disjointed content, I wanted to create a learning environment to enable my students to connect new material to their existing knowledge through concept mapping and demonstrate the formalization of their understanding through written explanations.

To assist my students in attaining quality written explanations, I implemented an innovative approach to learning that includes the use of technology as well as assisted my students in developing a method to organize their newly learned material. Science is a subject that naturally lends itself to inquiry, investigations, and experiments. Although these wonderfully exciting and scientifically enticing hands-on activities grasp students' attention and perhaps even desire to learn science, they in themselves do not guarantee personal student understanding and an ability to translate their knowledge into their own words. The foundation of cognitive constructivism is based on Piaget's theory related to the development of cognitive abilities and the theory that humans must construct their own knowledge through experience which allows them to create mental models. These mental models of knowledge expand and

become more complex as the learner personally assimilates and accommodates new knowledge into their existing knowledge (Clark, 1999; Kern & Crippen, 2008; Novak 1991, 1993; Gerstner & Bogner, 2009). This method of knowledge acquisition is supported by John Dewey's early perspective on learning as was addressed at the American Association for the Advancement of Science in Boston in 1909. Dewey (1910) asserted that knowledge is not information given to someone but comes from being involved and the practice of inquiry which should occur at an early age and focus on the student's learning experiences and interaction within their learning environment as critical piece to knowledge acquisition growth. The emphasis placed on student directed learning has been around for decades, however in many classroom environments teachers are still imparting their knowledge to students through teacher directed approaches to learning.

Purpose of Study

This chapter sets the premise for the action research proposed within this study. Within this chapter the purpose of this study is identified and defined in terms of connected and related concepts. Chapters following the introductory chapter include the literature that supports the purpose of this study as well as chapters explaining researcher methodology, data analysis used in the evaluation of written explanations and conclusions drawn based on student responses throughout this study.   Reflection on my current teaching practice has been a consistent theme throughout the past two years of participating in a Masters Degree Program in Mathematics and Science. As a teacher who believes in the full inclusion of students who learn differently, I believe my science learning environment supports students who struggle as well as those who are

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gifted. The purpose of my research is to implement an approach to learning such that the science material to be understood will be accessible for all the levels of ability of my students. More specifically, the questions that I seek to answer through this action research project are:

1) How will my use of Universal Design for Learning-Representation practices promote students ability to develop comprehensive concept maps or thinking maps for understanding adaptations in living things?

2) How will the use of concept maps assist my students in their ability to independently write a detailed, justified science explanation?

Many approaches for inclusion focus on students with learning difficulties, students with Individual Education Plans (I.E.P.), or students considered at-risk. While these students require various accommodations, students that are gifted should equally receive accommodations. An effective science classroom takes into account the approach to learning that is inclusive of all students' needs. Since the late 1990s, federal laws have generated dramatic changes in the academic expectations of students with disabilities through the Individuals with Disabilities Education Act (IDEA). This act originated in 1975 as the Education for All Handicapped Children Act of 1975 or P.L. 94-142 and required that all schools provide all eligible students with a free appropriate education in an environment setting containing the fewest restrictions (US Dept of Justice). The IDEA was reauthorized in 1997 inspiring breakthroughs for students with disabilities to participate and progress in the general education classroom and curriculum and to be assessed with the same accountability as their peers (Rose, Meyer, & Hitchcock, 2006).

In 2001, the No Child Left Behind Act (NCLB) supported the idea that students with disabilities are not only able to interact within the regular education classroom environment but

should also thrive academically and achieve, through the realignment of special education and general education standards, curricula, and accountability. Individuals with Disabilities Act underwent a second reauthorization in 2004 which emphasized NCLB's philosophy and instituted stronger efforts to provide for curriculum that would be universally designed to promote the learning of students with disabilities (Rose, Meyer & Hitchcock).

<u>Universal Design for Learning Practices</u>

This study utilized an approach to learning using universal design practices. Universal Design curriculum stemmed from the concept of Universal Design in architecture as the mobility needs of people with disabilities emerged. The movement towards Universal Design in architecture was coined by Ron Mace (Rose, 2000) as architects evaluated how a wheelchair bound person could reach the second floor of a building, access a sidewalk, or enter a shopping mall. Architects were presented with these issues as they were hired to design buildings for accessibility to the general public which included individuals with disabilities. The results created by engineers have been elevators, ramps, and curb cutouts to name a few. These creations were not only used by people with disabilities but also by the general public for example a mother uses it to push her stroller, a runner uses it to prevent jarring on their knees and walkers use it as well as it gradually slopes down and up rather than causing a potential tripping hazard. These creations, which were designed for individuals with disabilities, were being used by many citizens and were being implemented proactively in the design process rather than trying to retrofit them after a building had been completed (Rose 2000).

In the early 1990s educators at the Center for Applied Technology (CAST) began to recognize that the learning materials used in the classroom were much the same as the buildings being built. They determined that learning materials should be proactively created to meet the needs of all students rather than retrofitting materials into curriculum as new learners appear in the classroom (CAST, 2008). The CAST began to see parallels between Universal Design in architecture and "Universal Design" in curriculum by attempting to design materials, methods of instruction, and assessment for all learners resulting in the creation of an approach to learning, called Universal Design for Learning (Rose, 2000). For the purposes of the study, UDL related to representation will be implemented as students build upon their understanding of animal and plant adaptations through multimedia sources, computer research, and audio-taped trade books.

Universal Design for Learning and Technology

In addition to the audio-taped supplemental trade books, students also used computers and viewed a selection of multimedia DVD's related to animal adaptations during this unit. Technology is a component of Universal Design for Learning. Universal Design for Learning has a prime focus on using computers in the curriculum because of their flexibility to transform learning materials. Although intended for students with disabilities, the use of technology can also enhance the learning of students who are in the general education classroom and gifted as well. Technology can be utilized by students on IEP's, at-risk or gifted. The U.S. Department of Education states that while technology is not a requirement of universal design, it makes the creation and the use of universally designed curricula much faster and easier allowing teachers to adapt the curriculum more easily (1999). It is not the use of technology alone that makes the

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difference in learning using UDL practices but the inclusion of technology. Coyne, Ganley, Hall, Meo, Murray and Gordon (2008) note that teachers realize greater student success within their classrooms once they understand that technology combined with UDL practices, such as, providing background information, models, and choices of topics for assessment is mutually supportive.

<p style="text-align:center;">Concept Mapping of Content</p>

According to Chang, Suang, Chang and Cheng-Li (2005) researchers have built computer-based concept mapping systems to help students construct maps more easily. Since the construction of concept maps can be complex and difficult, and paper and pencil concept maps are not efficient when revisions are needed, computer generated maps could further enhance learning. Although difficult to construct, concept maps can make the structure of abstract knowledge become visible and can enable students to clearly express their knowledge and conceptual understanding which can lead to high-level cognitive learning and thinking(Chang, Suang, Chang, & Cheng-Li, 2005). A concept map is a visual organizational tool that represents the connection and relationship between a main idea or concept and supporting ideas or concepts which are linked by propositions which explain the connection or relationship of the supporting concepts to the main concept or supporting concepts to other supporting concepts. Concept maps can provide students with the opportunity to demonstrate their learning from their movement away from rote memorization toward knowledge construction (Novak, 2002). The creation of concept maps allows students to expand their thinking and visually represent their thoughts, ideas, and their knowledge. Concept maps are not

only an excellent method for students to demonstrate their scientific material understanding, it can also provide teachers with knowledge of the concepts that may still need to be reviewed or explored (Novak & Canas, 2008). Students in this study will present their concept map to each other which will provide an opportunity for clarification and correction of possible misconceptions.

<center>Written Science Explanations</center>

Concept maps or organizational tools are useful instruments to assist students in making connections and providing the amount of detailed information needed to write quality written explanations. The Florida Comprehensive Assessment Test (FCAT) for Science has included both short response and long response written explanations as test questions. Although the Florida Department of Education (FLDOE) has made a determination to remove this type of question, the importance of the skill to write a detailed, quality written explanation remains. Literature supports the uses of concept maps as a tool to promote student understanding of material. A secondary benefit for students would be the opportunity to use their concept maps as a visual representation of their knowledge for which they can build quality written explanations supported by factual evidence and examples. "Writing scientific explanations requires learners to integrate scientific concepts with their prior knowledge and with evidence gathered from different information sources (de la Chica, 2007, p.2)." The National Science Education Standards (NSES) emphasize the importance of developing information literacy skills to support learners in making connections, integrating new knowledge, and writing scientific explanations that are logically sound and established through scientific evidence and knowledge (de la Chica).

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Student generated assessment methods are encouraged in Universal Design for Learning practices however in this study students were asked to use their concept maps to respond to questions related to animal adaptations (CAST, Coyne, Ganley, Hall, Meo, Murray, & Gordon).

Limitations of the Study

The goal of having students create concept maps that they can turn around and use for quality written science explanations may seem like an overly ambitious task to undertake. This study also incorporates the creation of a new learning environment for my students using Universal Design for Learning practices, an innovative approach to teaching that I am newly becoming familiar with in my classroom. As a teacher working in a small, not-for-profit, private, school in the Central Florida area, the technological resources available at my discretion are limited thereby possibly excluding some technological aspects used in UDL. This study is being conducted with one group of fifth grade students which presents generalizability issues to other classes and to other demographic groups of 5th grade students. Eagleton (2008) warns that educators should be cautioned not to overstate the promise of Universal Design in educational settings as it has not yet been fully researched across multiple instructional environments or with multiple populations. Rose (2000) contends that tactile learning opportunities can help students retain information for further synthesis through episodic memory and that the practice of UDL provides opportunities to express their knowledge through alternative assessment means rather than traditional. This study includes one traditional assessment to evaluate student concept understanding through written explanations however students will be allowed to use a concept map that they create to assist in that process.

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Significance of the Study

The significance of this study is that Universal Design for Learning principles guide educators in finding innovative ways to make curriculum accessible and appropriate for individuals with different backgrounds, learning styles, and abilities. This paradigm for teaching and learning focuses on adapting the curriculum to suit the learner and not the learner adapting to the curriculum (Eagleton, 2008). Universal Design for Learning achieves the goal of meeting individual student needs by providing alternatives for students rather than seeking a single solution for everyone (Rose, 2000).

According to Rose (2000), UDL involves the use of digital multimedia technologies. Multimedia technology is versatile and flexible but it must also be accessible to all students and must therefore be properly designed. Concept mapping software can be used to assist students in creating their maps as they build their knowledge. Concept mapping can be used with a diverse group of topics and issues and can be used across all grade levels according to Enger (1996). In her study, Concept Mapping: Visualizing Student Understanding, Enger noted that students felt empowered from the creation of their concept maps as it showed their knowledge and understanding. For the purposes of this study, students will generate paper and pencil maps due to their inexperience with creating concept maps.

Summary

The literature I have reviewed for this study has elucidated Universal Design for Learning practices and the development of concept map information organizers used to assist

students in their writing of quality explanations about adaptations of organisms. Attempting to make a connection from an innovative method of learning to the creation of concept maps, and concept map creation becoming a tool to assist in quality written explanations may be daunting and questionable in theory. However, learning environments that meet the needs of all learners can provide students opportunities to connect to the content in a concrete manner. My questions "How will my use of Universal Design for Learning-Representation practices promote students ability to develop comprehensive concept maps or thinking maps for understanding adaptations in living things?" and "How will the use of concept maps assist my students in their ability to independently write a detailed, justified science explanation?" were investigated with fifteen of my fifth grade science students to evaluate the impact of this teaching method on my practice.

CHAPTER 2: LITERATURE REVIEW

This literature review provides a summary of how the implementation of the Universal Design for Learning Practices related to Multiple Means of Representation (UDL-R) may assist students in developing a concept map and a written explanation of a science concept to demonstrate their understanding. This chapter examines research related to universal design for learning principles and concept maps to support students' written explanations of science content.

Science Instruction and Current Status

The need for students in science to express themselves explicitly and with factual details is critical to their explanation and deep understanding of science content (Knipper & Duggan, 2006). According to de la Chica (2007), the National Science Education Standards focuses on the development of information literacy skills to support learners in their writing of logically sound and evidence-based, knowledgeable scientific explanations. Writing scientific explanations requires the learner to merge scientific concepts learned from a variety of sources with a learners' prior knowledge and then transfer that knowledge into written discourse (de la Chica 2007; Ruiz-Primo et al 2008). Understanding content involves more than doing and knowing something and can be demonstrated not only through reading but also through writing (Knipper & Duggan, 2006). According to Knipper and Duggan, integrating writing with reading

enhances comprehension because reading and writing are reciprocal processes. Writing engages every student as they grapple with putting their understanding into words. Writing extends thinking, deepens understanding, and energizes the meaning-making process (Knipper & Duggan, 2006). The need for a stronger ability to express science knowledge in writing is evident in the national, state, and county assessments that require some form of written assessment from all students. This need to prepare students to write in science is clear in assessments that are two-fold in the State of Florida. Florida has implemented a writing assessment for students in Grades 4, 8 and 10 evaluating narrative, expository and persuasive writing samples as well as having implemented a science assessment with writing expectations at grade levels 5, 8, and 11. The science assessment goes beyond just factual knowledge and expects students to express their knowledge through open-ended responses. According to the Florida Department of Education (FLDOE), the Next Generation Sunshine State Standards new "Big Ideas" incorporates the practice of science through scientific inquiry. The FLDOE identifies the "Big Ideas" for fifth grade students under the category of The Practice of Science as:

"A: Scientific inquiry is a multifaceted activity; the processes of science include the formulation of scientifically investigable questions, construction of investigations into those questions, the collection of appropriate data, the evaluation of the meaning of those data, and the communication of this evaluation.

B: The processes of science frequently do not correspond to the traditional portrayal of "the scientific method.

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C: Scientific argumentation is a necessary part of scientific inquiry and plays an important role in the generation and validation of scientific knowledge.

D: Scientific knowledge is based on observation and inference; it is important to recognize that these are very different things. Not only does science require creativity in its methods and processes, but also in its questions and explanations." (Florida Department of Education, 2008, p. 42)

Educators play a crucial role in supporting their students' mastery of the practice of science through an inquiry based approach by teaching students how to document and write clear, detailed, and evidence based observations and explanations. Although the role of the teacher is significant, assuring that students understand science content and can communicate their understanding does not necessarily always occur without misconceptions. Students learn to write when teachers surround them with examples and models of writing, set guidelines and expectations, let them make decisions and mistakes, provide feedback, and allow opportunities to practice in authentic, realistic ways (Knipper & Duggan, 2006).

The National Science Education Standards are expectations that have been established to ensure that educational environments produce a scientifically literate populace (National Academy of Sciences).

According to the National Academy of Sciences "learning science is something that students do, not something that is done to them. "Hands-on" activities, while essential, are not enough. Students must have "minds-on" experiences as well. The *Standards* call for more than "science as process," in which students learn such skills as

observing, inferring, and experimenting. Inquiry is central to science learning. When

engaging in inquiry, students describe objects and events, ask questions, construct

explanations, test those explanations against current scientific knowledge, and

communicate their ideas to others. They identify their assumptions, use critical and

logical thinking, and consider alternative explanations. .In this way, students actively

develop their understanding of science by combining scientific knowledge with reasoning

and thinking skills" (National Academy of Sciences, p. 2)

Explanations are a central artifact of science, and the construction related to students

coordinating evidence to support their claims and evaluating their explanations are central to

scientific argumentation (Sandoval & Millwood, 2005).

The goals for school science set within the National Science Education Standards

(1996) are established to educate students who are able to: 1) experience the richness and

excitement of knowing about and understanding the natural world; 2) use appropriate

scientific processes and principles in making personal decisions; 3) engage intelligently

in public discourse and debate about matters of scientific and technological concern; and

4) increase their economic productivity through the use of the knowledge, understanding,

and skills of the scientifically literate person in their careers (National Academy of

Sciences, 1996, p.13).

 Knipper and Duggan (2006) declare that writing-to-learn strategies invite students to

think about and interact with resources, encouraging more thoughtful reading while creating

more conscientious learners. They contend that teachers must be ready to incorporate an eclectic

repertoire of writing-to-learn strategies to meet the demands for the participation of every student

just as the National Science Standards are established for all learners. The Full Option Science

System (FOSS) curriculum is one approach to creating a learning environment that helps

students develop their ability to think critically and construct ideas through inquiry activities,

investigations, and analyses of observations (FOSS, 2009). FOSS is a research based nationally-

tested curriculum that supports the concept of "doing science" that the National Science

Education Standards are based upon as well as, based upon the way the brain constructs

knowledge. The flexible enriched learning environment provided within FOSS curriculum can be

aligned with UDL-R principles through its design to maximize learning opportunities using a

multisensory approach through the science kit tools and additional classroom learning resources

that provide access to science experiences for all (FOSS, 2009).

Potential Solutions

The National Academy of Sciences (NAS) define scientific literacy as the opportunity for

a person to ask, find, or determine answers to questions derived from curiosity about everyday

experiences.

The NAS further states that scientific literacy means that a person has the ability

to describe, explain, and predict natural phenomena. It entails being able to read with

understanding articles about science in the popular press and to engage in social

conversation about the validity of the conclusions. Scientific literacy implies that a

person can identify scientific issues underlying national and local decisions and express

positions that are scientifically and technologically informed. A scientifically literate

person should be able to evaluate the quality of scientific information on the basis of its source and the methods used to generate it.

The NAS further contends that scientific literacy implies the capacity to pose and evaluate arguments based on evidence and to apply conclusions from such arguments appropriately. According to the NAS, individuals will display their scientific literacy in different ways, such as appropriately using technical terms, or applying scientific concepts and processes. The NAS understands that individuals will have differences in literacy in different domains, such as more understanding of life-science concepts and words, and less understanding of physical-science concepts and words, as well as, having different degrees and forms. Scientific literacy should expand and deepen over a lifetime, not just during the years a person is in school but within an individual's life in their community and in the world. A critical concept linked to lifelong learning is how the attitudes and values established toward science in the early years will shape a person's development of scientific literacy as an adult (National Academy of Sciences, p. 22).

The NAS goals and standards contribute to educational reform at the state and local levels and teachers are left as the individuals to implement whatever reform decisions are made within the classroom. Although educators are charged with teaching students to be successful on state assessments; students are required to take an active role in their learning. Meaningful learning requires that the learner must possess some anchoring concepts, the material to be learned has authentic value and meaning, and that the learner chooses to understand meaningfully and not through memorization of facts. Meaningful learning can occur from

Universal Design for Learning principles that support the accessibility of curriculum content (Coyne, Ganley, Hall, Meo, Murray, & Gordon). As students utilize multiple methods to access information they have opportunities to comprehend new information and incorporate it into their knowledge base. The process of assimilating new concepts and propositions into a student's existing knowledge base can be demonstrated in a concept map that allows the student to make connections visually (Novak, 2002). As a student's knowledge base expands, their ability to express their knowledge through written explanation can grow.

<u>Concept Mapping</u>

How can we assess what we teach? How do we know what our students truly understand? Is there any way to observe that they are really getting it? Traditional formal assessment methods such as unit or chapter tests only require a verbatim regurgitation of facts and figures rather than true acquisition and internalization of learned content. As a teacher, the desire to observe my students assimilation of new knowledge has brought me to a point of inquiry into the practicality of the use of student created information organizers. Information organizers can be concise concept mapping tools that allow children to visualize and demonstrate their knowledge. Concept mapping is a method for representing knowledge graphically or visually with concepts encircled in nodes or bubbles, and the concept relationships represented through labeled links or propositions (Hilbert & Renkl, 2008). "The idea of concept mapping is based on Ausubel's assimilation theory of cognitive learning whereby the mind organizes information in a hierarchical fashion from the top down as well as, their interrelatedness of the concepts (Hilbert & Renkl, p. 53; Novak 1991, 1993)." According to Novak and Canas (2008),

Ausubel makes a clear distinction between rote learning and meaningful learning. The material

to be learned must be conceptually clear, be presented with language, and include examples

relatable to the learner's prior knowledge; and the learner must choose to learn meaningfully.

Creating new meanings requires the construction of new propositions according to Novak (1991,

2002). New concepts are acquired through discovery rather than through rote memorization of

definitions. Rote learning does not support students in their building upon their existing

knowledge nor does it allow for the understanding of consistent outcomes in events or

relationships among objects (Novak 1991; Guvenc & Acikgoz, 2007). According to Novak

(1991, 2002), science unfortunately has been one of those subjects whereby rote learning is the

fallback of educators due to the misconceptions that they themselves may have, thereby making

memorization of facts, vocabulary and algorithms a standard method of instruction continuing to

reinforce poor outcomes on science achievement tests.

    Hyerle (1995), creator of "Thinking Maps, Inc.", states that there are three theoretical

frameworks that shape "Thinking Maps" which are a specific type of information organizational

tool also known and discussed from this point forward as concept maps. Hyerle states that

Thinking Maps or concept maps utilize a constructivism, developmental, and interactive learning

approach. The constructivism approach to learning is based on theories of how children

assimilate new information using fundamental thinking processes. Hyerle's support of a

developmental approach to learning using concept maps stems from the ability for children to

use the concept maps as tools for cognitively processing simple to complex concepts through the

application and assessment of their thoughts using the information organizers. Finally, concept

maps support interactive learning as students use the tools to communicate their thoughts in

shared group activities. Thinking Maps, Inc. contains several different styles of information

organizers that children can utilize to organize the content material they are learning. Hyerle's

maps include a Circle Map, Bubble Map, Double Bubble Map, Tree Map, Brace Map, Flow

Map, Multi-Flow Map and Bridge Map. The different maps are intended to be used for the

different ways information may need to be organized for example, the Circle Maps were created

for brain storming or demonstrating prior knowledge, the Bubble Map for describing something,

the Double Bubble for comparing items, and a Tree Map for classifying. For the purpose of this

study, students utilized a concept map to demonstrate their acquisition of knowledge.

Concept maps not only can be used as learning tools but also as a tool for assessment and

evaluation (Novak 1991, 1993, Kern & Crippen, 2008). Educators have an opportunity to

evaluate student misconceptions through the student's connections drawn out in the information

organizers and then through sharing, continued discussions, and with further research assist the

student in making corrections. Concept maps are a powerful tool for meaningful learning as they

"serve as a kind of template or scaffold to help to organize knowledge and to structure it, even

though the structure must be built up piece by piece with small units of interacting concept and

propositional frameworks" (Novak & Canas, p. 7). Science textbooks are being designed with

concept maps either as a lesson assessment activity or within the chapter review. Armstrong

(1993) completed a study on Learning To Make Idea Maps with Elementary Science Text, which

confirmed that texts can be used to create concept maps to assist students in their understanding.

Students may also create maps that contain too much detail which in the end will defeat the maps

purpose of focusing on main ideas and key concepts. According to Hilbert and Renkl, concept

mapping could be a useful tool to foster learning for the integration of material that can occur

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from multiple resources. The more skilled and practiced students are in creating concept maps the more efficient they will be in representing their knowledge.

Connecting concepts is an important and essential part of meaningful learning and the ability to structure and share that knowledge is an indicator of being a proficient learner. Evidence supports that students that work in small groups and strive to learn subject matter typically have positive outcomes both cognitively and affectively (Novak & Canas, 2008) with perhaps even greater learning occurring from their peers. Even better, according to Stice and Alvarez (1986) in their study for the U.S. Department of Education, Choice of Educational Research and Improvement on Hierarchical Concept Mapping: Young Children and How They Learn, "all the children could participate successfully" (p. 21) and "this sharing and exchanging of ideas during concept mapping events, seems to be especially important for helping disadvantaged children become more successful learners" (p. 22). U.S. Department of Education's study completed by Stice and Alvarez discovered that classroom teachers in this study mentioned improvement on chapter tests, increased participation in classroom discussions, and recognition of motivation and enthusiasm in learning as a result of the mapping activities.

Concept maps are effective tools that help organize knowledge that is designed for long term memory and help form the mental scaffolds for students to think more critically and more creatively (Novak, 1993). Novak (1993) states that previous studies have indicated that educators need to empower learners by helping them organize and use carefully developed concept maps. According to the National Academy of Sciences the National Science Education Standards guiding principles state that:

- Science is for all learners.

- Learning science is an active process.

- School science reflects the intellectual and cultural traditions that characterize the practice of contemporary science.

- Improving science education is part of systemic education reform.

Universal Design for Learning (UDL) principles support these guidelines. Universal design reflects a more articulated understanding of learning and contextualizes presentational environments, where students are consistently supported in learning how to learn, and mastering skills and strategies not just consuming information. (Rose, Meyer, & Hitchcock, 2006) Concept Maps and UDL principles complement each other by minimizing barriers to enhance learning outcomes.

Universal Design for Learning

A new way to support students in content understanding is to provide more content sources with Universal Design for Learning (UDL) practices. UDL was designed for students with disabilities, to allow them an opportunity to access curriculum like every other student. According to the U.S. Department of Education, the concept of UDL is a spinoff from Universal Design in architecture where "considerations for physical access for individuals with sensorimotor disabilities led to designs that incorporated assistive technologies and adaptations" (p. 2). Universal Design is rooted in architecture and product development as engineers wrestled with a way to create and develop places and things that are accessible by all people. (Rose, 2000; McGuire, Scott, & Shaw, 2006). It began with a curb cutout for wheelchair bound persons and

soon became an avenue for runners, bicyclists, and parents with strollers (Rose, 2000; McGuire, Scott, & Shaw, 2006). Universal Design (UD) in architecture often came as an afterthought (Rose, 2000; McGuire, Scott, & Shaw, 2006). Architects questioned how to make stores, homes, parks, and businesses more accessible for a person who is blind or deaf (Rose, 2000; McGuire, Scott, & Shaw, 2006). The goal of UD started to evolve from how to change something already in existence to designing and building with the needed changes at the point of conception (Rose, 2000; McGuire, Scott, & Shaw, 2006).

Universal Design for Learning practices should occur within all classrooms so educators can plan, teach and assess curriculum in such a way that makes it accessible to all learners. Universal Design for Learning is rooted in three basic principles established through the Universal Design for Learning Task Force (Rose, Meyer & Hitchcock, 2005; Rose & Meyer 2006; National Universal Design for Learning Task Force, 2008). Flexibility and variety are key to the foundation of UDL. The principles are established as guidelines to support teachers' incorporation of UDL practices in their lesson plans. Under the UDL-Task Force guidelines, teachers must provide flexible and multiple methods of the representation of content (UDL-R), as well as, provide for flexible and multiple methods for diverse learners to express what they have learned. Teachers need to provide flexible and multiple ways to challenge and motivate diverse students while tapping into their interests (National Universal Design for Learning Task Force, 2008).

It is often implied that students falling within an Exceptional Education area are students with disabilities and that curriculum should be modified in such a way as to require less of the student. The underlying philosophy of UDL is meant for all learners; blind, dyslexic, deaf, and

any other disability that currently exists. The National Universal Design for Learning Task Force states that UDL was first mentioned as a method for making instruction accessible for students with disabilities, but the format gives all students the opportunity to learn. Universal Design for Learning becomes beneficial to all students including those who are learning English as a second language have attention deficit or are struggling readers, to students that perhaps may even be gifted and can grow in their connections and mastery through alternative materials and assessment. (National Universal Design for Learning Task Force, 2008) The Individuals with Disabilities Education Act 2004 and the Higher Education Opportunity Act of 2008 have provisions for UDL related to the Assistive Technology Act (Sopko, 2009). While technology is not a requirement of UDL, "it makes the creation and use of universally designed curriculum much faster and easier, allowing teachers to adapt the curriculum more easily to meet a wide variety of student needs (DOE, p. 2). According to Rose (2000), UDL would theoretically be possible using traditional materials but is more feasible, flexible, and versatile incorporating technology. Technology utilization in the learning environment also aligns with students of the 21st century, known as the M^2 Generation, who have increased the time they spend using media sources, particularly mobile media. (Kaiser, 2009). Aronin (2009) studied all three principles of UDL and noted that Principle II which related to providing multiple means for action and expression was the principle with the most significant impact. Aronin concluded that teachers need coursework and professional development to encompass modeling of UDL in K-12 situations as well as make a shift towards using technology to access curriculum to meet the needs of the mobile multimedia and digitally savvy students (Kaiser, 2009).

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Universal Design for Learning principles guide educators in finding innovative ways to make the curriculum accessible and appropriate for students with varying backgrounds, learning styles, and abilities in various learning situations and contexts (Eagleton, 2008). Universal Design for Learning is not another product for teachers to implement, but a framework that taps into recent research on the brain and learning differences (CAST, 2007). This paradigm for teaching, learning, assessment, and curriculum development focuses on adapting the curriculum to suit the learner rather than then learner adapting to the curriculum (Eagleton).

<div align="center">Representation</div>

Teachers found that by creating classrooms that included visual resources, their students were "much more engaged, reading with a critical eye for detail, more discerning about their responses, using more inference skills, responding positively to immediate feedback from technology sources, taking their learning and expression of that learning more seriously, and participation increased in lessons and discussions (Thorp). According to Rose and Meyer (2006) recognition networks allow students to gather facts and information—the "what" of learning. Recognition networks guide the collection and identification of the stimuli students perceive and help give meaning to the information, concepts, and ideas identified. Offering multiple means of representing the content provides diverse learners with the opportunity to acquire information and knowledge necessary to succeed.

Universal Design for Learning-Representation (UDL-R) refers to the modifications that can be made to classroom materials that would make them accessible to all learners (Spooner et al). The materials used in a classroom are only as good as the pedagogy on which they are based

and the way teachers and students use them. The Center for Applied Special Technology (CAST) has outlined three guidelines under Universal Design for Learning-Representation (UDL-R). Incorporating UDL-R requires the provision of options for perception, language and symbols, and comprehension. According to CAST, provisions for perception can include customizing the display of information and providing alternatives for auditory information and visual information. These options can be implemented by enlarging the size of the text or image; adjusting the amplitude of sound; providing contrast between background and text or image; using color to emphasize information; adjusting the speed or timing of video, animation, sound, simulations; adjusting the layout of visual or other elements, providing visual equivalents for sound effects or alerts; and utilizing visual analogues or symbols (CAST, 2008).

Using UDL-R's concepts provides options to define vocabulary and symbols, clarify syntax and structure, decode text or mathematical notations, promote cross-linguistic understanding, and illustrate key concepts to provide for multiple methods of representation of language and symbols. These provisions can be implemented by pre-teaching vocabulary and symbol; highlighting how complex expressions are composed of simpler words or symbols; utilizing text with automatic text to speech programs, accompanying digital text with voice recording; making key information in dominant language, linking key vocabulary words to definitions and pronunciation; and explicitly linking between information provided in texts and any accompanying information in charts, images, or diagrams. Providing for ways to activate background knowledge, highlight critical features, big ideas, and relationships, guide information processing, and support memory and transfer support the concept of UDL-R under comprehension options (CAST).

The CAST recommends anchoring instruction by activating relevant prior knowledge using advanced organizers; highlighting or emphasizing key elements in text, graphics, diagrams; using multiple examples and non-examples to emphasize critical features; using cues and prompts to draw attention to critical features; using interactive models that guide exploration and inspection; chunking information into smaller parts; creating checklists, organizers, electronic reminders and embedding new ideas in with existing ideas and context.

According to Meyer and Rose (2005) "learning is supported and facilitated by the interaction between the learner and the curriculum. If the curriculum can be flexibly designed, it can meet more learners where they need to be met. It can challenge and support the vast variety of needs, skills, and interests arrayed in a diverse classroom" (p. 19). Many of the curriculum materials available today inherently suffer from the same things as textbooks, meaning they are simply text based with a few visual images to support the written text, as well as potentially having falsely stated scientific information both of which lead to student misconceptions (Iona, 1974, 1993, 1994; Galley 2001). Providing text in digital form, including captions for all graphic representations and images is one way of addressing textbook shortcomes.

Teachers involved in Thorp's study indicated that the implementation of UDL strategies benefitted student learning as well as improved their own teaching strategies. The use of technology to assist students in learning material and creating their concept maps seems to lend to each other. The basic premise of UDL is that barriers to learning occur in the interaction with curriculum rather than within the learner, thus when education fails, the curriculum, not the

learner, should be evaluated for adaptations. Curriculum designers anticipate, reduce, and eliminate barriers by making the curriculum through UDL guidelines.

<div align="center">Written Explanations</div>

Just as UDL practices of incorporating technology lends itself to creating concept maps, so does creating concept maps lend itself to students needing to clearly have multiple ways to see the concepts to ensure they have the content to put into the concept maps. Once they have grasped the concepts or "big idea" through UDL-R, then this process should assist students in creating more detailed or focused concept maps and improve their written explanations of science concepts. Concept maps also can embrace UDL-R by providing multiple graphical pictures to represent concepts that students identify and can translate into their writing (Fellows). "Writing science explanations requires learners to integrate scientific concepts with their prior knowledge and the evidence gathered from different information sources, and to communicate effectively using established rules of discourse in the science domain (de la Chica, 2007, p. 2). Students' written explanations provide a vehicle for teachers to follow students' changes in thinking as they move from topic to topic and verbalize their understanding of concepts (Stanton, Shuy, Peyton, & Reed, 1998). According to Fellows, "when student writing was encoded into concept maps it provided a useful way to observe how thinking might have changed across time and learning" (p. 7).

De la Chica (2007) explains that learners should recognize the components of an ideal argument, including evidence, qualified claims, exceptions, warrants and backings as they read scientific information from multiple sources. Sandoval and Millwood stress that the

construction and evaluation of science explanations are a central core of science. Writing in science pushes students to evaluate, integrate, and elaborate their knowledge in ways that positively impact their learning (Ruiz-Primo, Li, Tsai, & Schneider, 2008). The effort for students to organize evidence and justify claims is also critical (Sandoval & Millwood). Knipper and Duggan (2006) contend that content area teachers must carefully consider how to use reading and writing to teach their subject. Writing to learn in all content areas is necessary as writing requires deeper processing and helps students think about the content, reflect on how they understand the content and consider what their own processes of learning involve (Knipper & Duggan; Ruiz-Primo, Li, Tsai, & Schnieder). According to Knipper and Duggan, writing to learn engages students, extends their thinking, deepens understanding, and energizes the meaning-making process while providing teachers with a tool for assessment of student concept understanding. Students can meet with success when given prompts that help support students' inquiry and explanation (Sandoval, 2003). De la Chica's technological note-taking scaffolding design process was created to assist students in writing quality explanations and has been an effective tool for students to build upon their knowledge. Writing science explanations that ask students to support a claim with evidence encourages learners to engage in more effort and personal processing of content, especially if learners are required to integrate information from more than one source (de la Chica, 2009).

"Writing scientific explanations presents unique pedagogical opportunities because it engages students in a realistic science activity that addresses the key dimensions of science learning: to integrate scientific concepts with their prior knowledge, possibly misconstrued knowledge, knowledge with evidence gathered from experiments and other information

sources; to communicate effectively using established rules of discourse in the science domain; and to evaluate available scientific information sources, including competing evidence and claims" (dela Chica, 2009, p. 8). This is an ominous task for students of the undergraduate level much less those at 5th grade level as in the case of this action research. "Even expert writers frequently lament the difficult and complex aspects of planning, composing, evaluating, and revising their writing necessary for effective communication" (Santangelo, Harris, & Graham, 2007, p. 1). Students at the 5th grade level are developing skills that allow then to think in a more abstract manner and are beginning to make rational judgments about the world around them however, they may not yet have the deductive reasoning skills required for some writing activities such as acquiring, utilizing, and managing the strategies used by skilled writers (Santangelo, Harris, & Graham).

Writing is a skill that students take with them beyond their school years. Students often fail to see patterns emerging across experiments or observations; and they often ignore data or distort it to match their misconceptions (Sandoval & Millwood). Students can lack the depth of conceptual understanding that scientists can bring to bear on specific topics (Sandoval & Millwood). According to de la Chica (2009) students using the presentation of content through multiple information sources performed better in an inference verification task and students writing arguments had a higher number of causal connectives in their essays showing that using multiple sources and engaging in the construction of an argument may lead to deeper understanding of the topic, but result in poorer performance of recall tasks.

Summary

Visual information organizers are tools that students can use to manipulate their knowledge in a way that makes sense to them. A critical component to the creation of the concept map or information organizer that students may use ties in to the actual curriculum content and the accessibility of the material to the learner. Universal Design for Learning-Representation components naturally fit into the scheme of curriculum accessibility. As students look to incorporate their new knowledge within their existing knowledge, the use of UDL-R promotes the use of concept mapping. Student concept maps in turn can provide the details to develop a quality written science explanation.

CHAPTER 3: METHODOLOGY

Introduction

The purpose of this study was to examine the following action-research questions:

1. How does the use of Universal Design for Learning-Representation (UDL-R) practices support my student's ability to create concept maps?

2. How does the creation of concept maps assist my students to develop quality science explanations?

According to Rose and Meyer (2006) Universal Design for Learning (UDL) offers three guiding principles for developing curricula that eliminate barriers to learning, build on student strengths, and allow for success. The guiding principles are: 1) to support diverse recognition networks by providing multiple means of representation; 2) to support strategic networks by providing multiple means of action and expression; and 3) to support diverse affective networks by providing multiple means of engagement. This study employed UDL principles that support learning through diverse recognition networks by providing multiple means or formats of representation of content material, known throughout this research as UDL-R. Quality science explanations in this action research study are explanations that include detailed evidence that support a scientific claim. This chapter includes the setting, methods, instrumentation, and data collection procedure used to answer my action research questions.

Research Design

This action research study was developed to answer the questions of how the use of UDL-R can support my student's ability to create a detailed concept map and how the concept map created by my students can assist them in their ability to write quality science explanations in my fifth Grade Science class. This action research study took place during the first semester of the school year during the instruction of life science. The relationship between the development of a detailed concept map type information organizer (independent variable) and a written science explanation supported with evidence (dependent variable) was evaluated.

Subjects

The sample selected for this study consisted of 16 fifth grade students, 10 females and 6 males, between the ages of 9 and 10. The racial demographics of this group were students who are Caucasian (8), African American (3), Hispanic (1), and Middle Eastern (4) descent students which coincide with the school demographics. This population reflects the overall school demographics. Thirty-three (33%) of the students from this sample received scholarships or financial aid however students with siblings also received a discounted tuition. The students in this group were heterogeneously grouped with the exception of math and reading levels prior to the current grade level. All students were currently working at one grade level ahead in mathematics.

<u>Setting</u>

The school setting for this action research project is a non-denominational, not-for-profit private school serving ages 2 through Grade 8 and located in one of central Florida's largest school districts. All students in this sample group identified English as their primary language. None of the students in this sample had been identified for exceptional education services nor had any student been assigned to the current grade level however, one student attends the gifted program services provided at their neighborhood school one day each week but does return to school for science class. The students at this school do not take the Florida Comprehensive Assessment Test (FCAT) however, all students, beginning with Kindergarten; take the Stanford Achievement Test 10 every April. The school also has a writing improvement goal as one of three school wide improvement goals under their Association of Independent Schools of Florida accreditation criteria. The writing goal expectation is to incorporate writing and add writing assessment to all subject areas. This writing goal is in its third year of implementation with science as the writing assessment set for the 2009-2010 school year.

The curriculum resource used within the classroom was Scott Foresman Science copyright 2000. Multimedia used during the study was a selection of Eyewitness Videos. Students were informed of the following websites to initiate their on-line learning www.ecokids.ca; www.woodlands-junior.kent.sch.uk; and www.uen.org , however students were also encouraged to explore additional websites on their own and share their website discoveries with each other.

<center>Data Collection</center>

Upon receiving permission from the school Director (Appendix A) and the University of Central Florida's Institutional Review Board (Appendix B), I requested parental permission (Appendix C) to allow students to participate in this research study. I read the student assent form (Appendix D) to all students and requested their signature for their willingness to participate in this research study as well. A total of 16 parents consented to allow their children to participate and a total of 15 students willingly consented to participate.

<center>Data Collection Instruments</center>

In this study three forms of data collection were used to gather information related to the use of UDL-R in science instruction on students concept maps and written explanations. Each form of data collection is summarized followed by a discussion of how each tool was used within the action research study.

Concept Maps

Students created two concept maps during this action research project. The concept maps were created using paper and pencil allowing students the ability to change the map as they needed. The first concept map was created after students completed all lessons and labs as outlined in Table 1 that were a part of the Scott Foresman Life Science unit on Adaptations. The second concept map was created after students completed UDL-R activities as outlined in Table 1. Students shared their concept maps with two or three other students and made changes if desired. The concept maps were used for students during their writing sample and then collected and scored accordingly.

Written Explanations

Students responded to an outlined page (Appendix E) asking them to share what they know about adaptations and to support their explanation with evidence discovered from their learning experiences. Students were asked to respond to the questions with the amount of information that they felt adequately represented their knowledge and enough information to answer the posed question to their satisfaction not the researcher's. Students were allowed to use the concept maps they created to assist them with their supportive evidence in their claim. Written responses were completed after each concept map was created from the two learning experiences. The written responses were collected and scored accordingly.

Student Presentations

Students were videotaped during their explanation of their final concept map and prior to their writing their final explanation of adaptations. As students shared their information, they reflected on their individual practices, experiences, and thoughts during the implementation of UDL-R particularly related to the learning activity that best supported their content mastery of adaptations. Videotapes were transcribed to identify the connection of UDL-R implementation as it related to content mastery for fifth grade students.

Procedures

The science curriculum is determined by a committee overseen by the school's Director and Superintendent. The curriculum used by the school was Scott Foresman Science. The unit of study completed with the students was Unit A Life Science Chapter 3 "Adaptations". Students used the Chapter introduction information organizer and chapter lesson review

questions to write about what they knew about adaptations after each lesson was read and discussed in class. The responses were written in their science notebooks. The sequence of instruction for text and content related activities is shown in Table 1. Concept map creation was taught to students during the prior chapter and at the beginning of the 2009-2010 school year.

As noted in Table 1 during days 1-7, students under the guidance of the teacher read through the textbook lessons and completed the textbook lab activities. As students were reading through each lesson, the teacher would pose questions to check for understanding. Students responded to lesson review and chapter outline graphic organizer questions. Question responses were reviewed the next day to check for understanding. Students were partnered with one other student for each of the three lab activities. The teacher guided discussion related to observations during and after each textbook lab activity. Upon the completion of Chapter 3: Adaptations lessons and labs, students were given a 12x18 blank, white paper to draw out their concept maps based on their knowledge from textbook lessons and labs.

Table 1: Science Concept Timeline

Timeframe & Scientific Concept & Vocabulary Concept	Student Activity	Teacher Activity & UDL support
Days 1-7 Scott Foresman Science Unit A Chapter 3: Adaptations Exploring Protective Coloration Lab Lsn 1. What Are Adaptations? Structural adaptations, Lsn. 2. What Are Some Adaptations for Living in Water and Land? Investigating Eggshells Lab Lsn. 3. What Are Some Adaptations for Climate? Investigating Insulation Lab Lsn 4. How Do Organisms Become Adapted to their Environment?	Students read through lessons in class as whole class activity, responded to questions outlined on Chapter 3 Introduction Graphic Organizer, and participated in lab activities as outlined in textbook	Teacher guided lesson and questioned students on concepts. Teacher allowed for graphic organizers, diagrams, or other alternative method of responding to questions from Chapter 3 Graphic Organizer. Lab activities were discussed prior to students completing responses.
Days 8-10 Create concept map based on textbook lessons and labs. Written scientific explanation.	Students created concept maps and used concept maps to support their written science explanation	Teacher guided students in sharing information and adding detail to concept map if needed.
Days 11-15 Multimedia Exploration Eyewitness Video and variety of tradebooks on adaptations	Students viewed multimedia sources about plants and animals identifying information specifically related to adaptations and read a variety of trade books independently or with a partner and documented information learned about adaptations of organisms.	Teacher introduced UDL-R sources, guided students as they rotated books and encouraged use of audiotaped books.
Days 16-18 Website exploration both guided and unguided	Students explored the world wide web for websites related to adaptations	Teacher directed students to specific websites as well as allowed students to explore on their own.
Day 19-20 Concept Map #2 Creation	Students used notes from UDL-R sources to create a concept map on adaptations and shared their concept maps.	Teacher assisted students as needed and videotape student presentations
Day 21 Written Explanation #2	Students used concept map #2 to write a scientific explanation about adaptations	Teacher allowed adequate time to complete explanation.

On day 8, students drew out their concept maps. The teacher supported students with questions that arose. Day 9 was spent with students sharing their concept map knowledge with two other students. The teacher rotated around the room listening to students as they shared with each other. During day 10, students used their concept maps to assist them in understanding in responding to the questions, "What can you tell me about adaptations? What are they? How do they help an organism to survive? What scientific evidence can you use to support your explanation?" The teacher supported students in their writing but did not influence the amount of written text by reinforcing to students that they needed to self-evaluate their explanation for completeness.

Days 11-18 began the Universal Design for Learning-Representation (UDL-R) practices. Students viewed curriculum content through the representation of a variety of sources. On days 11-13 students viewed a variety of multimedia Eyewitness source videos. Students took notes specifically related to adaptations. The teacher mentioned several behavioral or structural adaptation facts as noted during the beginning of the multimedia source to assist students in identifying adaptations throughout the videos. On days 14-15 students read, individually or with a partner, a minimum of three trade books of which audiotapes were available. Students were brought to the school computer lab on days 16-18, to research three internet websites. Students were allowed to work with a partner or individually.

On the 19th day, students created a second concept map based on their knowledge of adaptations learned from UDL-R sources. The teacher supported students by answering student questions. Students shared their concept maps with two other students. On day 20, students

shared their concept map and experience with the entire class while being videotaped. The

teacher questioned students on their experience of using UDL-R sources.

Students wrote a second explanation responding to the same questions as outlined in their

first explanation. The teacher supported students but remained neutral in responding to student

questions to whether or not they had written enough information.

Student Notebooks

Students maintained a binder, which was used throughout the school year and contained

work from each chapter. For this research project a lesson review worksheet was used to

reinforce concepts from each lesson as well as for student's to write responses to the Chapter

Outline and Lesson questions in student notebooks. Lab Activities as listed in Table 1 were also

completed by students as well as a lab report that was kept in their science binder. The lessons

and labs of the Scott Foresman Science curriculum were followed for seven school days. To

incorporate UDL-R learning practices, three alternative learning opportunities were introduced to

the students. Students viewed multimedia DVD/videos presented in class, participated in

website research, and read or listened to their choice of three trade books. Website research and

trade book learning opportunities could be done either individually or with a partner. Students

also took notes (Appendix I) on additional knowledge they learned through videos/DVD's, audio

taped trade books, and websites related to animal and plant adaptations. A recent study

completed by the Kaiser Foundation on Generation M^2 has discovered that use of every media

has increased for young people ages 8-18 in the past ten years. Of concern to me from this study

was that not only are young people spending more time using various forms of media especially

mobile media, they are also reading other forms of media less (Rideout, Foehr, & Roberts).

Students used their science notebooks to write information that they learned from the multimedia

sources, trade books, and websites. The notes were used to assist them in the creation of their

concept maps. Students shared their notes with two other students after each learning

opportunity. The students tracked information in notebooks and then transferred their

knowledge onto a 12x18 blank, white paper which they shared with their fellow classmates prior

to writing a final explanation about adaptations.

Data Analysis

The data collected for this action research study included student work on concept maps

and written explanations, teacher reflections, and videotaping of the student explanations of their

final concept maps prior to their writing their final explanation. Pre– and post- UDL-R concept

maps (Appendix G) were evaluated using Mueller's Classroom Concept Map Rubric.

Permission was given to use this scale from Dr. Jonathon Mueller of North Central College in

Naperville, Illinois. The Mueller Rubric is a point system scale that measures student concept

maps on legibility, accuracy, completeness, and sophistication. Legibility is defined as being

easy to read and free of spelling errors which has a point range of 0-2. Accuracy within the

concept maps is defined as the concepts being used accurately and has a 0-5 point range. The

completeness of the concept map rubric is the concept map contains a sufficient number of

relevant concepts and relationships and has a 0-5 point range. Finally, the sophistication of the

concept map rubric is outlined such that the student has made meaningful connections between

relevant concepts with a 0-8 point range. The written explanations (Appendix H) were scored

using the State of Florida's Department of Education's Science Writing Extended Response Rubric. The FCAT rubric has a four- point differentiation with zero (0) indicating that the student has not provided a responses or their response does not demonstrate understanding to a four (4) which indicates that the student has demonstrated a thorough understanding. Twenty-five percent of the concept maps and written explanations were rescored by another intermediate UCF-Lockheed Martin Academy graduate student/science teacher to establish reliability. Throughout this study the teacher researcher made several observations and reflections based on student participation, discussions, and behaviors.

Factors that may influence the quality and accuracy of student concept maps are level of student experience creating concept maps, student understanding of content to create concept maps, and variety of concept map assessment tools available. Factors that may influence the quality of written explanations may be level of student ability in writing and/or level of interest in writing.

<div align="center">Reliability and Validity</div>

Reliability of the pre- and post- concept maps and written explanations was established by the review of twenty-five percent of previously scored concept maps and written explanations. The reviewers and scorers were both science teachers and students in the Lockheed Martin Academy- Mathematics and Science cohort. The scores of both reviewers were compared to meet 97% accuracy within the scores. Validity of scores of the concept maps and written explanations was developed through teacher reflections of student comments during activities and during the videotaped sharing of student's final concept map.

Summary

In summary, this action research study allowed me to research how the implementation of UDL-R impacted student understanding about adaptations as they demonstrated their understanding through the creation of concept maps (independent variable). In turn, the student use of their concept maps to support a written science explanation (dependent variable) were compared to see if UDL-R impacted final written product.

CHAPTER 4: DATA ANALYSIS

This chapter provides a description and analysis of the data collected during this action research study on the implementation of Universal Design for Learning-Representation (UDL-R) practices on concept map creation and student ability to write quality explanations related to adaptations of organisms. The questions addressed during this study were:

3) How will my use of Universal Design for Learning-Representation (UDL-R) practices promote students ability to develop comprehensive concept maps or thinking maps for understanding adaptations in living things?

4) How will the use of concept maps assist my students in their ability to independently write a detailed, justified science explanation?

In this section the researcher highlights the underlying themes related to the research questions derived from student concept maps, written explanations, and notebooks.

Concept Maps

This study compared student generated concept maps after completing a unit on adaptations using Scott Foresman-Science curriculum and UDL-R practices of multimedia, the worldwide web and a multi-level variety of trade books with audiotapes available. Students received instruction on concept map creation at the beginning of the school year during an

introductory activity on "What is Science?' and during the chapter on "Comparing Living Things" which included concepts such as how animals and plants are classified. Prior to this experience students had not used or created concept maps for notetaking or as a method to organize their knowledge. The rubric used for this research was Mueller's Classroom Concept Map (Mueller, 2007). The rubric was chosen by the researcher due to the students' inexperience in concept creation and difficulty determining proposition words. This rubric assesses the concept map for legibility, accuracy, completeness, and sophistication. Under Mueller's concept map each area has a point range. To eliminate variation in interpretation of the point range the researcher outlined point criteria qualifications for the purposes of this study. The interpretation did not change the scoring structure used in previous research to validate the tool but just added clarification between intervals of the scores of 0, 1, 2 to assist with reliability and validity. After using this more specific scoring structure then the research team had a clearer definition of the differences in each item. It is understood by the researcher that this clarification did possibly invalidate the tool but without further clarification of the differences the reliability of scoring was not possible to achieve. Therefore, the intent of the tool as validated was used but for this action research project further clarifications were provided for reliability purposes.

Legibility as defined in Mueller's Concept Map is being easy to read and free of spelling errors. Legibility has a 0-2 point range. To qualify point range it was determined that 2 points would be given if the concept map was both legible and spelling error free, 1 point if it was legible but had spelling errors and 0 pints for non-legible concept maps. Accuracy of concepts under Mueller's Classroom Concept Map has a range of 'no inaccuracies 'with a point value of 5, 'a few accuracies' with a point value of 3-4, and 'many inaccuracies' with a point range of 0-

2. A 'few inaccuracies' was qualified as 1-3 point range with 1 or 2 inaccuracies earning 4

points and 3 inaccuracies earning 3 points, and 'many inaccuracies' were broken down to 4 or 5

inaccuracies being awarded 2 points, 6 inaccuracies was awarded 1 point, and 7 or more

inaccuracies awarded 0 points. Accuracies are defined by the researcher based on descriptions

given to students through their textbook, knowing that the textbook used in this study did not

provide evidence of a research-based, nationally field-tested curriculum tool such as Full Option

Science System curriculum, but was the tool selected by this school as the core curriculum.

Completeness under Mueller's rubric encompasses that the concept map contains a sufficient

number of relevant concepts and relationships. Completeness ranges from 0-5. The researcher

determined that a limited use of concepts/relationships which ranged from 0-2 under Mueller's

rubric included 0 concepts earning a 0, 4-5 concepts earning a 1 and 9 concepts earned a 2

points, 'some use of concepts and or relationships which earns 3 or 4 points was set at 10-12

concepts earning 3 points and 13-15 earning 4 points; with 16-20 concepts qualifying as a

sufficient number of concepts and relationships. The final area of assessment under Mueller's

rubric was sophistication which defined by Mueller is finding meaningful connections between

relevant concepts. Mueller sets this area with a range from 0-8. The researcher qualified the

subcategory ranges under sophistication as 'little or none' earned 1 point, 'few meaningful

connections point range of 2-4 was determined to be 3 points, some meaningful connections was

given a 6 point value and meaningful and original insights developed was given an 8 point score.

Under this point value system the maximum number of points that a student could earn was 20.

Twenty-five percent of the concept maps were rescored by a fellow teacher and cohort

member from the University of Central Florida- Lockheed Martin Mathematics and Science

Academy to verify the reliability of the researcher's use of Mueller's Classroom Concept Map Rubric. Concept Map 1's (traditional curriculum) reliability for scoring was determined 98.4% accurate and Concept Map 2's (UDL-R) had a reliability rate of 96.8% accuracy. The rescoring outcome above 90% indicates the criteria used to evaluate the concept maps were accurate and reliable and similar results would be expected if additional rubrics were scored.

Table 2: Concept Map Score Comparison

Student Number	Concept Map 1 Score	Concept Map 2 Score	Point Range + or -
1	1	9	(+8)
2	4	8	(+4)
3	7	15	(+8)
4	14	7	(-7)
5	18	18	0
6	13	14	(+1)
7	14	14	0
8	18	19	(+1)
9	11	2	(-9)
10	18	10	(-8)
11	16	15	(-1)
12	17	17	0
13	17	16	(-1)
14	15	15	0
15	15	18	(+3)
Average	13.2	13.13	

Table 2 shows a comparison of student scores of Concept Map #1, a concept map created after learning through textbook and lab resources compared to Concept Map #2, a concept map created after the implementation of UDL-R principles. A review of the total class scores

demonstrated that there is a decrease of 0.07 in the overall averages of scores on the concept

maps created using UDL-R practices and a decrease of -1 in the range of scores from the pre-

UDL-R concept map and the UDL-R concept map. Student 3 had the greatest gain in concept

map points (+8) whereas student 9 had the greatest loss (-9) in points from Concept Map #1 to

Concept Map #2 when UDL-R principles were implemented. Students 5, 7, 12, and 14 showed

no gains or losses from UDL-R principle implementation.

Table 3: Female Concept Map Scores

Student Number	Concept Map 1 Score	Concept Map 2 Score	Point Range + or -
1	1	9	+8
2	4	8	+4
3	7	15	+8
4	14	7	-7
6	13	14	+1
7	14	14	0
8	18	19	+1
10	18	10	-8
11	16	15	-1
15	15	18	+3
Average	12	12.9	

Table 4: Male Concept Map Scores

Student Number	Concept Map 1 Score	Concept Map 2 Score	Point Range + or -
5	18	18	0
9	11	2	-9
12	17	17	0
13	17	16	-1
14	15	15	0
Average	15.6	13.6	

       Table 3 and Table 4 show student concept map scores separated by gender. Table 3 shows female scores and Table 4 shows male scores. It is interesting to note that female scores showed an increase of 0.9 on the concept maps created from UDL-R principles as compared to the concept map created from textbook and lab activities while the male scores show a 2.0 point decrease. The male students scores show three males that maintained their concept maps scores between the two different activities precluding to creating the concept maps whereas the females had only one student who maintained her score from the first concept map to the second concept map.

Table 5: Concept Map Category Scores

Student	CM1 Legible Score	CM 2 Legible Score	CM 1 Accuracy Score	CM 2 Accuracy Score	CM 1 Complt. Score	CM 2 Complt. Score	CM 1 Sophist. Score	CM 2 Sophist. Score
1	0	1	0	1	1	4	0	3
2	2	2	4	2	0	1	0	1
3	2	2	0	3	2	4	3	6
4	2	1	5	3	4	2	3	1
5	2	2	5	5	5	5	5	6
6	1	1	3	2	3	5	6	6
7	0	0	4	3	4	5	6	6
8	1	1	4	5	5	5	8	8
9	2	1	0	0	3	0	6	1
10	2	2	5	0	5	5	6	3
11	1	0	3	5	5	5	6	6
12	0	1	4	3	5	5	8	8
13	2	1	5	4	3	5	6	6
14	2	1	5	3	5	5	3	6
15	1	1	4	5	4	4	6	8
Average	1.3	1.13	3.4	2.93	3.6	4	4.8	5

Table 5 shows all students' scores broken down by criteria category within Mueller's

Classroom Concept Map. The data in Table 5 shows that the overall average legibility score did

not increase or decrease in value from Concept Map 1 to Concept Map 2. Legibility is qualified

as a concept map that is easy to read and free from errors. Student scores for accuracy decreased

from Concept Map 1 to Concept Map 2 using UDL-R principles. Accuracy in Mueller's

Classroom Concept map is defined as concepts being used accurately. Table 5 shows that the

students' concept maps completeness and sophistication increased from Concept Map 1 to

Concept Map 2. Completeness under Mueller's Classroom Concept Map is defined as having a

sufficient number of relevant concepts and relationships; whereas sophistication is defined as

finding meaningful connections between concepts.

Table 6: Female Concept Map Scores by Category

Student	CM 1 Legible Score	CM 2 Legible Score	CM 1 Accuracy Score	CM 2 Accuracy Score	CM 1 Complt. Score	CM 2 Complt. Score	CM 1 Sophist. Score	CM 2 Sophist. Score
1	0	1	0	1	1	4	0	3
2	2	2	4	2	0	1	0	1
3	2	2	0	3	2	4	3	6
4	2	1	5	3	4	2	3	1
6	1	1	3	2	3	5	6	6
7	0	0	4	3	4	5	6	6
8	1	1	4	5	5	5	8	8
10	2	2	5	0	5	5	6	3
11	1	0	3	5	5	5	6	6
15	1	1	4	5	4	4	6	8
Average	1.2	1.1	3.2	2.9	3.3	4	4.4	4.8

Table 6 shows female scores on their concept maps broken down by category,

demonstrate a minimal decrease in legibility score and accuracy score. Concept map

completeness and sophistication increased in score.

Table 7: Male Concept Map Score by category

Student	CM 1 Legible Score	CM 2 Legible Score	CM 1 Accuracy Score	CM 2 Accuracy Score	CM 1 Complt. Score	CM 2 Complt. Score	CM 1 Sophist. Score	CM 2 Sophist. Score
5	2	2	5	5	5	5	5	6
9	2	1	0	0	3	0	6	1
12	0	1	4	3	5	5	8	8
13	2	1	5	4	3	5	6	6
14	2	1	5	3	5	5	3	6
Average	1.6	1.2	3.8	3	4.2	4	5.6	5.4

Table 7 shows that the male concept maps, broken down by category, demonstrated a similar minimal decrease in the legibility and accuracy however it is slightly more of a decrease then the females. Male scores for completeness and sophistication also decreased by 0.2 points respectively. Student 5 was the only student that utilized linking words to describe the relationship within the concepts on both concept maps. The lack of linking words did not affect student scores as it was not part of the rubric criteria and students were able to demonstrate their knowledge. Although linking words were not utilized by other students, lines were drawn from key concepts to supporting evidence.

<u>Written Explanations</u>

This study compared quality written explanations with the support of student created concept maps. The researcher qualified "quality written explanation" as those explanations that were written as a scientific claim or statement supported with facts or evidence. Written explanations were assessed using the Florida Comprehensive Assessment Test-Science (FCAT-

Science) Rubric for Extended-Response Questions. This rubric has a scale range of 0 to 4 points.

Scores for each written response are shown in Table 4. This rubric had been used across the

State of Florida for extended-response questions that students have answered during the Science

FCAT. Twenty-five percent of the written explanations were rescored by a fellow teacher and

cohort member from the University of Central Florida - Lockheed Martin Mathematics and

Science Academy to verify the reliability of initial scoring.

Table 8: Scientific Explanation Scores

Student Number	Written Explanation 1	Written Explanation 2
1	NA	2
2	1	2
3	4	4
4	2	1
5	4	4
6	1	1
7	4	3
8	4	4
9	2	2
10	4	4
11	3	4
12	1	2
13	2	3
14	2	1
15	2	3
Average	2.57	2.67

Table 9: Female Scientific Explanation Scores

Student Number	Written Explanation 1	Written Explanation 2
1	NA	2
2	1	2
3	4	4
4	2	1
6	1	1
7	4	3
8	4	4
10	4	4
11	3	4
15	2	3
Average	2.78	2.8

Table 10: Male Scientific Explanation Scores

Student Number	Written Explanation 1	Written Explanation 2
5	4	4
9	2	2
12	1	2
13	2	3
14	2	1
Average	2.2	2.4

The overall average writing scores in Tables 8, 9, and 10 indicate that the concept maps influenced by UDL-R had a slight positive impact on the written explanations by students. As a whole class, there was a minimal increase in averages by only 0.03. Female students' written explanation scores increased by 0.02 points and male students' explanations increased by 0.2 points. Student 1 did not participate and write an explanation due to absences. Four female

students had the same scores for both written explanations. Students 3, 8 and 10 scored four

points on both explanations and Student 6 scored a one on both explanations. Two male students

had the same score for both written explanations. Student 5 scored four points on both written

explanations and student 9 scored two on both written explanations.

<p style="text-align:center"><u>Student Notes</u></p>

Student's notebooks contained numerous pages of evidence from their UDL-R

experience. Notes for textbook and lab activities were limited to the single examples addressed

in the students' textbook and responses to questions that students answered. Students wrote

notes based on each of the three methods that UDL-R was implemented therefore they had notes

of information for the multi-media sources, trade book reading activity and website research

activity. Student notes using UDL-R principles contain up to one hundred facts related to

adaptations. Students 5, 8, 10, and 11 wrote 100 or more scientific facts of evidence related to

adaptations using UDL-R practices to support their concept map. Student 9 discovered over 70

but less than 100 scientific pieces of evidence. Students 2, 6, 13, and 14 identified at least 30 but

not more than 69 specific facts related to adaptations using UDL-R practices. In review and

analysis of the written facts it was noted by the researcher that although the students identified a

structure or behavior that an organism held, the students did not elaborate or explain the feature's

purpose.

Summary of the Data

In reviewing the concept maps and written explanations, UDL-R practices had mixed results on improving student concept maps as a tool for demonstrating their knowledge and had a negative impact on their written explanation. The results for this study's first question: How will my use of Universal Design for Learning practices promote students ability to develop comprehensive concept maps or thinking maps for understanding adaptations in living things? Student concept maps legibility and accuracy scores decreased. Student concept maps increased in their completeness and their sophistication. Completeness and Sophistication were outlined earlier in this section and are qualified as the students identifying a specific number of concepts and making connections to the concepts. Concept maps were more complex after UDL-R, which often lead to difficulty in scoring as maps were heavily laden with discovered supportive evidence. Based on researcher reflections, students were actively involved in sharing information they discovered from multimedia sources, websites, and trade books. Students shared their notes from multimedia sources, drew each other to their computers to share information learned from websites, shared websites that they discovered at home, and passed on trade books to other students encouraging them to read them for the information that was available. While students' concept maps became more complex, it is believed that they also became overwhelming as students then attempted to utilize their concept map to write a quality written explanation to answer this study's second question: How will the use of concept maps assist my students in their ability to independently write a detailed, justified science explanation? While students attempted to write their second explanation, concern was brought forward to the researcher as to whether or not they had to write all the facts that they had discovered from their

UDL-R activities or if what they had written was enough. Although not demonstrated in their actual written explanation; students verbalized that they felt they learned more about adaptations through the websites, multimedia, and trade books than they had while using the textbook only.

<center>Validity and Reliability</center>

Reliability of the Mueller's Classroom Concept Map Rubric and FCAT Science Extended Response Rubric was gained through rescoring twenty-five of concept maps and written explanations. Concept Map 1 had a 98.4% reliability rate when rescored. Concept Map 2 had a 96.8% reliability rate when rescored.

Written Explanation 1 and 2 were both rescored with 100% reliability when rescored. According to the Florida Department of Education's report on the 2007 FCAT Science Released Items, the reliability and validity measures implemented during scoring ensure that all performance tasks are scored according to Florida's standards.

Students verbalized the use of technology as being better because, "it gave more places to go than the textbook. I learned more from doing this then the regular textbook." Another student was quoted as saying that "I don't think that the textbook had a lot of info as much as technology and trade books. The textbook tells you just a little bit just so you understand, but with technology and trade books get you more info." Another student noticed that "the multimedia gave him a general sense of information but that technology gave more detail as he discovered that all animals in the world have some type of adaptation." One student summarized it well by stating that, "I learned that our textbook didn't give alot of information. I thought the

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multimedia was good because they showed it, the trade books were always there to go back to and the internet let you see whatever you wanted to see."

Summary

Trying to influence the content of concept maps and written explanations using UDL-R was the primary point of this action research study. Although quantitatively outcomes were not substantial, the students stated that not only did they enjoy the implementation of technology (UDL-R) as they were learning about adaptations but they felt that they also learned more supporting facts that reinforced their learning. Students on occasion would interpret a structural adaptation as a behavioral adaptation, but ultimately they understood that the adaptation was supporting the survival of an organism.

In evaluation of the outcomes related to my first question, "How will my use of Universal Design for Learning-Representation (UDL-R) practices promote students ability to develop comprehensive concept maps or thinking maps for understanding adaptations in living things?", I discovered that student interest was very high while utilizing technology, multimedia sources, and trade books as they discovered new scientific evidence to support and build upon their knowledge set. Although students did not demonstrate correct and highly sophisticated concept maps they did understand approximate correct placement of supportive evidence. Through student notes, it was obvious they were capable of gathering numerous supportive facts however there was some difficulty of their ability to expand upon or connect the fact to a specific aspect of adaptations.

In evaluation of the outcomes related to my second question, "How will the use of concept maps assist my students in their ability to independently write a detailed, justified science explanation?" I discovered that although my students may have created concept maps with numerous evidentiary support for understanding adaptations it did not necessarily indicate that their written explanation would contain an equal number of supportive evidence or that connections would be made a higher level of thinking.

Although students verbalized recognition that UDL-R practices supported their learning, they still struggled with differentiating between behavioral and structural adaptations, as well as, identifying or connecting how the adaptation assisted in the survival of the organism researched. My students' lack of experience working with concept maps influenced their difficulty to diagram their concept map correctly and make the hierarchical connections typically made in concept maps. In retrospect I would use concept maps more consistently throughout the school year so that students are comfortable and fluent in the practice of their creation including but not limited to utilizing technology as a tool for concept map creation.

CHAPTER 5: CONCLUSION

Introduction

The purpose of this action research project was to determine the influence of Universal Design for Learning-Representation (UDL-R) principles on students' ability to develop concept maps and write scientific explanations. The questions investigated for this study were:

1) How will my use of Universal Design for Learning-Representation practices promote students ability to develop comprehensive concept maps or thinking maps for understanding adaptations in living things?

2) How will the use of concept maps assist my students in their ability to independently write a detailed, justified science explanation?

The research goal for this study was to investigate whether the use of UDL-R principles enhanced student understanding of content and promoted organization of knowledge through the use of concept maps. A second research goal was to investigate whether organizational tools, specifically as concept maps assisted students in their ability to develop quality scientific written explanations.

<u>Connections from Practice to Literature</u>

"The laws and regulations requiring access to the general curriculum for all students have resulted in a trend toward inclusion (Jackson, Harper & Jackson, 2005, p. 127). These regulations have provided great opportunities for students with disabilities to be included within a regular classroom environment. "A primary goal of the National Center on Accessing the General Curriculum (NCAC) has been to identify effective, research-based classroom practices and enhancements in learning "(Hall, Meyer, & Strangmen, 2005, p. 149). Universal Design for Learning's theoretical principles align with NCAC's primary goal. This study focused strictly on one of the aspects of Universal Design for Learning principles, that of representation whereby students had the opportunity to explore curriculum content through multiple means of sources such as multimedia, website explorations, and trade books. As noted by the CAST, the implementation of UDL-R practices requires time for accessing alternative resources. In this action research study I found that additional time was required to create a classroom with UDL-R principle. Supplemental trade books had to be ordered through various websites. The trade books were not available with recorded tapes or CD's therefore additional time was required to audiotape the materials. Multimedia sources, although available, were limited to animal adaptations only not giving students an opportunity to view plant adaptations through this source. Therefore, despite a strong concept to allow students to access materials through multiple means of representation until more material is readily accessible, teachers who are often already stretched for time may find this option difficult to implement. Textbook companies and curriculum development specialists need to provide this material to enhance the learning of all students but especially for students with exceptional needs at the remedial and gifted levels.

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Textbook companies today must provide print material in a unified accessible format, according to the National Instructional Materials Standards (NIMAS) part of IDEA 2004, but without other ways to enhance these materials the true spirit of UDL-R will not be accomplished.

In the area of science, according to Sandoval and Millwood (2005), there has been much interest and effort to reform science education so that students are not only engaged, but engaged in authentic scientific inquiry. The practice of scientific inquiry involves engaging students in curricular materials and to use activities that require them to exercise their thinking processes as they attempt to make connections from the activities to their content knowledge. Primo, Li, Tsai, and Schneider (2008) propose that one of the fundamental activities of inquiry should be the construction of explanations. During this action research study, the students used Universal Design for Learning Representation (UDL-R) principles to extend their understanding of adaptations of organisms. Jackson, Harper and Jackson (2005) indicate that according to the founders of UDL theory, Rose and Meyer, a "digital curriculum holds promise of increased flexibility and the capacity to develop instructional goals, methods, materials, and assessments that accommodate students' diverse strengths and needs and promotes genuine learning" (p. 125). In this action research study, students expressed their knowledge through concept maps and written explanations that were developed through the use of multimedia sources, website searches and viewing of trade books. Thorp (2008) states that technology will promote student motivation and will augment opportunities for collaboration with other students. Students in this action research study supported Thorp's conclusion as they shared information learned and additional websites discovered through their searches. Students also gathered into groups with one or two other students to share their discoveries and confirm their understanding of

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adaptations after each form of UDL-R practice. This combination of a class rich in ways to

represent concepts combined with inquiry-based learning appears to help students to gain more

knowledge and deeper discussion about content. How inquiry-based instruction and UDL-R are

critical to overall student performance in science is a logical line of research to continue

exploring.

The implementation of Full Option Science System (FOSS) curriculum is an alternative

to the Scott Foresman curriculum used within this action research. FOSS is a research based

science curriculum that has been developed at the Lawrence Hall of Science, University of

Berkeley for students in grades Kindergarten through 8th grade (FOSS). This curriculum method

has set out to accomplish three goals for student science understanding. FOSS supports

"scientific literacy by providing students with science experiences that are appropriate to their

stage of cognitive development and serve as a foundation for more advanced ideas that prepare

them for life; instructional efficiency by providing teachers with a complete, flexible, easy-to-use

program that reflects research on learning, including collaborative learning, student discourse,

and embedded assessment and uses effective instructional methodologies of hands-on active

learning, inquiry, integration of disciplines and content areas; and systemic reform by meeting

community science-achievement standards and societal expectations that reflect the vision of the

National Education Standards" (FOSS, p. 2). These very goals of FOSS that align with the

National Science Education Standards also align with UDL-R principles and the approach to

science teaching that incorporates active learning for students of the 21st century classroom.

The students in this study utilized concept mapping as a method to demonstrate their understanding of content learned from various UDL-R practices. In Novak's (2004) longitudinal study on the reflections of thinking in science he purports that concept maps show the development and refinement of a child's knowledge and that concepts maps are typically characterized by placing individual concepts in boxes or ovals and with meaningful linking words connecting the ovals. Hilbert and Renkl (2008) confirm Novak's concept map design but identify the difficulty of the demands of mapping. The results by students in this study demonstrated that same difficulty as only one student used linking words although minimally. The lack of experience the students had with mapping served as a disadvantage although their maps did not lack for quantity of evidence. Hilbert and Renkl correlated number of nodes (ovals or boxes) with knowledge of a concept. For the purposes of this study, the researcher correlated the number of nodes (ovals or boxes) with completeness or amount of supportive evidence for a set concept within the student's concept map. The students in this study showed a total of 0.07 point difference from Concept Map #1 pre-UDL-R and Concept Map #2 –post ULD-R. Male students overall scores on their concept maps decreased by 2.0 points and female students overall scores increased 0.9 points from Concept Map #1 pre-UDL-R and Concept Map #2 –post ULD-R. The students in this study also showed an average increase in scores of 0.4 points in the completeness or number of supportive facts for their concept maps. Male students concept map completeness scores decreased on average a 0.6 and female concept map completeness scores increased by 0.7 increase points. Although the data shows a minimal increase in student's concept map points from the use of UDL-R, several students discovered numerous scientific supportive facts through their use of multi-media sources and technology. Four students had

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identified and written one hundred or more supportive facts on adaptations in their notebooks. One student identified over seventy supportive facts and several other students had identified at least thirty but not more than seventy supportive facts indicating that UDL-R provided opportunities for students to access content for knowledge mastery. The overall meaning of these increases and decreases cannot be clearly understood with a limited data sample, but students gaining great factual knowledge and females having a way, at least in my classroom, to apply that knowledge in their concept maps and this gaining of knowledge seemed to hinder male students is something I will continue to explore related to UDL-R.

As student understanding was reinforced through UDL-R practices and organized through the student's concept map detail and structure, students should be capable of utilizing the concept map to assist them in writing a deeper scientific explanation substantiated with stronger evidence. The written explanations completed by students in this action research study did not correlate to the student concept maps. Student explanations did not significantly improve using supportive evidence as might be assumed based on the numerous discoveries made by the students through using UDL-R. Knipper and Duggan (2006) state that good content writing is the result of quality instruction. Knipper and Duggan also state that students learn to write when teachers surround them with examples and models, give them expectations, let them make decisions and mistakes, provide feedback, and allow time to practice their writing. The students in this action research study responded to short answer essay questions throughout the school year, as well as participated in the creation of a science fair project where background research was required. Although the students did have practice with writing, their written explanations developed from their concept maps did not show an improvement in the quality and detail of

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supportive scientific evidence. The students in this study showed on average a 0.1 point increase

based on the FCAT writing rubric in their written explanation after using UDL-R. Male

students' written explanation scores increased by 0.2 points and female students' written

explanation scores increased on average 0.02. Although several students identified thirty or

more facts as supportive evidence through the use of UDL-R, it is interesting to note that they

were not able to translate and apply their knowledge into a written explanation. Further research

is needed between the relationship of UDL-R and enhancing students' written explanation in

science instruction.

<u>Implications from Classroom Practice</u>

Although UDL-R required more lesson preparation, resources, and teacher input: students

verbalized a deeper understanding through UDL-R practices. In reviewing student notebooks

and listening to student discussions, the amount of knowledge acquired and the depth of

discussions were richer after UDL-R concepts were implemented. As a classroom teacher, I

would continue to implement UDL-R practices as lesson plans are being developed.

In reviewing of student generated concept maps, I discovered that student experience was

limited to the introduction and practice of concept mapping skill solely in the science classroom.

Student inexperience was noticed in the lack of linking words used among concepts. In

hindsight, I would have modeled concept maps more frequently and perhaps even brainstormed

linking words with students that were on display within the classroom throughout the year.

Students only experienced paper and pencil created concept maps and if time allowed I would

have incorporated concept mapping software as a tool for students to utilize. Goss (2009)

indicated that students using electronic concept mapping were able to reduce the length of time it took to revise or restart their concept maps. As a classroom teacher, I would choose to implement the electronic concept mapping over paper and pencil mapping as the paper used for this study was too large to easily scan. I would also choose to utilize a variety of information organizers to assist students in their ability to organize information and then allow them to choose a graphic organizer that fits the way they prefer to structure their acquisition of knowledge. In addition to utilizing software and other supportive aids, I would choose to partner or group students together to provide opportunities for peer editing and critiquing of written explanations.

Limitations

The limitations of this study were similar to those addressed by Hilbert and Renkl regarding the development of students' concept maps related to nodes and linking words. The students in this action research had limited practice and experience with creating concept maps to assist them in organizing their understanding of any related concept. Student fluency in creating concept maps brings to surface an issue of assessment of the concept maps.

Knipper and Duggan (2006) indicate that a careful use of rubrics can help teachers with limited background in writing by giving them a better sense of qualitative differences in students' writing. The same could be said in the evaluation of concept maps. Concept map rubrics are tools to that allow teachers to distinguish the level and quality of work. The Mueller Classroom Concept Map's point range for each category assessment was too wide-spread in my

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opinion and left room for subjective interpretation. The Mueller Classroom Concept Map was further quantified by the researcher to meet the needs of objectivity in scoring for this action research study. As a classroom teacher, I would have liked to have used a variety of rubrics on student generated concept maps to allow for practice and experience for purposes of scorer reliability.

Summary

If I were to carry out or expand upon this action research study, I would teach concept mapping throughout the school year rather than as an introductory activity and later on as a "reminder" activity. I would also include concept mapping using technology. I would like to further investigate the FOSS curriculum and curriculum that is ready made with UDL-R concepts to save on time and to allow closer alignment of resources with my entire classroom learning objectives.

As students participated in UDL-R activities to learn content I noticed that my students were more engaged in the content and activities, were more cooperative in working together and in sharing their knowledge, and were motivated to gather information. It is possible that their excitement could have been generated based on the novelty of a new learning environment or the excitement of participating in a research project for a teacher they had both as 1st graders and currently. In the future I would establish note-taking outlines that would assist students to differentiate between disconnected facts and facts that become scientific evidence to support understanding and mastery. To support brevity and eliminate the outcome of too much information I would set guidelines of no more than three facts per extension from each node

within a concept map. In addition to supporting my students for note taking I would utilize a variety of information organizers throughout all content areas and allow student an opportunity to choose their own map style. Implementing technology for the use of organizing notes and creating concept maps would ideal for this project. Students may also benefit from creating their concept maps as they learn from each method of UDL-R activity rather than as a culminating activity. I would also consider having students build onto their first concept map rather than creating two separate concept maps. I would also share with students the rubric used for scoring their work.

Although the results for improved written explanations was minimum, the implementation of UDL-R for supporting understanding of content was observed through student actions, comments and through their numerous scientific facts generated from various sources. The field of science education not only needs the implementation of inquiry so that students utilize critical thinking and problem solving skills; it also needs the flexibility that UDL-R practices achieve in an effort to reach all learners.

In addition to the changes I would make for this action research study related to concept maps and writing samples, I would like to have implemented another Universal Design for Learning principle, that being, the principle of expression (UDL-E). Under UDL-E, students have the flexibility to express their knowledge in their own way. Inclusion of UDL-E could incorporate another method of assessment of knowledge gained through UDL-R practices.

Conclusion

The purpose of this action research study was to determine the influence of UDL-R practices on concept map development and the connection between concept map and quality written science explanations. As a teacher, I learned that UDL-R practices engaged my students in learning content and provided them with opportunities to build upon their existing knowledge and developed student social skills as they worked together and shared information. My students learned that their textbooks gave them a brief introduction to a concept, but that the use of multimedia and technology allowed them to expand on their knowledge base. The field of education should consider the implementation of UDL-R as a part of curriculum resource development, school resource support, and incorporation in lesson plan creation to increase student acquisition of knowledge while saving teachers valuable time in the process.

APPENDIX A: PRINCIPAL LETTER

Dear IRB Coordinator,

As you are aware, Mrs. Lisa Finnegan is completing her Masters Degree in Mathematics and Science through the University of Central Florida-Lockheed Martin Academy. I have granted her permission to complete her thesis research study with the 5th grade class at ████████████ during the 2009-2010 school year.

Sincerely,

[signature redacted]

Senior Director of Florida Schools

APPENDIX B: INSTITUTIONAL REVIEW BOARD

University of
**Central
Florida**

Approval of Exempt Human Research

From: **UCF Institutional Review Board #1
FWA00000351, IRB00001138**

To: **Lisa A. Finnegan**

Date: **September 18, 2009**

Dear Researcher:

On 9/18/2009, the IRB approved the following activity as human participant research that is exempt from regulation:

Type of Review:	Exempt Determination
Project Title:	The Impact of Universal Design for Learning Practices On Concept Maps and the Development of Quality Scientific Explanations
Investigator:	Lisa A Finnegan
IRB Number:	SBE-09-06401
Funding Agency:	
Grant Title:	
Research ID:	NA

This determination applies only to the activities described in the IRB submission and does not apply should any changes be made. If changes are made and there are questions about whether these changes affect the exempt status of the human research, please contact the IRB.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Joseph Bielitzki,DVM. UCF IRB Chair, this letter is signed by:

Signature applied by Joanne Muratori on 09/18/2009 01:38:02 PM EDT

Joanne Muratori

IRB Coordinator

APPENDIX C: PARENT ASSENT

SCHOOL LOGO

September 22, 2009

Dear Parents,

I am writing to request consent for your child to participate in a research study that I am conducting in Science with your child's class during this school year. I am currently studying for my Masters in Mathematics and Science at the University of Central Florida-Lockheed Martin Academy program.

I will be researching **The Impact of Universal Design Practices on Concept Maps and the Development of Quality Science Explanations**. The purpose of this study is to further understand the role of technology in learning science content and to determine the impact of universal design for learning practices in the development of student's written science explanations. Research will begin in September and end sometime in January at the latest.

There are no anticipated risks in this study, only the potential benefit of participating in a study which will help build understanding of science content utilizing technology. Students will be asked to research concepts using the internet, videotapes/DVD's, trade books, and hands-on labs to assist them in their creation of a concept map information organizer. Students will then be asked to use their concept map as a tool to assist them in writing a scientific explanation that is supported with evidence. The identity of every student will be kept confidential as each student will be assigned a random number that only I will have access to. I will also be audio taping and videotaping class activities for note taking purposes only. The videos will only be seen by my academic supervisors if needed.   All documentation (video tapes, audio tapes, anecdotal notes) will be destroyed within one year of research completion.

I am attaching a copy of permission from (Director Name), Director of (SCHOOL NAME) allowing me the ability to perform research for my Masters degree. Questions regarding this study can be addressed directly to me Lisa Finnegan at (EMAIL ADDRESS) or (PHONE NUMBER) or you may contact my thesis chairperson, Lisa Dieker, PhD at (EMAIL ADDRESS).

Research at the University of Central Florida involving human participants is carried out under the oversight of the Institutional Review Board (UCF IRB). This research has been reviewed and approved by the IRB. For information about the rights of people who take part in research, please contact: Institutional Review Board, University of Central Florida, Office of Research & Commercialization, 12201 Research Parkway, Suite 501, Orlando, FL 32826-3246 or by telephone at (4047) 823-2901.

Thank you for your consideration. Please sign and return the attached consent form indicating the level of your child's participation.

<div style="text-align:center">

Sincerely,

Lisa A. Finnegan

</div>

**The Impact of Universal Design for Learning Practices On Concept Maps and the
Development of Quality Scientific Explanation
IRB Number: SBE-09-06401
Expires September 17, 2010**

_____
Printed name of child

☐ I have read the research project as described on the previous page .

☐ I voluntarily agree for my child to take part in the research.

☐ I am at least 18 years of age.

☐ I am an emancipated minor per Florida state law 83.

☐ I agree to have my child audio taped.

☐ I agree to have my child videotaped.

☐ I do not agree to have my child participate in this study.

_____   _____   _____
Signature of parent   Printed name of parent   Date

_____   _____   _____
Signature of parent   Printed name of parent   Date

_____   _____
Principal Investigator Signature   Date

A copy of the signed consent form will be returned to you for your records.

APPENDIX D: STUDENT ASSENT

I understand that my parents have given permission for me to participate in a study that Mrs. Finnegan is doing to complete her Master's Degree. I _____ give Mrs. Finnegan permission to use photocopies of my classwork, videotapes of my participation, and documentation of my written science explanations for her research project on Universal Design for Learning Practices on Concept Maps and Written Science Explanations. I understand that my grade in Science will not be affected whether I choose to participate or not to participate. If I have any questions regarding the study, I am allowed to ask Mrs. Finnegan at any time.

Name _____   Date_____

APPENDIX E: THE NATIONAL ACADEMIES PRESS PERMISSION

THE NATIONAL ACADEMIES PRESS

Marketing Department
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March 31, 2010 **Update: Reference #: 03311000**

Lisa Finnegan

Dear Ms. Finnegan:

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Thank you,

Barbara Murphy
Permissions Coordinator
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APPENDIX F: PERMISSION TO USE RUBRIC FOR CONCEPT MAPS

Re: Mueller's Clasroom Concept Map Rubric

From: **Jonathan Mueller**
Sent: Fri 2/12/10 5:25 PM
To:

Lisa,

Hi. Yes, you are welcome to use the concept map rubric. I have an assessment web site at

http://jonathan.mueller.faculty.noctrl.edu/toolbox/index.htm

which includes lots of examples of authentic assessments, including some using concept maps. If you create anything as part of your project that you would be willing to share I would love to be able to share it on my site. Good luck with your work,

Dr. Mueller

===============

Jon Mueller
Professor of Psychology
North Central College
30 N. Brainard St.
Naperville, IL 60540
voice: (630)-637-5329
fax: (630)-637-5121

http://jonathan.mueller.faculty.noctrl.edu

>>> ◄   2/12/2010 11:15 AM >>>
Dr. Mueller,
I am an Education Masters level graduate student at the University of Central Florida. I am currently researching student understanding of adaptations of plants and animals through the use of concept maps and then through written explanations. I am requesting permission to use the Mueller's Classroom Concept Map Rubric as an assessment tool for my student's concept maps.
Sincerely,
Lisa Finnegan

APPENDIX G: MUELLER CONCEPT MAP RUBRIC

Mueller's Classroom Concept Map Rubric[5]

Legible—easy to read and free of spelling errors	No (0-1)		Yes (2)	
Accurate—concepts used accurately	Many inaccuracies (0-2)	A few inaccuracies (3-4)	No inaccuracies (5)	
Complete—sufficient number of relevant concepts and relationships	Limited use of concepts/relationships (0-2)	Some use of concepts and/or relationships (3-4)	Sufficient number of concepts and relationships (5)	
Sophisticated—finding meaningful connections between relevant concepts	Little or none (0-1)	Few meaningful connections made (2-4)	Some meaningful connections made (5-7)	Meaningful and original insights demonstrated (8)

[5] Mueller, J. Concept map rubric. Retrieved on December 20, 2007, from http://jonathan.mueller.faculty.noctrl.edu/240/conceptmaprubric.htm

APPENDIX H: FCAT RUBRIC

FCAT

Florida Comprehensive Assessment Test

General Scoring Rubric for Extended-Response (ER) Questions Grades 5, 8, and 11

READ
INQUIRE
EXPLAIN
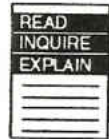
4 points   A score of four indicates that the student has demonstrated a thorough understanding of the scientific concepts and/or procedures embodied in the task. The student has completed the task correctly, used scientifically sound procedures, and provided clear and complete explanations and interpretations. The response may contain minor flaws that do not detract from a demonstration of a thorough understanding.

3 points   A score of three indicates that the student has demonstrated an understanding of the scientific concepts and/or procedures embodied in the task. The student's response to the task is essentially correct, but the scientific procedures, explanations, and/or interpretations provided are not thorough. The response may contain minor flaws that reflect inattentiveness or indicate some misunderstanding of the underlying scientific concepts and/or procedures.

2 points   A score of two indicates that the student has demonstrated only a partial understanding of the scientific concepts and/or procedures embodied in the task. Although the student may have arrived at an acceptable conclusion or provided an adequate interpretation of the task, the student's work lacks an essential understanding of the underlying scientific concepts and/or procedures. The response may contain errors related to misunderstanding important aspects of the task, misuse of scientific procedures/processes, or faulty interpretations of results.

1 point   A score of one indicates that the student has demonstrated a very limited understanding of the scientific concepts and/or procedures embodied in the task. The student's response is incomplete and exhibits many flaws. Although the student's response has addressed some of the conditions of the task, the student has reached an inadequate conclusion and/or provided reasoning that is faulty or incomplete. The response exhibits many flaws or may be incomplete.

0 points   A score of zero indicates that the student has not provided a response or has provided a response that does not demonstrate an understanding of the scientific concepts and/or procedures embodied in the task. The student's explanation may be uninterpretable, lack sufficient information to determine the student's understanding, contain clear misunderstandings of the underlying scientific concepts and/or procedures, or may be incorrect.

APPENDIX I: STUDENT CONCEPT MAPS

Student 3
Concept Map #1

Adaptations

Structural

Behavioral

Animals

Plant

Animal

Plants

Fur

Fat

Leaves

Stem

Playing dead

Making oxygen

eating

Fur gives the animal warmth.

The fat in an animal body keeps it warm

Alarmed Posture

Helps pro, animals

Helps keep plants alive

Polarbear

Polarbear

Leaves help capture sunlight

Helping protecting animal

Keep an alive

Stem help the plant get food.

Possum

Every plant

Cat

people

Dandelion

90

ADAPTATIONS

Plants

Structural

The Bengal Bamboo grows underground scattered in the patches in the forest

Lianas roots grow in the ground so they won't move when predators attack.

Bark's smoothness makes it difficult for other plants to grow.

Poison Ivy causes a painful sting which help it protect itself from grazers and people

Behavioral

Jumping Cholla will jump when stepped on or brushed against

Animals

Structural

White Checked Gibbon's small body size and long arms are designed for hanging to feed from terminal branches and for brachiating through the forest.

Dolphins have excellent hearing to protect itself from predators

The gray Seals fur is thick and waterproof, helping the animal maintain warmth in its cold-water habitat

Fennec fox has large ears that help it get rid of heat

Penguins have thick skin & lots of blubber to keep warm in cold weather

Giraffes tough tongues help it pull leaves from tree without getting hurt by the thorns

Behavioral

The male arrow-poison frog sings a humming chirping song to lure male to persuade her to lay eggs, which he then fertilizes

Adelie both the male & female take turns the eggs warm

Red eyed tree frog curls anal to keep in moisture

91

Adaptations

Adaptations

can be → **Structural**

can be → **Behavioral**

Structural are for → **Animals**

Structural are for → **Plants**

Behavioral are for → **Animals**

Behavioral are for → **Plants**

Structural — Animals (can have)

Mimicry: An adaptation in which an organism looks similar to another organism. Example: King snake

Protective Coloration: An adaptation in which the organism blends into its surrounding. Example: Flounder

Protective Pouch: Protects young. Example: Kangaroo

Warning Coloration: An adaptation in which an organism show colors to warn other organisms that they are poisonous or bad-tasting. Example: Poison arrow frog

Colorful Display: Bright colors to attract mates. Example: Peacock

Adaptations in Water

Gills: To breathe. Example: Fish

External Gills: The gill inhales oxygen from the water. Example: Sea Slug

Skin: The skin on a fish produces mucus to help it slide through water. Example: Barracuda

Adaptations in Land

Structural — Plants (can have)

Lightweight Seeds: Light seeds are easy to carry by wind. Example: Dandelion

Sharp Thorns: Thorns protect the organism from predators. Example: Raspberry

Stinky Flower: The odor attracts flies to carry pollen. Example: Giant Rafflesia

Adaptations for Water

Floats and Fronds: Water plants can have gas-

Behavioral — Animals (can be)

Alarmed posture: The organism shows a warning posture. Example: Cat

Playing Dead: An organism appears dead. Example: Opossum

Migration: Moving to meet needs. Example: Monarch

Feeding Young: To feed the young. Example: Woodpecker

Building Nest: To build a nest. Mates. Example: Weaverbird

Protecting Young: Keeps young safe from danger. Example: Scorpion

Avoiding Heat: Staying underground to avoid heat. Example: Kangaroo Rat

"Dancing": Showing other organisms something by moving. Example: Bees

Behavioral — Plants

Dying Back: The plant above ground "dies" While the roots stay dormant. Example: Mayapple Rabbit

Short Life Cycle: The plant grows, reproduces and dies. Example: desert-wild flowers

Sun-Tracking flowers: The petals follow the sun's movement. Example: Artic Poppy

Adaptations

can be

Structural   Behavioral (on back)

are for

Animals   Plants

Poison Glands protect toads from predators

The wax frog produces wax to keep water inside its body

American Bull Frog has large ears to listen to predators

Canadian Tree Frog produces anti-freeze during winter

Some frogs have paweed feet to glide in water

Fish have swim bladders to not float or sink

Salmon can change their body chemistry from fresh water to salt

Eels have electric cells to catch food.

Ostrich egg is hard to penetrate.

Camels have long eye lashes to keep sand out

Lions have rough tongues to rip flesh,

Turtles have shell to protect itself.

The ribs on a primate's hands help grab objects

Turtles have webbed toes to swim.

Ladybugs have hard wings to make sure they don't break

Crocodile has a large tail to help swim.

Dasor Monkeys have pads to help stay on trees.

A pelican's large mouth is net-like to catch fish,

Sharp beak on a woodpecker

Artic plants are small to avoid heavy wind

Some prairie trees have bark to resist fires

Artic Willow makes its own pesticide.

Bee orchard looks like female bee to attract other bees to pollinate.

Spine bush has strong leaves to protect itself.

A badger has claws to dig,

APPENDIX J: STUDENT WRITTEN EXPLANATION

Name ___ Student 3 ___

What can you tell me about adaptations? What are they? How do
the help an organism to survive? What scientific evidence can you
use to support your explanation?

Adaptations are what organisms use
to survive in it's habitat. Adaptations are
what animals and plants are doing when
they protect themselves, like when the
possum plays died to protect itself from
preadators. Possum playing died is called
a Behavioral Adaptation. Fur is a
adoption called Structral... They're are
two kinds of adaptations Structral and
Behaviral.

Another Structral Adaptation
is fat. Fat in a animals body keep it's
warm. Some other Behavioral Adaptations
are when a cat is in an alarmed posture

to warn preadators that it will attack.

Name Student 3

What can you tell me about adaptations? What are they? How do the help an organism to survive? What scientific evidence can you use to support your explanation?

Adaptations help animals survive in an habitat. Adaptations can be structural or behavioral. An structural adaptation is an adaptation having to do with the body. Structural Adaptations are things like fur, fat, and hair. Behavorial Adaptations are adaptations having to do with actions or things that come naturally. Behavioral Adaptations help the animal protect itself. An example of an behavioral adaptation is the Canadian tree frog freezes & heart stops but doesn't die because it produces its own anti-freeze. Another behavioral adaptation is the Red eyed tree frog curls up in shade to

keep moisture. Desert tortoise burrows underneath the sand to protect itself from -extreme desert temperatures. Firebelly toad flashes its red belly to warn other animals to go away. An example of an Structural Adaptation is the Red eyed tree frog having sharp eyesight to see preadators. Giraffe's long neck helps it get food and spot preadators. Camals have thick eyebrows that sheild their eyes from the desert sun.

APPENDIX K: STUDENT NOTES

shade

- ∅ Red eyed tree frog- curls up in to keep in moisture
- S Poison Dart Frog- warns other animals with color
- ∅+∅ Firebelly toad- flashes red belly to warn other animals
- ∅ Wax Frog- produces wax to prevent water loss
- S Bull Frog- big ears to hear predators
- S Bull Frog -camouflages to protect itself and to get food
- S Horned Frog- has hard head for protection
- ∅ Canadian tree frog- freezes and heart stops but does not die because it produces its own anti-free ze
- S Salamander- develops lungs and gills when needed
- S Red eyed tree frog- has big eyes and sharp eyesight to see predators
- ∅ Desert Frog- makes a bag when it rains and covers itself with it

Animal & Plant Notes - Internet - shared

S Camel-its long eyelashes keeps sand out of its eyes

S Camel-its nostrils open and close so sand doesn't get in

S Camel-its thick eyebrows protect its eyes from the sun

S Desert Tortoise- it burrows under sand to protect it from desert temperatures

S+S Desert Tortoise- pull themselves into their shell to escape predators

S Desert Tortoise- dig a shallow pit to catch water so they can drink it

S Fennec Fox-its large ears help it get rid of heat

S Giraffe-long neck helps it get food and find predators

X Giraffe-tough tongue helps it pull leaves off branches without getting poked by thorns

S Lion-its loose belly allows it to be kicked with little chance of getting hurt

S Lion-its mane makes the male look bigger and it protects its throat

Student 10
UDL - Tradebooks

Animal & Plant Notes-Book-Shared

∅ Humpback whale-leaps out of water to signal danger, attract a mates, or show force

∅ Skunk-sprays bad smelling liquid on predators when threatened

s Anteater-has long tongue which helps it eat ants and get food.

∅ Anaconda-wraps itself around prey to kill it

s Hummingbird-its long beak helps it drink nectar out of a flower

s Phasmid-camoflages with the branches it sits on

∅ Camel-its humps store fat so it can survive up to twelve days without food or water

s+∅ Badger-uses its claws and teeth as weapons

∅ Marmot-whistles to warn its companions as soon as it senses danger

∅ Gorilla-it scares its enemies away by pounding on its chest with its fists

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