Christ-Centered Professional Development Program for Science Instruction

by

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Field Project

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Signature Page

Date:

This field project paper has been examined and approved.

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Abstract

The following document details a field project using a Christ-Centered Professional Development Program for Science Instruction. The purpose of this project was to develop a common mindset among our faculty regarding the teaching of science in our Lutheran school. Such a mindset will serve as a foundation for developing a Christ-centered science curriculum that will enable us all to learn in humble awe about the wonderful world God created.

The teachers of St. Peters Lutheran School in Sturgeon Bay participated in this project. Five of the six teachers completed a Science Teacher Survey prior to professional development to determine attitudes and beliefs toward science instruction. All participated in the Professional Development Series - The Foolishness of God: A Biblical Perspective on Science. Participants then completed a duplicate survey with three additional questions used to help assess growth and future professional development. Results indicated very similar attitudes and beliefs toward science among the participants and a renewed understanding of the role Scripture plays in our science classes.

Acknowledgments

I would like to acknowledge the Lutheran Elementary School Committee of St. Peters Lutheran School, Sturgeon Bay, for its commitment to the accrediting process and for encouraging me to pursue a master's degree. I would like to thank St. Peters Congregation for financing this endeavor. I would also like to thank Paul Boehlke for sparking an interest in science for me once upon a time and for renewing that interest more recently with his simple "Did you know that…"

Table of Contents

Chapter I: Introduction

Identify the Issue

Our school handbook at St. Peters Lutheran School, Sturgeon Bay, Wisconsin, states that every subject is taught in the light of God's Word. The problem arises when we teach science. Science is a human endeavor that, when used correctly, can help us understand God's creation and use it for the benefit of man. However it is a human endeavor based on human reason; therefore it is filled with human error. The world in which we live continues to remove the Creator of the world from his creation. Over the last three decades our school has sheltered our students from science's glaring errors; we have shown our students those same errors and what the Bible teaches; and we have unintentionally turned the Bible into a science textbook using human reason to explain how Scripture verifies or rejects a scientific idea. The Bible is not a science textbook and should not be used as such. Our faculty can be better equipped to address current issues in science in order to more effectively help students study science, not with human reason but through the eyes of faith.

Importance of the Project

Our students have correctly learned that the big bang theory does not accurately explain the existence of the universe; that the world is not billions of years old; and that man did not evolve from apes. They know the Bible says differently. Yet they graduate from our school not really knowing science or how to defend their Christian beliefs. They still want to scientifically prove the Bible or use the Bible to support science. Our students and their families get bombarded with scientific fact, theory, and law. Modern science removes God from the equation; it does not accept supernatural causes. Opposing

views such a Creation Science and Intelligent Design are just as dangerous. They blend science and the Bible turning matters of faith into matters of logic, effectively taking credit and glory away from God. Scripture tells us in Matthew 6:24, “No one can serve two masters. Either he will hate the one and love the other, or he will be devoted to the one and despise the other” (NIV ‘84).

Our WELS elementary school is sixty miles from the nearest area Lutheran high school, so most of our graduates attend public high schools. That makes it even more important that we train them as best we can in the scientific process as well as in new discoveries and how they have verified or discredited past discoveries. Because of modern technology, much scientific information and misinformation is readily available for both students and teachers. Providing professional development opportunities and accurate science resources for our teachers will help them train the next generation of scientifically and scripturally discerning adults.

Project Purpose or Goal

It is the purpose of this project to develop among our faculty a common mindset regarding the teaching of science in our Lutheran school. Such a mindset will serve as a foundation for developing a Christ-centered science curriculum that enables us to learn in humble awe about the wonderful world God created.

Chapter II: Literature Review

Introduction

In the first line of Martin Sponholz's paper *Two Towers – The Relationship Between Science and the Bible* presented to the Minnesota District Pastoral Conference in 1982, he emphatically states "There is no relationship between science and the Bible" (Sponholz, 1982). He goes on to give examples of the tower of science made with human reason. This tower has bricks that crumble or are pulled out when new scientific evidence proves them false. The science community acknowledges that science is a human endeavor and that scientific knowledge is open to revisions in the light of new evidence (Next Generation Science Standards [NGSS], 2013). Scientific knowledge is reliable, yet can be abandoned or modified when new evidence is available (National Science Teachers Association [NSTA], 2000). This makes for a very shaky unstable tower. Picture a Jenga game. One piece after another is pulled out and added to the top. Amazing structures can be made, but eventually they all topple. To be in that modern tower of science is dangerous for the faith of a Christian. It is better to stay out.

Our WELS called workers, lay people, and students see that tower every day. We enjoy the benefits of science and we get bombarded with the errors of science. Our WELS schools teach science. If we did not, we would be doing a disservice to our students and their parents. We are working on developing a science curriculum based on the Next Generation Science Standards (NGSS). The NGSS use a Framework for K-12 Science Education advocated by the National Research Council (NRC). This framework is designed to help students observe, question, explain, test, and reflect (NGSS, 2013).

The National Science Teachers Association (NSTA) endorses the NGSS and the framework developed by NRC. In their position statement on The Teaching of Evolution (NSTA, 2013, p. 1), the NSTA "strongly supports the position that evolution is a major unifying concept in science and should be emphasized in K-12 science education framework and curricula." They also call for the removal of any alternative teaching that would de-emphasize evolution.

Application

So why involve NGSS standards in our WELS school? It is largely because of the Nature of Science (NOS) and the History of Science (HOS). They encourage the use of case studies from the HOS, such as Newtonian Mechanics, to give students a better understanding of the NOS (NGSS, 2013). The NOS uses scientific methods and processes to learn, to reflect and to evaluate. Research has also provided some evidence that using these HOS case studies can improve students' interest and participation in physical science lessons (Guney & Seker, 2012).

Using historical controversies in the HOS can be used to develop students' analysis and argumentation skills. The fact that some historical controversies have resolutions is important to these lessons. It shows that with the new evidence and documentation developed after the controversy, that scientific knowledge evolves and changes. An additional benefit is that these case studies can help train students to recognize "bad science" (Clary & Wandersee, 2013).

A major thrust of Martin Sponholz's writings is that we need examples from the history of science in our schools. This can be shown in his preface to *Separate from His*

Word: A Christian Commentary on the History of Science, which was written as a high school science course:

> It can be shown historically that each age of science has worked within its own circles of reason as supported by the paradigms of the age. Many times scientists promoting new revolutionary theories found it difficult to replace accepted laws until the old scientists were replaced by the younger generation. In time the laws of science change as new theoretical artistry explains new ideas and provides new hope for solving the problems of its age. Even scientific facts change under the interpretations of new theories and new laws (Sponholz, 1989, p. 7).

I am not advocating having one foot in each tower or blending the two. I am suggesting that we return, at least in part to Aristotle's four causes: material, formal, efficient, and final. Modern science still pursues the first two causes. The search for material causes would ask, "What are the substances?" Formal causes would ask, "What is its shape and function?" But efficient causes, "Who made this thing of nature?" and final causes, "Why was nature made to be and function as it does?" are lost. The efficient cause is God of creation. The final cause is God's motives which are beyond our comprehension unless He tells us in the Bible (Sponholz, 1982).

But what is that second tower? It is God's tower of nature. "It is in God's tower, one like Jacob saw, one of continual ascending and descending between God and man, one that leads up to Calvary and ascends to heaven where the true nature God has made can be fully understood" (Sponholz, 1982, par. 41). True education is fearing, loving, and

trusting God above all things. It is searching the Scriptures. It is putting on the full armor of God.

Misconceptions

Our WELS teachers, by virtue of the teaching situation to which they have been called, are jacks-of-all-trades, but it is difficult to be an expert in all subject areas. Misconceptions within accepted science are common. Research has shown that many of these misconceptions are particularly found in physical science. Science concepts are based on observation and reason. Our everyday experiences at an early age may lead us to incorrect assumption. Data collected using the "Science Beliefs Test" verified that many college students about to become teachers carry those misconceptions with them. The researchers' conclusion is specific scientific training for educators to correct those misconceptions before they pass them on to their students (Stein, Larrabee, & Barman, 2008).

What misconceptions might our WELS teachers have in what Scripture does or doesn't address regarding science? Stein et al. (2008) quoted Sir Francis Bacon to explain misconceptions. "For what a man likes to be true, he more readily believes" (p. 1). Caution must be taken not to speak with authority where Scripture has remained silent. Creation science goes too far in the other direction, using science to prove Scripture. We dare not use science to validate Scripture. Nor is Scripture a science book (Boehlke, 2005). "Although God's power is manifest for all to see, God's intentions are not" (Nurenburger, 2010, p. 135). Intelligent Design is another way of explaining origins without giving full credit to our Creator. This leads to support the false concept of a "God of the gaps" where the Creator only operates when a complex mechanism is

required in nature. The rest is left to natural causes. Theology of evolution argues that evolution and Christianity do not have to be incompatible (Scott & Branch, 2003).

Summary

A clearer understanding of science and its limitations can inspire great awe in the God who created it all. We will never, in this life, have a perfect understanding of how the world works. I cannot help but think of the book *Flatland* by Edwin A. Abbott (1992). The people, homes, and landscape of Flatland are all two-dimensional. There is no third dimension. When the main character introduces the concept of another dimension, he is ostracized as a heretic. When viewing science today, I can only imagine God shaking His head and saying, “If only you could see my creation like I do!”

Jacob Bronowski, mathematician and scientist, also realized this. He said, “I do not think that there is a God’s eye view of nature…we cannot extricate ourselves from our own finiteness.” What we have is a giant metaphor for nature (Bronoswski, 1978, p. 70).

Chapter III: Implementation

Introduction

Our faculty recognized the need for a better science curriculum which will enable the students at St. Peters Lutheran School to learn about the wonders of God's creation, the usefulness of science inquiry, and the limitations of any human endeavor such as science. Before our teachers can equip our students with the necessary knowledge and skills to participate in the scientific arena, we as teachers need to know how to recognize and combat errors in science as well as to know how to effectively use science.

It is the purpose of this project to develop among our faculty a common mindset regarding the teaching of science in our Lutheran school. Such a mindset will serve as a foundation for developing a Christ-centered science curriculum that enables us all to learn in humble awe about the wonderful world God created.

Procedures

The seven teachers of St. Peters Lutheran School Faculty were involved with every step, although the principal and one other teacher chose not to fill out the surveys. The principal was the researcher. Information was shared with the pastors although they did not join in with the video segments or discussion. On October 22, 2014, I had a meeting with the St. Peters Lutheran Elementary School (LES) teachers to explain the project and to obtain their consent (Appendix A).

In November, the faculty as a whole logged on to the Scientific Beliefs Quiz, (Stein, Larrabee, & Barman, 2007), (https://www2.oakland.edu/secure/sbquiz/index.cfm?questionnum=45) and proceeded with the T/F and explanation portion of the test. They discussed answers and locked into

the most mutually agreed upon answer. The faculty got 33 out of a possible 44 correct (Appendix B). We then went back through the answers and discussed possible misconceptions. The purpose of taking this quiz was two-fold. The first was to recognize that we all have some misconceptions about common scientific facts, many of which we deal with on a daily basis. If we as teachers have these misconceptions, it is highly probable that our students have even more misconceptions that need to be corrected. The other purpose comes out in our discussion of the misconceptions. If we can misunderstand some basic science concepts, are there possible misconceptions that we have regarding what Scripture says about God's created world? This was done to set up the purpose of the professional development series.

In January, the faculty was given a survey to find out how comfortable they are teaching science, what they believe their strengths and weaknesses are in teaching science, what they like or don't like about the current science curriculum, and what they would like to change if they could. The survey included a science attitude portion with a Likert scale design to determine their perceived enjoyment, factual knowledge, methodology, and Scriptural support for their beliefs (Appendix C).

Then once a week for six weeks in January and February, the faculty and I participated in Steven Thiesfeldt's (2014) Professional Development Series *The Foolishness of God: A Biblical Perspective on Science* through Martin Luther College. The format was multimedia with delivery of all podcasts, study guides, handouts, and digital links to web resources via MLC Moodle. Each segment with discussion was approximately 60 minutes long. Topics for the six weeks were:

1) The Quest for Truth

2) The Nature of Science

3) Science and Values

4) Science and Religion

5) Science, Faith, and Reason

6) God's Word: The Ultimate Authority

Additional resources were handed out after each video segment with the request to read them before the next segment. These readings are included in Appendix D. Discussions on the weekly readings were conducted at a faculty meeting prior to starting a new lesson with new additional readings.

The final step was to retake the science attitude survey and compare results with the first survey.

Artifacts

The assessment tool for determining the effectiveness of the professional development in science instruction was a survey filled out before the professional development and again after its completion. The first six questions dealt with strengths and weaknesses of instruction, likes and dislikes of curriculum, method of instruction, and desired changes in instruction. The five surveys returned ranged from Kindergarten to eighth grade instruction. Lower grade teachers tended to do more hands on discovery and wanted more time to prepare materials. Upper grade teachers did more lecture and wanted to do more hands on discovery. Too much content and the amount of resources necessary were also negative comments. This part of the survey did not change after the professional development.

The next ten questions required a rating with eight of them asking how strongly the teacher agrees or disagrees with the comment. There is not much change in the before and after professional development series (PDS) results. A few changes may be attributed

to poor wording on the survey. (*Key:* SA=strongly agree, MA=moderately agree, NO=no opinion, MD=moderately disagree, SD=strongly disagree)

Result Comparison for Questions 7-16

7.	enjoy teaching science					
	before PDS	SA-2	MA-3	NO-0	MD-0	SD-0
	after PDS	SA-2	MA-2	NO-1	MD-0	SD-0
8.	comfortable teaching					
	before PDS	SA-1	MA-4	NO-0	MD-0	SD-0
	after PDS	SA-1	MA-3	NO-1	MD-0	SD-0
9.	confident in knowledge					
	before PDS	SA-4	MA-1	NO-0	MD-0	SD-0
	after PDS	SA-3	MA-2	NO-0	MD-0	SD-0
10.	scientific process					
	before PDS	SA-0	MA-4	NO-0	MD-1	SD-0
	after PDS	SA-0	MA-3	NO-1	MD-1	SD-0
11.	science training					
	before PDS	none-1	little-1	some-3	much-0	degree-0
	after PDS	none-2	little-1	some-1	much-1	degree-0
12.	HOS & NOS importance					
	before PDS	SA-3	MA-1	NO-1	MD-0	SD-0
	after PDS	SA-3	MA-2	NO-0	MD-0	SD-0
13.	confident in Bible knowledge					
	before PDS	SA-1	MA-4	NO-0	MD-0	SD-0
	after PDS	SA-1	MA-3	NO-0	MD-1	SD-0
14.	comments discrediting science					
	before PDS	never-0	seldom-3	occasionally-1	frequently-1	all the time-0
	after PDS	never-0	seldom-1	occasionally-3	frequently-1	all the time-0
15.	creation as science					
	before PDS	SA-1	MA-0	NO-0	MD-1	SD-3
	after PDS	SA-0	MA-1	NO-0	MD-1	SD-3
16.	scripture to discredit science errors					
	before PDS	SA-0	MA-1	NO-1	MD-1	SD-2
	after PDS	SA-3	MA-1	NO-0	MD-0	SD-1

With only five surveys, it is difficult to come up with conclusive results. We have two teachers with 30 plus years of teaching experience, two with around ten years, and one relatively new teacher. There are two males and four females. When I looked at the results of the original survey, I was at first surprised by how similar they were. True, there were only five surveys, but they all teach different grade levels. As we progressed through the professional development series, the reason for the similarities became apparent. We all have the same educational background. We all went to WELS elementary schools and high schools. We all have Bachelor of Science degrees in Education from Martin Luther College. Many things have changed in the field of science within the forty years of difference in teaching experience on our staff. But the one thing we base all our instruction on has not changed, God's Word.

Results

The two surveys were used with the intention of determining the effectiveness of the professional development series with the faculty. The survey questions and the purpose of the professional development series were not well-aligned, therefore the results were inconclusive. Nevertheless, based on the discussions we had and the comments made by participants during the series, the professional development was successful in bringing the faculty to a common mindset regarding the teaching of science in our Lutheran school. The most common comment was on the timeliness of the additional readings and how the teachers could use that information with their students right away.

Chapter IV: Reflective Essay

Introduction

The purpose of this capstone field project was to develop a common mindset among our faculty regarding the teaching of science in our Lutheran school. To accomplish that purpose, the entire faculty participated in a Christ-centered professional development program for science instruction. The series titled *The Foolishness of God: A Biblical Perspective on Science* was developed by Steven Thiesfeldt and is available through Martin Luther College.

Conclusions

It was my intent to see if the professional development series (PDS) by itself would be successful in helping us reach our goal of a common mindset in science instruction. Through the survey, I discovered that our faculty had a pretty common mindset before we participated in the PDS. This most likely can be attributed to a common WELS education from elementary school through college. Not only did this affect our academic background but also our spiritual upbringing. Most of our faculty have parents or other relatives who were WELS pastors or teachers. All were brought up in WELS churches. That becomes evident in the strength of conviction that there is an ultimate truth and that God's Word reigns supreme over the faulty human reason of science.

During the PDS, I did not want anything else to influence the results of this project. We did not continue our science curriculum study during the PDS. The faculty had been introduced to the Next Generation Science Standards and the National Science Teachers Association's position statements. It is unclear if keeping the PDS and the

curriculum study separate was more beneficial to the overall development of our science program than if we had proceeded simultaneously with the two.

The PDS was successful in that it gave us a forum for discussing our common mindset and strengthening our conviction in the inerrancy of Holy Scripture. A concern I had for the faculty is something I struggle with myself. In my efforts to educate our students and to equip them with the tools to stand firm against errors in science, am I turning this into whoever has the best argument wins?

Arthur Eggert (2010) writes,

> When God acts through his word, as he did in the early history of the world, he violates the basic assumption of science. That makes the scientific method useless. Why is this so? The basic assumption specifically forces the exclusion of any supernatural involvement from scientific models. How can anyone know all the actions that God performed supernaturally so as to exclude them? In fact, trying to use scientific modeling to explain or justify creation is a trap (Eggert, p. 3, par. 2).

We know Darwin's theory of evolution must be false based on the Bible's teaching. But the Bible does not tell us if any particular theory of science is true (Buelow and MacPherson, 2004). Rather than "looking for gaps in evolutionary conclusions, we need to look at the assumptions that guide this thinking" (Boehlke, 2009). These and other additional readings for *The Foolishness of God* gave us a clearer vision of how Scripture can and should be used and for what it should not be used.

Once we were finished with the PDS *The Foolishness of God,* the faculty repeated the original survey. There were no significant changes in attitudes or beliefs that can be attributed to the PDS. All the faculty members felt the series was beneficial and was worth the time and effort to participate.

Recommendations

I became disillusioned with the survey when I had the teachers take it a second time. It became evident to me that the wording on some of the questions was ambiguous. Question #16 “Scripture should be used to discredit the errors of science such as evolution” was one that had some major shifts in responses. I don’t believe the change was due to a change in beliefs but in a different interpretation of the question. Also, repeating some of the background information was unnecessary since it wouldn’t have changed in the six weeks of the series. If I were to do this project over, I would use a revised survey such as the one in Appendix E. I would also seek out someone qualified to review the questions to ensure they are aligned with the goals of the PDS. This could also be viewed as a pilot project allowing others the opportunity to question if the PDS was effective and if the survey instrument can be sharpened.

Using the title *Christ-Centered Professional Development Program for Science Instruction* for the Capstone Project was misleading for one participant. The PDS *The Foolishness of God: A Biblical Perspective on Science* helped our understanding of the Scriptural foundation we should use with science. It also warned of trying to use Scripture when Scripture was silent on a certain topic. This teacher was looking for more practical science applications.

I would recommend stretching out the PDS from the six weeks we took to six months. The extra time would allow for including the study of the Next Generation Science Standards (NGSS). We would also become familiar with specific details or examples of commonly accepted science that has currently been disproven by science such as those in the History of Science (HOS). The paper *Questioning Evolution* (Quist, 2010) introduces some genetic research by Dr. Sanford of Cornell University, who states' "mechanisms of genetics demonstrate that the central axiom of Darwin's evolution cannot be true."

Additional resources (Appendix F) and the Answers in Genesis (AiG, 2011) video *Check This Out!* could be used to introduce other questionable topics. AiG has a number of short three minute videos on topics such as Radiometric Dating, Fossils and the Flood, The Origin of Races, Pain & Suffering, and Evolution Refuted. Developing a list of Bible passages that specifically and acceptably deal with certain scientific errors that can be used with our students would also be helpful. All this would give our faculty plenty of background information to then formulate a science curriculum to be used at our school.

A word of caution, when science disproves a scientific theory, it does not prove Scripture. The disproven science will be replaced by other science which may or may not be accurate. Science is worthwhile and beneficial, but it will never be able to save us eternally. We should not attack science that contradicts the Bible, but teach our students how to evaluate that science and stand firm on God's Word. The science will change; God's Word will not.

One other project that would assist our WELS schools in effective science instruction would be a parent version of *The Foolishness of God.* We cannot assume that

all our parents have the same viewpoint on the inerrancy of the Bible. In his paper *Understanding and Addressing a Postmodern* Culture, Paul Kelm (1999, par. 8) states, "When we admit to ourselves that our culture is no longer Christian, we may more readily see our community as a mission field." It is important for parents, teachers, and students to work as a team in all aspects of education, including science. Therefore all participants need to know what their foundation is.

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Appendix A: Consent Forms

CONSENT FORM
Christ-Centered Professional Development Program for Science Instruction

You are invited to be in a research study of the effects of Christ-Centered Professional Development. You were selected as a possible participant because you are a member of St. Peters Lutheran School faculty. Please read this form and ask any questions you may have before agreeing to be in the study.

This study is being conducted by Paul Lutze as part of the Instructor Emphasis in the MLC master's program.

Background Information
The purpose of this study is to develop among our faculty a common mindset regarding the teaching of science in our Lutheran school. We will use a Christ-Centered Professional Development in the field of science to improve teachers' attitudes, confidence, and knowledge in providing Christ-centered science instruction.

Procedures:
If you agree to be in this study, we would ask you to do the following things: complete a written Science Teacher Survey, complete an online Science Beliefs Quiz followed by faculty discussion, participate as a faculty in the Professional Development Series "The Foolishness of God," read and discuss additional articles with faculty, and retake the Science Teacher Survey. This procedure will take one hour per week for ten weeks of faculty group participation with approximately 30 minutes to an hour of additional individual reading time per week.

There will be no video or audio taping done of any kind to record discussions. Written assignments are limited to the pre- and post-surveys and the Science Beliefs Quiz.

Risks and Benefits of being in the Study
The study has several risks: First, you may discover you have some misconceptions in science; second, you may discover that you've made assumptions about God's Creation that are not Biblically sound.

The benefits to participation are possibly a clearer understanding of Scripture and science and a deeper appreciation for the wonderful world God created for us.

Compensation:
There is no compensation payment for participation in this program.

Confidentiality:
The records of this study will be kept private. In any sort of report we might publish, we will not include any information that will make it possible to identify a subject. Research records will be stored securely and only researchers will have access to the records.

Voluntary Nature of the Study:
Participation in this study is voluntary. Your decision whether or not to participate will not affect your current or future relations with the Martin Luther College, St. Peters Lutheran School, or Principal Paul Lutze. If you decide to participate, you are free to not answer any question or withdraw at any time without affecting those relationships.

Contacts and Questions:
The researcher conducting this study is Paul Lutze. You may ask any questions you have now. If you have questions later, **you are encouraged** to contact him at St. Peters School Office, 920-743-4432 ext. 148, plutze@stpeterssb.net.

If you have any questions or concerns regarding this study and would like to talk to someone other than the researcher, **you are encouraged** to contact the Director of Graduate Studies at Martin Luther College, 1995 Luther Ct, New Ulm, MN 56073; (507) 354-8221 ext. 398.

You will be given a copy of this information to keep for your records.

Statement of Consent:
I have read the above information. I have asked questions and have received answers. I consent to participate in the study.

Signature:_____ Date: _____

Signature of parent or guardian:_____ Date: _____
(If minors are involved)

Signature of Investigator:_____ Date: _____

Appendix B: Science Beliefs Quiz

Your quiz results are shown below. To logout of the quiz and return to the starting screen, click on the button below. Thanks for taking our quiz!

Note: Your results are not recorded due to the option you selected. This page only shows the results of what you input, and will not be kept for any records.

These results are based on your true or false answers and not on the explanations you provided. In some cases your explanation may be correct even though the item is scored as incorrect. This would change your overall score.

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LOGOUT OF QUIZ

Quiz started at: 9:09:18 AM
Quiz finished at: 9:25:03 AM
Total time: 15 min 45 sec

Question number	Question/Explanation	Correct Answer	Your Answer	Time Spent
1	**Question**: The only essential constituents that plants need in order to grow are: water, light, and nutrients from the soil or medium in which they exist.	False	FALSE	42 sec
	Explanation: Plants also need air to grow. Specifically, plants need carbon dioxide and oxygen from the air. The National Science Education Standards state that organisms have basic needs. Plants require air, water, nutrients, and light (K-4 Content Standard, National Science Education Standards, 1996, p. 129). Although most individuals understand that plants need water, nutrients (or soil), and light, many do not understand how and why plants need air. You may have provided another valid explanation as there are other requirements for some plants. However, many individual do not understand that specific gases are needed for plant growth.			
2	**Question**: Plants use oxygen.	True	FALSE	19 sec
	Explanation: Cellular respiration is a biochemical process that occurs in all cells. Plant cells use oxygen during cellular respiration. During photosynthesis plants use carbon dioxide and release oxygen. However plant cells also need oxygen in order to breakdown molecules of food to release energy used for building new cells. Some students incorrectly think that plants do a reverse type of human breathing - that is they take in carbon dioxide and release oxygen but do not utilize oxygen. In living organisms, oxygen is second only to hydrogen based on the number of atoms and oxygen is the largest constituent by mass. The National Science Education Standards state that plants require air, water, nutrients, and light (K-4 Content Standard, National Science Education Standards, 1996, p. 129). This helps to account for the fact that plants need carbon dioxide to make food and oxygen to utilize food.			
3	**Question**: Most animal species depend on plants.	True	TRUE	10 sec
	Explanation: According to the National Science Education Standards, students in grades K-4 should understand that all animals depend on plants with some animals eating plants and other animals eating animals that eat the plants (K-4 Content Standard, National Science Education Standards, 1996, p. 129). You may have thought of some exceptions to this that could make your			

	explanation correct. There are some animals, found near deep sea ocean vents, that do not depend on plants but instead are part of ecosystems based on chemosynthetic bacteria. Additionally, zooplankton in oceans feed on bacteria, diatoms, and algae. However, most common animals depend on plants if the flow of energy within a system is traced.			
4	**Question**: Typically, the arrows of a food chain symbolize what each organism is eating (e.g., grass -> mouse -> snake -> hawk).	False	TRUE	31 sec
	Explanation: In a food chain, each organism represented, symbolizes a population of that type of organism. The first population makes up the first trophic level (plants or producers), the second is the next trophic level (consumers) and so on. The arrows point from one trophic level to the next, signifying the energy that is transferred between these trophic levels. The arrows may also be used to represent the flow of nutrients (or toxicants) in an ecosystem. However, many students interpret the arrows to mean that an organism is eating another organism and often believe that the arrows are therefore drawn incorrectly (backwards). According to the National Science Education Standards, students in grades 5-8 should understand that "Energy entering ecosystems as sunlight is transferred by producers into chemical energy through photosynthesis. That energy then passes from organism to organism in food webs" (5-8 Content Standard, National Science Education Standards, 1996, p. 158). Students in grades 9-12 should understand that "energy flows through ecosystems in one direction, from photosynthetic organisms to herbivores to carnivores and decomposers" (9-12 Content Standard, National Science Education Standards, 1996, p. 186).			
5	**Question**: If the producers (plants) disappeared from Earth, organisms that prey on other organisms for food (carnivores) would only be slightly affected.	False	FALSE	15 sec
	Explanation: If plants disappeared from Earth, the organisms that eat plants (e.g., herbivores) would begin to die. Gradually, carnivores that prey on herbivores would also start to die from lack of food. According to the National Science Education Standards, students in grades 5-8 should understand that "Populations of organisms can be categorized by the function they serve in an ecosystem. Plants and some micro-organisms are producers – they make their own food. All animals, including humans, are consumers, which obtain food by eating other organisms. Decomposers, primarily bacteria and fungi, are consumers that use waste materials and dead organisms for food. Food webs identify the relationships among producers, consumers, and decomposers in an ecosystem" (5-8 Content Standard, National Science Education Standards, 1996, p. 157 - 158).			
6	**Question**: Humans, dogs, fish, worms, and insects are all considered to be animals.	True	TRUE	5 sec
	Explanation: The animal kingdom contains a diverse group of organisms, including those with backbones (vertebrates) and those without backbones (invertebrates). A combination of a few features distinguish animals from other organisms: animals have cells with defined nuclei that lack cell walls, they are composed of many cells, and they are not able to make their own food. However, many students tend to think of animals as only those with which they are familiar, often vertebrates, rather than invertebrates as well as species that are not as well known.			
7	**Question**: Any organism that possesses locomotive structures (e.g., movement capabilities) and is able to reproduce is correctly classified as an animal.	False	TRUE	53 sec
	Explanation: Although locomotive structures and reproductive behavior are features attributed to animals, they are not exclusive to these organisms. Some organisms in the kingdoms Protista (e.g., Ciliates and Flagellates) and Monera, (e.g., certain bacteria) also exhibit these features.			
8	**Question**: An organism is composed of one or more cells.	True	TRUE	7 sec
	Explanation: All organisms are composed of cells – the fundamental unit of life. Most organisms are single cells; other organisms, including humans are multicellular (5-8 Content Standard, National Science Education Standards, 1996, p. 156). However, if you considered organisms to include viruses, viroids, plasmids, or prions, then you may have responded false. These are not composed of one or more cells and some consider them to be living organisms.			
9	**Question**: Reproduction is a characteristic of all living systems.	True	TRUE	5 sec

	Explanation: Reproduction is a characteristic of all living systems; because no individual organism lives forever, reproduction is essential to the continuation of every species. Some organisms reproduce asexually. Other organisms reproduce sexually (5-8 Content Standard, National Science Education Standards, 1996, p. 157). Humans can artificially create sterile living systems that do not reproduce, which you may have thought of for your explanation, however reproduction is necessary for the continuation of all common living systems.			
10	**Question**: Sexually produced offspring can be identical to either of their parents.	False	FALSE	11 sec
	Explanation: This item specifically refers to "sexually" produced offspring rather than offspring produced via asexual reproduction, such as parthenogenesis, or other means. Sexually produced offspring are never identical to either of their parents. An egg and a sperm unite to begin development of a new individual. That new individual receives genetic information from its mother (via the egg) and its father (via the sperm). (5-8 Content Standard, National Science Education Standards, 1996, p. 157).			
11	**Question**: Extinction of species of organisms is common.	True	TRUE	2 sec
	Explanation: Extinction of species is common; most of the species that have lived on earth no longer exist. The background level of extinction known from the fossil record is about one species per million species per year, or between 10 and 100 species per year (counting all organisms such as insects, bacteria, and fungi, not just the large vertebrates we are most familiar with). Current estimates, based on the rate at which the area of tropical forests is being reduced, and their large numbers of specialized species, are that we may now be losing 27,000 species per year to extinction from those habitats alone. Extinction of a species occurs when the environment changes and the adaptive characteristics of a species are insufficient to allow its survival. Fossils indicate that many organisms that lived long ago are extinct (5-8 Content Standard, National Science Education Standards, 1996, p. 158).			
12	**Question**: When a book is at rest on a table (not moving), other than the force of gravity, there are no other forces acting on it.	False	FALSE	6 sec
	Explanation: When an object is not moving, many believe that no forces are acting upon the object. It is difficult to understand the concept of balanced forces in equilibrium, especially if the force is associated with static, inanimate objects, such as a book resting on a table (5-8 Content Standard, National Science Education Standards, 1996, p. 154). In the case of the book on a table, gravity is acting on the book and the table can be thought of as "pushing back" via the bonds that hold the table material together. This is sometimes called a reaction force. There may be other forces identified in your explanation as well. The main idea for this item is that many associate motion with forces. Thus, they incorrectly believe that when there is no motion evident, there are also no forces acting upon a stationary object.			
13	**Question**: An astronaut is standing on the moon with a baseball in her/his hand. When the baseball is released, it will fall to the moon's surface.	True	TRUE	23 sec
	Explanation: The moon, or any object with mass, exerts a gravitational attraction to other objects with mass. Gravitation is a universal force that each mass exerts on any other mass. The strength of the gravitational attractive force between two masses is proportional to the masses and inversely proportional to the square of the distance between them (9-12 Content Standard, National Science Education Standards, 1996, p. 180). While the gravitational force would not be as strong as on earth, because the moon is not as massive as earth, it still exists.			
14	**Question**: When two spheres that are the same size, have similar surfaces, but have unequal masses are dropped in a vacuum, the more massive sphere will fall faster. For example, assume one sphere is made of wood and one sphere is made of lead (greater mass).	False	FALSE	30 sec
	Explanation: All objects in free fall accelerate at the same rate regardless of mass. Near the surface of Earth, the acceleration due to the force of gravity is 9.8 m/s2. The velocity tends to increase as the object falls and this is independent of the mass of the object. However, one reason we think that there are differences is because objects falling through air experience a type of fluid			

	friction called air resistance. This is an upward force that is not the same for all objects. For example, the greater the surface area of an object, the greater the air resistance. We see many examples of this in our lives – like a leaf falling slowly to the ground while an acorn falls more quickly. If more than one force acts on an object along a straight line, then the forces ill reinforce or cancel one another, depending on their direction and magnitude. Unbalanced forces will cause changes in the speed or direction of an object's motion (5-8 Content Standard, National Science Education Standards, p. 154).			
15	**Question**: A force is needed to change the motion of an object.	True	TRUE	5 sec
	Explanation: A force is a push or a pull. The position and motion of objects can be changed by pushing or pulling. The size of the change is related to the strength of the push or pull (K-4 Content Standard, National Science Education Standards, 1996, p. 127). An object that is not being subjected to a force will continue to move at a constant speed and in a straight line (5-8 Content Standard, National Science Education Standards, 1996, p. 154).			
16	**Question**: It is possible to light a flashlight bulb with just one wire and one battery and no other equipment.	True	FALSE	1 min 41 sec
	Explanation: Only one wire is needed if one part of the bulb is in direct contact with the battery. However, the bulb cannot be in contact in just any arrangement. One must understand how a bulb becomes part of a circuit in order to understand this item. Electrical circuits require a complete loop through which an electrical current can pass (K-4 Content Standard, National Science Education Standards, 1996, p. 127). Electrical circuits provide a means of transferring electrical energy when heat, light, sound, and chemical changes are produced (5-8 Content Standard, National Science Education Standards, 1996, p. 155). A light bulb contains a very thin wire (the filament) that has one side attached to the side of the bulb and one side attached to the base of the bulb. In order to complete the circuit, the side and base of the bulb must be in contact with the wire and battery. In addition the positive and negative terminals of the battery must both be part of the complete circuit. One possible way to light the bulb with just one wire and one battery is to place the base of the bulb on the positive terminal of the battery. Then the wire needs to be in contact with the side of the bulb and the negative terminal of the battery.			
17	**Question**: We need light in order to see.	True	TRUE	1 min 2 sec
	Explanation: To see an object, light from that object – emitted by or scattered from it – must enter the eye (5-8 Content Standard, National Science Education Standards, p.155). Although our eyes can adjust to very dark environments, it is when an object interacts with light that we are able to see it. Light travels in a straight line until it strikes an object. Light can be reflected by a mirror, refracted by a lens, or absorbed by the object (K-4 Content Standard, National Science Education Standards, 1996, p. 127). The retina of an eye is made up of millions of tiny, light-sensitive cells (rods and cones). The rods and cones generate small nerve signals when they are hit by light.			
18	**Question**: If you see your head and shoulders in a mirror, with the mirror mounted securely and flat against the wall, and you wanted to see more of yourself (for example, your belt), you should back straight away from the mirror.	False	TRUE	22 sec
	Explanation: It doesn't make a difference, you will see the same view whether closer or farther away. This item refers to an ideal case during which all variables are controlled which is very hard to do (e.g., the person must not shift her/his eyes, the mirror must be perfectly orthogonal). A plane mirror produces an image that is right-side up and the same size as the object being reflected. Your image will seem to be the same distance behind the mirror as you are in front of it.			
19	**Question**: The velocity of a radio wave and a visible light wave in a vacuum are the same.	True	TRUE	35 sec
	Explanation: The term, radio waves, is often confused as sound waves emitted from a radio. However, radio waves are one type of electromagnetic radiation. Electromagnetic waves include radio waves (the longest wavelength), microwaves, infrared radiation (radiant heat), visible light, ultraviolet radiation, x-rays, and gamma rays. These waves travel at the same velocity but do not carry the same amount of energy. The energy of electromagnetic waves is carried in packets			

	whose magnitude is inversely proportional to the wavelength (9-12 Content Standard, National Science Education Standards, 1996, p. 180).			
20	**Question**: The total mass+energy in the universe is constantly changing.	False	FALSE	7 sec
	Explanation: The total mass+energy of the universe is constant. Energy can be transferred by collisions in chemical and nuclear reactions, by light waves and other radiations, and in many other ways. However, it can never be destroyed (9-12 Content Standard, National Science Education Standards, 1996, p. 180).			
21	**Question**: Heat flows from warmer objects to cooler ones until both reach the same temperature.	True	TRUE	15 sec
	Explanation: Heat energy moves in predictable ways, flowing from warmer objects to cooler ones, until both reach the same temperature (5-8 Content Standard, National Science Education Standards, 1996, p. 155). This item refers to heat exchange within a closed system. Your explanation might have correctly referred to a different situation in which the system is not closed.			
22	**Question**: A ball made of solid steel will not float on water. However, when steel is used to make a boat it floats because the steel is made less dense.	False	TRUE	10 sec
	Explanation: The density of the substance, steel, does not change. The density of a substance is the same for all samples of that substance (at a given temperature and pressure). The National Science Education Standards state that a substance has characteristic properties, such as density, a boiling point, and solubility, all of which are independent of the amount of the sample (5-8 Content Standard, National Science Education Standards, 1996, p. 154). Water exerts a buoyant force on a submerged object. This force acts in an upward direction against the force of gravity. The greater the volume of water displaced, the greater the buoyant force. The shape of a boat causes it to displace a greater volume of water than a solid piece of steel of the same mass. One might think of the density of the boat, that is the mass of the boat divided by the volume it occupies, as changing. However, the density of the steel, the material that makes up the boat does not change.			
23	**Question**: Under normal temperature and pressure conditions, all particles, such as atoms or molecules, are in constant motion.	True	TRUE	8 sec
	Explanation: Atoms and molecules are perpetually in motion. Even solids are composed of particles that are in motion. Increased temperature means greater average energy of motion. Theoretically, particles would not be moving at a temperature of Absolute Zero, but this is not a "normal" temperature or pressure condition. According to the National Science Education Standards, students in grades 9-12 should understand that "heat consists of random motion and the vibrations of atoms, molecules, and ions. The higher the temperature, the greater the atomic or molecular motion" (9-12 Content Standard, National Science Education Standards, 1996, p. 180).			
24	**Question**: An increase in temperature corresponds to an increase in the motion of particles.	True	TRUE	3 sec
	Explanation: Temperature is simply a measure of the average kinetic energy, or energy of motion, of a substance. Thus, the greater the motion of particles, the greater the temperature and vice versa. According to the National Science Education Standards, students in grades 9-12 should understand that "heat consists of random motion and the vibrations of atoms, molecules, and ions. The higher the temperature, the greater the atomic or molecular motion" (9-12 Content Standard, National Science Education Standards, 1996, p. 180).			
25	**Question**: If a small amount of sugar is added to a closed container of water and allowed to sit for a long period of time (e.g., a week or longer) without stirring, the sugar molecules will be more concentrated at the bottom of the container.	False	FALSE	22 sec
	Explanation: The water molecules are in continuous motion and act as a solvent for the small amount of sugar that is added to the container. Individual sugar molecules become surrounded by water and are pulled away from the original sugar crystal. Thus the sugar seems to "disappear" as the sugar molecules become part of the solution. Because the molecules are in constant motion,			

	they will become evenly distributed throughout the solution. This occurs until the solution becomes saturated with sugar. In this question, only a small amount of sugar was used so this indicates that it is not a saturated solution. This item combines two standards from National Science Education Standards – that students should understand that particles are in constant motion and that solubility is a characteristic property of a substance, such as sugar.			
26	**Question**: The bubbles in boiling water consist primarily of air.	False	FALSE	6 sec
	Explanation: As liquid water is heated, water molecules gain heat energy, speed up, and become water vapor. The bubbles in boiling water consist primarily of water vapor. Water vapor is less dense than liquid water and thus these bubbles rise to the surface of the liquid water. Usually other gases are also dissolved in water and these may also be present in the bubbles. According to the National Science Education Standards, students in grades K-4 should understand that "Materials exist in different states – solid, liquid, and gas. Some common materials, such as water, can be changed from one state to another by heating or cooling" (K-4 Content Standard, National Science Education Standards, 1996, p. 127).			
27	**Question**: Two containers with equal amounts of clear water are at two different temperatures. Equal amounts of green dye are added to each container. The dye will mix with the warmer water faster.	True	TRUE	15 sec
	Explanation: Warmer water has molecules that are moving faster than cooler water. Thus, the green dye will mix with the warmer water faster. Temperature is simply a measure of the average kinetic energy, or energy of motion, of a substance. Thus, the greater the motion of particles, the greater the temperature and vice versa. According to the National Science Education Standards, students in grades 9-12 should understand that "heat consists of random motion and the vibrations of atoms, molecules, and ions. The higher the temperature, the greater the atomic or molecular motion" (9-12 Content Standard, National Science Education Standards, 1996, p. 180).			
28	**Question**: When a chemical reaction occurs, the total number of atoms in the resulting products can be less than or greater than the original number of atoms that comprised the reactants depending on the type of chemical reaction that took place.	False	FALSE	9 sec
	Explanation: In chemical reactions the total mass+energy is conserved. During a chemical reaction, substances react with other substances to form new substances that have different characteristic properties. Matter and energy cannot be created or destroyed during this process. (5-8 Content Standard, National Science Education Standards, 1996, p. 154). During chemical reactions a gas may be released (a product of the reaction) and, therefore, may give the impression that less matter is present after the reaction. However, if you could measure the mass of the gas as well as any other products of the reaction, you would find that the mass of the reactants is equal to the mass of the products of the reaction. Theoretically, during reactions that give off heat energy (exothermic) or absorb heat energy (endothermic), the small energy change would be reflected in a mass change. The mass change would be so small that it is impossible to measure. However, the number of before and after the reaction remain the same.			
29	**Question**: On a hot, humid day you place a cold glass of lemonade on the table. The droplets of water you notice forming on the outside of the glass are due primarily to condensation of water vapor from the surrounding air.	True	TRUE	11 sec
	Explanation: Water vapor in the air is water in the gaseous state. These water molecules are moving fast and have very little attraction for each other. As a water molecule in the gaseous state comes into contact with the cold surface of the glass, it may lose energy and move slower. It may lose so much energy that it becomes water in the liquid state. The process of changing from a gas to a liquid is called condensation. As molecules of water slow, their attractive forces increase. Thus slower molecules are attracted to other water molecules on the glass or also to the surface of the glass. Small droplets of water form from condensed water vapor in the surrounding air. According to the National Science Education Standards, students in grades K-4 should understand that "Materials exist in different states – solid, liquid, and gas. Some common materials, such as water, can be changed from one state to another by heating or cooling" (K-4 Content Standard, National Science Education Standards, 1996, p. 127).			
30		True	TRUE	7 sec

	Question: As one goes higher into the atmosphere (for example, climbing a mountain), the atmospheric pressure decreases.			
	Explanation: Air pressure is the result of the weight of a column of air pushing down on an area. As one goes higher into the atmosphere, the amount of air "above" the person has decreased, thus the air pressure also decreases. Other factors also affect the air pressure. When there is more moisture in the atmosphere, it means that water molecules (H2O) have replaced other kinds of molecules that are heavier (e.g., N2 or O2) and therefore more moisture indicates lower density or lower air pressure. As the air pressure decreases, the density of the air also decreases. So density decreases as altitude increases. According to the National Science Education Standards, students in grades 5-8 should understand that "the atmosphere has different properties at different elevations" (5-8 Content Standard, National Science Education Standards, 1996, p. 160).			
31	**Question**: A baseball hit with the same force will travel farther on a humid day as opposed to a dry day, assuming the baseball maintains its properties of elasticity and mass independent of the weather conditions.	True	TRUE	10 sec
	Explanation: On humid days there is more moisture in the air. When there is more moisture in the atmosphere, it means that water molecules (H2O) have replaced other kinds of molecules that are heavier (e.g., N2 or O2). This makes the mass of the air less per unit area, therefore decreasing the density of the air. More moisture in the air indicates lower density or lower air pressure. Thus, the baseball hit on a humid day will be traveling through air that is less dense and will travel farther. This seems to be very counterintuitive because on humid days, we often believe that the air feels "heavy" or more dense. This is partially because evaporation of our sweat is decreased on humid days, making us feel "sticky" or like the air is heavy. To understand this, students need a more sophisticated understanding of atmospheric pressure and effects of moisture and temperature on the air around us. However, in reality the baseball itself is also affected by these conditions which can change these results.			
32	**Question**: A visible cloud in the sky consists primarily of water vapor.	False	TRUE	9 sec
	Explanation: Clouds form when water vapor in the air becomes liquid water or ice crystals. As the air temperature decreases, water vapor in the air condenses. Tiny particles must be present on which the water vapor condenses. When water droplets or ice crystals form on these small particles they stay suspended in the air and appear as various types of clouds. According to the National Science Education Standards, students in grades 5-8 should understand that "Clouds, formed by the condensation of water vapor, affect weather and climate" (5-8 Content Standard, National Science Education Standards, 1996, p. 160).			
33	**Question**: Approximately 97% of the earth's water is found in the oceans.	True	TRUE	11 sec
	Explanation: Of all the water on earth, approximately 97% is found in the oceans and only about 3% is fresh water. Of the fresh water, only a fraction is available for humans to use. Thus, of all the water on earth, less than 1% is usable by humans. This statement can be confused with the percentage of the earth's surface that is covered by water (71%) as opposed to land (29%). If you were looking for a percentage in this range, you may have been thinking about how much water there is compared to land rather than where we find the water that does exist (mostly in the oceans). Students should be aware that although water is plentiful on Earth, usable water is limited. According to the National Science Education Standards, students in grades 9-12 should understand that "the earth does not have infinite resources; increasing human consumption places severe stress on the natural processes that renew some resources, and it depletes those resources that cannot be renewed" (9-12 Content Standard, National Science Education Standards, 1996, p. 198).			
34	**Question**: Molten earth material (magma) that produces such features as volcanoes comes from the middle mantle (about half way between the Earth's center and surface).	False	FALSE	18 sec
	Explanation: Magma forms in the earth's mantle. The magma that reaches the earth's surface is formed just below the lithosphere, not as deep as the middle mantle. Because liquid magma is less dense than the surrounding solid material, magma will flow upward. It flows into any cracks in			

	the rock above it. Magma rises until it reaches the surface and then we call it lava. It also may become trapped beneath layers of rock. According to the National Science Education Standards, students in grades 5-8 should understand that "The solid earth is layered with a lithosphere, hot, convecting mantle; and dense, metallic core"(5-8 Content Standard, National Science Education Standards, 1996, p. 159). They should also understand that "Lithospheric plates on the scales of continents and oceans constantly move at rates of centimeters per year in response to movements in the mantle. Major geological events, such as earthquakes, volcanic eruptions, and mountain building, result from these plate motions" (5-8 Content Standard, National Science Education Standards, 1996, p. 160).			
35	**Question**: Moderate earthquakes (5.0 - 5.9 on the Richter Scale) happen approximately twice a day.	True	TRUE	10 sec
	Explanation: Some earthquakes are too small to be felt but can cause movement of the earth, opening up holes and displacing rocks. Shock waves from a very powerful earthquake can trigger smaller quakes hundreds of miles away from the epicenter. Approximately 1,000 earthquakes measuring 5.0 and above occur yearly. Earthquakes of the greatest intensity happen about once a year and major earthquakes (7.0-7.9) occur about 18 times a year. Strong earthquakes (6.0-6.9) occur about 10 times a month and moderate earthquakes (5.0-5.9) happen more than twice daily. Most earthquakes are not even noticed by the general public, since they happen either under the ocean or in unpopulated areas. Sometimes an earthquake under the ocean can be so severe, it will cause a tsunami, responsible for far greater damage.			
36	**Question**: There is a 10% chance that Chicago will experience a powerful earthquake (greater than 5.0 on the Richter scale) in the next 50 years.	True	TRUE	9 sec
	Explanation: In the United States, the risk for severe earthquakes is highest along the Pacific coast, because that is where the Pacific and North American plates meet. However, even east of the Rockies, the region has experienced some of the most powerful quakes in the nation's history. Scientists hypothesize that the plate forming most of North America is under stress and this stress could disturb faults that formed millions of years ago causing major earthquakes. Less than 200 years ago Chicago experienced a major earthquake and it is not unlikely that this could happen again in the near future. The New Madrid fault system stretches beneath the central Mississippi River valley (approximately 400 miles south of Chicago). Scientists estimate that there is a 90 percent chance that a moderate earthquake will occur in this area in the next 50 years. According to the National Science Education Standards, students in grades 5-8 should understand that "Lithospheric plates on the scales of continents and oceans constantly move at rates of centimeters per year in response to movements in the mantle. Major geological events, such as earthquakes, volcanic eruptions, and mountain building, result from these plate motions" (5-8 Content Standard, National Science Education Standards, 1996, p. 160).			
37	**Question**: One type of rock, such as a igneous rock, can be transformed into another type of rock, such as a sedimentary rock.	True	FALSE	7 sec
	Explanation: One type of rock can be changed into another type of rock through various processes or a series of processes. Some changes in the solid earth can be described as the "rock cycle." Old rocks at the earth's surface weather, forming sediments that are buried, then compacted, heated, and often recrystallized into new rocks. Eventually those new rocks may be brought to the surface by forces that drive plate motions, and the rock cycle continues (5-8 Content Standard, National Science Education Standards, 1996, p. 160).			
38	**Question**: From homes in the continental United States, there is no date or time when the sun is directly overhead.	True	TRUE	18 sec
	Explanation: In the continental United States, even at noon, the sun is always to the south. In the Northern Hemisphere, the noon sun is directly overhead at 23.5 degrees north around June 21st, called the summer solstice. However, latitudes in the continental United States are far north of this position and thus the sun is never directly overhead. Seasons result from variations in the amount of the sun's energy hitting the surface, due to the tilt of the earth's rotation on its axis and the length of the day (5-8 Content Standard, National Science Education Standards, p. 161). Also, according to the National Science Education Standards, students in grades K-4 should begin to understand that "objects in the sky have patterns of movement. The sun, for example appears to			

	move across the sky in the same way every day, but its path changes slowly over the seasons" (K-4 Content Standard, National Science Education Standards, 1996, p. 134).			
39	**Question**: Day and night are caused because the earth spins on its axis.	True	TRUE	5 sec
	Explanation: Only half of the earth is illuminated by the sun at any given time. This half is lit by the sun (day) and the other half is dark (night). The Earth's spinning on its axis is called rotation. The Earth's axis is an imaginary line that passes through Earth's center and the North and South poles. The Earth's rotation on its axis causes day and night. As Earth rotates eastward, the sun appears to move westward across the sky. Student in Grades K-4 should understand that, "The sun, moon, stars, clouds, birds, and airplanes all have properties, locations, and movements that can be observed and described. Objects in the sky have patterns of movement. The sun, for example, appears to move across the sky in the same way every day, but its path changes slowly over the seasons" (K-4 Content Standard, National Science Education Standards, p. 134).			
40	**Question**: We see phases of the moon because the moon moves into the earth's shadow.	False	TRUE	14 sec
	Explanation: Phases of the moon are caused by the relative positions of the moon, Earth, and the sun. The sun lights the moon and it is always only half lit. Since the moon revolves around Earth, we see the moon from different angles and see fractions of the portion of the moon that is lit. The phase of the moon you see depends on how much of the sunlit side of the moon faces your position on Earth. According to the National Science Education Standards, students in grades K-4 should begin to understand that "objects in the sky have patterns of movement. . . The observable shape of the moon changes from day to day in a cycle that lasts about a month" (K-4 Content Standard, National Science Education Standards, 1996, p. 134).			
41	**Question**: In the northern hemisphere, the earth is closer to the sun in the summer.	False	TRUE	37 sec
	Explanation: Earth has an average distance of about 150,000,000 kilometers from the sun. However, in the northern hemisphere, Earth is actually closer to the sun in December, although it is one of our coldest months. This is because the reason for the seasons does not have to do with how close Earth is to the sun at a given time, but instead on how concentrated or directly sunlight hits Earth's surface. In June, the northern hemisphere of Earth is tilted towards the sun and the sunlight is more direct. According to the National Science Education Standards, students in grades 5-8 should understand that "Seasons result from variations in the amount of the sun's energy hitting the surface, due to the tilt of the earth's rotation on its axis and the length of the day" (5-8 Content Standard, National Science Education Standards, 1996, p. 161).			
42	**Question**: When people in North America view a full moon, people who live in Australia would see a different phase.	False	TRUE	10 sec
	Explanation: The Moon phase we see is due to the relative positions of the Earth, Moon, and Sun. The Moon is always half illuminated by the Sun. From Earth we see fractions of the lit Moon, which we view as phases. When people in North America see a full Moon, they are seeing the full side of the lighted portion of the Moon. The Earth also rotates and people in Australia would see the same phase as those who live in North America. However, for phases such as a first quarter, the side on which the Moon appears to be lit will be the opposite. This means that first quarter would look different, depending on your viewpoint from Earth.			
43	**Question**: The reason we experience seasons is because the distance between the earth and sun changes.	False	FALSE	7 sec
	Explanation: Earth has an average distance of about 150,000,000 kilometers from the sun. However, in the northern hemisphere, Earth is actually closer to the sun in December, although it is one of our coldest months. This is because the reason for the seasons does not have to do with how close Earth is to the sun at a given time, but instead on how concentrated or directly sunlight hits Earth's surface. In June, the northern hemisphere of Earth is tilted towards the sun and the sunlight is more direct. According to the National Science Education Standards, students in grades 5-8 should understand that "Seasons result from variations in the amount of the sun's energy hitting the surface, due to the tilt of the earth's rotation on its axis and the length of the day" (5-8 Content Standard, National Science Education Standards, 1996, p. 161).			

44	**Question**: The longest daylight period in Australia occurs in December.	True	TRUE	5 sec
	Explanation: In December, the northern hemisphere of Earth is tilted away from the sun and the southern hemisphere is tilted towards the sun. Thus, the northern hemisphere is experiencing shorter daylight periods while the southern hemisphere is experiencing longer daylight periods. According to the National Science Education Standards, students in grades 5-8 should understand that "Seasons result from variations in the amount of the sun's energy hitting the surface, due to the tilt of the earth's rotation on its axis and the length of the day" (5-8 Content Standard, National Science Education Standards, 1996, p. 161).			

Total questions: 44
Total correct answers: 33
Total incorrect answers: 11
Final percentage score: 75 %

Comments? Questions? Contact the **administrators**

Appendix C: Survey

Science Teacher Survey

Male / Female Years teaching experience _____ Grades currently teaching _____

1. What are your strengths teaching science?

2. What are your weaknesses?

3. What do you like about your current science curriculum?

4. What do you dislike?

5. What is your main method of instruction:

Textbook	lecture	lecture w/ visuals
teacher demonstration	guided student discovery	other _____

6. How would you change your science instruction if you could?

7. I enjoy teaching science.
   strongly agree moderately agree no opinion moderately disagree strongly disagree

8. I am comfortable teaching science to my students.
   strongly agree moderately agree no opinion moderately disagree strongly disagree

9. I am confident in my knowledge of science for the grade level I teach.
   strongly agree moderately agree no opinion moderately disagree strongly disagree

10. I know and use the scientific process in my science classes.
    strongly agree moderately agree no opinion moderately disagree strongly disagree

11. I have science instruction/training beyond college basic requirements for general education.
    none little some much science degree

12. Both the History of Science (HOS) and the Nature of Science (NOS) are important for any science curriculum.
    strongly agree moderately agree no opinion moderately disagree strongly disagree

13. I am confident in my knowledge of what the Bible does and doesn't say regarding the natural world.
    strongly agree moderately agree no opinion moderately disagree strongly disagree

14. I have made comments to my students about the glaring errors of evolutionistic science that tends to discredit all science.

never seldom occasionally frequently all the time

15. Creation can be taught as a science.

strongly agree moderately agree no opinion moderately disagree strongly disagree

16. Scripture should be used to discredit the errors of science such as evolution.

strongly agree moderately agree no opinion moderately disagree strongly disagree

*These additional questions will be included on the survey retake.

17. What, if anything, has changed in your beliefs about science instruction?

18. What additional professional development would you like in the field of science?

Appendix D: Additional Readings for *"The Foolishness of God"*

Answers in Genesis and The Veracity Project (Co-producers), (2011). *Check This Out* [Video]. United States: Answers In Genesis.

Baumler, Gary P., (2003, January). Science and Faith. *Forward in Christ, 90* (1).

Bivens, Forrest L., (2011, March). New Atheism. *Forward in Christ, 98* (3).

Bivens, Forrest L., (2013, December). Witnessing to the Truth. *Forward in Christ, 100* (12).

Boehlke, Paul R., (2009, April). Only Natural Causes; God Above Natural Causes. *Forward in Christ, 96* (4).

Boehlke, Paul R., (2009, March). A World without God; a World with God. *Forward in Christ, 96* (3).

Braun, John A., (2010, June). Woo-woos? *Forward in Christ, 97*, (6).

Buelow, Ronald A. and Ryan C. MacPherson, A Lutheran View of Science, *Forward in Christ* magazine, January 2004, Vol. 91, No. 1

Eggert, Arthur A., (2010, August). In the Beginning. *Forward in Christ, 97* (8).

Kelm, Paul, (1999, January 21). Understanding and Addressing a Postmodern Culture. *Board for Parish Services*. Milwaukee, Wisconsin

Koelpin, Arnold J., (2009, May). Faith or Science. *Forward in Christ, 96* (5).

Quist, Allen, (2010, February). Questioning Evolution. *Forward in Christ, 97* (2).

Sellnow, David D., (2006, September). Confessing Truth Today. *Forward in Christ, 93* (9).

Truman, Harry S., (1945, July 25). *Truman's Diary*, public domain

Appendix E: Revised Survey

Participant Profile
Gender _____

Elementary School Education: _____ WELS, _____ public, _____ other _____

High School Education: _____ WELS, _____ public, _____ other _____

College Education: _____ WELS, _____ public, _____ other _____

What additional science instruction/training do you have beyond college basic requirements for general education? _____
_____
_____

Years Teaching Experience _____
Grade Level Currently Teaching _____
Do you currently teach science in a
_____ self-contained classroom
_____departmentalized setting
_____ (not at all)

My main method of science instruction is
_____ textbook
_____ lecture
_____ teacher demonstration
_____ video
_____ guided student discovery

1. What are your strengths teaching science? _____
   _____
   _____
2. What are your weaknesses teaching science? _____
   _____
   _____
3. What are the strengths of your current science curriculum? _____
   _____
   _____
4. What are the weaknesses of your current science curriculum? _____
   _____
   _____

Attitudes

1. I enjoy teaching science.
   Before PDS: ____ strongly agree ____ moderately agree ____ moderately disagree ____ strongly disagree
   After PDS: ____ strongly agree ____ moderately agree ____ moderately disagree ____ strongly disagree

2. I am comfortable teaching science.
   Before PDS: ____ strongly agree ____ moderately agree ____ moderately disagree ____ strongly disagree
   After PDS: ____ strongly agree ____ moderately agree ____ moderately disagree ____ strongly disagree

3. I am confident in my science knowledge.
   Before PDS: ____ strongly agree ____ moderately agree ____ moderately disagree ____ strongly disagree
   After PDS: ____ strongly agree ____ moderately agree ____ moderately disagree ____ strongly disagree

Beliefs

1. Science curriculums in our WELS schools should include:

	Before PDS:	After PDS:
Scientific Process	_____ True _____ False	_____ True _____ False
History of Science	_____ True _____ False	_____ True _____ False
Nature of Science	_____ True _____ False	_____ True _____ False
Scriptural Proof	_____ True _____ False	_____ True _____ False

2. Creation should be taught as a science.
   Before PDS: _____ True _____ False
   After PDS: _____ True _____ False

3. Scripture should be used to prove scientific facts.
   Before PDS: _____ True _____ False
   After PDS: _____ True _____ False

4. Scripture should be used to discredit scientific errors.
   Before PDS: _____ True _____ False
   After PDS: _____ True _____ False

5. Science can effectively support Scripture.
   Before PDS: _____ True _____ False
   After PDS: _____ True _____ False

6. Differences between Scripture and science are acceptable.
   Before PDS: _____ True _____ False
   After PDS: _____ True _____ False

7. Science can be used in our WELS schools to show that evolution is wrong.
   Before PDS: _____ True _____ False
   After PDS: _____ True _____ False

Changes

What, if anything, has changed in your beliefs about science instruction? _____

_____

_____

Appendix F: Additional Resource List

Becker, Siegbert W. (1982). *The Foolishness of God: Place of Reason Theology of Martin Luther*. Milwaukee, WI: Northwestern Publishing House.

Boehlke, P. (2005). Contemplating Our Navels: Consideration of Time That Never Was. *Charis Publications.* Retrieved June 27, 2014, from Charis Wisconsin Lutheran College: http://www.charis.wlc.edu/publications/charis_spring05/boehlke.pdf

Boehlke, P. R., Knapp, L. M., Kolander, R. L. (2006). How Science Works: Foundations, Methods, and Teleology. *Zygon, 4* (2), 415-425.

Boehlke, P. R., Klockziem, R., and Paulsen, J. ed. (1997). Discovering God's Creation: A Guidebook to Hands-On Science. Retrieved on July 30, 2014 from Martin Luther College: http://www.mlc-wels.edu/home/files/discovering_gods_creation.pdf.

Bronowski, Jacob (1978). *The Common Sense of Science.* Cambridge, MA: Harvard University Press.

Bronowski, Jacob (1979). *The Origins of Knowledge and Imagination.* New Haven, CT: Yale University Press.

Sponholz, M. (1982, April 20). Two Towers - The Relationship Between Science and the Bible. *Minnesota District Pastoral Conference* . Minneapolis, Minnesota.

Sponholz, M. (1989). *Separate from His Word: A Christian Comentary on the History of Science.* New Ulm, Minnesota: Dr. Martin Luther College.

Sponholz, M. (1979, March 7). Some Truths of Science. Retrieved July 30, 2014 from Wisconsin Lutheran Seminary: www.wlsessays.net/files/**SponholzTruths**.pdf.

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Sponholz, M. (1986). The Saving Waters: Implications of the Noachic Flood from a Biblical and Scientific Standpoint. Retrieved July 30, 2014, from Wisconsin Lutheran Seminary: www.wlsessays.net/files/Sponholz**Waters**.rtf

Sponholz, M. (1972). Facing Evolution–Things Too Wonderful for Me. Retrieved July 30, 2014, from Wisconsin Lutheran Seminary: www.wlsessays.net/files/Sponholz**Evolution**.rtf