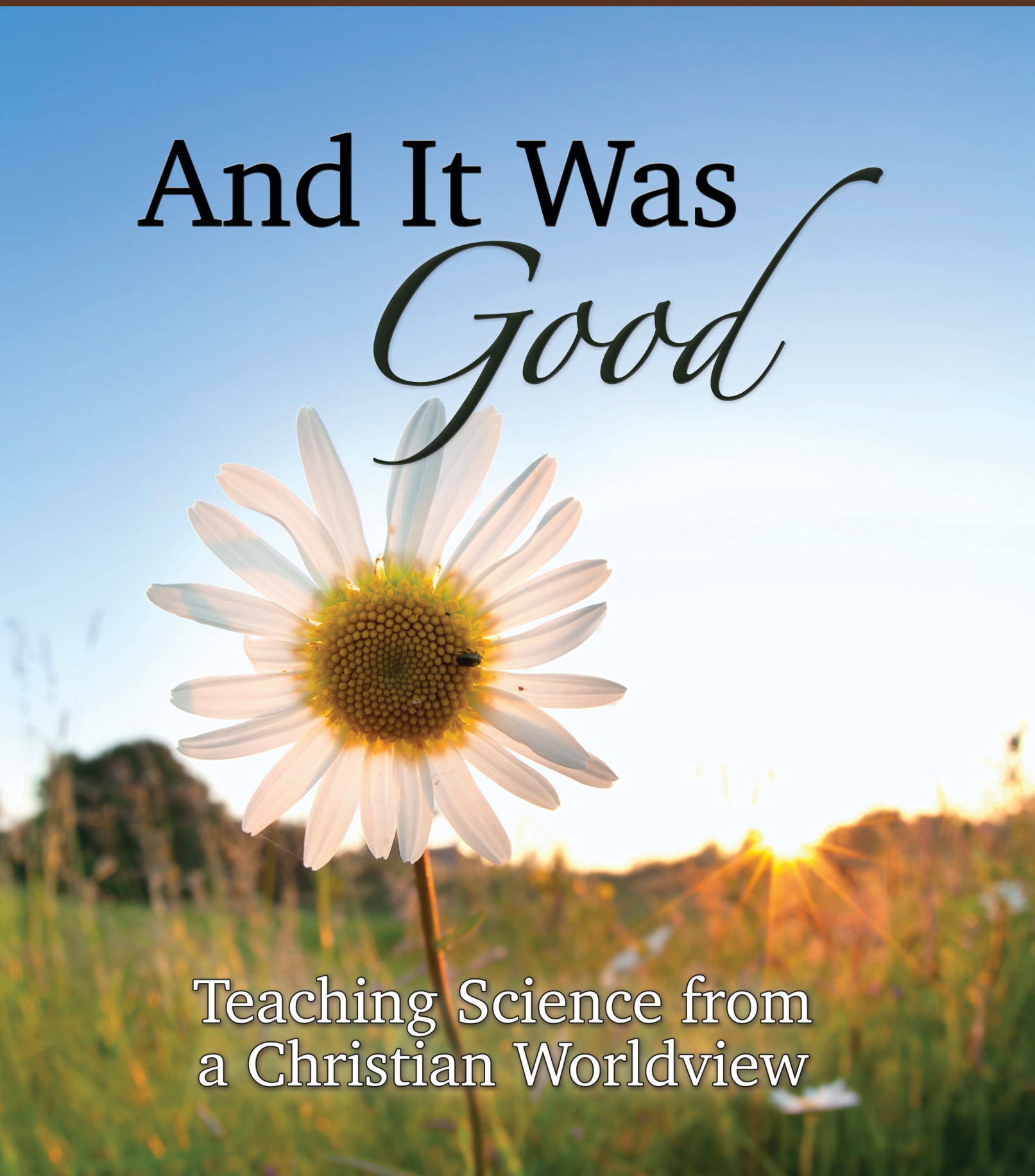
Christian Schools International

Grade 2

And It Was *Good*



Teaching Science from a Christian Worldview

And It Was *Good*

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Grade 2

Christian Schools International

And It Was Good: Teaching Science from a Christian Worldview

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Acknowledgments

Each generation stands on the shoulders of those who have gone before. Over the history of Christian Schools International, there have been many people involved who have created sound science curricula to assist teachers in showing students how God reveals himself in creation. We stand grateful for their efforts and the solid foundation upon which we can build. This latest effort, titled *And It Was Good: Teaching Science from a Christian Worldview*, is rooted in the Christian Schools International science curriculum but is itself a very different product. This curriculum resource offers teaching strategies that will model ways to teach current science standards with a fully integrated Christian perspective without compromising either faith or scholarship, and it can be used in conjunction with any science curriculum.

In our efforts to serve our schools and teachers and to continue our refinement of the biblical worldview perspective in science education, we have attempted to incorporate research data gained from our teachers and other leaders into this curriculum resource. This information was gathered through surveys, focus groups, and other forms of feedback. Darryl Shelton, Rachael Heyboer, and Christina Van Eyl were instrumental in gathering feedback data and, in response to the research, put together the framework for the resource. They also selected and trained the teachers and subject matter experts for the project.

The writer for the grade 2 curriculum resource was Sara Woltjer, a third–grade teacher at Dutton Christian School in Dutton, Michigan. Albert Kok, vice principal and middle–school teacher at Beacon Christian School in St. Catharines, Ontario, provided assistance with the lesson writing and managed the accuracy and integrity of the biblical worldview integration. David Smith, director of the Kuyers Institute for Christian Teaching and Learning, and Susan Koppendrayer, middle–school science teacher at Calvin Christian School in Edina, Minnesota, provided training and resources in biblical worldview integration and the Next Generation Science Standards (NGSS) for the writing team.

Elco Vandergrift, executive director of the Prairie Centre for Christian Education, and Doug Monsma, director of learning of the PCCE, provided the framework for the development of the biblical worldview integration through use of the material *Teaching for Transformation: A Guide to Developing Christian Curriculum* (copyright © 2009 by Prairie Association of Christian Schools). This model of biblical worldview integration helps teachers develop a foundational understanding for the topics that they teach and helps them truly teach for transformation. The biblical Throughlines also challenge students to see, understand, and practice the discipleship attributes they need to truly be kingdom–builders. For more information call the Prairie Centre for Christian Education—phone: 780.465.8384; email: office@pcce.ca; website: http://pcce.tftshare.ca.

Many experts in their field contributed to this frontmatter section to help explain and instruct on how to properly implement this curriculum resource in the classroom. Tim Krell, administrator of the CSIonline Academy, wrote the introduction statement on science education and biblical worldview integration. Jim Jadrich, professor of science education and physics at Calvin College in Grand Rapids, Michigan, revised and updated the Christian Schools International science perspective statement. Doug Monsma, director of learning at the Prairie Centre for Christian Education, wrote the general overview and purpose of the Teaching for Transformation Throughlines. Susan Koppendrayer, middle school teacher at Calvin Christian School in Edina, Minnesota, wrote the overview of the NGSS. Tim Leugs, middle school teacher at Legacy Christian School in Grand Rapids, Michigan, wrote the overview of the lesson writing process.

Christina Van Eyl, Laura Stormo, Donna Huisjen, and Rachael Heyboer edited and proofread the written material. Ken Bergwerff, assistant professor of science education at Calvin College in Grand Rapids, Michigan, read each manuscript for scientific accuracy and integrity. Credo Communications provided the layout, design, and production of the finished product. Rachael Heyboer supervised the development process from training to final print copy. Darryl Shelton provided quality control assurance for the project.

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Introduction

The Opportunity

The created world gives us tremendous opportunity for exploration and study. We've all witnessed a barefooted toddler wobble onto the cool grass on a spring day. Guided by innate curiosity, she shrieks with delight as she stoops to grab a yellow dandelion. She bears God's image, as we all do, and reflects that image through wide–eyed wonder at the goodness of all God gives us on this Earth.

Not only has God gifted us with this planet, but he has also called us to care for it. As God imagined this world into existence, we must use our imaginations to wisely steward all that God has entrusted to us. Our opportunity as science teachers is to open up the world to our students in ways that enliven their curiosity and equip them to care for all of creation.

The Task

The task of the science teacher is not merely to upload science curricula into the minds of students, nor is it to moralize scientific theories. Instead, great teachers ask open–ended, essential questions in order that they and their students might reflect, inquire, and imagine together about the key discoveries of science. It's okay—maybe even desirable—that a teacher doesn't have all the difficult questions figured out. When we "reason together" with our students, more is remembered and, more importantly, there is more potential for the knowledge to become an active part of their lives.

Parker Palmer, in *The Courage to Teach,* suggests that teachers and students gather around the subject as co–learners and co–teachers.

> As we try to understand the subject in the community of truth, we enter into complex patterns of communication—sharing observations and interpretations, correcting and complementing each other, torn by conflict in this moment and joined by consensus in the next. The community of truth, far from being linear and static and hierarchical, is circular, interactive, and dynamic.

If teachers see their classrooms as communities of grace, then operating in a hierarchical framework where the teacher is the expert becomes unnecessary. Teachers who hold the space in which important ideas are shared and discussed know it is easier to end discussions by a final, authoritative word than to maintain them in a spirit of grace by asking questions that promote an open dialogue.

In his *Nurturing Faith* blog, February 27, 2012, Dan Beerens emphasizes this point as well.

> Daniel Boorstin said, "The greatest obstacle to discovery is not ignorance; it is the illusion of knowledge." We know from 1 Corinthians 8:1b that "knowledge puffs up, but love builds up." When we feel inflated about what we know, it not only has idolatrous power, but it also shuts down our desire to continue to be curious, to discover, to wonder, to be the sense makers, the inquirers, the delighters that God intended us to be.
>
> Better to share honest questions as educators with our students and reflect, inquire, and wonder together, than to act as if we have it all figured out. Isn't this a more truly God–honoring approach?

Of course, the specifics of this type of interaction change with the ages of students. Younger

students will naturally wonder about different things, and the questions teachers ask them will likely be less complex. But students of all ages can reason their way through any idea with the guidance of good teaching.

Science and Faith

You probably know the story of Job. Job is a great guy with a wonderful family. He's built up the family farm into something very significant. Life is good until Satan challenges God to strip away all of Job's possessions, his family, and even his good health. Satan thought it was Job's good fortune that caused him to believe in God and worship him. We know from the end of the story that this is not the case. The last thing that Job says just before God restores everything for him is, "My ears had heard of you, but now my eye has seen you. Therefore I despise myself and I repent in dust and ashes" (Job 42:5–6).

Why does Job say this? Obviously his faith has been deeply shaken. How does God confirm his divine presence in Job's life so explicitly that Job would say, "My ears had heard of you, but now my eye has seen you"? God starts by asking a key question in chapter 38:4: "Where were you when I laid the earth's foundations?" In the next four chapters God delivers not a lesson on philosophy or theology, but a great lesson on geology, biology, astronomy, and physics. God's approach for renewing Job's faith was to describe some of what he continues to do daily: to sustain the world that he created. The picture of creation was so vivid that Job could say, "Now my eye has seen you." It was so compelling that he turned his eyes from himself and from all the problems besetting him, turned his face toward God, and repented in dust and ashes.

God described the Earth and all that's in it to Job because this creation is central to our lives. Every day God gives us clear glimpses of his wisdom, his creative care, his power, and his love as we walk in the garden of his creation. As God's image–bearers, we are co–creators and caretakers in bringing his creation to fulfillment. He gave us power to have dominion over every other living thing, and he put the first humans in the middle of a beautiful garden to till and keep it. Our faith in a creator God enlivens our passion to fulfill this creation mandate. It is our privilege to live by faith as we answer this call.

But humanity disobeyed God and ate of the tree of life, distorting that original image of God in us. Everything changed. Humans were banished from the garden. Now the once–sacred ground is cursed, and in painful toil we humans eat from it. Although our role as co–creators and caretakers still stands, we've lost the power and wisdom to exercise dominion in a God–honoring way. We need a redeemer to restore us to our original image and the world to its created condition. Now our task is to work alongside Christ to restore creation to its original order.

Studying science grants us important knowledge to do our restorative work. The more we know about our world, the more we are able to bring justice and hope to everyone in it. But a deep desire for power and prestige tempts us to use scientific discoveries for selfish gain. In Christ, we have a different role: to have the same attitude that Jesus had when in humility he gave up his life and died on the cross. When we act in a God–honoring manner, in humility and love we will use scientific and technological advances to work to restore the world and to serve one another.

Hope

Our hope is first in Christ. Without his help, we are plagued with our own sin and doomed to fail. As redeemed people, we can become people who redeem creation for its original purpose. Although science can help us achieve this goal, science is not the goal in and of itself.

We live in an age in which science and the knowledge it brings are easily exploited for material gain. The high calling of Christian teachers is to help young people to think like scientists while equipping them to do justice, love mercy, and walk humbly with God in a fallen world. Our second hope is that teachers will be vessels of Christ's love, thereby teaching students to have the mind of Christ as they learn to think like scientists. That Christlike mind is first humble—sacrificing self for the sake of Christ and the larger community; then loving—applying science principles and discoveries to improve the world on behalf of others; and also courageous—standing against all who exploit creation for sordid gain.

When we study science, we get another glimpse of God's faithfulness to us. "[T]he land is satisfied by the fruit of his work" (Psalm 104:13). God winks and causes the sun to rise each morning. The seasons move through their common cycle because of the word of the Lord. "[T]he earth is full of [God's] creatures" (Psalm 104:24). Our task is to take care of the possessions God has entrusted to us. "He set the earth on its foundations; it can never be moved" (Psalm 104:5). Herein lie great hope, comfort, and peace.

Worldview Statements

Christian Schools International Statement

As an organization and as a resource development agency, we subscribe to a Christian worldview and apply that worldview to our initiatives, policies, and products.

God and his Word are the source of all truth.

A biblically informed curriculum points to God as the source of all truth, leads students toward biblical wisdom and a response to God's call to discipleship, and nurtures all students toward Christlike living. God's truth permeates every academic subject and educational initiative. Faith is imbedded in curriculum, and faith and learning are inseparably linked.

Recognizing God as the source of all truth is freeing.

Everything, from the smallest molecule to the greatest star, was created by God. He chose not to reveal every part of his creation immediately but to equip humans with the gift of research and discovery so that these things can be revealed in his appointed time.

God created humans in his image as whole persons—spiritual, physical, social, emotional, and intellectual. We have the responsibility to develop all areas of our lives. We are not restricted, but instead we are empowered by our creator to discover, probe, explore, and seek after knowledge in every discipline.

Nothing can separate us from God and his love for us.

There is nothing that has been learned or that will be discovered that will shake our faith in the creator of the universe. New discoveries or theories that discount our creator are to be explored and studied. People of faith must be equipped to understand in order to both support and refute.

Knowledge and applications can be used inappropriately or for selfish intents. As Christians, we can participate in the broader community, showing mercy, promoting justice, acting in godly ways, and caring for God's world, or we can dishonor God, disrupt our community, and misuse God's world. We take part in the work of the Holy Spirit and assist in the process of renewal when we share in the work of Jesus as we collaborate to make the world a better place.

Christian Schools International Science Perspective Statement

The Christian Schools International science program centers on the acknowledgment that the world in which we live belongs to God, who created and upholds it. Through scientific inquiry we can perceive a degree of the amazing complexity and orderliness of God's world. With this fuller understanding of creation comes a deepened awareness of the goodness and power of its creator.

When we study creation, we learn not only about God but also about ourselves. We are a part of God's creation—a very special part. God perfectly harmonized relationships among humans, animals, plants, and nonliving things, but our fall into sin disrupted this unity and balance. As God's redeemed people through Christ's renewing power, we have been entrusted with working toward restoring and reconciling God's good creation.

God has put his world under our control and made us its caretakers. Caring for God's creation requires great responsibility that cannot be taken lightly or in ignorance. Science is an essential tool for us to use in learning about the natural processes God utilizes so that we can care for the world wisely.

We live in an age in which scientific knowledge has increased at an explosive rate; the use of that knowledge changes our lives daily. Some people believe that we can gain complete knowledge of—and mastery over—the world through science. Medical researchers have nearly eradicated some diseases, specialists have developed laser instruments that have revolutionized surgery, astronomers have solved many mysteries of the universe, and computer scientists have created machines that seemingly border on human intelligence. The possibilities of science seem endless.

Because science is a human activity, however, the knowledge that it can help us gain is limited. Secular culture tends to reduce the world to the human realm and therefore widely considers scientific inquiry or human reason as the path to all knowledge. But Christians find ultimate truth only in God. Science is one avenue—an important avenue, but still only one—toward gaining an understanding of God's creation.

Science and the Bible

Christians should conduct science within a larger framework, or worldview, based on faith. The Bible, the divinely inspired record of God's redemptive work on behalf of his people, contains all that is necessary for bringing us to salvation and instructing us about how to live. As the infallible Word of God, it is the only book that has the status of divine authority.

We learn about God through the direct revelation of his Word. We can also learn about God through the general revelation of his creation. As defined by theologian Louis Berkhof, general revelation is the way that "God speaks to man in his entire creation in the forces and powers of nature, in the voice of conscience, and in the providential government of the world in general and of the lives of individuals in particular." As Berkhof also notes, however, general revelation has limitations as a result of the Fall.

The study of science is one method of learning about God as he reveals himself in creation. Science is important for studying cause and effect and natural relationships in the material world. It can explain how events occur, but it cannot explain why. For this reason, understanding scientific study in the light of biblical revelation is vital. The Bible tells us who the creator is and explains our relationship to him, each other, and the creation, while science gives us some insight into *how* God acts in his creation. The Bible and science are complementary, together helping us understand God's plan and purpose for creation.

For some people, the relationship between science and the Bible is an emotionally charged issue. Sometimes non–Christians extend scientific ideas beyond their proper bounds, as if scientific theories imply that there is no God involved in the natural world. In science textbooks, encyclopedias, library books, the internet, and magazines, students often encounter beliefs that do not acknowledge God, such as theories that explain the origin of the universe as a chance occurrence.

Because of this, many Christians believe that science and Christianity are antithetical. It is important for students to realize that these kinds of beliefs spring from a worldview that does not include God. That such beliefs exist, however, does not make science itself incompatible with Christianity.

Christian Schools International science materials are designed to be used in a school that includes both devotions and Bible study on a daily basis. Throughout the science materials, students are encouraged to examine a biblical perspective and to discuss Christian responses to issues in science.

Implementing the Science Resource

Teaching for Transformation

See the Story—Live the Story

"God is sovereign and Jesus Christ is Lord over all things! That is the biblical truth that must gently whisper and boldly resound in every part¸ every thread of a Christian school's curriculum. It must serve as the core curriculum in every Christian school classroom" (Teaching for Transformation Manual).

The biblical truth that resounds in our Christian school curriculum is that all things in the world belong to God. It is important not to presume that this truth is obvious or apparent to all. The task of a Christian school teacher is to help students "see the story."

Thus, a teacher's task is one of revealing creation. We do this by teaching under the "all things" principle. God created all things. Even after the Fall, which indeed affects and infects all things, creation remains good. Redemption touches all things, redirecting them to their God–designated purposes.

Someday all things will be fully restored, but the work of renewal begins now, and we are privileged to be coworkers with God in this process. Teachers who reflect on learning through this perspective assist students to see God's story in all things and help students develop the understanding that there is not even one area untouched by God's dominion. The purpose of a Christian education must always be the training and developing of every potential God has given us for him. The Christian school's role, therefore, is to make every possible attempt to cultivate each student's abilities "for service and worship and glorification of God," so that he or she can be God's partner, a member of God's team to "fix up" or to "transform" God's world and to reveal God in all things.

Our job as Christian teachers is to expose the idea that our mandate as Christians is to be transformers of everything that is broken in this world. This perspective is often called a "transformational worldview." The word *worldview* refers to the concept that we all experience the world through different lenses, which affect how we interpret and interact with it. Thus, a transformational worldview implies that the way we interpret and interact with the world is transformational both for self and society. Developing a "transformational worldview" context for learning is a crucial component of Christian education.

The starting point of this science curriculum resource stems from a quotation from Abraham Kuyper: "There is not a square inch in the whole domain of our human existence over which Christ, who is Sovereign over all, does not cry, Mine!" God's Word clearly describes this connection in Colossians 1:16–17—"For in him all things were created: things in heaven and on earth, visible and invisible, whether thrones or powers or rulers or authorities; all things have been created through him and for him. He is before all things, and in him all things hold together."

All things belong to God! This world is his kingdom; he is building it every minute of every day. And he invites us, his people, to join him in his kingdom building. He is working to restore the world, all of it, one step at a time, and he wants you and me, as teachers, to be a part of it. We are kingdom builders. This is who we are called to be, not just what we are to do.

Christian Schools International used the Teaching for Transformation model and Throughlines for this resource to ensure that teachers and students understand that God is already working in and

through his creation of science—that science can and should be part of God's kingdom–building and that it can be further used to see God's work. Again, science is an opportunity for teachers to point out to students where God is working and to show students how to answer God's call to be restorers and transformers of his world. The Teaching for Transformation Throughlines are a way for us to remember and reimagine who we are to be in God's story.

Toward this end, the resource has been designed to be formational in the lives of children. The design is intended to shape the hopes and imaginations of the students, creating a vision for what the kingdom can look like, not merely inputting the data and adding to intellect. Some lessons involve an experience in which students use God's gift of science to "live the story" of God's rebuilding. Whether by using magnets to build a device for a physically disabled person, by using their knowledge of weather to discover how to bless those who have been affected by adverse weather conditions, or by practicing who they are to be, students can, with the help of these lessons, be formed as kingdom–builders now and in the future.

Other lessons offer opportunities to reflect on God's gift of science to "see the story" of God's kingdom. Lessons offer a reflective piece for students to work out a personal awareness of their learning and experiences and their relationship to God's story and their role in it. Whether by reflecting on the order found in the structure of the atom or hearing the story of the communities found in nature, students will connect the lesson to who they are and will practice who God calls them to be.

We want students to recognize God's story in science with the Throughlines: creation–enjoyers, image–reflectors, order–discoverers, community–builders, and God–worshipers. We want students to live the story, to use science to fulfill their biblical calling of being justice–seekers, servant–workers, idolatry–discerners, beauty–creators, and Earth–keepers.

Science is a tool that allows us to see God in his creation and to join him in the restoration of his world. When we use this science curriculum resource to help students see and live the story by practicing these experiences, we are teaching them who they are called to be and what they are called to do. Ultimately we are reminding them that God is in all things and that there is not a single area that God's dominion does not reach.

The Teaching for Transformation Throughlines, as developed by the Prairie Centre for Christian Education (PCCE) region, provide a framework for the development of authentic and integral Christian learning experiences that are grounded in a transformational worldview with a focus on the biblical story. Teaching for Transformation, the culmination of several years of exploration, discovery, and rewarding work, is intended to help teachers develop authentic Christian formational learning experiences.

Throughlines are "big picture" ideas around which we can organize curriculum. They are qualities/attributes that we desire students to develop as God is revealed to them. They are discipleship concepts that guide our living. These characteristics describe how we can become part of the restoration of creation. They answer "How NOW shall I live?" Throughlines weave the big ideas into a transformational worldview.

This science curriculum resource uses the following biblical Throughlines.

Creation–enjoyer

Science encourages students to observe the world with all their senses—noticing and drawing attention to what there is to be seen in God's world.

Order–discoverer

Science points out the order and harmony imposed on creation by God.

Servant–worker

Science is one tool of a servant worker to heal brokenness and bring joy to individuals and to culture.

Earth–keeper

Science challenges our students to think about how they can encourage themselves and others to reclaim the world and relearn how to treat all things contained in it with respect.

God–worshiper

Science helps us worship when we enjoy God's creation.

Community–builder

Science can be used to bring shalom to a community.

Image–reflector

Science enables us to reflect God's image through our creativity and through the shalom we create.

Beauty–creator

Science creates opportunities to re–create beauty in the world around us.

Justice–seeker

Science can be used as an agent of change to identify and respond to injustice.

Idolatry–discerner

Science should encourage students to test the ideas they are uncovering against God's truth.

Teachers carefully and prayerfully choose one or two Throughlines for each unit/lesson that they teach and then link all of the learning outcomes to the chosen Throughlines. These Throughlines become the "thematic Velcro" that connects and organizes the many facts, skills, and experiences. "All things" in the unit/lesson are now intentionally connected back to God's story. In this way the learning becomes truly transformational, both inviting and encouraging students to influence the world for Christ.

The Next Generation Science Standards (NGSS)

"*Science engineering and technology permeate nearly every facet of modern life; they also hold the key to many of humanity's most pressing current and future challenges*" (A Framework for K–12 Education).

The Next Generation Science Standards (NGSS) were written to provide educators with an opportunity to improve science education. Standards provide a map or a tool to direct future actions and decisions. For the Christian educator, science is more than teaching standards, facts, and content. Studying God's creation gives us a greater understanding of God. "Science is far more than a collection of facts and figures. When we look closely at nature, we see God's fingerprints" (Christian Schools International Science Curriculum, Grade 6, p. 9). A science–literate student has the opportunity to make a difference in the lives of others, discern, and speak the truth about science as it relates to God's norms in creation. The NGSS provides a renewed vision for science literacy.

In 1996, the National Research Council published the National Science Education Standards. Over the past 17 years, societal needs, student attitudes, teaching practices, and technology have changed. Consequently, in the summer of 2013 the Next Generation Science Standards, designed to improve and update science education, were released.

The creation of the NGSS was a two–step process. First, the National Research Council formed a team of leaders in science, education, and science curriculum development. Together they wrote and published *A Framework for K–12 Science Education*. Next, a team of experts from 26 lead states reviewed the framework and received nationwide feedback. This document became the skeleton for the Next Generation Science Standards.

The NGSS focuses on three areas or dimensions: concepts, practices, and disciplinary core ideas. Cross–cutting concepts are key ideas that span all grades from K–12. Examples of cross–cutting concepts include patterns, cause and effect, structure and function, and stability and change. The practice of science involves developing the skills that scientists use to discover the natural world. Specifically, this involves the development of engineering practices from K–12. Science content includes topics in life science, earth science, physical science, and engineering.

Teachers will begin placing more emphasis on science and engineering practices in classrooms. The way science is taught will be less fact driven and more tactile and will involve project–based inquiry science. Engineering practices will be imbedded in many of the in–class labs, and higher order critical thinking skills will be encouraged.

The Next Generation Science Standards will have a lasting influence on K–12 practices and outcomes. New standards serve to realign education to meet current and future needs of students and society. To facilitate this (realignment) transition, this book provides model lessons and guiding questions from a Christian perspective to assist your implementation of the NGSS using existing curriculum and resources.

No document or standard is perfect. The NGSS, however, recognizes the ways students learn, makes connections among curricular disciplines, and strives to deepen their understanding of the complexities found in our world. Viewed through the lens of Scripture, the standards provide a framework that will guide us in the 21st century.

From the Scientific Method to Scientific Practices and Engineering Processes

At an early age, children participate in science. They ask questions, discover, and try to make sense of God's world through practice and repetition. In school, science is taught to all students. They have the opportunity to learn skills and methods used by scientists, design controlled experiments, and make models to explain the principles placed in God's creation.

The scientific method is a multifaceted, controlled, repetitive process used to describe the way a scientist finds answers to questions. Some have the misconception that the scientific method is a sequential, step–by–step, linear process. Perhaps science can better be called a process than a method. When students and scientists ask questions, investigate, interpret data, and provide explanations, they are participating in science practices essential to scientific processes.

The Next Generation Science Standards emphasize the science and engineering design process instead of a single method. The process involves discussion, inquiry, and a series of actions that lead to a solution. Engineering and experimentation can best be described as a cyclical progression of science practices.

The Next Generation Science Standards and *A Framework for K–12 Science Education* include the words *science practices* instead of *science methods*. "We use the term 'practices' instead of a term such as 'skills' to emphasize that engaging in scientific investigation requires not only skill but also knowledge that is specific to each practice" (*NRC Framework*, 2012, p. 30, and *NGSS*, 2013, Appendix F).

The NGSS and *A Framework for K–12 Education* include eight science practices that are key to student understanding of the role that science plays in helping discover the world: asking questions; developing and using models; carrying out investigations; analyzing and interpreting data; using math skills; constructing explanations; engaging in argument from evidence; and obtaining, evaluating, and communicating information. The NGSS suggest that all eight concepts be taught in all grades with increasing complexity. For example, in grades K–2 a student would be encouraged to ask questions based on observations, and a child in grades 9–12 would ask questions that arise from examining a model or theory. In grades 3–5, students may represent data in graphs to show patterns, while grades 6–8 may discuss the limitations of data analysis.

Engaging in science practices enables students to gain literacy skills that will assist them to become informed citizens, conscientious consumers, and advocates for the things that matter in God's kingdom.

STEM to STEAM

Science, technology, engineering, and math are four disciplines often linked and taught together. STEM education is a teaching method that integrates the science and engineering design process with the use of technology and math. The STEM subjects help students connect their learning to real world problems and solutions. For example, a student studying monarch butterfly metamorphosis might be challenged to help scientists monitor their migration patterns and connect what they are learning to real world problems.

"Nobel laureates in the sciences are seventeen times likelier than the average scientist to be a painter, twelve times as likely to be a poet, and four times as likely to be a musician" (Pomeroy, S. (2012) *From STEM to STEAM: Science and Art Go Hand in Hand*).

Our newest science initiatives have included an emphasis on and connection between the STEM disciplines and art. Scientists and artists use similar skills—what do scientists and artists have in

common? Both are creative and look for original solutions. Both look at the world with wonder and attempt to explain what they see. The scientist may focus on an experiment or the development of new technology; the artist may focus on a dance, a video, a painting, or a 3–D model. But both the artist and the scientist are students of God's design, communicating their observations with others while using repetition and practice to find solutions.

The solutions to many of society's challenges are regularly solved with innovative ideas that come from artists, designers, and scientists. Critical thinking skills, communication, collaboration, and creativity are considered 21st–century skills. The arts and sciences encompass all these skills in the foundation of their subject area. These skills and experiences will assist students as they seek to serve God in all facets of his kingdom.

Performance Expectations from a Christian Perspective

All standards, curricula, and lessons include performance expectation statements. Such statements encapsulate expectations for learned skills, attitudes, reflective thinking, and knowledge that students are expected to acquire. The NGSS uses the term *performance expectations* to describe student outcomes. The performance expectations are designed to indicate what a student should know after instruction. Each NGSS performance expectation begins with the phrase "Students who demonstrate understanding can . . . ." Each performance expectation statement includes a disciplinary core idea, a cross–cutting concept, and an engineering practice. Viewed from a Christian perspective, performance expectations are aimed at helping students identify their delight, articulate their enjoyment of shalom, and express confidence in their ability to be stewards who develop care for and preserve creation to the glory of God.

To assist teachers as they implement the Next Generation Science Standards, the Christian Schools International science curriculum team developed biblical worldview statements. A Christian school teaches science to assist students in appreciating the beauty and wonder of creation and its created order and to inspire worship and infuse sufficient knowledge of science and engineering. Students will then be qualified to engage in and influence public discussions on related issues, including justice, earthkeeping, and ethical issues. We also acknowledge that students who study science become careful discerners of scientific and technological information. As a means of honoring God and serving others, students will be able to use their skill and gifts to follow God's calling and will be equipped to engage in science outside of school.

And It Was Good: Teaching Science from a Christian Worldview
Lesson Development Process

These lessons are designed as examples that will familiarize teachers with the process that this project's authors used to understand a new perspective on science curriculum design. A number of common threads were used as the basis for each lesson's formation. These common threads were adapted from a variety of different sources but most significantly from the Teaching for Transformation model developed by the Prairie Association of Christian Schools (PACS) and from the Next Generation Science Standards developed by 26 NGSS lead states, the National Research Council (NRC), the National Science Teachers Association, the American Association for the Advancement of Science, and Achieve.

Although teachers using this resource need not read these documents in their entirety to understand the direction of this guide, both resources are valuable to science instruction (and, in the case of Teaching for Transformation, to Christian teaching in a larger sense). A brief description of the writing process and those components of the lessons follows.

Teaching for Transformation and Throughlines

The Teaching for Transformation model is itself an adaptation of Wiggins and McTighe's Understanding by Design model (2005), a development tool that aims to organize learning around what Wiggins and McTighe call "big ideas." As Wiggins and McTighe state, "A big idea may be thought of as a *linchpin*. The linchpin is the device that keeps the wheel in place on an axle. Thus, a linchpin is one that is essential for understanding. Without grasping the idea and using it to 'hold together' related content knowledge, we are left with bits and pieces of inert facts that cannot take us anywhere" (*Understanding by Design*, p. 66). Through purposeful, intentional curricular planning, the Understanding by Design model begins by identifying those ideas and concepts that students should carry with them beyond a single lesson or even a single subject.

Such a perspective is valuable to any teacher; to a Christian teacher especially, this perspective is vital. With a larger perspective—carrying learning beyond one lesson or subject—the teacher is given a framework for education in which all parts of the lesson work toward a specific goal: finding and relating God's perspective in all of education. Such a focused goal allows education to move away from either activity–focused teaching or coverage–focused teaching, instead honing in on those components of lessons in every subject and discipline that allow students to concentrate on that which is most important: seeing all of creation as God sees it.

In order to establish a more specific continuity within lessons and units, the authors of this project adapted the Teaching for Transformation model and developed 10 big ideas called Throughlines, defined as "qualities [and] characteristics that we desire students to develop as God is revealed to them in all things. They are discipleship concepts that guide our living. These characteristics describe how we can become part of the restoration of creation. They answer 'How NOW shall I live?'" (*Teaching for Transformation: A Guide to Developing Christian Curriculum*, p. 14). In using Throughlines, the authors developed their lessons beyond a (valid) perspective such as "And the Lord God made it all" toward a deeper goal: creating lessons that build student understanding that recognizes God's hand in a variety of areas, including God–worshiping, idolatry–discerning, servant–working, and community–building.

The Next Generation Science Standards and Storylines

The Next Generation Science Standards are a result of the 2011 *A Framework for K–12 Science Education*, a document intended to "ensure that by the end of 12th grade, all students have some appreciation of the beauty and wonder of science; possess sufficient knowledge of science and engineering to engage in public discussions on related issues; are careful consumers of scientific and technological information related to their everyday lives; are able to continue to learn about science outside school; and have the skills to enter careers of their choice, including (but not limited to) careers in science, engineering, and technology" (*A Framework for K–12 Science Education,* p. 1). As can be seen through this statement, the authors of the framework and the standards are intent in their efforts to promote enjoyment of the world and to help all people to be scientifically literate—goals that are remarkably cohesive with our responsibilities and opportunities as caretakers of creation.

In order to organize each of the standards, the Next Generation Science Standards identify clear outcomes of lessons, or performance expectations, for each standard. Since the objectives of the standards are written as performance–based tasks, the goal of each lesson describes concepts that students should be able to do rather than an assessment in which students "know" or "understand." The performance expectations additionally organize the standards through connecting performance tasks of all grade levels as parts of a larger storyline, an overview of the larger scientific themes within each area of science. These storylines were used in this project in order to coordinate the lessons in this book; for curriculum directors and teachers alike, these

storylines serve well to help maintain grade–level appropriateness, both in content and in context for lessons.

Essential Questions

Once Throughlines were developed for the larger project and storylines were identified, specific questions for each sample lesson were created, relating the Throughlines to the NGSS storylines. In each sample lesson, these essential questions were developed with the intent to not only engage students' deeper thinking about that scientific topic (such as asking the question "How do the stars shine at night?" in a lower elementary science class) but also to engage thinking about the overarching ways in which the concept points toward building better understanding of the kingdom of God (modifying the question to "How do the heavens declare the glory of God?"). This activity was extremely valuable to this project's authors, ensuring that the lessons focus on helping students build scientific understanding in order to better comprehend who God is and how we can relate to him.

BSCS 5E Instructional Model

Whereas the essential questions set the tone for each lesson, the 5E Instructional Model established the structure of each lesson. The model was designed by a variety of science educators but has been used extensively by the Biological Science Curriculum Study (BSCS) since the late 1980s (www.bscs.org/bscs–5e–instructional–model). A rough summary of each of the five components (or phases) of the model follows:

Engage

> Engage phase activities begin to create interest in the students through a reading, an activity, or an experiment, provoking curiosity within the students with regard to the topic.

Explore

> Explore phase activities give students opportunities to work with one another through hands–on activities. In these activities, the teacher works to guide the students while they think, test, predict, hypothesize, and record observations.

Explain

> Explain phase activities provide students with opportunities to explain their possible solutions or answers from the explore activities and listen to other students' explanations. Through this process, the teacher encourages students and formally provides definitions, explanations, and new labels. In this project, the Throughline is generally introduced in this phase.

Elaborate

> Elaborate phase activities provide students with opportunities to challenge, deepen, and apply their new knowledge using formal labels, definitions, and explanations to ask questions, propose solutions, make decisions, and design experiments. In this project, the Throughline and storyline are generally integrated in this phase.

Evaluate

> Evaluate phase activities allow students to demonstrate their understanding or knowledge of the Throughline and storyline through a measurable, specific activity.

Inquiry

As defined by the National Science Education Standards, inquiry is a description of "the activities of students in which they develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world" (p. 23). Such a definition allows for a number of perspectives regarding how to lead lessons that use inquiry; to read more about the varied definitions of inquiry activities, you are encouraged to read "The Many Levels of Inquiry" (learningcenter.nsta.org/files/sc0810_26.pdf). Recognizing the value of student ownership and the logistical constraints of time management in a classroom, the project authors identified inquiry activities as either guided inquiry or structured inquiry: activities in which teachers present questions to be solved and often present some procedural elements to give students direction in their work to build understanding.

Engineering Components

As the old term for engineering implies, "applied science" allows the concepts of science to be better understood through solving particular human problems. An important focus of the Next Generation Science Standards places a new emphasis on the role of engineering in science—an addition that has not been included in earlier science standards (www.nextgenscience.org/sites/ngss/files/Appendix%20I%20–%20Engineering%20Design%20in%20NGSS%20–%20FINAL_V2.pdf, p. 1). In the Next Generation Science Standards, a variety of performance expectations integrate engineering practices into understanding scientific concepts, but take note that engineering in the NGSS is a practice in which students are encouraged to identify strengths and weaknesses, refining the solution to a problem in order to reach a solution. It is not a practice in which students are encouraged to try out ideas randomly. The project authors intended to help teachers understand engineering as a tool for learning in the same vein as inquiry, allowing understanding to be built in a variety of scientific problems. For a visual of the engineering design process, see the K-2 Engineering Process Diagram available at www.csionline.org/anditwasgood_resources.

References

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And It Was Good: Teaching Science from a Christian Worldview
Web–Based Activities

The internet provides a rich resource for educators. Teachers can find any number of lessons, activities, experiments, and visual aids to enhance classroom instruction. This resource identifies a number of web–based enhancements that relate to the sample lessons. The web resources, while not specifically Christian, are compatible with Christian teaching. The goal is to provide material that is in keeping with the concepts of the lessons and, in some cases, the identified Throughlines.

Educators can have access to a webpage of pre–vetted web activities. The web resource provides a brief description of each site and potential Throughline suggestions. These are intended only as guidelines. Some activities might lend themselves well to additional or different Throughlines. Some items tagged as student activities might be more appropriate as group activities. Teachers are encouraged to familiarize themselves with the resources and to use the activities as they see fit.

Teachers may also review each web activity and let others know how they used a particular tool. Teachers who have had success with additional online resources should feel free to suggest them so that they might be added to the online library. Like the internet itself, the online resource will be flexible and fluid to allow for the best teacher support possible.

And It Was Good Lesson Template

This template is offered as a framework so that the teacher can apply the concepts in these sample lessons to additional science materials. An electronic copy is available at www.csionline.org/anditwasgood_resources

Grade Level:_____

Next Generation Science Standards Storyline: _____

Next Generation Science Standards Performance Expectation	
Teaching for Transformation Throughline	**Essential Question**

Lesson Steps (BSCS 5E Instructional Model)

Engage

Explore

Explain

Elaborate

Evaluate

Resources

Grade 2 Overview

NGSS Storyline	NGSS Performance Expectation	Teaching for Transformation Throughline	Essential Question
Structure and Properties of Matter Sample Lesson 1	2-PS1-1: Students who demonstrate understanding can plan and conduct an investigation to describe and classify different kinds of materials by their observable properties. 2-PS1-2: Students who demonstrate understanding can analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.	Creation-Enjoyer	How do the different types of material God places in his world allow us to enjoy great variety?
Structure and Properties of Matter Sample Lesson 2	2-PS1-3: Students who demonstrate understanding can make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object.	God-Worshiper	How does God's creativity inspire awe and worship?
Interdependent Relationships in Ecosystems Sample Lesson 1	2-LS2-1: Students who demonstrate understanding can plan and conduct an investigation to determine if plants need sunlight and water to grow.	Beauty-Creator	How can plants be used to create beauty?
Interdependent Relationships in Ecosystems Sample Lesson 2	2-LS2-2: Students who demonstrate understanding can develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.	Creation-Enjoyer	How does God's design for seed dispersal lead us to enjoy creation?

NGSS Storyline	NGSS Performance Expectation	Teaching for Transformation Throughline	Essential Question
Earth's Systems: Processes That Shape the Earth Sample Lesson 1	2-ESS1-1: Students who demonstrate understanding can use information from several sources to provide evidence that Earth events can occur quickly or slowly.	Order-Discoverer	What is God's order for shaping the Earth's surface?
Earth's Systems: Processes That Shape the Earth Sample Lesson 2	2-ESS2-2: Students who demonstrate understanding can develop a model to represent the shapes and kinds of land and bodies of water in an area. 2-ESS2-3: Students who demonstrate understanding can obtain information to identify where water is found on Earth and that it can be solid or liquid.	Earth-Keeper	How can we teach others to be good stewards of God's gift of water?
K–2 Engineering Design Sample Lesson	NGSS K-2-ETS1-3: Students who demonstrate understanding can analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs. NGSS 2-ESS2-1: Students who demonstrate understanding can compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land.	Image-Reflector	How can we reflect God's image by using his gift of engineering to help others and protect the Earth?

Structure and Properties of Matter

An Introduction

NGSS performance expectation 2–PS1–1: *Students who demonstrate understanding can plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.*

NGSS performance expectation 2–PS1–2: *Students who demonstrate understanding can analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.*

***NGSS performance expectation 2–PS1–4:** *Students who demonstrate understanding can construct an argument with evidence that some changes caused by heating and cooling can be reversed and some cannot.*

*No sample lesson is provided for this standard, but only a suggested Throughline.

Throughline: Creation–enjoyer

Science encourages students to observe the world with all their senses, noticing and drawing attention to what God's world offers. Creation–enjoying is looking at, talking about, and studying creation. Science gives students a tool to make the ordinary extraordinary, whether through microscopes, stethoscopes, oscilloscopes, electroscopes, stereoscopes, or telescopes. Psalm 65:8 says, "The whole earth is filled with awe at your wonders; where morning dawns, where evening fades, you call forth songs of joy."

We need to encourage our students to sing "songs of joy" or "ahhs of wonder" or "ooohs of discovery" when they use science to study creation. We need to encourage students to revel and rejoice in creation. Isaac Newton said, "This most beautiful system of suns, planets, and comets could only proceed from the counsel and dominion of an intelligent and powerful Being" (*The Principia: Mathematical Principles of Natural Philosophy*, 1687).

Imagine enjoying a walk through a forest. You feel the cool breeze and the tree bark. You hear the burbling brook and the wind in the leaves. You smell the rich soil and the fresh air. You see the green grass and the yellow sun. In a city, you enjoy the warming heat from the brick wall and the rough surface of the sidewalk. You hear the swish of cars on the road and the ding of a shop door. You see the black asphalt and enjoy the red brick houses. This great diversity is a result of the variety of material that God places in this world. God did not create a world of uniformity. Rather, God created a world with different colors, smells, textures, and sounds. Students can examine the absorbency, flexibility, hardness, transparency, and strength properties of different materials. As young students seek, examine, study, discover, and most of all enjoy the various properties of matter, they can begin to grasp what the psalmist meant when he exclaimed in Psalm 104:24: "How many are your works, Lord! In wisdom you made them all."

Students will also see order in creation when they examine how heating and cooling affect objects. This God–given order gives us great enjoyment: ice cream on a hot day or a hot fire on a cold day. Students can look at how heating and cooling an object can change it. They can also observe that sometimes this can be reversed and sometimes it cannot. Students can examine different changes that we enjoy and discover whether they can be reversed. This will lead the students

to learn how heating and cooling objects can help us enjoy creation.

NGSS performance expectation 2–PS1–3: *Students who demonstrate understanding can make observations to construct an evidence–based account of how an object made of a small set of pieces can be disassembled and made into a new object.*

Throughline: God–worshiper

Science helps us worship when we enjoy God's creation. God gives us this world to delight in and play in and to explore. In Psalm 148, the psalmist recognizes that all creatures praise the Lord.

> Praise the LORD.
>
> Praise the LORD from the heavens;
> praise him in the heights above.
> Praise him, all his angels;
> praise him, all his heavenly hosts.
> Praise him, sun and moon;
> praise him, all you shining stars.
> Praise him, you highest heavens
> and you waters above the skies.

Seventeenth–century astronomer Johannes Kepler echoes Psalm 8: "Great is God our Lord, great is His power and there is no end to His wisdom. Praise Him you heavens, glorify Him, sun and moon and you planets. For out of Him and through Him, and in Him are all things . . . . We know, oh, so little. To Him be the praise, the honor and the glory from eternity to eternity" (*Epitome of Copernican Astronomy and Harmonies of the World*).

As we explore God's creation, we cannot help but worship God. Creation gives us a sense of God's delight in his plants, rocks, animals, and stars. When we encourage students to delight in God's creation through science, we help them understand that worshiping God is about celebrating who God is, his creation, and active participation in it.

Students love to show others their handiwork. Students will reflect on how they feel when someone says "Wow!" about their work; a larger and more important discussion about worshiping God should follow. Saying "Wow!" about God's work in creation is worship. God is the master builder! Hebrews 3:4 says, "For every house is built by someone, but God is the builder of everything." That is amazing! God uses smaller pieces to create something larger in the natural world. As the students are drawn to see possibilities from the Master's designs, how God has put together small things to make larger things, they will come to understand that everything in creation is fashioned to be perfect in detail and design. When they see the perfection in God's detail and design of his creation, they will worship by saying "Wow!"

Structure and Properties of Matter

Sample Lesson 1

How Do the Different Types of Material God Places in His World Allow Us to Enjoy Great Variety?

Structuring the Curriculum

Prior to this lesson, students should have an understanding of the difference between manufactured (human–made) and natural (God–made) objects.

Students will first explore a variety of objects by classifying them in as many ways as they can think of. They will also explore a variety of classroom objects and test for a variety of properties. This sets the stage for a discussion about what objects are made of and what their intended uses may be.

Students will then demonstrate their understanding that manufactured objects are made from materials best suited for their purposes. They will be asked to imagine that a variety of familiar objects were made from a different material and indicate which material is more adequate.

As students explore, they will be encouraged to appreciate the variety of materials at their disposal and to look to God as a creator of variety.

Read #3 under Elaborate for ideas about the types of materials to provide for student exploration.

Preparation and Materials

- Resealable plastic bags that contain 10 different familiar objects, one bag per team. Examples: toy soldiers, marbles, scraps of fabric, balloons, toothpicks, buttons, noisemakers, etc. Ideally, each team's set of objects should be the same. Four objects should be made of a single material (e.g., plastic, wood, metal, fabric, paper), and six should be composite objects—made from more than one material. Include multiple objects that contain the same material (e.g., two objects made of wood along with

Objective

NGSS 2-PS1-1: Students who demonstrate understanding can plan and conduct an investigation to describe and classify different kinds of materials by their observable properties.

Clarification statement: Observations could include color, texture, hardness, and flexibility. Patterns could include the similar properties that different materials share.

NGSS 2-PS1-2: Students who demonstrate understanding can analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.

Clarification statement: Examples of properties could include, strength, flexibility, hardness, texture, and absorbency.

Assessment boundary: Assessment of quantitative measurements is limited to length.

Throughline

Creation-enjoyer: Science encourages students to observe the world with all their senses, noticing and drawing attention to what there is to be seen in God's world.

Vocabulary

material—what an object is made of

property—a way something looks, feels, or acts

some other material, four objects made of metal and some other material).

- Pipettes (optional)
- Water
- Flashlights (optional)
- Spatula (or another common household object)
- "Data Table" worksheet, one set per student (see pages 41–42)
- "Uniquely Designed" worksheet, one per student (see page 43)

Background

Imagine enjoying a walk through a forest. You feel the cool breeze and touch the tree bark. You hear the brook and the wind in the leaves. You smell the rich soil and the fresh air. You see the green grass and the yellow sun. On a walk in the city, you enjoy the warmth emanating from the brick wall and the sidewalk's rough surface. You hear the swish of cars on the road and the ding of a shop door. You see the black asphalt and enjoy the red brick houses. This great diversity we enjoy every day is a result of the variety of material God places in this world. God did not create a world of uniformity. Rather, he created a world with different colors, smells, textures, and sounds. In this lesson students will examine the absorbency, flexibility, hardness, transparency, and strength properties of different materials. As students seek, examine, study, discover, and most of all enjoy the various properties of matter, they begin to echo the psalmist in Psalm 104:24: "How many are your works, Lord! In wisdom you made them all."

Many objects are composed of one or more materials, all of which come from raw materials. For example, ore, which is found in rock, is the raw material from which metal is smelted. Metals, in turn, are used to make a variety of objects. The way that an object can be used is related to the properties of its material.

A material's properties determine its use. Such properties include smell, appearance (such as size, shape, and color), texture (such as hardness, flexibility, and stickiness), how it reacts to other materials (such as solubility, absorbency, magnetic interaction, and sounds it emits when struck), and quantitative properties (such as density and temperature).

When scientists plan and carry out investigations, they answer questions about the world around them, while engineers test designs of products. Coming up with a good question is key in scientific investigations. Students in early grades should be given a question to explore and guided through investigations so they become familiar with the process. As they work through the grade levels, they will work more and more independently. They will also work on understanding variables and controls as they become more mature in their understanding of planning and carrying out investigations.

It is important also to explicitly teach students about patterns as they collect data. Patterns are apparent everywhere; students should learn to observe, describe, and predict with them. In the younger grades, begin by collecting data and using that data to predict. This lesson allows for students to look for patterns in the properties of objects and begin to predict how other objects might be classified.

Note that classification schemes are constructs to help us sort things. There is no "right" or "wrong" but only "useful" or "not useful."

Lesson Steps

Engage

1. Mention to students that God created great variety in the world and that the purpose of this lesson's activities is to help us understand and enjoy God's creation a bit more.

2. Give each pair or small group a bag of objects prepared earlier. Review how to make observations using the senses.

3. Have students make observations of the objects, and ask them to sort the materials based on their properties and the patterns they see. Once they have sorted one way, encourage them to find additional classification methods. They may classify the objects by manufactured and natural, color, material, size, use, etc.

4. As they sort, reflect on some of the properties they observed in the provided materials and brainstorm what purpose God may have intended for certain properties (e.g., soft fabric is good for clothing).

5. Have students explain their classification schemes to the class. Validate all responses as long as the students provide rationale for their choices. As the students share, present them with another small object from the classroom, and have the rest of the class predict where the object would be placed in that group's classification scheme.

6. Ask the group where they would place it. As patterns emerge in the ways students classify the objects, they should be able to begin to predict where other objects would be placed.

Explore

1. Point out that God created variety in the materials and objects around us. We should respond in awe; as Psalm 65:8 says, "The whole earth is filled with awe at your wonders." Discuss how the students are able to respond with awe by being able to explore and describe things in God's creation—both in natural objects and manufactured objects—by their properties, and that is what the following investigations are all about: learning about the variety of properties God places in our lives.

2. Remind students that scientists conduct investigations to understand the world around them and that they often start with a question. Students will be imitating scientists through their exploration by answering the question, "What patterns do you see as you test the properties of objects?"

   Have students work with partners to select among several objects from around the room and test them for a variety of properties—absorbency, flexibility, hardness, transparency, and strength.

3. Distribute the "Data Table" worksheet and talk through each of the headings by discussing the following questions with the students. Have students help come up with ways to administer each test. Ideas are suggested below.

   - How does the material change when it is wet? (absorbency/waterproofness)

     Explore this with the "water test." Either dip an object in water or use a pipette to drop some water on the object.

   - How does the material bend? (flexibility/rigidity)

     Through the "bend it" test, students should record their observations about how well something bends. Review re-

spect for others' property and remind students to be careful not to break anything in this activity.

- How hard is the material? (hardness/softness)

  In the "hard/soft" test, students may want to just push on the object with a finger and see how far their finger pushes it.

- Can you see through the material? (transparency/opaqueness)

  Explore the "see–through" test by looking through an object or shining a strong flashlight on an object to check for a shadow.

- Does the material break easily? (strength/weakness)

  In the "breakable" test, students should be encouraged to use their prior knowledge and compare the material of the object with one they know is breakable or not.

  Although many other properties can be explored, these offer students a good basis of properties to test and relate to the function of the materials.

4. Have students record their observations of the tests, as well as other observations of each object's properties on the data tables.

Explain

1. Refer to the question "What patterns do you see as you test the properties of objects?" Students might have noticed that a rubber object bends easily or that plastic objects are hard and waterproof.

2. Discuss again God's creation of a variety of materials for us to explore. As his image–bearers we are able to create with them also. Each material has specific properties (color, texture, hardness, and flexibility) that are useful for specific purposes.

3. Point out that materials have specific properties and are used in a variety of ways, but some properties are better suited for certain tasks than others. For example, both cardboard and plastic can be made into a container, but which one can hold a liquid?

4. Specifically discuss the objects in the bag in the first activity. What was similar about the objects? different? What are the objects made of? Explain that objects are made of substances called materials. Give examples of wood, metal, plastic, and glass, and explain that many materials are manufactured from materials in God's creation. For example, plastics are made of oil from the ground. Cloth comes from plant fibers (cotton), animals (wool), or oil (nylon).

5. Talk about the objects students explored in their investigation. What properties did the objects have, and how does that aid in the function of each item? As you revisit each test, talk about the science vocabulary words associated with each.

6. Ask, "If something gets soaking wet, would you consider it to be waterproof?" (No.) "When would you want something to absorb liquid?" (When cleaning up spills.) "What types of materials absorbed the liquid?" "Why would that be okay for the purpose of the object?" "What types of things were waterproof?" "Why would that be okay for the purpose of the object?"

7. Ask similar questions for the other tests, and relate the questions to the materials' functions.

Elaborate

1. As time and resources allow, have students explore the following websites. The first link has informative summaries of a variety of materials and their properties. The

second link is a game that provides for further testing of waterproofness, strength, flexibility, and transparency. It also provides an activity involving experiments with making a few items out of a variety of materials.

- www.bbc.co.uk/bitesize/ks2/science/materials/material_properties/read/1/
- www.bbc.co.uk/schools/scienceclips/ages/7_8/characteristics_materials.shtml

2. Show students a common household object, such as a spatula, and talk about the materials that compose it. Point out it wouldn't work as well if it were made from material such as fabric because the spatula needs to be firm.

3. Pose the following questions, and have students respond with their answers on individual white boards or by telling a partner. Then discuss each one as a class. Feel free to adapt the questions as you see fit or come up with questions of your own.

   - Would you make a window out of wood? (No.) What property is needed? (Transparency.) What material would be a good one to use instead? (Glass.)
   - Would you make a table out of rubber bands? (No.) What property is needed? (Rigidity.) What material would be a good one to use instead? (Wood.)
   - Would you make a spoon out of string? (No.) What property is needed? (Strength.) What material would be a good one to use instead? (Metal or plastic.)
   - Would you make a bucket out of paper? (No.) What property is needed? (Waterproofness.) What material would be a good one to use instead? (Plastic or metal.)
   - Would you make a bouncy ball out of glass? (No.) What property is needed? (Flexibility.) What material would be a good one to use instead? (Rubber.)
   - Would you make a sweatshirt out of metal? (No.) What property is needed? (Softness.) What material would be a good one to use instead? (Fabric.)

4. Mention that just as each object has materials uniquely designed for its purpose, we should remember that God is the creator of all and that he has created the properties of all the materials so that we are able to create useful objects with them.

Evaluate

1. Distribute the "Uniquely Designed" worksheet. Have students choose one object from the classroom and describe the materials.

2. Then have students imagine that the object is made from a different material. What material would they choose, and would the object still work as it was designed? How would it be changed?

3. Finally, have students describe why the original material was chosen.

Resources

abpi. “Properties of Materials.” Accessed April 12, 2014. http://www.abpischools.org.uk/res/coResourceImport/modules/solids-liquids-gases/en-documents/propemat.pdf

“All Sorts of Stuff.” In *Under Construction*. AIMS Education Foundation, 1997.

BBC. “Characteristics of materials.” Accessed April 12, 2014. http://www.bbc.co.uk/schools/scienceclips/ages/7_8/characteristics_materials.shtml

BBC. “Material properties.” Accessed April 12, 2014. http://www.bbc.co.uk/bitesize/ks2/science/materials/material_properties/read/1/

Bozemanscience. “Patterns.” Accessed April 11, 2014. http://www.bozemanscience.com/ngs–patterns

Bozemanscience. “Planning & Carrying Out Investigations.” Accessed April 11, 2014. http://www.bozemanscience.com/ngs-planning-carrying-out-investigations

Ferrier, Barbara. “What Are Materials and Objects Like?” Christian Schools International 2nd Edition Science Curriculum, Grade 1, 2011.

Ferrier, Barbara. “What Are the Properties of Different Materials?” Christian Schools International 2nd Edition Science Curriculum, Grade 1, 2011.

Structure and Properties of Matter

Sample Lesson 2

How Does God's Creativity Inspire Awe and Worship?

Structuring the Curriculum

This lesson begins with students building a small creation out of building bricks and communicating how to duplicate their masterpiece to a partner who will have a matching set of building bricks.

Students are then allowed to create their own masterpieces out of building bricks. As they do this, they will see how the smaller pieces fit together to make their object. Once the pieces are showcased, students are encouraged to make a connection to God's creation and find evidence of God's use of smaller parts to make up much of his creation. The stage will then be set to talk about how worship is recognizing God as the creator of all things.

Bringing students to a nature preserve or nearby outdoor park to revel in God's creation would be ideal; if this is not possible, however, you may wish to gather resources with pictures of many examples from God's natural world for students to explore and find evidence that he creates using smaller pieces.

Objective

NGSS 2-PS1-3: Students who demonstrate understanding can make observations to construct an evidence-based account of how an object made of a small set of pieces can be disassembled and made into a new object.

Clarification statement: Examples of pieces could include blocks, building bricks, or other assorted small objects.

Throughline

God-worshiper: Science helps us worship when we enjoy his creation

Preparation and Materials

- Building bricks (such as Lego), several pieces for each pair of students; as you prepare for the Engage portion of the lesson, you will need to have small sets of matching bricks (5–6 pieces) for each pair of students. Each pair may have a different set of duplicated bricks.
- Small tri–fold display boards or folders that can stand up and provide privacy
- Blank paper, one piece per student
- Books or magazines with pictures of a variety of things in God's creation (animals, plants, landscapes, etc.)
- "God Is the Master Builder" worksheet, one per student (see page 45)
- Index cards (4"x6"), one per student

Background

Students love to show others their handiwork. As students reflect on how much they appreciate

hearing someone say “Wow!” about their work, tie in a discussion about worshiping God. Saying “Wow!” about God’s work in creation is worship. God is the master builder! Hebrews 3:4 says, “For every house is built by someone, but God is the builder of everything.” That is amazing! God uses smaller pieces to create something larger in the natural world. As students are drawn to see possibilities from the Master’s designs, they will come to understand that everything is created to be perfect. When they see the perfection in God’s detail and design of his creation, they will worship by saying “Wow!”

Before this lesson, students should understand that materials have a multitude of observable and describable properties. These properties allow for each material to have purpose. Observable properties for building materials are rigidity and strength. While working with building bricks, students will find evidence that an object made up of smaller parts can be taken apart and that those smaller parts can then be assembled into another larger object.

Lesson Steps

Engage

1. Pair students up, and give each pair a set of five or six building bricks.
2. Have them place a small tri–fold display board or privacy fold between them. Have one student be the builder and the other the engineer. Discuss how engineers design something for someone to build and that good communication is important. Have the engineer build something with the bricks and describe to the builder what to create.
3. The builder should try to duplicate the engineer’s design without looking at the engineer’s creation. Compare and switch roles.
4. Have students share their experiences.

Explore

1. Ask students what worked well in the previous activity and what was difficult. Discuss how engineers come up with a plan and builders need to interpret that plan to create something. Effective communication is important—encourage students to keep this in mind as they work through the next activity.
2. Have student pairs build something from a larger set (size to be determined by the teacher) of bricks. The object can have a function, be a building, or be something else that they will be proud of. As they build, encourage them to explain how the pieces fit together. If they make a mistake or decide to change the design, are they able to rectify the situation easily? Continue to encourage good communication about how smaller pieces can make up a larger object.
3. Once students have completed their masterpieces, display them for the class with the students’ names in a prominent place. Set out each with a sheet of paper for students to record encouraging comments. You may wish to have a “walk around” time for students to quietly write down their comments. Give students time to read the comments.

Explain

1. Ask students what evidence the activity gave them of objects being made up of smaller pieces. Their work with fitting the bricks together and taking them apart to change something shows how an object made of pieces can be disassembled and made into a new object. Their initial engineer–and–builder activity is additional evidence of this.

2. Ask students how they felt when they read their comment sheets. Discuss how it feels when someone says "Wow!" about our work.

3. Introduce the idea that God also should be praised for his work in creation and that everything in God's creation is also made up of smaller pieces, just like their masterpieces. For example, a tree has a trunk, branches, leaves, and roots working together to keep it alive. The thought God put into his creation is amazing. Whenever we say "Wow!" about God's creation, we are worshiping.

Elaborate

1. Allow students to find things that "wow" them about God's creation. Either visit a nature preserve or a nearby park, or have students page through books or magazines about God's natural world.

2. Have students find things that not only elicit a "wow" moment about God's creation but also provide evidence of God's use of smaller parts to create a larger masterpiece. Examples include a tree or a bird's nest.

3. Have students draw and label these objects on the "God Is the Master Builder" worksheet. Before students begin, demonstrate your expectations about the details in their drawings and how they should use labels appropriately. As they work, encourage them to reflect on God being the master builder.

Evaluate

1. Distribute index cards. Explain to students that they will watch a video; their job is to look for all the things a beaver uses to build its home and be attentive to a "wow!" about God's creation of beavers.

2. Show the video *How Beavers Build a Lodge—BBC Animals*. www.youtube.com/watch?v=VuMRDZbrdXc

3. As they watch the video, have students record all the things the beaver uses to build a lodge and how they are used to build the lodge. Have them do this on one side of an index card. Sticks, vegetation, mud, and logs are specifically mentioned. On the other side of the index card, encourage them to worship God by recording what they find amazing about God's creation of beavers and the way they build their lodges. For example, before putting the logs in place, beavers strip the bark from the logs and eat it; nothing goes to waste.

4. Students should be able to use the example of the beaver lodge to explain how God created beavers to use smaller pieces to make something larger for an intended purpose.

Resources

BBCWorldwide. "How Beavers Build a Lodge – BBC Animals." Accessed April 14, 2014.

Jackson, Mia, et al. *Family Engineering: An Activity and Event Planning Guide*. Portland: Foundation for Family Science and Engineering, 2011.

http://www.youtube.com/watch?v=VuMRDZbrdXc

Interdependent Relationships in Ecosystems

An Introduction

NGSS performance expectation 2-LS2-1: *Students who demonstrate understanding can plan and conduct an investigation to determine if plants need sunlight and water to grow.*

Throughline: Beauty-creator

Science creates opportunities to re–create beauty in the world around us. Genesis 1:31 says, "God saw all that he had made, and it was very good."

Looking around creation helps us understand what "good" means. Creation shouts that God loves diversity, complexity, and creativity. We see this in his rocks, trees, animals, insects, skies, and space. We especially see it in people and their ability to create. We, as image bearers, continue to create. Although God chose not to reveal every part of his creation immediately, he does equip humans with the gifts of research, discovery, and creativity so that these things can be revealed in his appointed time. We need to tell students that God created creation to be re-created by us! As Marie Curie said: "And this is a proof that scientific work must not be considered from the point of view of the direct usefulness of it. It must be done for itself, for the beauty of science, and then there is always the chance that a scientific discovery may become like the radium: a benefit for humanity" (lecture at Vassar College, Poughkeepsie, New York, 14 May 1921).

God injected opportunities within the rules of his creation for scientists to create beauty. The rules of chemistry allow for the creation of fireworks with light and sound. The rules of water and chemistry allow for watercolors. The rules of electricity and sound allow for music.

The beauty in plants is amazing. All plants need carbon dioxide, water, minerals, and sunlight. God could have created plants of completely boring, dull, monotone colors, each having the exact number and design of leaves and identical stems. But God gives plants specific adaptations, using a riot of colors, textures, and designs. Jesus says this about plants: "Consider how the wild flowers grow. They do not labor or spin. Yet I tell you, not even Solomon in all his splendor was dressed like one of these" (Luke 12:27). Since we are made in God's image, we too are created to be beauty creators. Students can create beauty with chia seeds (just as God creates beauty with plants) and use their knowledge to identify what every plant needs in order to survive.

NGSS performance expectation 2-LS2-2: *Students who demonstrate understanding can develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.*

Throughline: Creation-enjoyer

Science encourages students to observe the world with all their senses, noticing and drawing attention to what there is to be seen in God's world. Creation-enjoying is looking at, talking about, and studying creation. Science gives students a tool to make the ordinary extraordinary, whether through microscopes, stethoscopes, oscilloscopes, electroscopes, stereoscopes, or telescopes. Psalm 65:8 says, "The whole earth is filled with awe at your wonders; where morning dawns, where evening fades, you call forth songs of joy."

We need to encourage students to sing "songs of joy" or "ahhs of wonder" or "ooohs of discovery" when they use science to study creation. We need to encourage students to revel and rejoice in

creation. Isaac Newton said, “This most beautiful system of suns, planets, and comets could only proceed from the counsel and dominion of an intelligent and powerful Being” (*The Principia: Mathematical Principles of Natural Philosophy,* 1687).

You see a dandelion puff and you want to blow it, a maple key and you want to throw it up and watch it twirl down, a milkweed seed and you want to catch it and make a wish. The ways seeds spread are meant to be enjoyed. Science can engage students into thinking about different ways God designed plants to disperse their seeds. Through video and physical activity, students can be struck with awe at the ways God designed seeds.

***NGSS performance expectation 2-LS4-1:** *Students who demonstrate understanding can make observations of plants and animals to compare the diversity of life in different habitats.*

*No sample lesson is provided for this performance expectation, but only a suggested Throughline.

Throughline: God-worshiper

Science helps us worship when we enjoy God’s creation. God gives us this world to delight in, to play in, and to explore. In Psalm 148, the psalmist recognizes that all creatures praise the Lord.

> Praise the Lord.
>
> Praise the Lord from the heavens;
> praise him in the heights above.
> Praise him, all his angels;
> praise him, all his heavenly hosts.
> Praise him, sun and moon;
> praise him, all you shining stars.
> Praise him, you highest heavens
> and you waters above the skies.

Seventeenth-century astronomer Johannes Kepler echoes Psalm 8: “Great is God our Lord, great is His power and there is no end to His wisdom. Praise Him you heavens, glorify Him, sun and moon and you planets. For out of Him and through Him, and in Him are all things . . . . We know, oh, so little. To Him be the praise, the honor and the glory from eternity to eternity” (*Epitome of Copernican Astronomy and Harmonies of the World*).

As we explore God’s creation, we can’t help but worship God. Creation gives us a sense of God’s delight in his plants, rocks, animals, and stars. When we encourage students to delight in God’s creation through science, we help them understand that worshiping God is about celebrating who God is, his creation, and his active participation in it.

> But ask the animals, and they will teach you,
> Or the birds of the sky, and they will tell you . . . .
> Which of all these does not know
> that the hand of the Lord has done this?
> In his hand is the life of every creature
> and the breath of all mankind (Job 12:7, 9–10).

The tremendous biodiversity in creation is God’s marvelous gift to creation and to all its creatures, especially to us humans, who can appreciate it and glorify God for it. We come to worship God, as Paul says in the Book of Romans, when we look at the diversity of life around us.

Different habitats are like a beautiful book in which all creatures, large and small, are as letters to us to make us worship and ponder the invisible things of God: his infinite care, his creative design, his faithfulness to his creatures, and his eternal power. When the Lord answers Job about the mysteries of life, the Almighty teaches Job that the animals of the Earth have a message to proclaim—behold the works of God in us! How marvelous are his deeds!

Interdependent Relationships in Ecosystems

Sample Lesson 1

How Can Plants Be Used to Create Beauty?

Structuring the Curriculum

Chia seeds can be found in health food stores or grocery stores, although you may be more familiar with them as grown on chia pets. They sprout readily on most moist surfaces and are easy to grow. If chia seeds are not available, parakeet feed or radish seeds are options.

About a week before the lesson, place several bricks on a patch of grass in the schoolyard that receives direct sunlight. Have students plant several chia seeds in two cups of soil, just below the surface of the soil. Have them work in small groups and mark each cup with their group members' names and mark them with an A and B or something similar.

Students will begin this lesson by observing what happens to grass after it is covered for about a week. They will then brainstorm variables that affect plant growth and choose one to investigate. Investigations with chia plants will be set up and monitored for about two weeks.

They will discuss how God creates beauty through plants and then create a piece of artwork with chia gel to share with others.

Objective

NGSS 2-LS2-1: Students who demonstrate understanding can plan and conduct an investigation to determine if plants need sunlight and water to grow.

Assessment boundary: Assessment is limited to testing one variable at a time.

Throughline

Beauty-creator: Science creates opportunities to re-create beauty in the world around us.

Preparation and Materials

- Chia seeds
- Potting soil
- Clear plastic cups, two per group
- Water
- Rulers
- "Plant Investigation" worksheet, one per student (see page 47)
- "My Observations" worksheet, several pages per student (see page 49). Staple these together.
- Pictures or other evidence of God's beauty in plants

- Chia gel (three parts water to one part chia seeds, in squeeze bottle, or use a pipette with a cup)
- Paper toweling
- Markers
- Resealable sandwich bags
- Optional: Hard–boiled eggs, cotton balls, permanent markers

Background

God could have created a single type of plant. Instead, he created an amazing variety of plants that bring beauty and function to our world. All plants need carbon dioxide, water, minerals, and sunlight. Beyond that, each plant is beautifully unique. God gives plants specific adaptations and creates plants using a riot of colors, textures, and designs. Jesus says this about plants: "Consider how the wild flowers grow. They do not labor or spin. Yet I tell you, not even Solomon in all his splendor was dressed like one of these" (Luke 12:27). In this lesson students will use chia seeds to create beauty, just as our Father in heaven creates beauty with plants, and use their knowledge to identify what every plant needs to survive.

The atmosphere provides plants with unlimited carbon dioxide, but the amounts of available water, minerals, and sunlight vary by location. Leaves capture sunlight for photosynthesis and give off excess water. Leaf size must balance these two tasks. Surrounded by abundant rainfall and constant warmth, tropical plants can afford large leaves to compete for sunlight with the dense growth of surrounding plants. Aquatic plants also have large leaves as well as a tough, waxy surface to repel excess water.

Deciduous tree leaves must also be broad to capture sunlight in crowded spaces, but these trees shed their leaves in autumn to conserve water during the dry, short winter days. Conifer tree leaves, which are small and waxy to prevent water loss, photosynthesize year–round. Soil provides the minerals plants need. Some plants need acidic soil; others require neutral or slightly alkaline soil. Some plants, such as the pitcher plant and the venus flytrap, grow in nitrate–poor soil and must supplement their diets with insects. Plants called epiphytes grow on tree trunks, branches, and leaves, drawing minerals from decaying matter trapped in the rainforest canopy.

Tropical plants live in a narrow temperature range. Desert plants survive wide daily temperature swings. Deciduous trees are adapted to the temperatures of four seasons.

Sometimes plants need to defend themselves. Some species are armed with a mat of fine hairs on the leaf surface to deter small plant predators. Other plants ward off larger herbivores with spines, thorns, and stinging needles. Certain plants release chemicals that cause painful irritations, and others have leaves shaped to hold pools of water to drown invading insects.

When scientists plan and carry out investigations, they answer questions about the world around them, while engineers test designs of products. Coming up with a good question is key in scientific investigations. Students in early grades should be given a question to explore and guided through investigations so they become familiar with the process. As they work through the grade levels, their work with planning and carrying out investigations will be scaffolded so that they can do this more and more independently. They will also work on understanding variables and controls in their investigations as they become more mature in their understanding

of planning and carrying out investigations.

Even the youngest children are interested in exploring why something occurs. As cause–and–effect relations are explored, students should be guided to link the cause with the effect and assisted in understanding what is causing a phenomenon. This can be done by bringing to light the patterns that occur in plant growth.

Lesson Steps

Engage

1. Students will be working with chia seeds, which quickly germinate and respond well to environmental changes. Divide the class into groups and have each group plant several seeds in two cups of soil one or two weeks before you begin this lesson. Plant seeds just below the surface, and keep the soil moist. Have them label each cup with their names and cup A and B (or a similar designation).

2. Place several bricks on the school lawn in direct sunlight a week before you teach this lesson. After a week, take students outside, and have volunteers pick up the bricks. Ask why the grass has yellowed. (It is missing something that it needs: sunlight.)

Explore

1. Explain that students will be exploring what plants need in order to remain healthy and what might affect plant growth. They will be coming up with a question for an investigation, just as scientists use their questions about God's natural world to guide their investigations.

2. As a class, brainstorm a list of variables that might affect a plant's growth. Variables might include temperature, sunlight, amount of water, type of soil, etc. Record the list of variables as they are mentioned. If students are having a hard time coming up with variables, write the following question on the board and have them fill in the blank with a word or phrase: "How does _____ affect the growth of a plant?"

3. Go through the list with the class, and eliminate any variables that cannot be investigated with the resources you have available, such as how being in space might affect a plant's growth. As you eliminate variables from the list, explain why they are being eliminated.

4. Explain that you will be doing a classroom investigation about sunlight while students will also be working in small groups investigating another variable that might affect plant growth.

5. Have each student group choose which variable they would like to investigate and work through the "Plant Investigation" worksheet together, filling in information for the class investigation while guiding the students' thoughts.

   - What question is your group investigating?
   - How does sunlight affect the growth of a chia plant?

     Note to teacher: Seeds will germinate in the dark. They may grow quite tall, but they will be weak and will eventually die from lack of light.

   - Which variable is your group changing?

     Sunlight. Guide students to recognize that the variable refers to what they think might affect the growth of their chia plants.

- How do you plan to keep the other variables the same?

  Place one cup of chia in sunlight and the other in the closet. Make sure they both get the same amount of water each day. Explain that the students will treat one cup of chia normally; for the other one the students will want to change only the one variable they are testing. This is a tough concept to grasp. Help students determine how to control their variables, what they will need to keep the same, and what they will need to change as they fill out this section.

- What do you predict will happen?

  I think the cup of chia in sunlight will _____ because _____ . I also think the cup of chia in the closet will _____ because _____ . Talk about how scientists use what they already know to help them make their predictions. Guide students to give a reason for their thinking.

6. Have students make observations the first day of the investigation and once every one or two days for at least two weeks. Demonstrate your expectations by carefully modeling how to draw and label observations on the "My Observations" worksheet pages. Over the next several days, have students share anything notable with the class. Have them measure the height of their chia plants in millimeters and record this information with their observations. Encourage them to make note of the color and overall appearance of the chia in each of the cups, as height does not always indicate health.

Explain

1. After sufficient time has passed (at least two weeks), discuss the conclusions. Talk about how changing variables cause reactions by the plant because it is a living organism. Summarize the sunlight investigation.

2. Demonstrate how to answer the question they initially posed by including evidence. For example: Sunlight affected the growth of the cup of chia by _____ because we noticed _____ in our investigation. Have each group write a summary with evidence on a separate sheet of paper.

3. If groups did not notice any significant difference between their two cups of chia, either not enough time had passed for results to occur or the variable they picked did not have a significant enough impact on the growth of their chia. The groups may choose to continue observing their chia or write that the variable they investigated did not influence the growth of chia enough to make a significant change.

4. Have students share their findings with the class via posters or display boards, including the question they were investigating, how they set up their investigation, and their conclusion (backed up with evidence from their observations).

5. Discuss how many of the things they investigated affected the growth of their chia plants. Explain the basic needs of plants: water, nutrients from the soil, sunlight, and carbon dioxide. Discuss what affected the growth of the chia plants based on student investigations and how each of those relates to plants' four basic needs.

6. Read Genesis 1:31 aloud:

   "God saw all that he had made, and it was very good. And there was evening, and there was morning—the sixth day."

7. Discuss how God's creation contains much beauty, especially in plants. Share some pictures of plants you find to be beautiful parts of God's creation. Then talk about ways in which plants are used to create

beauty, such as in floral arrangements, decorative wreaths, and food art. Have the students brainstorm some of these ways that they have encountered.

Elaborate

1. Explain that the students will be creating artwork with chia seeds to create beauty. Have students use markers to draw on paper towel. Have them use a pipette or squeeze bottle to add the chia gel to their artwork; then have them moisten the paper towel and put it inside a resealable plastic sandwich bag. Have students observe these over time. It is not necessary to put them in direct sunlight; they will germinate almost anywhere. Have students decide where they would like to put them.

2. You may also choose to have students create their own "chia pets" with egg shells. You may wish to do the prep work ahead of time. Hard boil one egg per student and slice off the top fourth of the hard–boiled egg. Remove the egg from the bottom three–fourths of the shell. Have students draw a fun face or decoration on the outside with permanent markers. Have them soak a cotton ball in water, roll it in chia seeds or sprinkle some chia seeds on the cotton ball, and put it in the base of the egg shell. Allow time for the seeds to germinate, ensuring that the cotton ball stays moist.

Evaluate

1. Have students write about the four basic needs of plants, using evidence from classroom investigations to support their answers. Since you investigated sunlight as a class, students should make sure to use evidence from that investigation. Have them also describe other variables that affect plant growth with evidence from the classroom investigations. They may use the summaries they wrote for their own investigations as part of their written work here.

2. Have students brainstorm another way they could use plants to create beauty to share with someone to brighten their day. If time and resources permit, you may choose to allow students to continue to create beauty with plants to share with others. Pressing and drying leaves and/or flowers as a class would be one option.

Resources

Bozemanscience. "Cause & Effect: Mechanism and Explanation." Accessed April 24, 2014. http://www.bozemanscience.com/ngs-cause-effect-mechanism-and-explanation

Bozemanscience. "Planning & Carrying Out Investigations." Accessed April 24, 2014. http://www.bozemanscience.com/ngs-planning-carrying-out-investigations

eHow. "Chia Crafts for Children." Accessed April 26, 2014. http://www.ehow.com/info_8450419_chia-crafts-children.html#ixzz306la1l81

Eimer, Timothy, and Barbara Ferrier. "What Do Plants Need?" Christian Schools International 2nd Edition Science Curriculum, Grade 3, 2011.

Fine, Caitlin, and Margaret Conover. "Ch–Ch–Ch–Chia Seed Science." *Science and Children,* December 2013.

Interdependent Relationships in Ecosystems

Sample Lesson 2

How Does God's Design for Seed Dispersal Lead Us to Enjoy Creation?

Structuring the Curriculum

Students should have an understanding of the parts of plants, the function of these parts, and especially that seeds provide a way for a plant species to continue to survive as it grows into a new plant of the same species.

This lesson begins by engaging students into thinking about different ways God planned for plants to disperse their seeds. Through an outdoor activity, they will then explore what it means for seeds to be dispersed, after which they will read about and view examples of a variety of seeds, and they will learn about their physical characteristics.

If your school library does not have *Planting the Wild Garden* by Kathryn O. Galbraith, reserve it from your local library or order it for future classroom use.

Students will be given task cards to modify dried beans/peas in order to mimic God's creation of seed dispersal.

Objective

NGSS 2-LS2-2: Students who demonstrate understanding can develop a simple model that mimics the function of an animal in dispersing seeds or pollinating plants.

Throughline

Creation-enjoyer: Science encourages students to observe the world with all their senses, noticing and drawing attention to what there is to be seen in God's world.

Vocabulary

seed dispersal—the movement of seeds from the parent plant

Preparation and Materials

- Open area outdoors (or gymnasium)
- Bucket or tub of beanbags
- *Planting the Wild Garden* by Kathryn O. Galbraith
- Dried beans or peas, at least five per pair or group
- "Seed Modification Checklist" worksheet, one per student (see pages 51-52)
- Supplies for modification of dried beans/peas, such as tape, rubber bands, cotton balls, craft sticks, balloons, pipe cleaners, string, paper clips, paper, glue, scissors

Background

You see a dandelion puff and you want to blow it, a maple key and you want to throw it up and watch it twirl down, or a milkweed seed and you want to catch it and make a wish. This lesson begins by engaging students into thinking about different ways God created plants to disperse their seeds. Through video and physical activity, students will be awestruck at the ways God designed seeds.

Seed dispersal occurs so that the parent plant is not overcrowded by new plants of the same species and so that the new plants have room to grow. Seeds are dispersed in a variety of ways: through water, wind, animals, and mechanical methods. Some seeds float and are dispersed by moving downstream in a stream or river or even by rain washing seeds to a new location. Seeds that have puffy coverings or winglike features are dispersed by the wind. Animals disperse seeds by eating fruit and passing the seed through their digestive systems, by burying seeds for later use, or even by carrying them to a new location on their fur. Mechanical methods include a seed pod drying out and opening up to "shoot" seeds away from the parent plant.

Scientists use models to understand the natural world around them. The goal is to help elementary students become familiar with and develop their own models by making drawings and representing phenomena, as well as using them. In this lesson, students will create physical representations of seeds to be dispersed in a variety of ways.

Lesson Steps

Engage

1. Tell students that they will be learning more about God's creation today. Scientists look at God's creation and try to make sense of it. As God's children, we do the same thing, but we also are able to look at it as though it is a gift waiting to be unwrapped.

2. Read Psalm 65:8 aloud:

   The whole earth is filled with awe at your wonders;
   where morning dawns, where evening fades,
   you call forth songs of joy.

3. Ask students if they have ever been as much in awe of anything God has created as this verse describes. Allow them to share with each other or the class. As you share the following video clips, encourage them to look for ways to rejoice in God's creation. Both clips are from PBS's Nature episode *The Seedy Side of Plants*. Though some of the vocabulary is advanced, the videography is beautiful.

   - www.pbs.org/wnet/nature/episodes/the-seedy-side-of-plants/video-flying-seeds/4664/
   - www.pbs.org/wnet/nature/episodes/the-seedy-side-of-plants/video-shooting-seeds-burrowing-seeds/4665/

4. Have students share ways in which they may have rejoiced in God's creation of seeds during the video clips.

Explore

1. Briefly review the function of seeds: they provide a way for a plant to reproduce.

2. Find an open area outdoors to play a game about seed dispersal. Before you begin, explain that one student will represent a tree or plant, and beanbags will represent seeds. Other students will take the place of the beanbag seeds and represent where

the seeds are dispersed from the adult tree. Discuss that a new plant will continue to grow if it has the things it needs: sunlight, water, nutrients from the soil, and carbon dioxide.

Scenario 1: Gravity

Have one student pretend to be a tree by spreading out his or her arms. Tell the class that each beanbag in the bucket or bin by the tree represents a seed. With this type of tree, the seed drops to the ground. Have the student drop each seed to the ground and have another student stand where the beanbag lands. Continue until the area has become too crowded.

Scenario 2: Wind

Have another student pretend to be a tree. This time the wind will help disperse the seeds. Have the student throw the beanbags in multiple directions. Again, have other students stand wherever a beanbag lands. Continue until it is evident that these seeds disperse farther than those that disperse by gravity alone.

Scenario 3: Water

Have another student pretend to be a plant. This time, the water will help disperse the seeds. Have the student roll the beanbags (as best as possible) in multiple directions to represent rain washing seeds away or them floating downstream. Again, have students stand where the beanbags land. Continue until it is evident that these seeds also disperse farther than the ones dispersed by gravity alone.

Scenario 4: Birds

Have one student pretend to be a tree, while three pairs of students pretend to be birds. Have one of each pair of students mimic birds taking a seed to eat and flying off to meet its partner. Then have his or her partner make a bird call; the one carrying the seed should make the same bird call, dropping the seed while doing so. When they drop their seeds, have another student from the class stand where they have dropped the beanbag. Continue until students see how birds help disperse seeds in this manner.

3. Ask the students to describe similarities and differences among the ways the seed was dispersed. Mention that these are just a few examples and that you will discuss more possibilities when you return to the classroom.

Explain

1. Talk about how God created ways for seeds to be dispersed away from the parent plant in order for the seeds to have a chance to grow. If they all fell to the ground right under the parent plant, the sunlight and nutrients needed for the new plants to grow would be mostly taken up by the parent plant.

2. Read *Planting the Wild Garden* by Kathryn O. Galbraith. This book has great illustrations and examples of how seeds are dispersed. As you read, make connections between the previous seed dispersal activity and the ways the author describes how the wild garden is planted. Focus on wind, water, mechanical, and animal dispersal. Also, pause and reflect on how God created each of these methods, and allow students time to share any connections they have made with the text. Enjoy God's creation through this book, as the illustrations contain some great detail to explore.

3. Use the following websites to show pictures of a variety of seeds. Describe the seeds' physical characteristics and how they relate to their dispersal. For example, brightly colored berries attract animals, who eat them and disperse the seeds in their droppings. The websites offer several examples of each method of dispersal.

- theseedsite.co.uk/dispersal.html
- www.vtaide.com/png/seed–dispersion.htm

4. As you work through the pictures and examples, reflect again on how God's creation of seed dispersal is a gift for students to unwrap and figure out.

Elaborate

1. Explain that students will use their understanding of seed dispersal to create models for many of the methods by modifying dried beans or peas.

2. First test some different seeds together as a class in the following seed dispersal interactive game. This may give students a better idea as to what affects seed dispersal. If students seem to catch on to the workings of the game, you may choose to have them explore the activity further with partners. revolution.caret.cam.ac.uk/flash/seeds.swf.

3. Divide the class into pairs or small groups, and distribute five dried beans or peas to each group. Distribute the "Seed Modification Checklist" worksheet. Encourage students to draw their models and then test them. If they need to make further modifications, guide them to modify their drawings and then make modifications to their drawings.

- How can you change your seed so that it floats on water?
- How can you change your seed so that it hooks onto animal fur?
- How can you change your seed so that it glides through the air?
- How can you change your seed so that it shoots through the air?
- How can you change your seed so that it attracts animals?

Evaluate

1. Have students draw an example of a seed for each type of dispersal—wind, water, animal, and propulsion—and describe how God created the physical characteristics of each to disperse as it does. You may have students do this on drawing paper or create posters. Have them share their favorite method God created for seed dispersal and explain why it is their favorite.

2. Alternatively, have students draw how they modified their dried beans/peas in the previous activity and describe how the physical characteristics will help in its dispersal. You may have them do this on drawing paper or create small posters.

Resources

Bozemanscience. "Developing & Using Models." Accessed April 19, 2014. http://www.bozemanscience.com/ngs-developing-using-models

Galbraith, Kathryn O. *Planting the Wild Garden*. Atlanta: Peachtree Publishers, 2011.

"How Seeds Are Dispersed." Accessed April 25, 2014. http://www.vtaide.com/png/seed-dispersion.htm

Nature. "Video: Flying Seeds." In *The Seedy Side of Plants*. Accessed April 25, 2014. http://www.pbs.org/wnet/nature/episodes/the-seedy-side-of-plants/video-flying-seeds/4664/

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OPAL Explore Nature. “Summer: Seed Dispersal.” Accessed April 25, 2014. http://www.opalexplorenature.org/sites/default/files/7/file/education–packs–summer.pdf

Revolution. “Seed Dispersal.” Accessed April 25, 2014. http://revolution.caret.cam.ac.uk/flash/seeds.swf

“Seed Dispersal.” OBIS, 1979. Accessed April 25, 2014. http://www.outdoorbiology.com/files/resources/activities/SeedDispersal.pdf

Seed Site, The. “Seed Dispersal: How Plants Spread.” Accessed April 25, 2014. http://theseedsite.co.uk/dispersal.html

Earth's Systems: Processes That Shape the Earth

An Introduction

NGSS performance expectation 2–ESS1–1: *Students who demonstrate understanding can use information from several sources to provide evidence that Earth events can occur quickly or slowly.*

Throughline: Order–discoverer

Science points out the order and harmony imposed on creation by God. Johannes Kepler reflected on order discovery when he said, "When things are in order, if the cause of the orderliness cannot be deduced from the motion of the elements or from the composition of matter, it is quite possibly a cause possessing a mind" (*Kepler's Somnium: The Dream, or Posthumous Work on Lunar Astronomy*).

The order of the universe calls out that there is a creator. The creation story is one of God creating order out of chaos. Our desire is to point out to students God's faithfulness that can be seen in the orderliness of his creation. Creation is covered with God's fingerprints. Our students must come to the same conclusion as Paul: "what may be known about God is plain to them, because God has made it plain to them. For since the creation of the world God's invisible qualities—his eternal power and divine nature—have been clearly seen, being understood from what has been made, so that people are without excuse" (Romans 1:19–20).

Kepler points out, "The chief aim of all investigations of the external world should be to discover the rational order and harmony which has been imposed on it by God and which He revealed to us in the language of mathematics" (*Astronomia Nova*, 1609).

Students will be able to see God's order in planetary motion, in the atom, in DNA, in waves, and in the forces at work around them. All have rules to follow; once discovered, these rules point to God as the creator.

Students understand that in the beginning God created and shaped the Earth. It is more difficult for students to comprehend that God continues to shape the Earth today through many means, including erosion. Colossians 1:16–17 tells us: "For in him all things were created: things in heaven and on earth . . . . He is before all things, and in him all things hold together."

The Earth's surface changes constantly. Animals move the soil when they dig. Plants deplete and restore soil nutrients. Wind and water cause weathering and erosion.

These are slower processes than earthquakes, volcanoes, and landslides, which cause dramatic changes in the Earth's surface quite quickly. Students can look for the God–given order in erosion by noticing the patterns of change on the Earth's surface due to wind, water, and glaciers by repeatedly answering the question of God's design of shaping the Earth through erosion.

*__NGSS performance expectation 2–ESS2–1:__ *Students who demonstrate understanding can compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land.*

NGSS performance expectation 2–ESS2–2: *Students who demonstrate understanding can develop a model to represent the shapes and kinds of land and bodies of water in an area.*

NGSS performance expectation 2–ESS2–3: *Students who demonstrate understanding can obtain information to identify where water is found on Earth and to confirm that it can be solid or liquid.*

*No sample lesson is provided for this performance expectation, but only a suggested Throughline.

Throughline: Earth–keeper

Science challenges students to consider how they can encourage themselves and others to reclaim the world and relearn how to treat all things contained in it with respect. Christians often use Genesis 1:28 as our cultural mandate, in which God commands us to have dominion over and subdue creation. The historical, cultural definition of these words are "rule" or "bring under control." In Genesis 2:15, however, the command is different: "The Lord God took the man and put him in the Garden of Eden to work it and take care of it." The Hebrew word *avad* is used here. *Avad* is typically used in other places to describe slaves serving masters. We are to serve God by serving his creation. John Wesley writes it this way: "We are now God's stewards. We are indebted to him for all we have . . . . A steward is not at liberty to use what is placed in his hands as he pleases, but as his master pleases . . . . He is not the owner of any of these things but barely entrusted with them by another" (sermon, "The Good Steward," 1768).

In science, we need to challenge students to think about reclaiming the world and relearning how to treat all creation with respect. Teachers need to point out where people have not served creation; they also need to find real opportunities for service learning—for example, providing class time to clean up rivers and parks or build paths and gardens.

The erosion of the dustbowl of the 1930s was partly caused by overcropping. A cause of landslides is deforestation. The crisis in the Sahel area of Africa is caused by overgrazing. Humans can cause an increase in natural erosion activity. Humans can also slow the erosion. God has called us to keep his Earth. Students can test windbreaks (such as trees or stone walls), reforestation, and improved farming to reduce the rate of erosion caused by natural factors such as water and wind.

"And God said, 'Let the water under the sky be gathered to one place, and let dry ground appear.' And it was so. God called the dry ground 'land,' and the gathered waters he called 'seas.'" (Genesis 1:9). And God saw that it was good, and it continues to be good.

As students learn the vocabulary for various bodies of water, they will come to understand the intricacies and patterns in God's designs for the bodies of water. As they examine our use of God's gift of water, they will feel a sense of sadness in how we have abused God's precious gifts. Pollution and wasting the Earth's resources may cause them to despair; remind them that not only has God created all things, but he has also planned for restoration and renewal for the Earth. He calls us, his children, to share in this plan, to provide hope and healing for his creation. Therefore we can pray with the students, "For the waters of the earth; for their careful use and conservation, that we may have the skill and the will to keep them clean and pure."

Earth's Systems: Processes That Shape the Earth

Sample Lesson 1

What Is God's Order for Shaping the Earth's Surface?

Structuring the Curriculum

The lesson begins with a demonstration of how water expands as it freezes, cracking rock. You may wish to try this activity ahead of time to find the desired consistency of plaster of paris and gain the expected results. Students will then investigate God's order for shaping the Earth's surface through wind, water, and ice. If materials are limited, you may wish to set up the first three activities in the Explore section as centers for students to rotate through.

Preparation and Materials

- Engage: two milk cartons (250 ml), plaster of paris (prepare enough so that it almost fills both milk cartons), balloon (preferably a water balloon), water
- Activity 1: How Does the Wind Change Earth's Surface?: newspapers (one per station or per team); aluminum pie plates (one per station or per team); sand, gravel, and potting soil mixture (enough to fill one pie plate per team); plastic drinking straws (one per student); rulers (one per station or per team)
- Activity 2: How Does Rain Change Earth's Surface?: newspapers (one per station or per team); aluminum pie plates (one per station or per team); sand, gravel, and potting soil mixture (one container per station or per team); droppers (one per station or per team); water; meter sticks (one per station or per team)
- Activity 3: How Do Waves Change Earth's Surface?: newspapers (one per station or per team); dishpans (one per station or per team); damp sand; water; rulers (one per station or per team)
- Activity 4: How Do Glaciers Change Earth's Surface?: newspapers, milk jug, water, dishpan,

Objective

NGSS 2-ESS1-1: Students who demonstrate understanding can use information from several sources to provide evidence that Earth events can occur quickly or slowly.

Clarification statement: Examples of events and timescales could include volcanic explosions and earthquakes, which happen quickly, and erosion of rocks, which occurs slowly.

Assessment boundary: Assessment does not include quantitative measurements of timescales.

Throughline

Order-discoverer: Science points out the order and harmony imposed on creation by God.

Vocabulary

erosion—the wearing down of Earth's surface due to wind, water, and ice

gravel, soil

- "Erosion" worksheets, four pages per student, stapled (see page 53)
- "Sandcastle Erosion" worksheets, one per student (see page 55)

Background

Students understand that in the beginning God created and shaped the Earth. Understanding that God continues to shape the Earth today through many means, including erosion, is more difficult. Colossians 1:16–17 reminds students: "For in him all things were created: things in heaven and on earth . . . . He is before all things, and in him all things hold together."

The Earth's surface changes constantly. Animals move the soil when they dig. Plants deplete and restore soil nutrients. Wind and water cause weathering and erosion. These are slower processes than earthquakes, volcanoes, and landslides, which cause dramatic changes in the Earth's surface quite quickly. In this lesson students look for the God–given order in erosion by noticing the patterns of change on the Earth's surface due to wind, water, and glaciers and by considering God's design of shaping the Earth through erosion.

Erosion occurs because moving wind and water carry energy. As that energy is converted to other forms (such as heat that occurs at the points of friction), there is less energy of motion; the particles of soil that were lifted and carried along by the water or wind are then deposited.

Lesson Steps

Engage

1. Begin the lesson with a demonstration. Fill a balloon with water until it is about the size of a ping-pong ball. (If possible, use a water balloon.) Tie a knot at the end so there is minimal air left in the balloon. Fill two milk cartons with prepared plaster of paris, and push the balloon down into one of the milk cartons so that the balloon is just covered. Hold the balloon in place until the plaster has set enough so that the balloon does not surface. Let the plaster harden completely, and then place both milk cartons in the freezer, marking which milk carton contains the balloon.

2. Have students predict what will happen to the milk cartons when they are frozen. As they discuss, encourage them to back up their predictions with an explanation based on prior experience or understanding.

3. After the plaster–filled milk cartons have been removed from the freezer, have students observe what has happened. (The plaster with the balloon should have cracked, while the one without the balloon should not have cracked.)

4. Explain that God planned this process to help shape the Earth. Water seeps into cracks in rocks and expands as it freezes, enlarging the cracks. Explain that students will be exploring other processes that God set into place to help shape the Earth's surface.

Explore

1. Read Psalm 102:25–28 aloud:

   In the beginning you laid the
   foundations of the earth,
   and the heavens are the work of
   your hands.
   They will perish, but you remain;

they will all wear out like a
garment.
Like clothing you will change them
and they will be discarded.
But you remain the same,
and your years will never end.
The children of your servants will
live in your presence;
their descendants will be
established before you.

This passage proclaims that God will never change but that the Earth will wear out. Ask students how they think the Earth's surface changes. Record all responses. As they share, ask them to describe the change to the Earth's surface. For example, if students simply say "earthquakes," have them explain how earthquakes might change the Earth's surface.

2. Explain to students that they will be investigating the order in processes God set in place to shape the Earth's surface through a series of activities. They will be investigating the question, "How is the Earth's surface shaped by wind, water, and ice?"

   Activity 1: How Does the Wind Change Earth's Surface?

   Have students fill in the top portion of the "Erosion" worksheet so that it says "God's design of shaping the Earth through wind." Describe the activity to the students and have them predict what will happen. As they make their predictions, have them record them on their worksheets and also jot down their reasoning (or explanation) for it.

   Spread out a newspaper. Fill an aluminum pie plate with the soil mixture and set the pie plate on a newspaper. Tell students to hold a drinking straw about 30 cm (12 inches) away from the side of the pie plate and to blow gently through the straw at the soil. Ask the following questions:

   - Did bits of soil blow away?
   - Did one kind of soil blow away more easily than the others?

   Have students record their observations on their worksheets.

   Now have students hold the straw about 10 cm (4 inches) away from the side of the pie plate and blow at the soil again. Ask the following questions.

   - How much soil was blown away this time?
   - How far were soil particles moved?
   - When might this happen in nature?

   Have students record their observations on their worksheets.

   Activity 2: How Does Rain Change Earth's Surface?

   Have students fill in the top portion of the second worksheet so that it says "God's design of shaping the Earth through rain." Describe the activity to the students, and have them predict what will happen. As they make their predictions, have them record the predictions on their worksheets and also jot down their reasoning (or explanation) for it. Note to teacher: the results of this activity will vary depending on how dry the soil is.

   Fill a pie plate with the soil mixture, and set the pie plate on a newspaper. Direct students to press the soil to flatten and smooth it. Then have them fill the dropper with water, hold the dropper about 1 m above the soil, and squeeze several drops of water onto the soil. Ask the following questions:

   - Did the water change the soil?
   - How far away did the grains move?

   Have students record their observations on their worksheets.

Have students carefully stand on their desks and hold the dropper about 2 m above the soil and squeeze several more drops of water onto the soil. (You could also do this step for them.) Ask the following questions:

- How much soil moved this time?
- How far away did the grains move?
- Do you think that raindrops falling from a cloud could move soil?

Have students record their observations on their worksheets.

Activity 3: How Do Waves Change Earth's Surface?

Have students fill in the top portion of their third worksheet so that it says "God's design of shaping the Earth through waves." Describe the activity to the students, and have them predict what will happen. As they make their predictions, have them record them on their worksheets and also jot down their reasoning (or explanation) for it.

Place a dishpan on a spread–out newspaper. Have students use sand to build a "beach" on one side of the dishpan. Then have them gently pour water into the other side of the dishpan, trying not to disturb the "beach."

Tell them to make small waves in the water by lightly tapping it with the ruler. Ask the following questions:

- Do the waves move the sand?
- Do you think that waves would move more or less sand if plants were growing on the beach?
- Do you think water in a river could move soil?
- How could you find out?

Have students record their observations on their worksheets.

Activity 4: How Do Glaciers Change Earth's Surface?:

Have students fill in the top portion of their fourth worksheet so that it says "God's design of shaping the Earth through glaciers." Describe the activity to the students, and have them predict what will happen. As they make their predictions, have them record them on their worksheets and also jot down their reasoning (or explanation) for it.

Describe glaciers. You may wish to do this activity as a whole class to demonstrate glacial erosion. Freeze gravel and water in the bottom of a milk jug. The frozen mixture is a model of a glacier. Fill a large flat pan with clay or soil. Model the process of glacial movement by scraping the ice block across the clay or soil. As an alternative, place the ice block on an elevated area of soil or clay, and let it melt. Have students observe and record the changes in the soil's surface.

To create mini–glaciers, place sand and gravel in an ice cube tray, fill with water, and freeze.

Explain

1. Refer to the initial question: "How is the Earth's surface shaped by wind, water, and ice?" Have students share their ideas and back them up with evidence from the previous activities.
2. Point out that they have investigated ways by which the Earth's surface goes through erosion: through wind, water, and ice. These factors slow changes to the size and shape of landforms.
3. The following document has several photographic examples of weathering and erosion. Use the pictures to explain how

God uses wind, water, and ice to create the changes that are depicted. Relate the pictures to the activities the students just explored. www.doe.virginia.gov/instruction/gifted_ed/project_promise/science_curriculum/grade_two/handouts/earth_science/weathering_erosion_pictures.pdf

4. The following video has some good examples of weathering and erosion. Have the students view the video clip independently in your school's computer lab. The video clip becomes grainy if you zoom in on it. When they are done, relate what they have learned from the video to the activities they did. www.unitedstreaming.com/videos/dsc/externalApplications/interactiveVideos/index.html?vid=32

Elaborate

1. Distribute the "Sandcastle Erosion" worksheet. Have students pretend that they are building a sandcastle at the beach or in a sandbox. They should draw and label the sandcastle that they have imagined building. Then they should imagine erosion occurring on the sandcastle. Have them draw, label, and describe this erosion.

Evaluate

1. Students should be able to relate how God designed processes to continually shape the Earth's surface. Wind, water, and ice cause erosion of the Earth. Students should also be able to explain how each of these factors changes the Earth's surface slowly. Their answers to the Elaborate portion of the lesson will also serve as an evaluative tool.

Resources

Discovery Education. "Weathering and Erosion." Accessed April 14, 2014. http://www.unitedstreaming.com/videos/dsc/externalApplications/interactiveVideos/index.html?vid=32

Ferrier, Barbara. "How Does the Earth Change?" Christian Schools International 2nd Edition Science Curriculum, Grade 1, 2011.

Public Broadcasting Service. "Breaking it Down." Accessed April 14, 2014. http://www.pbs.org/wnet/nature/lessons/breaking-it-down/activities/1700/

"What is the difference between weathering and erosion?" Accessed April 14, 2014. http://www.doe.virginia.gov/instruction/gifted_ed/project_promise/science_curriculum/grade_two/handouts/earth_science/weathering_erosion_pictures.pdf

Earth's Systems: Processes That Shape the Earth

Sample Lesson 2

How Can We Teach Others to Be Good Stewards of God's Gift of Water?

Structuring the Curriculum

Students should have already gained an understanding of a variety of the Earth's landforms. This activity will introduce them to bodies of water.

The lesson begins with an activity to get students thinking about the ratio of land to water on the Earth's surface. They will then brainstorm what they already know about bodies of water and explore their makeup through an activity in which they make and refine models of common bodies of water.

If your school's library does not have *Follow the Water from Brook to Ocean* by Arthur Dorros or *Make a Splash!* by Cathryn Berger Kaye, reserve them ahead of time from your local library, or order them for future classroom use.

Students will then discuss the importance of keeping these bodies of water clean and gain the opportunity to discuss and present ways to take care of God's creation of water.

Objective

NGSS 2-ESS2-2: Students who demonstrate understanding can develop a model to represent the shapes and kinds of land and bodies of water in an area.

Assessment boundary: Assessment does not include quantitative scaling in models.

NGSS 2-ESS2-3: Students who demonstrate understanding can obtain information to identify where water is found on Earth and that it can be solid or liquid.

Throughline

Earth-keeper: Science challenges our students to think about how they can encourage themselves and others to reclaim the world and relearn how to treat all things contained in it with respect.

Vocabulary

body of water—part of the Earth's surface covered by water (e.g., ocean, lake, pond, river, stream)

Preparation and Materials

- Inflatable globe
- "What Does the Earth Look Like?" worksheet, one per student (see page 57)
- "Bodies of Water" worksheet (see page 59)
- "Venn Diagram" worksheet, one per student (see page 61)
- Foam deli trays, one per pair
- Non–hardening modeling clay, at least two sticks per pair
- Plastic cups filled with water, one per pair

- Plastic cups with four small holes in bottom, one per pair
- *Follow the Water from Brook to Ocean* by Arthur Dorros
- *Make a Splash!* by Cathryn Berger Kaye or similar resource on how kids can help protect our world's water
- Paper and supplies for students to make a brochure or poster

Background

"And God said, 'Let the water under the sky be gathered to one place, and let dry ground appear.' And it was so. God called the dry ground 'land,' and the gathered waters he called 'seas'" (Genesis 1:9). And God saw that it was good, and it continues to be good.

In this lesson, students will learn the vocabulary for various bodies of water. They will come to understand the intricacies and patterns in God's designs for the bodies of water. As they examine our use of God's gift of water, they will feel sadness over human abuse of God's precious gifts. Pollution and wasting the Earth's resources may cause them to despair. Remind them that God has not only created all things but has planned for restoration and renewal for the Earth. He calls us, his children, to share in this plan, and to provide hope and healing for his creation. Therefore, we can pray with the students: "For the waters of the earth; for their careful use and conservation, that we may have the skill and the will to keep them clean and pure."

For the purposes of this lesson, students will discuss the ratio of land to water as three–fourths water and one–fourth land; technically, it is close to 71 percent and 29 percent.

Common bodies of water include oceans, lakes, ponds, rivers, and streams. Streams are smaller flowing bodies of water that flow into larger flowing bodies of water called rivers. Rivers continue to flow downhill into ponds, lakes, or oceans. Lakes and ponds are bodies of water that are surrounded by land. Oceans are the largest bodies of water and surround continental land.

Lesson Steps

Engage

1. Have students brainstorm what the Earth's surface is like. They may mention mountains, plains, deserts, oceans, etc. Ask if they know how much land there is compared to water on the Earth's surface. Allow for discussion.
2. Have them draw their prediction in the first circle on the "What Does the Earth Look Like?" worksheet. Direct them to use blue to represent water and one other color to represent the land. They will revisit this worksheet later.
3. Display the inflatable globe and discuss the variety of colors and what they represent. Explain how they will use the inflatable globe for the activity. Pass the globe around, and as each student grabs it, have him or her identify where their index fingers are pointing—land or water. Keep track with a tally chart visible to the class.
4. You may wish to continue the activity for a second round so that the tally chart more obviously indicates a larger number of times that students' fingers landed on water than land. Discuss the findings, and explain that about three–fourths of the Earth's surface is made up of water, while the remaining one–fourth consists

of land. You may choose to draw a circle, divide it into fourths, and color in three–fourths blue and one–fourth green to better visually represent this.

5. Show a photo of Earth from space, such as eoimages.gsfc.nasa.gov/images/imagerecords/0/501/goes_earth_millenium.jpg and discuss why Earth is often referred to as the Blue Planet or the Big Blue Marble. (It looks blue because of all the water on Earth).

6. Refer to students' drawings of their predictions of the ratio of water to land. Have them modify their drawing in the second circle on the worksheet based on the activity and photo.

Explore

1. Talk about how scientists create models so they can better understand what they are investigating. Point out that the students are going to be doing just that. They are going to be creating models of bodies of water on Earth.

2. Brainstorm with students and allow them to tell about the bodies of water with which they are familiar. They may mention and describe oceans, lakes, rivers, etc.

3. Place students in pairs and have them draw with pencils bodies of water and landforms on the activity sheet "Bodies of Water."

4. Distribute the foam trays and modeling clay to each student pair. First, have them shape the clay so that it slopes gradually from one end of the tray to the other.

5. Have students work in pairs to model the different bodies of water and landforms they drew on their worksheets.

6. Distribute plastic cups filled with water and empty plastic cups with holes in the bottom. Have students pour the water from the filled cups to the cups with the holes over top their models and observe what happens.

7. Encourage students to add the water slowly and not to completely saturate their models. Students should carefully observe what happens.

8. After they have distributed the water, ask them about where the water flowed and gathered in their models. If they included any slopes on their models, where did the water flow? Did the angles or shape of the landforms they modeled affect the flow or gathering of water? Allow them to relate their observations of their models to real life experiences.

9. After your discussion, ask them if they would like to make any changes to their initial drawings of the water on the Earth's surface. They will be filling in the final circle on their worksheet at a later time.

Explain

1. Have student pairs share with the class the models they created and whether they want to adjust their initial drawings.

2. Discuss God's creation of the seas and how water occurs in different forms on the Earth's surface. Show a landform map of the United States or Canada to help in this discussion.

   - Ocean: An ocean is the largest body of water, much larger than a lake or pond. Oceans are very deep and surround the continents. The ocean floor has mountains, volcanoes, and valleys.

   - Lake or pond: A lake is a body of water that is surrounded by land. It is a depression (or low spot) in the ground filled with water. A pond is a small lake.

   - River or stream: A river is a path of flowing water through the land. It flows from high to low ground into lakes and other

rivers (which eventually flow into the ocean). A stream is a small river.

- Rivers and streams flow into larger bodies of water, such as lakes and ponds, which are surrounded by land. Oceans are the largest bodies of water and surround our continents. Talk also about how water on the Earth's surface can be liquid or frozen (in winter or in glaciers).

3. Use *Follow the Water from Brook to Ocean* by Arthur Dorros to aid your discussion. This book talks about the flow of water on the Earth's surface from a brook to an ocean. You could use a similar resource as well. As you read, have the students refer to their clay models and add any details necessary to accurately portray bodies of water. After you finish reading and they have adjusted their models, allow them to drip a bit more water over them to observe the water flow. Discuss their observations regarding any changes they made.

4. Discuss how scientists' models often change as they learn more about what they are investigating. Relate this to this activity.

5. After you discuss each body of water and the students are satisfied with their models, use the Venn diagram to compare characteristics. Discuss how to use the three interlocking circles on the diagram. Have the students label one circle "oceans," another "lakes/ponds," and the last "rivers/streams." You may wish to have one displayed for the whole class to view as you fill this out together.

6. Direct students to fill out the last circle on their "What Does the Earth Look Like?" worksheet that includes their new knowledge of bodies of water.

7. Read Genesis 1:9–10 aloud:

> And God said, "Let the water under the sky be gathered to one place, and let dry ground appear." And it was so. God called the dry ground "land," and the gathered waters he called "seas." And God saw that it was good.

Elaborate

1. Discuss how much of Earth's surface water is the salt water found in oceans or the frozen water near the poles. That leaves only a fraction of fresh water left for plants, animals, and people to use. Refer back to the circle you divided into fourths. Demonstrate that a very small sliver of the water—only 1/3200—would be usable by plants, animals, and humans. Talk about how we use water (for drinking, watering gardens, doing dishes, etc.).

2. Talk about water pollution and wasting the Earth's water.

3. Read Genesis 1:26 aloud, and discuss our mandate to take care of God's creation:

> Then God said, "Let us make mankind in our image, in our likeness, so that they may rule over the fish in the sea and the birds in the sky, over the livestock and all the wild animals, and over all the creatures that move along the ground."

4. Explain that it is our responsibility to be good stewards and earthkeepers. Discuss the ways in which we could be good stewards of the water locally. Offer ideas to provide restoration and renewal for the Earth's water. *Make a Splash!* by Cathryn Berger Kaye offers some good ideas. Examine some of them together.

5. As a class, choose at least one way to conserve water together. Follow through with this plan as the school year progresses.

Evaluate

1. Evaluate the students' work on the last circle on the "What Does the Earth Look Like?" worksheet. Students should be able to show that the Earth's surface is close to three–fourths water and includes bodies of water in the land.
2. Have students make a poster or brochure to show how they could be good earthkeepers of a body of water in their community. Have them choose an audience (younger sibling, parent, grandparent, friend, classmate, etc.) to share it with.

Resources

Battle Creek Area Mathematics and Science Center Outreach Staff. *Earth's Land and Water.* Battle Creek: Battle Creek Area Mathematics and Science Center, 2008.

Dorros, Arthur. *Follow the Water from Brook to Ocean*. New York: HarperTrophy, 1991.

"Earth." Accessed April 15, 2014. http://eoimages.gsfc.nasa.gov/images/imagerecords/0/501/goes_earth_millenium.jpg

Kaye, Cathryn Berger. *Make a Splash!* Minneapolis: Free Spirit Publishing Inc., 2013.

"Lesson 1: The Blue Planet" In *Journey through the Universe*. Accessed April 15, 2014. http://journeythroughtheuniverse.org/downloads/Content/ESS_GK–4_L1.pdf

K–2 Engineering Design

Sample Lesson

How Can We Reflect God's Image by Using His Gift of Engineering to Help Others and Protect the Earth?

Structuring the Curriculum

Prior to teaching this lesson, it would be beneficial for students to have an understanding of rivers as bodies of water and water as a means of erosion. Students will begin this lesson by learning about flooding and ways to prevent flood damage in their communities. One of these ways is to build levees. They will research, design, and engineer at least two levees to find the best solution to a flooding problem. As they do this, they will evaluate the strengths and weaknesses of each design.

Preparation and Materials

- Science notebook pages (see page 63). Copy and staple at least five per student.
- Paint trays with slope, one per pair or small group
- Pitcher of water
- Plastic cups with four or five small holes poked in the bottom, one per pair or small group
- Moist sand, enough for a generous layer of sand on each sloped paint tray (damp potting soil also works well)
- Supplies for building levees: non-hardening modeling clay, craft sticks, rubber bands, toothpicks, small building bricks, paper clips, pipe cleaners, etc.

Objective

NGSS K-2-ETS1-3: Students who demonstrate understanding can analyze data from tests of two objects designed to solve the same problem to compare the strengths and weaknesses of how each performs.

NGSS 2-ESS2-1: Students who demonstrate understanding can compare multiple solutions designed to slow or prevent wind or water from changing the shape of the land.

Clarification statement: Examples of solutions could include different designs of dikes and windbreaks to hold back wind and water, and different designs for using shrubs, grass, and trees to hold back the land.

Throughline

Image-reflector: Science enables us to reflect God's image through our creativity and through the shalom we create.

Vocabulary

levee—a structure designed to prevent flooding

Background

Galileo said "I do not feel obliged to believe that the same God who has endowed us with sense, reason, and intellect has intended us to forgo their use" (letter to the Grand Duchess Christina, 1615). As students are encouraged to use their intellect and creativity, they are reflecting God's

image through the creative process. In this lesson students will design levees, thus further reflecting God's image by helping others and the Earth.

Levees, which block water and prevent flooding, are often made of earthen material. They may also be made out of wood, plastic, or metal and reinforced with concrete. Temporary levees can be made out of sandbags to help control flooding.

In order to teach students how to optimize the best design solution, help them brainstorm as many solutions that they can think of and try to decipher the best one to design. Lower elementary students should be building designs, comparing them, and testing them by observing their strengths and weaknesses.

Lesson Steps

Engage

1. Ask students if they have ever experienced flooding. If so, have them share their connections to flooding. Ask also what they think causes flooding. Create a word web about the students' current thinking about flooding.

2. Layer a generous portion of moist sand on the slope of a paint tray. Create depressions down the slope for a river and a few tributaries. You may also add other objects to simulate a town along the river.

3. Use a plastic cup with four or five small holes poked through the bottom to pour water near the top of the slope over top the depression for the river. As the sand becomes more saturated, the water should flow down the "river." As it becomes too saturated, you will notice some flooding.

4. Demonstrate what would happen if the rain were heavier or came all at once: the water would overflow the river completely.

5. Have students record their observations in their science notebook pages. Encourage them to create detailed drawings with good labels, as well as to write down their observations. Discuss what they observed.

6. Refer to the word web, and add some more causes of flooding. Explain that flooding can occur during heavy rainfall when the water comes too quickly (demonstrated in the previous activity), when levees or dams break, when a large amount of snow melts quickly when the ground is still frozen so that the water cannot soak into the ground, or even when large ocean waves wash ashore.

7. Explain that although some floods are disastrous and affect animal habitats and humans, some floods are beneficial. In some regions, seasonal flooding helps farmland gain nutrients and replenishes water supplies. Sometimes, though, flood waters contain toxic materials, and flooding affects the surrounding community negatively.

Explore

1. Explain that levees, dikes, dams, reservoirs, and flood walls are examples of things that are built to protect cities and land from flood risk. Planting in bare soil also helps reduce soil erosion because the plants help keep the soil in place.

2. Tell students that they are going to learn about levees and then design a levee to help reduce flood damage.

3. Have students research earthen levees, I-wall levees, and T-wall levees. The following website offers helpful graphics and brief descriptions of each type. You may find other resources as well that the

students may use: www.stronglevees.com/traditional/.

4. Have students write down the information they find in their science notebooks.

Explain

1. Connect the concepts about floods, levees, and floodplains by showing *Floodplains by Design* from the Nature Conservancy: www.youtube.com/watch?v=-PBT4OEJfGs .

2. Have students watch it one time through and listen for what devices are used to control flooding. If necessary, watch it a second time and point out some of the key ideas.

3. Discuss God's mandate for us to take care of the Earth. Explain how floods can damage the land and our communities by depositing toxic materials such as chemicals and sewage. Levees can help control flood damage. *Floodplains by Design* shares a design that not only helps protect communities but also preserves God's natural creation.

Elaborate

1. Read Genesis 1:27 aloud: "So God created mankind in his own image, in the image of God he created them; male and female he created them."

2. Together list how we reflect God by who we are through our inner being. We were created to reflect his love and compassion, as well as his grace and mercy. Talk about how humankind also reflects God's image through creativity in engineering. In their upcoming project, students will have a chance to reflect God's image by creating a way to help others and the Earth.

3. Explain that students will be designing and creating levees to help control flooding. Begin by using your flood model from earlier. Smooth out the moist sand and add a river through the land. Slowly fill the river with water and allow the water to flow down the river. The sand will continue to become saturated as more water is added to the model, re–creating a flood.

4. Talk about the flow of the river and what happens to it when a flood occurs. Explain that the levee they create should prevent the water from flooding the surrounding area and help direct the flow of the water to the bottom of the paint tray.

5. Brainstorm many ideas on designs for levees. Have students work in pairs or small groups and draw at least two designs of levees in their science notebooks, one per page. Have them use their knowledge of levees, floods, and floodplains to sketch their designs. Explain that there is more than one solution to any problem and that it is important to test more than one design in order to come up with the best one.

6. Allow time for students to build and test their designs. Guide them to list the strengths and weaknesses of each one on the science notebook pages where they made drawings. Allow them to modify and retest their designs to come up with the best solution.

7. After they have come up with a solution that prevents flooding and also directs the flow of the water, have them share their solutions with the class. Again, talk about how a problem may have many solutions.

Evaluate

1. Read Colossians 3:17 aloud, and connect it to students' work as God's image reflectors in their engineering activity: "And whatever you do, whether in word or deed, do it all in the name of the Lord Jesus, giving thanks to God the Father through him."

2. Have students draw the levee that worked best for them, record why they think it worked the best, and write what Colossians

3:17 means to them in their work of creating a levee to assist people and protect land from flooding. You may have students draw and write their responses on a science notebook page or another place of your choosing.

Resources

"Be a Hero! Youth Emergency Preparedness Grades 1-2" Accessed April 26, 2014. http://www.fema.gov/media-library-data/543412ca31bff9997896913115536a10/FEMA+LE+TG_082613_508.pdf

Bozemanscience. "ETS1C - Optimizing the Design Solutions." Accessed April 26, 2014. http://www.bozemanscience.com/ngs-ets1c-optimizing-the-design-solutions

eHow. "Science Projects With Flood Models." Accessed April 26, 2014. http://www.ehow.com/list_5953736_science-projects-flood-models.html

"Flooding Fast Facts." Accessed April 26, 2014. http://www.stopdisastersgame.org/en/pdf/Flooding_fact-sheet.pdf

My Life Is Education. "Second Grade – Earth's Systems: Processes That Shape the Earth." Accessed April 26, 2014. http://ramarrag.weebly.com/science-lesson-2nd-grade.html

National Geographic. "levee." Accessed April 26, 2014. http://education.nationalgeographic.com/education/encyclopedia/levee/?ar_a=1

The Nature Conservancy. "Floodplains by Design." Accessed April 26, 2014. http://www.nature.org/ourinitiatives/habitats/riverslakes/floodplains-by-design.xml

The Nature Conservancy. "What Is Floodplains by Design?" Accessed April 26, 2014. https://www.youtube.com/watch?v=-PBT4OEJfGs

StrongLevees. "Current Levee Solutions." Accessed April 26, 2014. http://www.stronglevees.com/traditional/

Name: _____

Data Table Worksheet

Object	Water Test	Bend It	Hard/Soft

Data Table Worksheet, continued

Object	See Through	Breakable	Other Properties

Name: _____

Uniquely Designed

Draw and label the object and the materials it is made from.

What if it were made out of _____

_____?

Why does it need to be made out of _____

_____?

Name: _____

God Is the Master Builder

Draw and label objects that give evidence that God uses smaller pieces in his creation.

Name: _____

Plant Investigation

1. What question is your group investigating?

_____

_____

2. Which variable is your group changing?

_____

_____

3. How do you plan to keep the other variables the same?

_____

_____

4. What do you predict will happen?

_____

_____

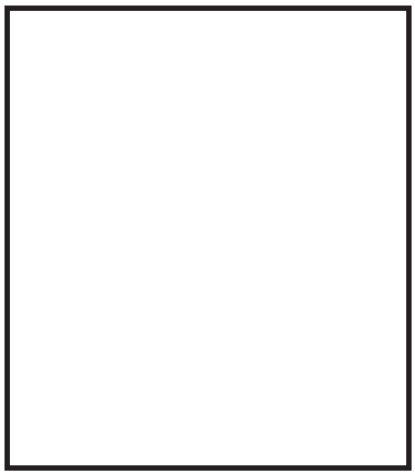
Name: _____

My Observations

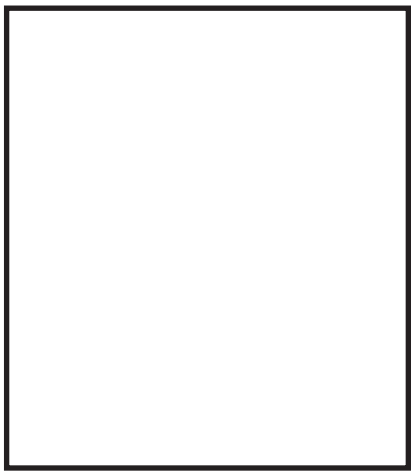
Draw and label both of your chia cups

Date:

_____



Cup _____



Cup _____

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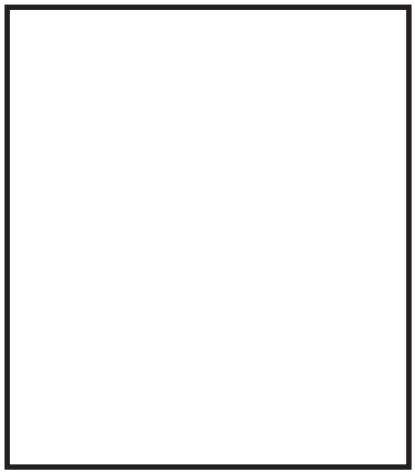

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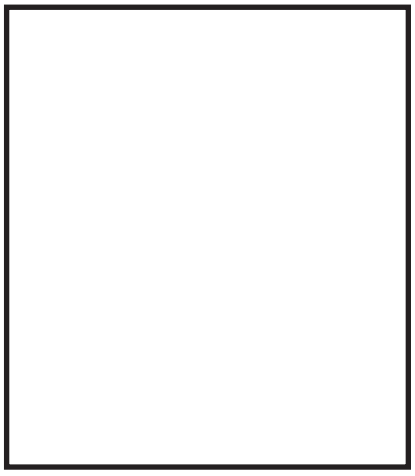
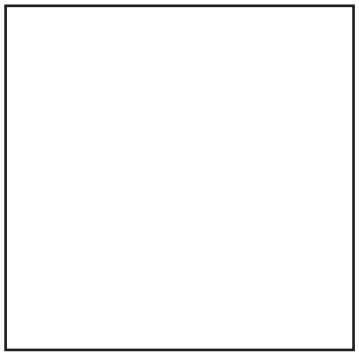


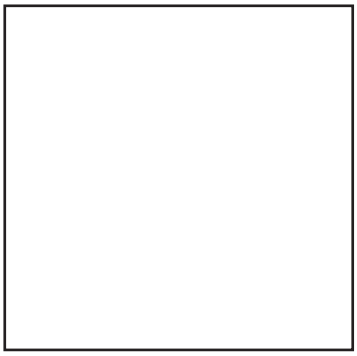
Cup _____

Name: _____

Seed Modification Checklist

1. How can you change your seed so it floats on water?





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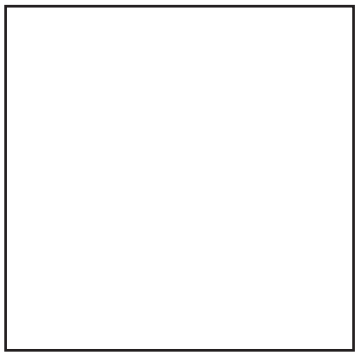
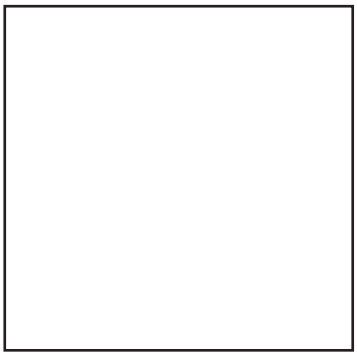
_____

2. How can you change your seed so it hooks onto animal fur?





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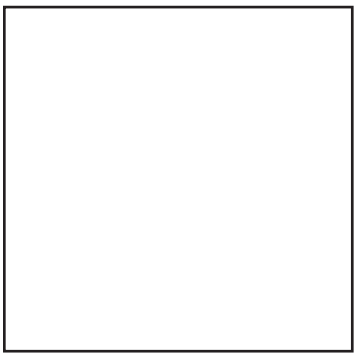
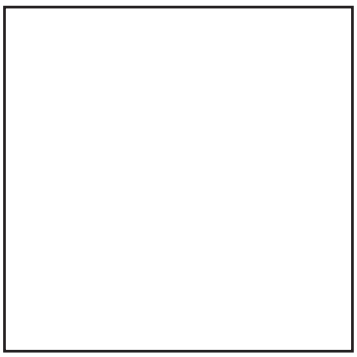
_____

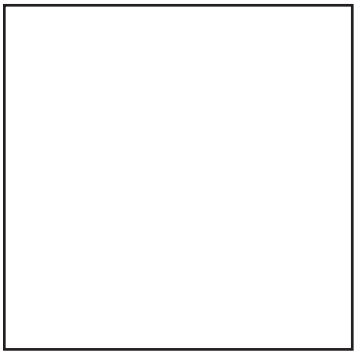
Seed Modification Checklist, continued

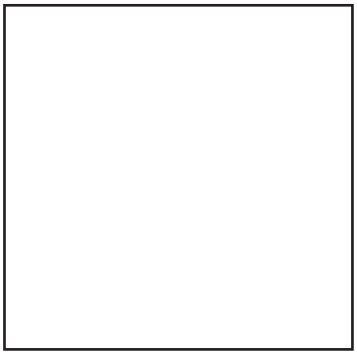
3. How can you change your seed so it glides through the air?



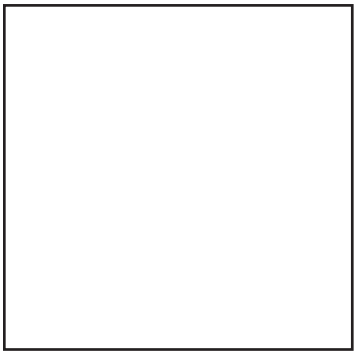


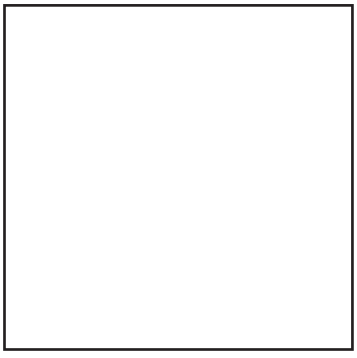
4. How can you change your seed so it shoots through the air?





5. How can you change your seed so it attracts animals?





Name: _____

Erosion

God's design of shaping the Earth through _____

Predictions

Observations

_____

_____

_____

_____

Name: _____

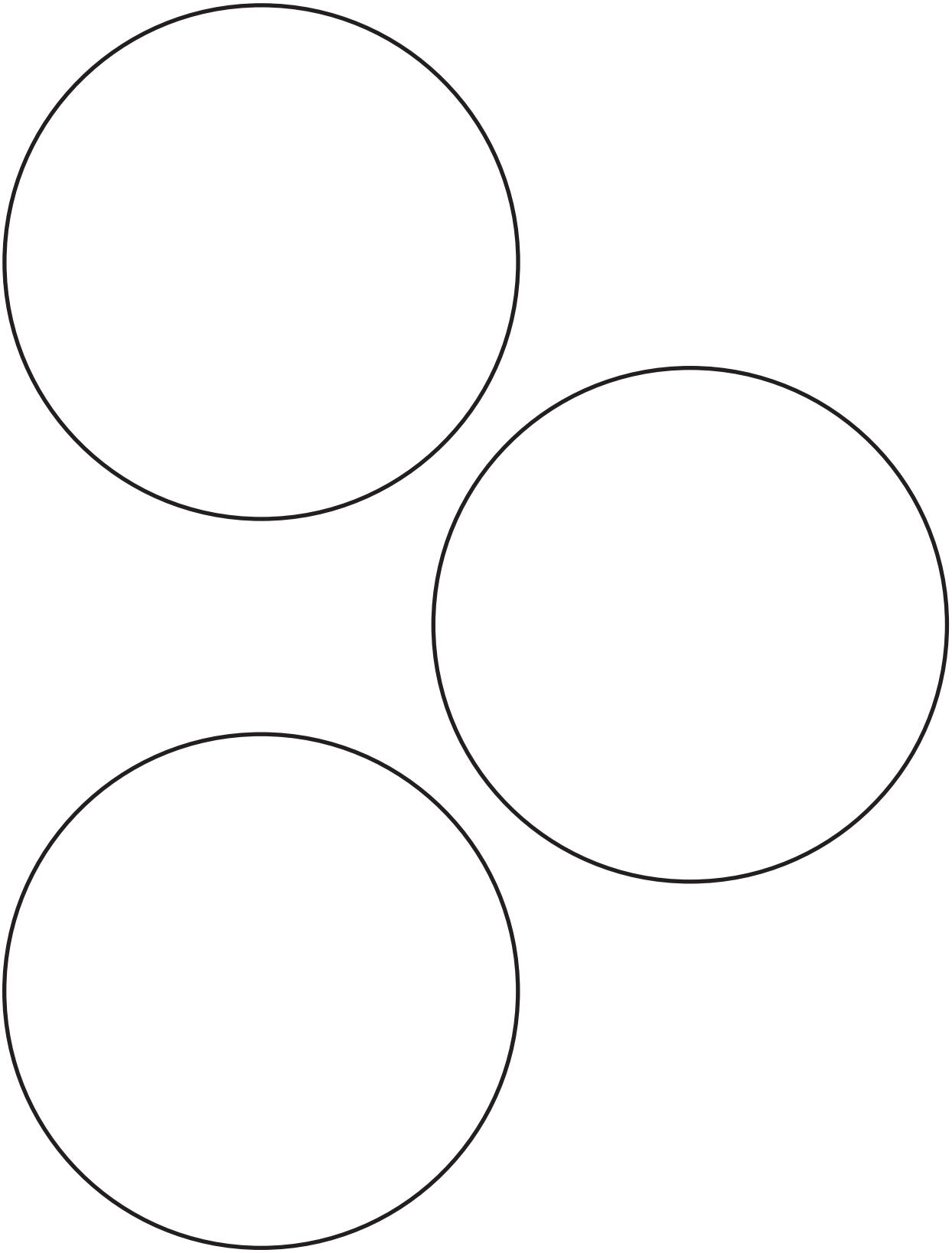
Sandcastle Erosion

Pretend you are building a sandcastle at the beach or in a sandbox. Draw and label your sandcastle and its surroundings.

Draw and label your sandcastle after erosion has occurred. Make sure you describe how your sandcastle eroded away.

Name: _____

What Does the Earth Look Like?



Name: _____

Bodies of Water: Oceans, Lakes, Rivers

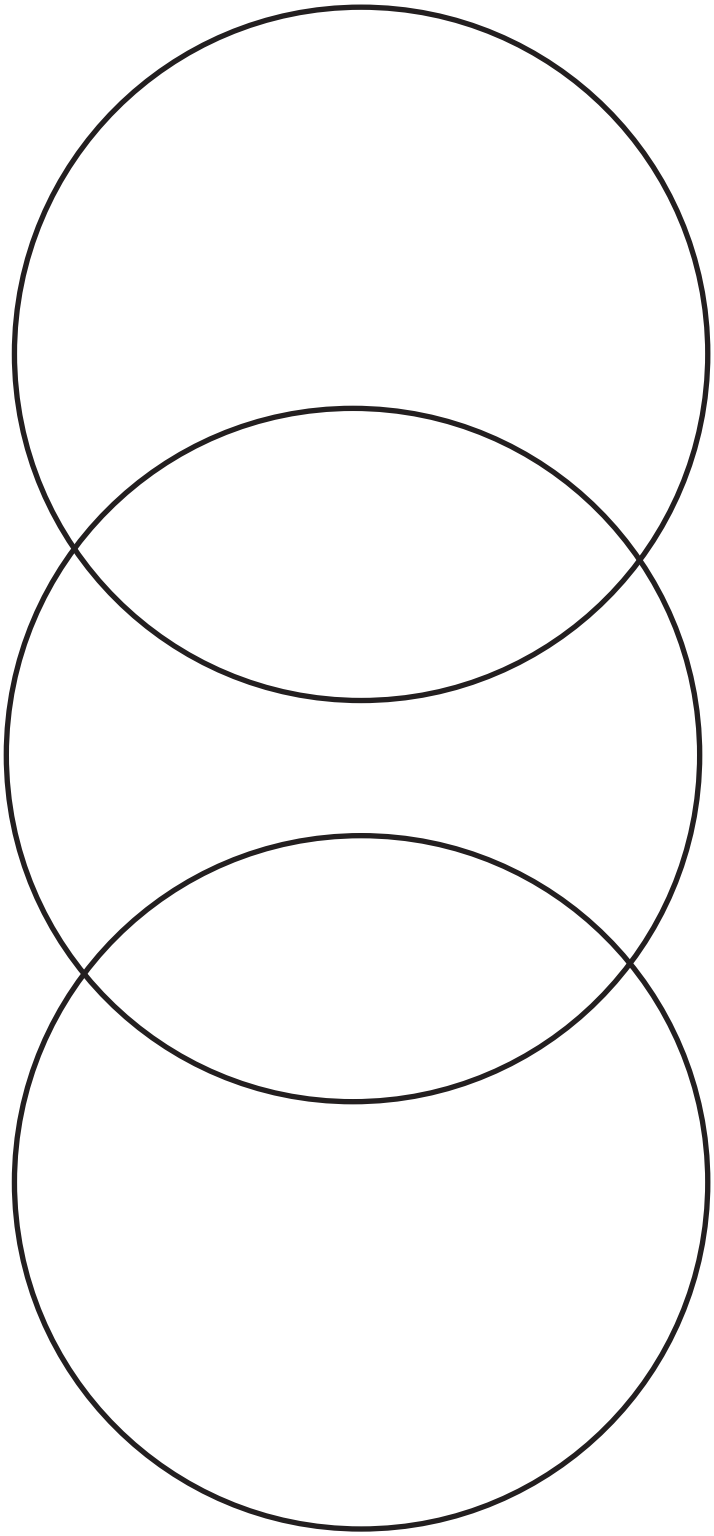
Oceans

Lake/Pond

River/Stream

Name: _____

Venn Diagram



Name: _____

Science Notebook Page