SECTION I

ASSESSMENT

1. **Questions to Ponder**
2. **Connecting with the Questions**
3. **Achievement Targets & Charts**
4. **"The Spirituality of Assessment"**

"Each tree is known by its yield."

Luke 6: 44

ASSESSMENT

By
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This Science Curriculum is the educational milieu from which teachers should draw their energy and direction for sound classroom assessments and creative instruction, and within which students should learn the wondrous art of discovery, and then to reflect on the quality of their discoveries.

Questions to ponder:

What would it look like in a Catholic school classroom if the students knew exactly ***what*** the teacher expected them to achieve?

What would it look like in a Catholic school classroom if the students knew exactly ***the ways in which*** the teacher was going to measure their achievement?

What would it look like in a Catholic school classroom if the students knew exactly ***how*** the teacher was going to facilitate their achievement?

Some thoughts on the questions:

The quality of the responses to the **first question** is directly related to whether or not teachers have *a vision of what they value so much* that they want students to learn, and have clearly articulated these highly valued achievement expectations for themselves and for their students.

The quality of the responses to the **second question** is directly related to whether or not teachers *honor the multiple ways* through which students learn, by understanding and developing authentic, alternative ways of assessing student achievement.

The quality of the responses to the **third question** is directly related to whether or not teachers *are willing to become proficient* in varied instructional techniques and to use the ones that best match a given valued achievement expectation.

The above three questions deal with areas of education with which every teacher is familiar: namely, **Curriculum** (first question), **Assessment** (second question), and **Instruction** (third question).

While these guidelines focus firstly on assessment, teachers must understand the connectedness among curriculum, assessment and instruction. These are not three different and independent aspects of education, but rather, three intertwined experiences of the educational process. Assessment cannot be considered an isolated educational experience, but rather must be seen as intimately connected with curriculum and with instruction. Because they are so closely intertwined, the quality of each experience affects and in turn is affected by the quality of the other two.

These Science Curriculum Guidelines are the result of reflection and collaboration of the Diocesan Science Curriculum Committee, who sought authentic and quality responses to the three questions raised. It was necessary that the Committee deal with each of those questions, so that a coherent, holistic, continuous and credible set of guidelines would be produced.

Connecting with the first question:

The first question deals with curriculum: *What would it look like in a Catholic school classroom if the students knew exactly what the teacher expected them to achieve?* If the students are to know exactly what teachers expect of them, then teachers must clearly articulate for the students what those expectations are. In order to do that, teachers must first grapple with the question, *"What do I value so much that I want students to achieve?"*.

Research suggests that the appropriate response to this question lies in a clear vision of what excellence in learning looks like. Dr. Richard Stiggins, (1994) after many years of research, has identified and articulated specific "Achievement Targets" that teachers value and want their students to achieve. (p. 67)

These Achievement Targets are described as follows:

- *Knowledge* — What content knowledge should students master?
- *Reasoning Proficiencies* — Can students use knowledge productively to reason and solve problems?
- *Performance Skills* — What performance skills should students demonstrate?
- *Creation of Products* — What kinds of products should students be able to produce?
- *Affective Qualities* — What attitudes, values, interests should students demonstrate toward school and learning?

According to Stiggins (1990): "Students will meet any Achievement Target that has been clearly articulated to them and holds still for them." (Presentations given in Boston, Massachusetts)

The K – 12 Science Curriculum Guidelines developed by the Science Curriculum Committee clearly articulates these "Achievement Targets." Further, this Curriculum is expressed as a continuous natural flow of learning experiences, which are broadened and deepened as students progress from one grade level to the next. This Curriculum is written as a coherent whole, showing the connectedness of the major areas of content with each other, while at the same time, honoring the integrity of each individual area as worthy knowledge in its own right.

Connecting with the second question:

The second question deals directly with assessment: *What would it look like in a Catholic school classroom if the students knew exactly the ways in which the teacher was going to measure their achievement?* If the students are to know exactly how their teachers are going to measure their achievement, then teachers must be able to use appropriately a variety of methods of assessing that achievement. First, however, teachers must grapple with the question, *"How will I know that the students have learned?"*.

As a first step to a response to this question, teachers are encouraged to articulate their vision of excellence in assessment: a vision which honors the multiple intelligences of students, provides diverse ways for students to demonstrate to their teachers what they have achieved, and ensures that the valued Achievement Targets and the alternative assessment methods are appropriately matched.

Again, research provides valuable insights into how teachers can best measure student achievement. Stiggins (1997) suggests that there is a wide range of alternative assessment methods that should be used, since no single method appropriately measures all of the valued Achievement Targets. Quality assessments accurately match the articulated achievement target of the teacher. (p. 73) Stiggins (1997) has identified and defined the following alternative methods of assessment. (pp. 75 – 78)

- ***Selected Response / "Right Answer"***
  Paper and pencil test questions whose answers are generally right or wrong (true/false, multiple choice, matching, fill in the blank)
- ***Essays***
  Evaluation of exercises that need preparation in order to provide an extended written answer
- ***Performance Assessments***
  Evaluation of performance skills based on observations and professional judgment
- ***Personal Communication***
  Evaluation of oral responses to questions and/or personal conversation between the teacher and the student

Sound assessments flow out of and are dependent upon the teacher's ability to match the appropriate assessment method with the intended valued Achievement Target. The chart below, developed by Stiggins and Knight, (1997) clearly demonstrates how well each alternative assessment method matches each valued Achievement Target, by answering the question, "Which assessment method works best?" (p. 32).

To assess if the Student:	**"Right Answer" Tests**	**Essays**	**Performance Assessments**	**Personal Communication**
Has mastered **Content Knowledge**	Good match	Good match	Not the best match	Good match
Can demonstrate **Reasoning Proficiencies**	Good match for some problems	Good match for some problems	Good match for some problems	Good match for some problems
Can demonstrate **Performance Skills**	Not a good match	Not a good match	Good match	Good match for Communication Skills only
Can use skills to **Create Products**	Not a good match	Not a good match	Good match	Not a good match

For a more detailed description of valued Achievement Targets and Alternative Assessment Methods, please see the list of references at the end of these Science Curriculum Guidelines.

As teachers ***focus less*** on: (adapted from Texley and Wild, 1996)

1. testing what they can easily measure,
2. testing to learn what students do not know and cannot do,
3. testing for scientific knowledge only, and
4. end-of-chapter tests,

and ***focus more*** on:

1. assessing what they highly value,
2. assessing to learn what students do know and can do,
3. assessing for scientific understanding, reasoning, and skills, and
4. training students in on-going self-reflection and evaluation of their own achievement and the achievement of others. (p. 60)

then:

assessment becomes the educational milieu in which both teachers and students experience the energy that transforms the teaching/learning process. That energy is to be found in the *questions*, and seldom, if ever in the instant "right" answers.

Throughout the Science Curriculum Guidelines, assessment strategies are indicated. The following table (adapted from Stiggins and Knight, 1997) indicates samples in specific content areas of how valued Achievement Targets can realistically be matched with the appropriate assessment method. The content area, grade level, and page number where teachers can find this information are shown in each box.

It would be helpful for teachers to discover other areas in the Curriculum Guidelines that could also be appropriately used in the same manner.

To assess if the Student:	**"Right Answer" Tests**	**Essays**	**Performance Assessments**	**Personal Communication**
Has mastered **Content Knowledge**	**See:** Life Science 9th Assessment Strategy **Grades:** K-1-2 **Page:** 99	**See:** Earth & Space 6th Assessment Strategy **Grades:** 3-4-5 **Page:** 168	**See:** Life Science 4th Assessment Strategy **Grades:** K-1-2 **Page:** 97	**See:** Physical Science 5th Assessment Strategy **Grades:** 6-7-8 **Page:** 56
Can demonstrate **Reasoning Proficiencies**	**See:** Physical Science 7th Assessment Strategy **Grades:** Secondary **Page:** 79	**See:** Physical Science 2nd Assessment Strategy **Grades:** 6-7-8 **Page:** 54	**See:** Physical Science 3rd Assessment Strategy **Grades:** 3-4-5 **Page:** 43	**See:** Life Science 1st Assessment Strategy **Grades:** Secondary **Page:** 147
Can demonstrate **Performance Skills**	Not a good match	Not a good match	**See:** Earth & Space 3rd Assessment Strategy **Grades:** Secondary **Page:** 189	**See:** Life Science 9th Assessment Strategy **Grades:** 3-4-5 **Page:** 108
Can use skills to **Create Products**	Not a good match	Not a good match	**See:** Earth & Space 2nd Assessment Strategy **Grades:** 6-7-8 **Page:** 178	Not a good match

(adapted from Stiggins & Knight, 1997, p. 32)

Connecting with the third question:

By now it should be evident to teachers, that before they even *decide on* which instructional strategies they will use, they must have a clear vision of the specific Achievement Targets they want their students to achieve and predetermined assessment methods they will use to measure student achievement. Once these quality decisions are made, teachers must then ponder the third question which deals with instruction: *What would it look like in a Catholic school classroom if the students knew exactly how the teacher was going to facilitate their achievement?*

If the students are to know exactly how the teachers would facilitate their learning, then the teachers must be proficient in using a variety of instructional techniques. First, however, teachers must grapple with the question, *"How will I help them?"*.

This question challenges the teachers' ability to honor the natural coherence of Achievement Targets, assessment methods, and instructional strategies, while at the same time honoring the multiple ways that students learn in any given classroom. This diversity of learning styles demands a responding diversity in instructional strategies, and assessment methods as well.

Carol Ann Tomlinson, (1999) in her book, ***The Differentiated Classroom***, asks the same question of herself that many other teachers ask. "How do I divide time, resources, and myself so that I am an effective catalyst for maximizing talent in all my students?" (p. 1) Teachers who respond well to this question are those teachers who "...strive to do whatever it takes to ensure that struggling and advanced learners, students with varied cultural heritages, and children with different background experiences all grow as much as they possibly can each day, each week, and throughout the year." (p. 2)

Teachers who honor the multiple ways in which students learn do not "force-fit students into a standard mold", (p. 2) nor do they assume that one type of instruction fits all. Rather, they explore a variety of instructional strategies that best match the diverse abilities, experiences, and interests of the students.

Tomlinson (1999) describes a wide variety of instructional strategies that teachers could use to match the unique learning styles of their students. The following are some of the strategies described in her book.

- ***agenda*** personalized list of tasks that a particular student must complete in a specified time (pp. 66 – 68)
- ***centers*** classroom areas that contain a collection of activities and materials designed to teach, reinforce or extend a particular skill or concept (pp. 75 - 81)
- ***complex instruction*** a rich strategy developed to deal with the sort of academic ranges that frequently exist in classrooms that are academically, culturally and linguistically heterogeneous (pp. 68 – 71)
- ***orbital studies*** independent investigations, generally of three to six weeks, which "orbit" or revolve around some facet of the curriculum (pp. 71 – 74)
- ***tiered activities*** activities that enable all students to focus on essential understandings and skills, but at different levels of complexity, abstractness and open-endedness (pp. 83 – 87)

- ***portfolios*** collections of student work that help students set appropriate learning goals and evaluate their own growth (p. 92)

For more detailed descriptions of instructional strategies, please see the list of references at the end of these Science Curriculum Guidelines.

Assessment: A Matter of Honor

What does excellence look like: excellence in curriculum standards, excellence in assessment methods and excellence in instructional strategies? In a Catholic school classroom, excellence is a natural consequence of the belief that:

- ***every student is unique, unrepeatable, and irreplaceable***

  --- no matter how gifted

  --- no matter how she or he learns

  --- no matter how she or he performs

- ***every student is sacred***

  --- no matter what color

  --- no matter how rich

  --- no matter how poor

- ***every student is mutually interdependent***

  --- no matter what culture

  --- no matter what religion

  --- no matter how he or she behaves

"The Spirituality of Assessment"

Excellence in Catholic education is the heritage of all who are involved in this great ministry of Jesus Christ, who in his "teaching strategies" honored the diversity, sacredness and mutual interdependence of every "student" he encountered. Jesus constantly guided his disciples through open-ended and thought-provoking challenges, toward an ever-deepening understanding of his message, and when they were ready, sent them out to the world to carry on the work he had begun in them.

Imagine for a moment, an event that occurred at the beginning of Jesus' public ministry of teaching. The scene is described in the first chapter of St. John's Gospel. Two disciples of John the Baptist were curious about Jesus, so they decided to follow him one day. St. John describes what happens (John 1: 38-39).

> *Jesus turned, saw them following him, and asked, "What are you looking for?". They answered, "Where do you live, Rabbi?". (This word means Teacher) "Come and see," he answered. So they went with him and saw where he lived and spent the rest of that day with him.* (Good News Bible, 1979)

By their very presence in the classroom, every teacher is virtually Jesus the Teacher, and every student is virtually one of the disciples of John the Baptist. At the door of every classroom in a Catholic school, this dialogue is an implicit exchange between the teacher and each student who enters that classroom. The teacher is essentially asking each student, *"What are you looking for?".* (Tell me what you want to know, learn, and be able to do.) Like John the Baptist's disciples before them, each student asks the teacher, *"Where do you live?".* (Let me come into your "home" and spend some time with you, for I know that you will help me to find what I am seeking to learn.) *"Come and see,"* the teacher replies. (Come and see what I have planned for you.)

Come, that I might guide you as you enhance your knowledge into ever deeper understanding. Come, that I might facilitate the expanding of your reasoning proficiencies to more complex levels. Come, that I might help you to hone those special skills that are so uniquely yours. Come, that I might provide opportunities for you to produce your own creations that bring to fruition all that you have learned and can do.

Come, that you may find all that you are seeking, and when you truly understand, then I will send you forth so that you may continue what I have begun in you.

So the children came and spent the day with their teacher.

The "Spirituality of Assessment" is a unique and profound reflective section for all teachers and administrators.

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SECTION II
NSES CONTENT STANDARD A

SCIENCE AS INQUIRY

1. **Definition of Inquiry**
2. **Practices of Inquiry according to the following grade clusters:**
   - **K – 1 – 2**
   - **3 – 4 – 5**
   - **6 – 7 – 8**
   - **9 – 12**

"We have seen incredible things today."
Luke 5: 26

Science As Inquiry

Definition of Inquiry

Inquiry is a set of interrelated processes by which scientists and students pose questions about the natural world and investigate phenomena; in doing so, students acquire knowledge and develop a rich understanding of concepts, principles, models and theories.

(National Science Education Standards, p. 214)

Science As Inquiry
K – 1 – 2

NSES: Science as Inquiry, Content Standard A

As a result of activities in grades K – 1 – 2, all students should develop:

- abilities necessary to do scientific inquiry
- understanding about scientific inquiry

NJCCCS:

Standard 5.2

- All students will develop problem solving, decision making and inquiry skills, reflected by formulating useable questions and hypotheses, planning experiments, conducting systematic observations, interpreting and analyzing data, drawing conclusions and communicating results.

DIOCESAN STANDARDS:

- Students will develop strategies and skills necessary to apply the scientific method.
- Students will demonstrate the ability to apply the scientific method.

OUTCOMES: By the end of grade 2, students will be able to:

- ask a simple question
- complete an investigation requiring the use of observation and measurement
- communicate the results of an investigation to others
- conduct an investigation using a "trial and error" format

SCIENCE AS INQUIRY

ASSESSMENT STRATEGIES	INSTRUCTIONAL STRATEGIES
• Create a book of questions about things that can be observed in the environment, e.g., *Why do leaves fall off some trees and not others?*	• Practice observation skills, e.g., *record what is seen on a penny with and without a magnifying glass*
• Group objects according to a common attribute	• Go on a color scavenger hunt • Search for items of a particular color in the environment • Use commonly found colors like green and brown
• Create a display of objects that demonstrates the ability to classify them	• Provide various types of objects to classify, e.g., *shells, pasta, candy, rocks, leaves*
• Measure objects in the environment using standard and non-standard units△	• Provide opportunities to practice using measurement tools
• Communicate the results of classifying objects by graphing e. g. *bar graphs, pictograph* △	• Show students a picture for a limited amount of time and ask them to recall and list as many details as they can
• Demonstrate the ability to accurately observe changes in a given object, e.g., *growth of classroom plant, changes in a tree on the playground* 🖷	• Show students a variety of objects, remove one object and students must identify the missing object
• Record observations accurately, e.g., *record the daily weather on a calendar* 🖷🕮	• Use cooperative groups to analyze and describe a different way of arriving at a solution and recognize the elements of the scientific method that were used ☺

Science As Inquiry
3 – 4 – 5

NSES: Science as Inquiry, Content Standard A

As a result of activities in grades 3 – 4 – 5, all students should develop:

- abilities necessary to do scientific inquiry
- understanding about scientific inquiry

NJCCCS:

Standard 5.2

- All students will develop problem solving, decision making and inquiry skills, reflected by formulating useable questions and hypotheses, planning experiments, conducting systematic observations, interpreting and analyzing data, drawing conclusions and communicating results.

DIOCESAN STANDARDS:

- Students will develop strategies and skills necessary to apply the scientific method.
- Students will demonstrate the ability to apply the scientific method.

OUTCOMES: By the end of the fifth grade, the students will be able to:

- state a problem about the natural world in the form of a question
- develop strategies and skills for information gathering and problem solving using appropriate tools and technologies
- use technology to present the design and results of an investigation
- develop the skills of observing and recording
- evaluate data used to make conclusions

SCIENCE AS INQUIRY

ASSESSMENT STRATEGIES	INSTRUCTIONAL STRATEGIES
• Create a display and chart comparing the pros and cons of two products • Use the information to create an advertisement or commercial for the product	• Predict how many drops of water coins of various sizes can hold △ • Conduct trials, record and graph the result △
• List the variables that affect the speed of an object moving down an inclined plane△ • Keep a journal record of observations 🕮	• Analyze an experiment to determine the variables △ • Research some experiments using controls, e. g., *the trials of Salk vaccine* 🔑 🖷
• Recognize patterns of observations and summarize finds	• Model recording of observations in a class log or journal
• Design an experiment with one variable to answer a question	• Write a simple lab report 🕮

Science As Inquiry
6 – 7 – 8

NSES: Science as Inquiry, Content Standard A

As a result of activities in grades 6 – 7 – 8, all students should develop:

- abilities necessary to do scientific inquiry
- understanding about scientific inquiry

NJCCCS:

Standard 5.2

- Students will develop problem solving, decision making and inquiry skills, reflected by formulating useable questions, hypotheses, planning experiments, conducting systematic observations, interpreting and analyzing data, drawing conclusions and communicating results.

DIOCESAN STANDARDS:

- Students will develop strategies and skills necessary to apply the scientific method.
- Students will demonstrate the ability to apply the scientific method.

OUTCOMES: By the end of the eighth grade, students will be able to:

- identify problems that can be solved by conducting experiments to test a hypothesis
- plan and conduct simple investigations
- perform experiments and be able to gather and interpret data obtained
- systematically present and display findings through graphs, written paragraphs, charts, lab reports and diagrams
- debate current issues using supporting facts, data and arguments
- assess the benefits and hazards associated with alternative actions

SCIENCE AS INQUIRY

ASSESSMENT STRATEGIES:

- Using the Scientific Method, describe, either orally or in written form, problems that you encountered and solved. 🕮
- Give an oral report on "Blastic Balls" (see Appendix)
- Using the Scientific Method, build a bridge that can bear weight without collapsing. (see Appendix)
- Write a paragraph or display graphs to prove or disprove a hypothesis 🕮
- Display results in charts and pictures △
- Assess the benefits and hazards associated with alternative actions ☺

INSTRUCTIONAL STRATEGIES:

- Provide students with blocks or cardboard shapes to represent furniture and a grid to plan a room arrangement △
- Perform "Blastic Ball" inquiry experiment (see Appendix)
- Provide students with materials to build and test bridges to see if their bridge can bear weight without collapsing
- "M and M" experiments – Students predict and then count the number of each color candy in a one-pound bag
- Do an opinion poll on any topic: favorite ice cream, color, or food ☺
- Compare the new biodegradable corn packing peanuts with the traditional Styrofoam packing peanuts ☺
- Debate: Should humans volunteer for experimental drug program? Research current pilot drug programs: diabetes, elevated cholesterol, or depression 🕮 🔑 ☺

Science As Inquiry
Secondary Level

NSES: Science as Inquiry, Content Standard A

As a result of activities in grades 9 – 12, all students should develop:

- abilities necessary to do scientific inquiry
- understandings about scientific inquiry

NJCCCS:

Standard 5.2

- All students will develop problem-solving, decision-making, and inquiry skills, reflected by formulating useable questions and hypotheses, planning experiments, conducting systematic observations, interpreting and analyzing data, drawing conclusions, and communicating results.

DIOCESAN STANDARDS:

- Students will develop strategies and skills necessary to apply the scientific method.
- Students will demonstrate the ability to apply the scientific method.

OUTCOMES: By the end of the twelfth grade, students will be able to:

- demonstrate knowledge of basic lab skills in the various areas of science including safety procedures
- work alone and in cooperation with other students to design, conduct and present the results of an investigation
- demonstrate the ability to use critical analysis and reasoning skills to analyze and assess arguments and to determine whether any of the premises are possibly sound
- be able to select and use appropriate lab equipment and technology to carry out an investigation
- demonstrate that they can critique and analyze data from a variety of sources and determine what conclusions can be drawn from the particular data
- apply mathematical concepts to gather and manipulate data for their investigations in science

SCIENCE AS INQUIRY

ASSESSMENT STRATEGIES:

- Provide students with ample opportunities to design and carry out their own experiments from questions that arise during class.

- Require students to design and carry out a science project that can be worked on during the course of the year. Begin with guided step-by-step deadlines during the early years and end with a complete student directed design during the later years of high school. (These projects could be part of a Science Fair.)

- Give a periodic lab practical to determine the skill level of students with the use of lab equipment and technology.

INSTRUCTIONAL STRATEGIES:

- Provide students with various examples of collected data that can be critically analyzed and from which conclusions can be drawn. Have them compare/debate their conclusions with those of other students.

- Discuss examples of the scientific process being carried out by companies every day. Point out how conclusions change with the accumulation of additional information or the advancement of technology.

- Use the student's peers to critique experiment designs that the student developed. Students can develop rubrics to determine the criteria for the evaluations.