Science of Spin ™
and the 2010 TEKS Science Objectives
Grades 6-8

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The Science of Spin ™ program is an interdisciplinary program between science and physical education. Math, Language Arts, Social Studies, and additional Science are also incorporated into the Interdisciplinary Curriculum provided to the school. This writing summarizes how the Science of Spin ™ program supports the Texas Essential Knowledge and Skills **science** objectives.

Format of this document

Page 1-2 identifies the Science concept that are addressed as part of the Science of Spin ™ presentation and curriculum.

Pages 3-7 discusses in detail how these concepts are addressed in the Science of Spin ™.

Pages 8-11 identifies specific TEKS statements of science objectives by grade level and explains in general how the Science of Spin™ addresses these concepts.

NOTE: Keep in mind that some of these concepts, though not specifically named in the TEKS Objectives are contained in the science textbooks and taught in the classroom in order to build upon in mastering the TEKS Objectives.

SCIENCE

Introduction

TEKS Science objectives for grades 6-8 identify increasingly complex concepts of science. The Science of Spin ™ assembly program is designed to primarily support science concepts in the area of physics, particularly in the area of F**orce, Motion and Energy**. The Science of Spin ™ Interdisciplinary Curriculum, however, which is provided to the school as part of the program, continues to support not only physics, but also scientific processes such as the Scientific Method, which is addressed in increasing complexity in all grade levels.

During Science of Spin Presentation:

1. Gyroscopic Stability, Rotational Inertia and Angular Momentum – (Newton's Laws of Motion)
2. Distribution of Mass
3. Gyroscopic Precession
4. Planes of Spin – vertical, horizontal, diagonal
5. Friction – force which causes change
6. Air Resistance (drag)
7. Aerodynamics

8. Levers – effect on energy production
9. Gravity – natural force that causes motion
10. Potential & Kinetic Energy – transfer of energy

Additions included in Interdisciplinary Curriculum / Products

11. Scientific Method
12. Systems
13. Electricity – flows in a circuit and can produce light

Summary of Science Concepts Addressed Grades 6-8

1. **Gyroscopic Stability, Rotational Inertia and Angular Momentum (Rotational Momentum) (i.e. spinning energy)** This physics concept relates for Force, Motion and Energy. Newton's First Law of Motion states, "Every object in a state of uniform motion tends to remain in that state of motion unless an external force is applied to it." In physics, rotational inertia is a measure of an object's resistance to changes to its rotation. The angular momentum of an object rotating about some reference point is the measure of the extent to which the object will continue to rotate about that point unless acted upon by an external torque, or force. The students are to observe that a spinning object will rotate around a fixed point, its axis, while observing the direction and position of objects as they are affected by a force.

The Science of Spin ™ Presentation addresses Gyroscopic Stability/Angular Momentum throughout the program in the following manner:

- Once a wheel is spinning in a particular plane (review of horizontal, vertical and diagonal planes of spin), it does not want to change its plane of spin, as long as it has Gyroscopic Stability or Angular Momentum (spinning energy). This concept is continually repeated throughout the program using objects such as a wheel, a gyroscope, a yo-yo, a spin top, and a football.

a. The gyroscope or spin top remain upright while spinning on its point and not fall off when hanging from the string due to their angular momentum.

b. The wheel remains upright while spinning across the floor, until acted upon by enough ground friction or an outside force, such as a wall, to halt the spin.

2. Distribution of Mass. This physics concept relates for Force, Motion and Energy. The students are to observe that an object with a greater mass distribution on the outside rim will move a greater distance or spin longer than one with less, given that the velocity begins the same.

The Science of Spin ™ Presentation addresses Distribution of Mass throughout the program in the following manner:

- When two or more objects are spun or thrown while spinning, each with the same velocity of spin, the object having the greatest percentage of mass on the outside rim will spin the longest or travel the furthest. This concept is visually reinforced with demonstrations with flying discs, spin tops and footballs.

3. <u>Gyroscopic Precession.</u> Precession is a change in the orientation of the rotation axis of a rotating body. Torque-induced precession (**gyroscopic precession**) is the phenomenon in which the axis of a spinning object (e.g. a part of a gyroscope) "wobbles" when a torque, or force, is applied to it. The phenomenon is commonly seen in a spinning top, but all rotating objects can undergo precession.
The students are to observe the action of precession during the spinning top demonstration.

The Science of Spin ™ Presentation addresses Gyroscopic Precession throughout the program in the following manner:

- Most obviously shown during the spin top demonstration, gyroscopic precession is demonstrated both when the top is spinning in a hand if not spinning perfectly vertical, and most markedly, when it is spinning while hanging on the string, causing the spin top to rotate around the string axis itself.

4. <u>Planes of Spin</u>. This physics concept relates to Force, Motion and Energy in describing the position and direction of an object. Planes are also an important function of mathematics. Students are to observe the different planes in which a spinning object may spin.
The Science of Spin ™ Presentation addresses Planes of Spin when demonstrating with the wheel, as well as the spin top in concept 1 – Gyroscopic Stability/Angular Momentum. Students are expected to respond to the presenter in answering what plane a particular object is spinning in; i.e. horizontal, vertical or diagonal.

5. <u>Friction</u>. Friction is directly related to Force, Motion and Energy, as it is a force that must be addressed with any type of motion. The students are introduced to friction being an example of something that causes change.

The Science of Spin ™ Presentation addresses Friction throughout the program in the following manner:

- Describing why a wheel, yo-yo or spin top eventually stops and falls over. A discussion ensues regarding where the friction exists in each of these examples (ground, air, hand, and string). Air Friction (air resistance) is most specifically discussed as it relates to flying discs.

6. <u>Air Resistance (Drag)</u>. This is yet another part of Force, Motion and Energy. As a type of friction, air resistance (drag) is also an outside force affecting motion. Students are to observe the effect of air resistance when an object is thrown.

The Science of Spin ™ Presentation addresses Air Resistance throughout the program in the following manner:
See concept 5. Friction.

7. <u>Aerodynamics</u>. Aerodynamics is the way objects move through air. The more air that hits a surface, the more the drag the air produces making the object less aerodynamic. Designing objects in such a way (thinner, rounded edges, etc) so as to reduce wind drag will, therefore, increase efficiency.

The Science of Spin ™ Presentation addresses Aerodynamics throughout the program in the following manner:
- In comparing the flight of 2 different styles of flying discs, one which is solid throughout and one which is a thinner, "ring" style, the question becomes, "Which of these flying discs, thrown with the same velocity of spin (force), will spin the longest?" One reason is that of aerodynamics, that is, the thinner flying disc will be more aerodynamic because of its shape and more efficient interaction with the air (air resistance).

8. <u>Levers</u>. Levers are an ideal tool to use in the explanation of Force, Motion and Energy. The student is to observe the increased amount of force, motion and energy that is generated as the lever gets longer.

The Science of Spin ™ Presentation addresses Levers in the following manner:
- Description that the finger, hand, forearm and entire arm all are levers. To throw a yo-yo most forcefully requires the longest lever available, the entire arm. Yo-yos that are thrown with the wrist generate less spin time.
- A diabolo is used to demonstrate the use of levers to generate power, to transfer energy, and to throw the diabolo into the air.
- Question to the students about what sports use levers? Not only the obvious ones such as baseball, golf and tennis, but also football and soccer, as the entire body is a set of levers.

9. <u>Gravity</u>. Related to Force, Motion and Energy, gravity is, of course, a force that has an effect on virtually all motion. The students are to observe how gravity relates to a spinning object, both when it is spinning and when it is at rest.

The Science of Spin ™ Presentation addresses Gravity in the following manner:
- The very first yo-yo trick taught to a volunteer member of the audience is called the 'Gravity Pull' where gravity pulls the yo-yo down and the player pulls it back up.
- Another popular yo-yo trick, 'Reach for the Moon' is described as being difficult because the yo-yo is going *against* gravity.
- Gravity is also described as the force causing a gyroscope or spin top to fall off of one's hand or the string, or a wheel to fall over, if the object is not spinning.

10. <u>Potential & Kinetic Energy</u>. Related to the study of Force, Motion and Energy, potential and kinetic energy are two different forms of energy. The students are to observe that force and motion are related to potential and kinetic energy.

The Science of Spin ™ Presentation addresses Energy in the following manner:

- While demonstrating the diabolo skill toy, the transfer of potential energy in the muscles of the arm (when still) to the kinetic energy of the arm, sticks, and string (when moving).

- Energy is then described as being converted into spinning energy of the diabolo through the use of friction between the string and the diabolo axle itself (transfer of energy).

- Energy is described as never being lost. The most dramatic example is when a student stands on a lazy susan, holding a wheel which is spun. When asked to tip the wheel from a vertical to a horizontal position, the student spins around. Because the spinning object does not want to change its plane of spin (concept 1-Gyroscopic Stability), the energy it took to force it to change its plane transferred through the student's body, and spun him/her around.

11. <u>Scientific Method</u>. Scientific investigations are explored at all grade levels, particularly through the use of the scientific method. The students are expected to be able to conduct classroom investigations, ask questions, observe, gather information, make measurements and draw conclusions. The students are also expected to summarize their findings verbally and/or through the use of tables and graphs.

The Science of Spin ™ Interdisciplinary Curriculum contains simple experiments in both the Science and Math sections that may be used in the classroom which use the Scientific Method involving:

- measurement
- sorting
- drawing inferences related to functionality

12. <u>Systems</u>. All grade levels study our world with regard to increasingly complex systems. The students should understand a whole in terms of its components and how these components relate to each other and to the whole.

The Science of Spin ™ Presentation addresses simple systems in the following manner:

- a yo-yo cannot work without a string and visa versa

- describe yo-yos with fixed axles vs. ball-bearing axles and the effect on performance.

- describes Hubble Telescope and how telescope is ineffective without the gyroscope working inside of the telescope.

The Science of Spin ™ Interdisciplinary Curriculum contains simple experiments that may be used in the classroom involving:

- fixed vs. ball-bearing axle and the effect on performance

13. <u>Electricity</u> Electricity relates to Force, Motion and Energy. The Law of Conservation of Energy states that energy can neither be created or destroyed, it just changes form. The student should understand that complex systems may not work if some parts are removed, such as a light bulb in a circuit.

The Science of Spin ™ product offerings frequently include a LED lighted Torch yo-yo. Students are encouraged to discover how this works (centrifugal switch making electrical contact when the yo-yo is spun). Energy is changed from chemical energy to electrical energy to light energy. Activities are planned to be added to the Interdisciplinary Curriculum in the near future.

TEKS Specifics by Grade Level – Grades 6 through 8

The Science of Spin ™ program (consisting of both the assembly presentation and/or the Interdisciplinary Curriculum) address the following TEKS Objectives:

GRADE 6 – Physical Science

1. Force, Motion and Energy.

- TEKS 112.18 (a)(C) states:
*"*Energy *occurs in two types, potential and kinetic, and can take several forms….It can also be changed from one form to another."*

Science of Spin ™ Presentation addresses many facets of Force, Motion and Energy throughout the program. Potential and Kinetic Energy is directly addressed during the diabolo demonstration.

Potential energy in a resting arm is transferred to kinetic energy once the arm is engaged in action. That kinetic energy is then transferred to the stick and the string. Since the string is not directly connected to the diabolo, this kinetic energy is then transferred once again, via friction, to the diabolo itself and thus producing the spin.

The arm of a yo-yo player also has potential energy that is then transferred into kinetic energy once the arm is engaged, releasing the yo-yo.

- TEKS 112.18 (a)(D) states:
"The topics include organization of our solar system, the role of gravity,and space exploration."

Science of Spin ™ Presentation addresses gravity in multiple ways
Science of Spin ™ The "Gravity Pull" yo-yo trick where gravity pulls the yo-yo down and the player pulls it back up. "Reach for the Moon" yo-yo trick goes against gravity, rather than with it. Gravity is also described as the force causing a gyroscope or spin top to fall off of one's hand or the string, or a wheel to fall over, once the object has stopped spinning, thus ending its Rotational Momentum. The Hubble Telescope is also mentioned during the presentation as a way to show the importance of gyroscopes in space exploration and investigation.

2. Force, Motion and Energy.

- TEKS 112.18 (b)(8) states:
"The student knows force and motion are related to potential and kinetic energy. The student is expected to:"
(B) "*idenfity and describe the changes in position, direction, and speed of an object when acted upon by unbalanced forces"*
(C) *calculate average speed using distance and time measurements;"*

Science of Spin ™ Presentation addresses many facets of Force, Motion and Energy throughout the program. Potential and Kinetic Energy is directly addressed during the diabolo demonstration. Changes in position and direction are addressed continually, particularly in relation to wheels and spin tops. Outside forces are also addressed continually in reference to air resistance (drag), friction, the string and barriers. The Interdisciplinary Curriculum has grade appropriate experiments that can be done with yo-yos and spinning tops in the classroom utilizing measurement and the Scientific Method in predicting outcomes, as well as mathematical calculations.

3. Force, Motion and Energy.

- **TEKS 112.18 (b)(9)** states:

"The student knows that the Law of Conservation of Energy states that energy can neither be created nor destroyed, it just changes form. The student is expected to:"
(C) "*demonstrate energy transformations such as energy in a flashlight battery changes from chemical energy to electrical energy to light energy."*

Science of Spin ™ Program addresses the Transfer of Energy in the diabolo demonstration and with a student volunteer holding a wheel while standing on a lazy-susan. The energy to manipulate the diabolo is transferred from potential to kinetic and then through friction from the string to the diabolo itself. The most dramatic example is with the student volunteer. The wheel, which is being held is spun vertically. The student is then asked to change the wheel to a horizontal plane of spin, resulting in the transfer of energy through the body and thus turning the student around!
In addition, the frequently used LED lighting "Torch" yo-yo has a battery operated circuit visible through its clear side disks. A bar causes contact with a post completing the circuit during the centrifugal force caused by the rotation of the yo-yo. Students are encouraged to discover on their own how this works.

4. Earth and Space.

- **TEKS 112.18 (b)(11)** states:

"The student is expected to:
(B) *understand that gravity is the force that governs the motion of our solar system"*

Science of Spin ™ : Presentation addresses gravity. "Gravity Pull" yo-yo trick where gravity pulls the yo-yo down and the player pulls it back up. "Reach for the Moon" yo-yo trick goes against gravity, rather than with it.

Gravity is also described as the force causing a gyroscope or spin top to fall off of one's hand or the string, or a wheel to fall over, once the object has stopped spinning, thus ending its Rotational Momentum.

5. Scientific Investigations.

- A. TEKS 112.18 (a)(4)(A)(ii) states:
"All investigations require a research question, careful observations, data gathering, and analysis of the date to identify the patterns that will explain the findings…..when conditions can be controlled in order to focus on a single variable, experimental research design is used to determine causation."

- B. TEKS 112.18 (b)(2) states:
"Scientific investigation and reasoning. The student uses scientific inquiry methods during laboratory and fields investigations. The student is expected to:
(D) *"construct tables and graphs, using repeated trials and means, to organize data and identify patterns; and"*
(E) *"analyze data to formulate reasonable explanations, communicate valid conclusions supported by the data, and predict trends."*

Science of Spin ™ : Interdisciplinary Curriculum has simple grade appropriate experiments that can be done with yo-yos and spinning tops in the classroom utilizing measurement and the Scientific Method in predicting outcomes.

GRADE 7 - Organisms and the Environment

1. Force, Motion and Energy.

- **TEKS 112.19 (b)(7)** states:
"The student knows that there is a relationship among force, motion, and energy."

Science of Spin ™ Presentation addresses many facets of Force, Motion and Energy throughout the program. See Summary of Science Concepts on pages 3-8.

2. Scientific Investigations.

- A. TEKS 112.19 (a)(4)(A)(ii) states:
"All investigations require a research question, careful observations, data gathering, and analysis of the date to identify the patterns that will explain the findings…..when conditions can be controlled in order to focus on a single variable, experimental research design is used to determine causation."

- B. TEKS 112.19 (b)(2) states:

"Scientific investigation and reasoning. The student uses scientific inquiry methods during laboratory and fields investigations. The student is expected to:
(D) *"construct tables and graphs, using repeated trials and means, to organize data and identify patterns; and"*
(E) *"analyze data to formulate reasonable explanations, communicate valid conclusions supported by the data, and predict trends."*

Science of Spin ™ : Interdisciplinary Curriculum has simple grade appropriate experiments that can be done with yo-yos and spinning tops in the classroom utilizing measurement and the Scientific Method in predicting outcomes.

GRADE 8 – Earth and Space Science

1. Force, Motion, and Energy.

- A. TEKS 112.20 (a)(4)(C) states:
"Students experiment with the relationship between forces and motion through the study of Newton's three laws…students recognize that these laws are evident in everyday objects and activities. Mathematics is used to calculate speed using distance and time measurements."

- B. TEKS 112.20 (b)(6) states:
"The student knows that there is a relationship between force, motion and energy. The student is expected to:
(A) *demonstrate and calculate how unbalanced forces change the speed or direction of an object's motion;*
(C) *investigate and describe applications of Newton's law of inertia, law of force and acceleration…"*

Science of Spin ™ : Presentation addresses Force, Motion and Energy throughout the program. See Summary of Science Concepts on pages 3-8.

2. Scientific Investigations.

- A. TEKS 112.20 (a)(4)(A)(ii) states:
"All investigations require a research question, careful observations, data gathering, and analysis of the date to identify the patterns that will explain the findings…..when conditions can be controlled in order to focus on a single variable, experimental research design is used to determine causation."

- B. TEKS 112.20 (b)(2) states:

"Scientific investigation and reasoning. The student uses scientific inquiry methods during laboratory and fields investigations. The student is expected to:

(D) *"construct tables and graphs, using repeated trials and means, to organize data and identify patterns; and"*

(E) *"analyze data to formulate reasonable explanations, communicate valid conclusions supported by the data, and predict trends."*

Science of Spin ™ : Interdisciplinary Curriculum has simple grade appropriate experiments that can be done with yo-yos and spinning tops in the classroom utilizing measurement and the Scientific Method in predicting outcomes.