Adventures in Inquiry: Learning About Life Cycles

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INTRODUCTION

I am a first grade teacher at an inner city school, an assignment that poses many challenges. The neighborhood where I teach is working class and predominantly Hispanic. One of these challenges is keeping students on task and interested. Since the majority of the children at my school come from economically disadvantaged homes where education levels are low and anxiety about school is high, I must work hard to develop lessons that attract and keep student interest. Furthermore, since the education levels of parents in the neighborhood are low, these children often do not get exposure to scientific ideas at home. Therefore, the responsibility falls on me as their teacher not only to introduce scientific information but also to do so in a way that invokes and keeps a high level of interest. In this unit I will teach life cycles using an inquiry-based and hands-on approach.

OBJECTIVES

This curriculum unit addresses a number of objectives that include both scientific processes and science concepts. In this unit, students will develop the skills necessary for scientific inquiry and critical thinking. They will also develop science process skills and an understanding of life cycles. This will be achieved through inquiry-based and hands-on activities. In particular, this unit will focus on observing and recording changes in the life cycles of animals and plants while comparing and contrasting them.

This unit covers all of the nature of science objectives including those for inquiry, critical thinking, and process skills. Many, if not all, of the life science objectives are addressed. The specific objectives will be determined by the direction that the students choose in the inquiry-based activities. This unit is designed to address the following Texas Essential Knowledge and Skills (TEKS) 112.3 Science, Grade 1 objectives for first grade from the Texas Education Agency:

- (1A) Ask questions about organisms, objects and events.
- (2B) Plan and conduct simple descriptive investigations.
- (2E) Communicate explanations about investigations.
- (4B) Record and compare collected information.
- (6B) Observe and describe the parts of plants and animals.
- (7A) Observe, measure, and record changes in size, mass, color, position, quantity, sound and movement.
- (7D) Observe and record changes in the life cycle of organisms.

RATIONALE

This curriculum unit teaches students about the concept of animal and plant life cycles. This unit will cover the life cycles of butterflies, ladybugs, sea urchins, mealworms, and bean plants. We will compare and contrast the life cycles of these organisms while investigating metamorphosis. I chose this subject because of the high level of interest it tends to spark in students as well as the ease with which a hands-on approach can be applied.

This unit focuses on how life cycles of different organisms are similar and different. This unit will be useful to any teacher who is teaching about plants, animals, life cycles, adaptations, plant and animal interdependence, or ecosystems. It is adaptable to any grade level and for any group of students by varying the scope, sequence, and level of detail to meet the needs of the particular group of students. For example, teachers of middle and high school students may wish to inquire about how organisms change on a cellular level throughout their life cycle. This unit is easily adapted by changing the organisms that are studied to meet the needs, interests, and background of your students.

Life cycles are an area of high student interest for several reasons. Children are naturally curious about the world around them and are especially drawn to discrepant events, such as metamorphosis**.** There is a magical quality to such unusual observations. Children love to hold, touch, and see the things they learn about out in the real world. Students are often kinesthetic and visual learners who thrive on hands-on experiences. Butterflies, ladybugs, mealworms, and bean plants are relatively easy resources to use in an elementary classroom and add endless benefits for the hands-on learner. It is easier to understand the concept of life cycles when you can see it unfold before your eyes.

It is for these reasons that I will use an inquiry-based approach. By involving the students in inquiry, I will allow them to discover the magic of life cycles on their own in the real world, rather than learning about it via textbook and direct instruction. This method will encourage students to own their knowledge in ways traditional direct instruction cannot. By allowing students to take ownership in their learning, through inquiry of this high interest content, we can allow students to enjoy fully the benefits of education while ensuring that they learn to their fullest potential.

UNIT BACKGROUND

Inquiry-based Learning

The objective of this unit is to teach life cycles through inquiry-based activities and hands-on experiences. I want my students to go beyond labeling and sequencing to understanding the how and why of life cycles. In this section, I will answer two general questions. First, what is inquiry? And second, why should we use inquiry? By the end of this section, the reader should understand the benefits of an inquiry approach to science and be able to apply its basic concepts to the classroom.

What is inquiry?

The National Research Council's *National Science Education Standards* best defines inquiry and the student's experience in this way:

> Students at all grade levels and in every domain of science should have the opportunity to use scientific inquiry and develop the ability to think and act in ways associated with inquiry, including asking questions, planning and conducting investigations, using appropriate tools and techniques to gather data, thinking critically and logically about relationships between evidence and explanations, constructing and analyzing alternative explanations, and communicating scientific arguments.

Inquiry is a student-centered approach to learning. Constructivist in its basic philosophy, it allows students to build on prior knowledge by asking questions about a particular subject and exploring those questions through open-ended investigation. The inquiry method seeks to motivate children by appealing to their natural curiosities and connecting prior knowledge to high interest content. By doing so, inquiry allows the child to take ownership of her newly acquired knowledge, thus increasing the chances she will retain that knowledge for future use.

The theory of constructivism states that individuals construct their own knowledge. They do so based on their prior knowledge. Inquiry learning allows the learner to construct his or her own learning by becoming actively involved in his or her learning, creating ownership. Students learn and retain information best when they are active participants in their learning. When students are allowed to participate in the direction of their learning and to pursue answers to their own questions, they have ownership of their learning. They become invested in their learning and the outcome. Becoming actively involved gives students motivation and a sense of excitement that help them to understand the content and integrate it into their knowledge base. Life cycles are a perfect way to allow a child to grasp scientific concepts using their natural curiosity through the process of inquiry.

> …[I]nquiry-based learning cultivates and capitalizes on a child's natural curiosity to help her learn about the world. It's about encouraging your child's curiosity and natural wonder, and fostering a fascination for discovery and a way for learning that has real-world relevance …child-centered and based on the real ways in which scientists learn about the world. (Barber, Parizeau, Bergman 3)

When students come to our classrooms with questions and enthusiasm for learning, we should encourage their natural curiosity and provide opportunities to participate in student-centered learning. Students should be encouraged to ask questions freely about the content that is being studied based on their interests. Although not all of the questions can be investigated using inquiry, students need practice in forming open-ended questions. A good strategy is to encourage all students to contribute a question about the topic and then comb through the list for the most open ended questions with which to pursue inquiry.

Children have a natural curiosity which drives them to explore the world around them, and it can be utilized to help them learn about science content. "It is a process in which children have been engaged virtually since they were born, and it is mirrored effectively in inquiry-centered science programs" (National Science Resource Center 14). Once students have formulated their questions, they should plan and conduct simple investigations. Teachers can support students in working out their ideas and providing resources for investigations. The students should then gather information, construct explanations, and communicate what they have learned to others. Students should develop skills in communicating ideas to other students because it provides the opportunity to reflect on their learning, defend it and make adjustments if necessary. "From the earliest grades, students should experience science in a form that engages them in the active construction of ideas and explanations that enhance their opportunities to develop the abilities to do science" (National Research Council, *NSES*).

"Effective learning requires that students take control of their own learning" (National Research Council, *Inquiry* 119). Inquiry creates high student interest because it allows students to take this sort of ownership. When students are allowed to pursue the questions they have come up with themselves, they develop a direct connection to the content. It provides the opportunity to connect their prior knowledge in a direct way with the new knowledge that they are constructing. "Inquiry is intimately connected to scientific questions – students must inquire using what they already know and the inquiry process must add to their knowledge" (National Research Council, *Inquiry* 13). When students follow their interests, they gain a personal and meaningful connection to the material and become invested in the learning process. All of these help students to construct their own meaning instead of learning facts and information through rote memorization. By avoiding memorization in favor of constructed meaning, students increase the likelihood of retaining the newly learned information.

Why Should You Use Inquiry?

Inquiry-based learning is an effective teaching method. According to National Research Council, there are"…strong parallels between how research says students learn important science concepts and the processes of scientific inquiry that are used in inquiry-based teaching" (*Inquiry* 115). "For example, Arthur Reynolds and co-workers at Northern Illinois University found that students who had been taught science in inquiry-centered elementary school classrooms were more successful in middle school and high school science classes than were students taught in more traditional ways, such as by reading a textbook" (National Science Resource Center 17-18). Further, by tapping into a student's prior knowledge, a teacher can be better prepared to lead his or her students through the phases of learning since the inquiry method naturally allows students to explore ideas, gather information, and apply learned information to multiple situations; "Inquiry-based learning taps into how [students learn] best:

investigating and discovering things for [themselves], as well as reading and being instructed" (Barber, Parizeau, Bergman 52, 97).

Hands-on Exploration

Inquiry is best done through hands-on exploration, which involves providing students with direct experiences with the subject matter. That is, students are given the opportunity to try things out for themselves first hand, by literally getting their "hands on" materials and tools relevant to the content area being studied. It is also important that these experiences be applicable to the real world.

Although we are moving towards student-centered activity, teachers have an integral part to play in implementing a hands-on approach. Providing genuine, interactive learning experiences for students is, to a large degree, the responsibility of the teacher. For example, measuring real world objects with either balance scales or measuring tapes, growing plants from seed, watching the life cycle of frogs develop, building ramps to observe acceleration, sorting rocks into groups by type, or building models of planets are all wonderful hands-on activities that a teacher can set up for his or her students.

Some will ask why it is so important to take a "hands-on" approach. To answer this best, we need to consider the idea of Howard Gardner's multiple intelligences found in his book *Multiple Intelligences: The Theory in Practice*. The traditional approach to instruction often addresses only one or two of these intelligences. When we take into account the different learning styles of our learners, it is in our student's best interests for us to take an alternate approach rather than the traditional direct instruction approach.

Barber *et al.* tell us that research states that one of the most effective ways that people learn best is through "active" learning. Hands-on can be interacting with materials, and can also be interacting with ideas by discussing, writing, and reflecting (Barber, Parizeau, Bergman 52). A hands-on approach will often generate excitement and enhanced learning for all learning styles (National Science Resource Center 23).

Hands-on activities provide direct experiences with content to students who otherwise might never have such experiences:

> Part of the pressing need for hands-on experiences stems from the fact that as today's children grow, they have increasingly little contact with the natural world. The lack of concrete experiences means that children have fewer resources to draw on in their efforts to make sense of the world. (National Science Resource Center 10)

In "Bridging the Gap Between the Concrete and the Abstract," James Heddens states that learners should start with the concrete level and progress towards the abstract level of understanding. Many science concepts are abstract, and it is much easier for students to understand them if they begin at the concrete level. Hands-on experiences provide learning experiences at the concrete level.

As stated above, prior knowledge is necessary for students to make connections with new information. By providing hands-on experiences, we not only provide a supportive learning environment for kinesthetic learners, but we may broaden the knowledge base of those students who may not have had the requisite experience to make connections between new and existing knowledge.

"Experience is the key factor. Research on children's learning has revealed that when children do not have firsthand experiences with the things they are learning about in school, the information that the curriculum seeks to convey will often not make sense to them"(National Science Resource Center 10). Best teaching practices also indicate that it is best to reach students using as many modalities as possible. As stated above, students are often exposed to written and oral modalities. But many students learn best through tactile and kinesthetic learning. Children love to get involved by actively participating and getting their hands on materials. They love to build, measure, touch, and watch concrete objects. This enjoyment provides motivation and interest in content. Providing students with opportunities to learn through the concrete allows them to synthesize the content into abstract understanding. All of these experiences enrich their learning.

Life Cycle Unit Implementation

It is important to teach life cycles for several reasons. The life sciences in elementary school are the beginning of our students' experiences in biology. It is important to provide interesting, relevant, and in-depth experiences at an early age to foster a love of science and help develop the scientific leaders of the future. The life sciences provide excellent opportunities to explore and inquire about the world around us and instill a love of learning. In addition, life cycles are important objectives in the elementary curriculum. It is important for students to understand the cycle of life and its recurrence in the world around them and to understand that these processes are not exclusive to mammals, but also occur in other animals and plants. Many students are able to identify adults and young of the same species when they look alike (e.g. young/adult elephant). However, there are a number of instances when connecting adults with their young is not an intuitive process because of metamorphosis (e.g. butterflies, mealworms). While investigating the life cycles of different species, students will be able to see that this process is characteristic of all living things while also appreciating the uniqueness of individual organisms. I want my students to capture the great beauty of the big picture of cellular organisms while also admiring the value of details.

This curriculum unit deals specifically with the life cycles of butterflies, ladybugs, mealworms, sea urchins and sea stars, and bean plants. The lessons in this unit do not need to be done in order but are intended to be taught in the spring to accommodate the utilization of the butterfly garden. The unit does not need to be done as a cumulative process and, therefore, not all of the life cycles need to be taught for the unit to be effective. When first teaching this unit, you may prefer to work only with butterfly and ladybug life cycles. Perhaps the next year you may wish to add mealworms and bean plants. The next year you may wish to add sea urchins. Students may also be interested in learning about life cycles of animals with incomplete metamorphosis. For example, grasshoppers and dragonflies have an incomplete metamorphosis which means that they have only three stages: egg, nymph, and adult. The nymph stage often looks like a small adult without wings. Having a repertoire of life cycles is beneficial for both students and the teacher. It provides a greater chance that each student will find an organism that he/she is interested in learning about, while also keeping the teacher interested and excited about what she is teaching.

The unit can be tailored to your needs which may depend on your student's interests, your interests, and the availability of time, materials, and space. The unit can be adapted to meet the needs of any grade level by varying the depth and complexity of the life cycles. Older students may be interested in learning about the importance of cellular events and their impact on the life cycle (e.g. phototropism and plant production of auxin). With regard to time constraints, it is possible (and may be preferable) to learn about several life cycles at the same time. Life cycles by nature must be observed and inquired about over a period of time to allow for the progression from one stage to the next. Depending on the stage of the life cycle of the organism, it may or may not take a full class period. Also, the interests of the students often dictate the amount of time. In addition to the hands-on and inquiry-based activities included in this unit, students will also listen to and read nonfiction and fiction stories about the organisms and their life cycles, write about and illustrate what they are learning, and measure, chart, and graph data they have recorded.

There are several concepts which should be covered prior to this unit. These include understanding characteristics of living and nonliving things, the differences and similarities of plants and animals, and the major groups of animals with their main characteristics. All of this provides vital background knowledge for the students to drawn on as they begin to understand the concept of life cycles. An opening lesson on life cycles begins with the non-metamorphic life cycles of mammals, birds, reptiles, and fish. It is important for students to understand the similarities and differences between these life cycles. They should understand that the animal progresses from an egg or liveborn young to an adult that reproduces and then dies, while the cycle continues if reproduction was successful. They should recognize that the young and juvenile look very similar to the adult animal. Most children grasp this quickly based on their prior knowledge and experience. The use of photographs and well-illustrated literature will help facilitate this understanding. Students will play a matching game where they will match photographs of baby and adult animals to assess their understanding. Once an understanding has been established, then metamorphic life cycles can be introduced in any order. It is best if this can be determined by students' interest as this will increase their ownership of their learning.

Life Cycle of the Butterfly

The life cycle of the butterfly begins as an egg. The eggs are laid by butterflies on leaves. In general, butterfly eggs are small, round, and are located on or near the caterpillar's food source. They are often hard to find and observe without a lens. Caterpillars are the larval stage of the butterfly. The caterpillar does a lot of eating and growing. When the caterpillar hatches out of the egg, it is very hungry. It first eats its eggshell, which is a good initial source of food. Then it finds its intended food source. Caterpillars look like worms with legs and can be different colors depending on the species. Caterpillars usually have three sets of real legs towards the front of the body and 5 sets of prolegs towards the back of the body. Caterpillars eat and eat and eat, until they are much bigger and their skin is too tight. Then they molt and shed their skin. Once they produce enough juvenile hormone, the caterpillars will go to find a good place to make a chrysalis, the pupa stage. The caterpillar hangs upside down and attaches itself by making a little adhesive pad. Then it forms the hard shell of the chrysalis around its body. Inside the chrysalis, the composition of the caterpillar changes and the body of the butterfly takes shape. Over time the chrysalis darkens and eventually it opens. When the adult butterfly emerges, it is wet and has a large abdomen. It will stay close by while it dries its wings and pumps the fluid in its abdomen into its wings. Then the butterfly is ready to fly. The adult butterfly drinks nectar from flowering plants, water from puddles, or liquid from rotting fruit through its proboscis. It will mate, and the female adult butterfly will lay eggs, beginning the cycle again.

In the unit, the students will utilize a butterfly garden to engage in hands-on, inquiry learning about the butterfly life cycle. The students will also learn important vocabulary including egg, larva, pupa, and adult, which will be important for discussions and understanding when comparing and contrasting life cycles later in the unit. In these lessons the teacher will model inquiry. The students will brainstorm questions to ask about the various stages of the butterfly life cycle and the teacher will facilitate a discussion about which questions can actually be investigated. Some examples of questions may be about how many times caterpillars will molt or which plants butterflies prefer to lay eggs on. The class can then choose one or more questions to investigate. Depending on the experience and level of the students, the teacher can direct the investigation or allow for some student direction. The teacher may also have an investigation in mind and direct students towards it.

The lessons about the life cycle of the butterfly are based on the use of a butterfly garden. I highly recommend creating, maintaining, and utilizing a butterfly garden. The butterfly garden is an authentic way for students to observe, record, and study the life cycle of butterflies in true hands-on exploration. The butterfly garden should be set up in the fall prior to the unit so that the plants will be established, and it should contain a lot of milkweed plants. The garden will also need several butterfly bushes, lantana, lavender, and other flowers. The caterpillars like to make their chrysalises in the dense foliage of the lantana. When the butterflies emerge, they will drink from the butterfly bush. There are lots of other plants that will work, and plant lists are readily available on the Internet. For monarchs, the most important part is the milkweed. The adult female monarch butterfly lays the eggs on the underside of the milkweed leaves. When the caterpillars hatch, they are on their food source, and they will eat until they are large caterpillars. The caterpillars are yellow, black and white striped.

Monarchs are not the only option. The painted lady butterfly is also common in the United States and would work well. Your garden could cater to lots of kinds of butterflies. The choice is yours.

The butterfly garden that I created was designed to attract monarch butterflies throughout the life cycle by providing habitat and food sources for all of the stages of the life cycle. Butterfly gardens do not need to be large to attract butterflies. Our garden is relatively small in size and is located in an urban neighborhood, yet the butterflies find their way to us. Our most recent group of caterpillars numbered 42, and they consumed our entire milkweed stock in record time. What was once a weedy area between a walkway and the building is now our delightful garden.

If you find that you are truly not able to have a garden, then you can purchase caterpillars from biological supply companies such as Carolina Biological Supply Company or Delta Education. They sell kits containing caterpillars with food and a home to keep the butterflies in while observing them. You can observe the caterpillars, chrysalises, and butterflies in the classroom. It provides the opportunity for hands-on exploration and observation of the daily changes in the life cycle. Observing the caterpillars and butterflies in their natural habitat is highly beneficial and strongly recommended. It opens the door for students to ask a lot of questions that might not otherwise have arisen.

The lessons include making observations and notes in their science journals to illustrate and write about the stages they are seeing and to note the changes over time (the size and color of the caterpillars, the darkening of the chrysalis, the drying of the wings, etc.). It is also an opportunity to practice important process skills. Students will make non-standard and standard measurements of caterpillars. Non-standard measurement uses objects of uniform size such as paper clips or cubes, which do not represent accepted units of measurement. Standard measurement is measurement using metric or customary units of measurement. The will also record the length of time for the growth of the caterpillars, the number of times they molt, and the length of time in the chrysalis. For details on how to implement this, please see Lesson Plan One below. Students will be able to see these changes first hand for themselves, which really makes an impression on them. They are excited about learning and invested in the learning process through internal motivation. This increases their ability to learn the order of the life cycles and details about the event. Key details include the color change of the chrysalis, the molting of caterpillars, the eating of the shell, and the color and number of eggs laid.

Life Cycle of Ladybug

The life cycle of the ladybug is also a complete metamorphic life cycle. The ladybug life cycle begins when the female adult ladybug lays a mass of eggs in or near an aphid colony. The eggs are small, cylindrical, and yellow or orange. The larvae that hatch from the eggs look like long dark, ridged insects with three sets of legs. The larvae first eat their eggshell and then feed on aphids for several weeks. The larvae also molt as they grow. The larvae attach themselves to leaves by the abdomen and then form the pupa. The pupa stage often lasts for about a week, at which time the adult ladybug comes out. Although the adult does not immediately have spots, they usually develop in the first day. The ladybug life cycle is similar to the butterfly life cycle in that there are egg, larva, pupa, and adult stages. In addition the insects at the larval stages do not look like the adult insects, and they both molt. Both insects have a pupa that is not mobile, in which metamorphosis is taking place. They are different in several ways. The eggs differ in number and color. Butterflies lay one egg at a time while ladybugs lay a mass of eggs. The wormlike caterpillar larvae of butterflies eat plants, while the more insect-like ladybug larvae eat aphids.

In these lessons, the students will have hands-on experiences watching the ladybug life cycle in their classroom. A ladybug habitat will be obtained from a supply vendor and kept in the classroom for daily observation. Students will make observations, record notes and illustrations in their science journals, ask questions, participate in class discussions, and participate in one or more inquiry investigations. In this inquiry activity, the teacher will again facilitate student questions and help determine which can be investigated. Students will take on more responsibility with designing how to investigate the questions. For example, the class may vote on investigating what ladybugs prefer to eat, and the students will then find ways to test this. Other questions could be about light or sound sensitivity. The number of investigations will depend on student interest and available time. If the first investigation is lengthy, then there may not be time for another. High student interest may dictate further study with ladybugs and less time with another life cycle. The lessons on the ladybug life cycle could be done at the same time as the lessons on the butterfly life cycle. Observing and learning about both butterfly and ladybug life cycles gives students repeated exposure to material. It allows them to see make connections between these two metamorphic life cycles to help them integrate it into their schema.

Life Cycle of Mealworms

The life cycle of the mealworm is a complete metamorphosis which means that it goes through four stages: egg, larva, pupa, and adult. The eggs are small and round and usually difficult to find. The mealworms that hatch from the eggs are the larval stage. They look like worms with three sets of legs. The mealworms eat a lot, just as the caterpillars and ladybug larvae do. They also molt as they grow larger. The mealworm eventually forms a hard casing and becomes a pupa where it changes into the adult form. The adult that emerges is actually a beetle which then lays eggs to continue the life cycle. Mealworms are relatively easy to care for. There are many resources available with guidelines for the care of mealworm populations. They do well with a glass container, oatmeal, and potato halves. They are also relatively easy for students to handle and observe. They can be observed easily by removing one mealworm from the storage container and placing it either on wax paper or inside a plastic baggie. The greatest benefit of working with the mealworm life cycle is that the larvae are very easy to handle, making observation and investigation a much easier process.

At this point in the unit, the students will be working more independently. The students will spend time observing the mealworms and practicing their process skills by observing, recording, measuring, and collecting data on the mealworms. After spending time observing, the students will each come up with a question and a way to investigate their question. The teacher will provide feedback, assistance with materials, and guidance as necessary. The students will then share their question and results with the class. The students will be asked to repeat their investigation to see if the results are the same. For details on implementing this, see Lesson Plan Two below. In subsequent lessons, the students will spend a few minutes observing the mealworm and will then ask additional questions and design additional investigations. They may draw on the reports of other students in the class, or they may have new questions they wish to investigate. The students may be interested in the insect's reaction to light, sound, color, and vibration, or food preferences. The teacher should facilitate and provide guidance on issues of safety and appropriateness. An excellent example of an inquiry-based activity using mealworms can be found in the article "Introducing a Reformed Curriculum - Critters' Log" by Choi, Gonzales, and Ramsey.

These lessons can build on the experiences of the other life cycle investigations. As with all of the life cycles being studied in this unit, the order of the organisms can be changed, and the inquiry activities can be altered. The inquiry-based activities can fall anywhere on the inquiry continuum, from teacher modeling to student centered, but the idea is to make progress toward a totally student centered project.

Life Cycle of Bean Plants

The life cycle of the bean plant begins as a seed. The seed has certain needs that are required to sprout. Once it begins to sprout, a root begins to grow down into the soil. The seed is pushed up as shoots grows up towards the sun. Next the leaves develop. The plant will develop seeds which are dispersed in different ways. This continues the life cycle of the plant. Lima bean plants tend to sprout quickly and are easy to work with in the classroom. It does take time and energy to get the plants to produce seeds in order to watch the complete life cycle; using Wisconsin Fast Plants® may reduce some of the time needed. The life cycle of the bean plant provides many opportunities for inquiry and hands-on exploration. Students will plant seeds, grow plants in the classroom, at home, and in an outdoor garden in order to investigate the bean plant life cycle. Students will design and conduct experiments with plants based on student interest. They may be interested in investigating the factors that affect seed dispersal, flower structure, and growth factors (air, soil type, amount and/or type of light, amount of water, space) to determine the effects on the life cycle and the organisms' survival. See Lesson Plan Three below for details.

Life Cycle of Sea Urchins and Sea Stars

The life cycle of sea urchins and sea stars are also unique metamorphic life cycles where the larval stage looks very different from the adult stage. The life cycles of these two echinoderms begin as eggs. The larva that develops is microscopic and has a very interesting shape. As the larva grows, its body changes and begins to look like the adult. When it has developed into an adult, it is then able to reproduce, continuing the life cycle. This lesson will be done through video and photographic evidence, as it is not possible to do a hands-on activity unless you have these resources available to you. In addition, students would not be able to observe the complete life cycle directly in the classroom, as sea urchins and sea stars do not reach sexual maturity for a few years. In this case direct instruction through visual and auditory sources is necessary but provides a valuable opportunity for students to extend their understanding of life cycles to an organism with which they may be very unfamiliar. It provides another opportunity for them to discuss the stages of the life cycle and to compare and contrast the life cycle to other organisms. For example, these echinoderms do not have a pupa stage, which contrasts with the butterfly and ladybug life cycles.

Compare and Contrast

The students will spend time reflecting on what they have learned through writing and illustrating in their science journals, class discussion, and independent reading of nonfiction literature. After reflection and collaboration, the students will be asked to create a Venn diagram comparing and contrasting two of the life cycles covered in the life cycle unit. For details on this lesson, refer to Lesson Plan Four below. Each student will then share his or her findings with the class in the form of a brief oral report and display of the Venn diagram. Students will then break into small groups and work cooperatively to compare and contrast two life cycles that have been assigned to them. As a group the students will create a new and larger Venn diagram and short oral report which will be presented to the class. The goal of the second report is to have the students incorporate all of the ideas that were shared into one diagram comparing and contrasting the two life cycles. The students will have to apply what they have learned in order to successfully complete this project.

LESSON PLANS

Lesson Plan 1: Life Cycle of the Butterfly

Objective

The objective of this lesson is for students to engage in hands-on exploration of the butterfly life cycle by observing, measuring, and recording changes in the size, color, position, quantity, and movement of caterpillars, chrysalises, and butterflies.

TEKS: 112.3 Science, Grade 1

(4B) Record and compare collected information
(6B) Observe and describe the parts of plants and animals
(7A) Observe, measure, and record changes in size, mass, color, position, quantity, sound and movement.

Materials

Butterfly garden or classroom butterfly habitat, science journals, pencils, crayons, hand lenses, metrics rulers and measuring tapes.

Procedures

At the beginning of the lesson, bring students outside to spend five to ten minutes just observing the butterfly garden. Students should be looking for caterpillars, chrysalises, and butterfly activity. They should also be examining the plants' growth or loss, presence or absence of other organisms, unusual developments or changes, and placement of chrysalises. After students have had an opportunity to make observations, they should be directed to make a dated entry in their science journals, recording their observations in words and illustrations. Allow five to ten minutes for students to make their entries. Have individual students share an observation with the class. Divide the class up into small groups, and give each group an assignment and the science tools that they will need to complete their job. One group will count the *quantity* of caterpillars in the garden/habitat and break it down into the number of each *size* (small, medium and large caterpillars) and note changes in *color*. The second group will be responsible for counting the number of caterpillars on each milkweed plant to look for changes in *location* and observe *movement*. The third group will look carefully for chrysalises and note their *locations*. The fourth group will note the number of butterflies visiting the garden, the particular plants visited, their observable behavior and the development of the plants. The students will come back together in a large group, and each small group will informally present their observations to the whole group. Each student will then be given a metric ruler or tape and asked to measure the length of one caterpillar. Students will then return to the classroom where the recorded data will be recorded on the class data sheet.

Assessment:

Students will be assessed on their participation in small groups and class discussion using a rubric. Each student is expected to participate in cooperative group work. Students will also be assessed formally on the observations recorded in their science journal.

Lesson Plan 2: Inquiry Lesson on Life Cycle of Mealworm

Objective

The objective of this lesson is for students to be involved in inquiry-learning about the life cycle of mealworms. Students will ask questions, plan and conduct simple investigations, and observe the life cycle of the mealworm.

TEKS: 112.3 Science, Grade 1
(1A) Ask questions about organisms, objects and events
(2B) Plan and conduct simple descriptive investigations
(7D) Observe and record changes in the life cycle of organisms

Materials

Mealworm population, wax paper, plastic baggies, science journals, pencils, hand lenses, resources requested by students (ex. cardboard, flashlights, stopwatches, etc).

Procedures

Students should be familiar with handling and care of mealworms. They have had prior experience practicing their process skills and observing the larval stage with a hand lens. Students have also had practice designing inquiry questions in prior lessons with the life cycle of the ladybug. In this lesson the students will come up with their own question to investigate the larval stage of the life cycle of the mealworm. The students will briefly present their question to the teacher to screen for questions that are not easily investigated. Students will then design and carry out the investigation that they have designed. The teacher will assist with providing appropriate materials and guidance as needed. The students will then present their findings to the class in a brief oral report.

Assessment

Students will be assessed on what they have learned about the larval stage of the mealworm through their oral report to the class using a rubric. They will also be informally assessed through teacher observation during questioning and investigating.

Lesson Plan 3: Inquiry Lesson on Life Cycle of Bean Plant

Objective

Students will work in small groups to learn about the life cycle of the lima bean plant by investigating the answer to a self-generated question.

TEKS: 112.3 Science, Grade 1
(2B) Plan and conduct simple descriptive investigations
(3A) Make decision using information
(7D) Observe and record changes in the life cycle of organisms.

Materials

Lima bean sprouts, lima bean seeds, hand lenses, rulers, measuring tape, other materials as needed by students for investigations, science journals, pencils.

Procedures

Students will investigate the life cycle of the lima bean plant through hands-on exploration and inquiry investigation. Students will work in small groups to decide cooperatively on a question to investigate the life cycle of the lima bean plant. Some examples of possible investigations include factors that affect seed dispersal, flower design, and growth factors (air, soil type, amount and/or type of light, amount of water, space, nutrients) to determine the effects on the life cycle and the organisms' survival. The students will conduct their investigations, collect and record data, and request materials and assistance from the teacher as needed. All students in the group are required to make notes of observations and record data in their science journals. When the investigation is completed, the students will be required to report their findings to the class. All members of the group are required to participate in the investigation and report in some meaningful way. The group will be asked to self-assess on their own contribution to the group as well as the other members' contributions.

Assessment

The students will be assessed informally through teacher observations of small group investigations and oral presentation. Students will be assessed formally on the content of their science journals using a rubric given to the class at the beginning of the project.

Lesson Plan 4: Compare and Contrast Lesson

Objective

Students will compare and contrast the life cycle of the bean plant with the metamorphic life cycle of the butterfly using Venn diagrams and class discussion.

TEKS: 112.3 Science, Grade 1
(2E) Communicate explanations about investigation
(7D) Observe and record changes in the life cycles of organisms.

Materials

Venn diagram, paper, markers.

Procedures

The students will participate in a class discussion to review the life cycle of the lima bean plant and the metamorphic life cycle of the butterfly. Any two life cycles in the unit can be substituted in this lesson. After reviewing and discussing both life cycles, students will be asked to compare and contrast the two life cycles. The teacher will prompt the students by asking questions such as: What do the bean plant and butterfly life cycles have in common? What are their similarities? What are the differences between the two life cycles? Students should be encouraged to consider all of the stages of the life cycles when looking for comparisons and contrasts. Other questions may include: How many stages do they each have? What happens at the end of both life cycles? Are eggs and seeds similar or different? Does a plant have something like a larval stage or a pupa stage? Do they both have adult stages? After discussing, the class will complete a Venn diagram as a whole group. The students will be asked to complete a Venn diagram on their own using two life cycles of their choosing.

Assessment

The students will be assessed informally on their understanding of life cycles through class discussion. The students will be assessed formally on their ability to compare and contrast life cycles through the completion of individual Venn diagrams.

ANNOTATED BIBLIOGRAPHY

Works Cited

Barber, Jacqueline, Nicole Parizeau, and Lincoln Bergman. *Spark Your Child's Success in Math and Science.* Berkeley: U of California at Berkeley, 2002.
This is a book from the Lawrence Hall of Science (U of CA at Berkeley) written with parents in mind. It includes good information on current science education reform and research, strategies for helping children, and a chapter on inquiry-based learning.

Choi, Sanghee, Claudia Gonzales, and John Ramsey. "Introducing a Reformed Curriculum-Critters' Log." *The Texas Science Teacher* 36 (2007): 10-17.
This article showcases an inquiry-based lesson utilizing mealworms where students practice science process skills through scientific investigations. This lesson also focuses on student understanding through questioning, discussion, and collaboration.

Gardner, Howard. *Multiple Intelligences: The Theory in Practice.* New York: BasicBooks, 1993.
A discussion of the multiple intelligences can be found in this book.

Heddens, James W. "Bridging the Gap between the Concrete and the Abstract." *Arithmetic Teacher* 33.6 (February 1986) 14-17.
This article discusses student learning from the concrete to abstract stages.

National Research Council. Content Standards: K-4. *National Science Education Standards*. Washington, DC: National Academy Press, 1996. 29 February 2008. <http://www.nap.edu/readingroom/books/nses/6c.html>.
This is a reference resource for the National Science Education Content Standards for Grades K-4, content standards A through G.

National Research Council. *Inquiry and the National Science Education Standards: A Guide for Teaching and Learning.* Washington, DC: National Academy Press, 2000. 29 February 2008. <http://www.nap.edu/catalog.php?record_id=9596#toc>.
This book explores inquiry in the National Science Education Standards. Chapter 2: Inquiry in the *National Science Education Standards* and Chapter 6: Making the Case for Inquiry are especially helpful.

National Science Resource Center. *Science for All Children: A Guide to Improving Elementary Science Education in Your School District*. Washington, DC: National Academy Press, 1997.
This book discusses a model for science education based on research and practice, with the goal of bringing elementary education in line with the National Science Education Standards, including inquiry-based and hands-on learning.

"Texas Essential Knowledge and Skills – First Grade." *Texas Essential Knowledge and Skills*. 2007. Texas Education Agency. 6 March 2008. <http://ww.tea.state.tx.us/teks/grade/First_Grade.pdf>.

Supplemental Sources

Teacher Resources

Allen, Maureen Murphy, *et al*. *Critters*. Fresno: AIMS Education Foundation, 2004.
This is a book contains activities for use in lessons dealing with "critters" and includes sections on life cycles, observation and interdependence among others. These activities could be used in student inquiry activities.

American Association for the Advancement of Science. “Chapter 1: The Nature of Science.” *Benchmarks for Science Literacy Online*. 1993. 11 April 2008. <http://www.project2061.org/publications/bsl/online/ch1/ch1.htm>.
This chapter provides detailed information on the AAAS’s benchmarks for science literacy including the scientific world view, scientific inquiry and the scientific enterprise.

Blaxland, Beth. *Echinoderms: Sea Stars, Sea Urchins, and Their Relatives*. Broomall, PA: Chelsea House Publishers, 2003.
This book has good information on echinoderms including sea stars, brittle stars, sea urchins, and sea cucumbers. It includes a section on life cycles of echinoderms with photographs.

Bonner, John Tyler. *First Signals: The Evolution of Multicellular Development*. Princeton: Princeton UP, 2000.
This is a good book to provide background information for teachers on multicellular development.

Bybee, R.W. “Teaching Science as Inquiry.” In *Inquiring into Teaching Inquiry Learning And Teaching in Science.* Washington, DC: American Association for the Advancement of Science, 2000.

Carroll, Sean B. *Endless Forms Most Beautiful*. New York: W.W. Norton & Company, 2005.
This book explores the field of evolutionary developmental biology for the general reader. It discusses the development from egg to adult as well as the evolutionary process.

Grande, Jennifer. “Slime and Other Adventures: Inquiry-Based, Hands-on Learning.” In *Chemistry Through the Ages: From Alchemy to Molecular Design.* Ed. Scott Perry. Houston: Houston Teachers Institute, 2005. 99-117.
This is a unit written with the goal of teaching through inquiry and hands-on exploration.

Hoover, Evalyn and Sheryl Mercier, *Primarily Plants*. Fresno: AIMS Education Foundation, 1990.
This is a book containing activities for use in lessons dealing with all areas of plant development in the life cycle that can be used in inquiry-based activities.

National Research Council. *How People Learn: Brain, Mind, Experience and School: Expanded Edition.* Washington, DC: National Academy Press, 2000. 4 March 2008. <http://www.nap.edu/catalog.php?record_id=9853>.
This publication contains a lot of useful information on how people learn. It also discusses Vygotsky’s zone of proximal development which is a useful model for effective teaching.

National Science Foundation. *Inquiry: Thoughts, Views, and Strategies for the K-5 Classroom. Foundations, Vol. 2.* 2000. National Science Foundation. 11 April 2008. < http://www.nsf.gov/pubs/2000/nsf99148/htmstart.htm>.
This publication discusses in depth varied aspects of inquiry learning and teaching.

Stefoff, Rebecca. *The Amphibian Class*. New York: Marshall Cavendish, 2008.
This book contains information on amphibians and life cycles including frogs, toads, salamanders, newts and caecilians. It has fantastic photographs.

Student Resources

Aloian, Molly, and Bobbie Kalman. *Insect Life Cycles.* New York: Crabtree Publishing Company, 2005.
This book covers insect life cycles including complete and incomplete metamorphosis and has detailed photographs.

Blaxland, Beth. *Echinoderms: Sea Stars, Sea Urchins, and Their Relatives*. Broomall, PA: Chelsea House Publishers, 2003.
This book has good information on echinoderms including sea stars, brittle stars, sea urchins and sea cucumbers. It includes a section on life cycles of echinoderms with photographs.

Burke, Melissa Blackwell. *A Butterfly’s Life*. Texas: Steck-Vaughn, 2001.
This is a book about the butterfly life cycle is has fantastic photographs of the stages of the life cycle.

Jeunesse, Gallimard. *The Egg.* New York: Scholastic, 2004.
This is a well illustrated book for children with several transparent pages that talks about the eggs of birds and specifically the life cycle of the chicken.

Jeunesse, Gallimard, and Sylvaine Peyrols. *The Ladybug and Other Insects.* New York: Scholastic, 2004.
This is a beautifully illustrated book for children with several transparent pages that talks about the ladybug's body parts, behavior and life cycle.

Jordan, Helene. *How a Seed Grows.* New York: HarperCollins, 1992.
This is an illustrated book that talks about growing bean seeds and includes an activity that can be done along with the book.

Posada, Mia. *Ladybugs Red, Fiery, and Bright.* New York: Scholastic, 2002.
This is a great book with good illustrations and lots of good information on ladybugs including the life cycle.

Spilsbury Richard, and Louise Spilsbury. *From Egg to Adult: The Life Cycle of Amphibians.* Chicago: Heinemann Library, 2003.
This book has good information on the amphibian life cycle along with great photographs.

Zemlicka, Shannon. *From Egg to Butterfly*. Minneapolis: Lerner Publications Company, 2003.
This is an early reader book about the life cycle of the butterfly with excellent photographs.

Zoehfeld, Kathleen Weidner. *From Tadpole to Frog.* New York: Scholastic, 2001.
This is an early reader book with great photographs of the frog life cycle.