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Birds of New England and Costa Rica: A Science-Based Interdisciplinary Curriculum

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An Abstract of

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Abstract

Students are naturally inquisitive scientists, and successful interdisciplinary curricula access this curiosity by shaping academic studies around students' needs as scientists. Therefore, students are scientists who need opportunities to study and observe the world around them. This curriculum, "Birds of New England and Costa Rica: A Science-Based Interdisciplinary Curriculum," is based on children's abilities to observe and question by studying the immediate environment of the students and relating it to another environment. In this way, students compare and contrast relationships in order to construct their own knowledge about birds in New England and in Costa Rica. Through this study, students question and delve into the adaptations of organisms which have enabled these species to thrive in their specific niches. By treating students as peer scientists, teachers are able to engage students so that students' enthusiasm provides internal motivation to children, which encourages them to question and learn more deeply.

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I. Rationale

Bank Street College of Education instills in students the values of a social-studies-based curriculum, and indeed, this approach has many merits that benefit students and teachers alike. After my studies for my master's degree in Childhood General Education, I believe that the works of John Dewey and Lucy Sprague Mitchell, as well as other educational theorists, support taking this approach even further. From reading these theorists and from my personal experiences, I believe that children benefit from a science-based curriculum, one in which children interact with the world around them in the manner of scientists. Children already benefit from social-studies-based curriculum, and through this paper, I will explore these benefits. Then, I will make the connection to how a science-based curriculum is similar yet provides additional gains to the students' development. This rationale supports the necessity of a science-based curriculum, and I provide a sample curriculum that exemplifies the interdisciplinary connections that are possible through such a curriculum. This work clearly illustrates that students' naturally inquisitive minds work well when fostered with a social-studies-based curriculum and that there can be even more meaningful development with a science-based curriculum, such as the bird curriculum provided. I believe this style of curriculum leads to greater development for students so that students are able to think creatively and problem solve both in- and outside the classroom.

The study of science and dealing with students as innate scientists springs from Lucy Sprague Mitchell's belief in the structure of a social-studies-based curriculum. A social-studies-based curriculum explores how people interact with the world around them and how the world changes in response. It also investigates how environmental changes affect people and the structures of society. The choices humans make affect the

environment in countless ways, and children learn about these causal relationships as well as their roles in their environments through a social-studies-based curriculum. Social studies and science are inherently intertwined since people and the environment affect and are affected by one another. As a result, "Birds of New England and Costa Rica – A Science-Based Interdisciplinary Curriculum" includes social studies components even though it is a science-based curriculum because the two approaches are intimately interwoven; the difference is in how children shape their environmental discoveries since a science-based approach encourages students to use the scientific method. Therefore, first, I explore the benefits of a social-studies-based curriculum since many of these aspects are vital components of a science-based curriculum.

A. Why a Social-Studies-Based Curriculum Works

Many progressive schools and some traditionally-structured schools are turning to curricula that are based out of children's everyday-life experiences. These curricula, referred to as social-studies-based, create units of study from experiences that many students live through outside of school. After deciding on a central experience that motivates students, the teacher works with the students to develop questions that they can explore. From these questions, teachers create interdisciplinary relationships that connect the everyday-life experience to various academic subjects, including but not limited to mathematics, science, language arts (reading, writing, grammar instruction, spelling instruction), visual arts, music, blocks and/or dramatic play, and field trips, as well as connections between the home and school. Social-studies-based curricula arise from the interests of the students and from a subject area with which the students have prior knowledge. Teachers serve as people who guide the students through their explorations so that students can make meaningful connections.

Many theorists support the structure of the social-studies-based curriculum. One of the strongest benefits of a social-studies-based curriculum is that of Csikszentmihalyi's theory of intrinsic motivation (1984). Students are inherently motivated when they are interested in the materials, especially when the curriculum is fueled by the children's personal questions. When their environment is the classroom, students become an integral part of the study. As Lucy Sprague Mitchell (1934) says:

> They [the children] must be experimenters; they must hunt for sources and study the relationships; they must explore their environment; they must analyze the culture of which they are a part, see what part of it is geographic, what part is historic; they must think; they must play. (p. 19)

Mitchell, an educator who believed in the development of the whole child, underscores the importance placing children at the center of that which they study so that they can truly immerse themselves in the exploration. Mitchel viewed children as geographers that needed to examine and engage with their world, and by using the term "geographic," Mitchell sought to focus on the map-making skills that children utilized to create spatial relationships between themselves and places. In addition, children need to appreciate the culture that surrounds them so that they better understand their roles in the world and can make greater connections between themselves and others. However, in order to do this, students need to understand and study the society of which they are a part by understanding the geographic components and thinking of those components instead of listening to a teacher's ideas.

Another benefit of a social-studies-based curriculum is that it encourages students to think critically and puts their questions into a larger perspective. Because students are interacting with their environments, students realize that they have questions about their

environment. In order to find solutions, children must think of ways to answer these questions, and these experiences give children an opportunity to problem solve in a manner that can be used at other times in their lives. This chance for creative thinking is unique to the modern-education shift towards social-studies-based curriculum. Mitchell (1934) explains the difference between this style of education and the traditional form of education:

> The chief distinction between education of the traditional type and that of the modern so-called "progressive" type is that the old schools tended to postpone the opportunities for active creative thinking until children had accumulated, had absorbed, a given amount of facts. It was assumed, and still is assumed by many traditional schools, that children are not mature enough to "think" and must accumulate a certain amount of erudition by a more or less passive absorption as a preliminary to and a basis for their thinking.... The modern school, in contrast, asserts that children grow in mental maturity from the very beginning by the active process of discovering relationships and regards the school essentially as a laboratory where such discoveries are made. (p. 5)

The benefit of a social-studies-based curriculum is that children are not only encouraged to engage in creative thinking but that children have to think creatively in order for the curriculum to progress. Furthermore, each student must think creatively so that all of the children's ideas help the group work together so that the strengths of all of the children bring in a variety of ideas. This assemblage of information that comes together to create a solution in a social-studies-based curriculum capitalizes on the strengths of all of the students while encouraging children to come to an innovative solution through their own efforts.

In this vein, social-studies-based curricula are created with the idea that a part of each student's environment is the ideas of his or her peers. Therefore, when the students work together, they learn to think about ideas in new ways that stretch their previous rationales. This idea, known as the Zone of Proximal Development (ZPD), was articulated most prominently by Soviet psychologist Lev Vygotsky. Vygotsky (1978) describes how other peers become the means of furthering a child's thinking by enabling the child to complete more difficult tasks than the child would be able to do on his or her own. In Vygotsky's words, this "zone of proximal development defines those functions that have not yet matured but are in the process of maturation, functions that will mature tomorrow but are currently in an embryonic state" (Vygotsky, 1978, p. 86). A social-studies-based curriculum is successful because the children work together as a group, and if a child is at one developmental stage, some concept will not make sense to this child. However, if another child is somewhat more developed than the first child, these children can work together so that the first child is able to accomplish tasks that he wouldn't be able to do on his own.

In this situation, the first child experiences a state of disequilibrium, which Piaget (1928) describes as a state of confusion in which the child tries to assimilate jarring, new information with previously learned knowledge but cannot initially process the new information. The new ideas offset the balance of thoughts in the child's mind. After this state of disequilibrium, the child works to integrate the new information with his previous knowledge so that he comes to a new state of equilibrium. Vygotsky (1978) explains that if the new concepts are far beyond the developmental stage of the child, this disequilibrium does not occur because the child is not yet able to compare these ideas with his or her previous knowledge. Therefore, Vygotsky (1978) believes that learning

must precede development but that the learning must be scaffolded so that it is accessible for the child's understanding, meaning that it must be presented to the child in a way that is developmentally appropriate. The learning is the experience that occurs with a child in the Zone of Proximal Development, while the development is the new equilibrium reached by the child after sorting the new information. Play is a manner with which children can acquire this new knowledge because as Vygotsky (1978) explains, play provides children a context in their zone of proximal development. Therefore, children need to be able to play with new information in order to realize how ideas fit in with their previously acquired information so that they can continue to grow.

Greene (2000) articulates that students need to be aware that they are encountering a new experience, which means they will need to "[leave] something behind while reaching toward something new, and this kind of awareness must be linked to imagination" (p. 20). As children grapple with the experience of new information, they must continue to stretch towards the new ideas, which is possible through the utilization of their imaginations. Piaget (1976) underscores the importance of communal sharing of ideas so that the full development of the personality can occur because it is only through this sharing that students realize that the teacher is not the absolute authority of information but that students can construct their knowledge by working together. As a component of a social-studies-based curriculum, peer learning is integral because students realize that they are informational resources for one another, and they become aware that teachers do not have to become the sole arbitrators of information. The importance of peers in a social-studies-based curriculum is profound for children to continue cognitive development, which is why this component is valuable in curriculum development.

To this end, students learn best when they are active learners. No longer is it enough for students to sit at a desk and listen to information given to them as they passively take in and memorize. Instead, students benefit more when they engage with the world around them so that they may take responsibility for their own learning. American psychologist Jerome Bruner critiques the outlook that learning and teaching are merely one-way relationships where teachers feel that they have certain objectives that they must accomplish. As Bruner (1971) expounds:

> One begins by setting forth the intellectual substance of what is being taught. Yet in such a recounting, one tends to "get across" the subject, the ingredient of pedagogy is in jeopardy. For only in a trivial sense is a course designed to "get something across," *merely to impart information.* There are better means to that end than teaching. *Unless the learner develops his skills, disciplines his taste, deepens his view of the world, the "something" that is got across is hardly worth the effort of transmission.* (p. 57, italics added).

Bruner is describing the stale learning environment of too many classrooms before social-studies-based progressive education revitalized school systems. Previously, teachers felt that their mission was to "merely impart information" to students, and in turn, students needed to memorize this information and reiterate the material for tests. There was no active involvement in constructing new knowledge, and because of this, learning was not dynamic and not memorable and was difficult to apply outside of the testing situation. Bruner highlights that this is not what teaching should be; instead, a true learning environment is one in which teachers and students create new knowledge together so that the students can become active participants in the development of themselves and of their communities.

A social-studies-based curriculum provides many aids to help children grow, including a motivating environment where children want to engage with the material, an opportunity for children to practice critical thinking in order to problem-solve, and a means of working with other students in order to learn and develop. This structure of a social-studies-based curriculum is also meaningful because it makes interdisciplinary connections so that children learn that problems do not involve discrete subject areas but instead rely on the synthesis of information from various disciplines to provide a solution. These values of a social-studies-based curriculum become part of a science-based curriculum as well. However, there are several aspects of a science-based curriculum that encourage the development of children, as supported by the work of various theorists.

B. Why a Science-Based Curriculum Enriches

Recognizing students as the true scientists they are an idea that has been around for decades and yet has not received enough attention. Theorists like Mitchell, Dewey, Piaget, and others support the idea that students are inherently scientists and that they can benefit from solving problems in accordance to the scientific method of exploring, questioning, observing, analyzing, and applying. I believe that because students are inherently scientists who want to explore their environments, curricula should be shaped around the scientific method.

All children are inherently scientists because of the way they explore the world, and when curriculum stimulates children's thinking, they become invested in their learning. When children are drawn into the material, they actively want to find the answers to questions; this same sense of stimulation rarely occurs in traditional curriculum. This intrinsic motivation occurs in social-studies-based curriculum, but I

argue that it happens in a greater degree in science-based curriculum because the students not only have experiences guide the creation of the curriculum, but they are using their questions to guide the discovery of new information. These questions draw the children in so that they are not satisfied until they come to a resolution about their queries. As previously discussed, these resolutions typically generate further questions, thus perpetuating Dewey's Continuum of Experience, in which experiences continue to build on another without clear beginnings and ends since all activities are related. This process of continuously questioning and discovering solutions encourages further development for the students.

In this thesis, a science-based curriculum refers to an entire approach to curriculum development, where the general source of inspiration arises from the children being scientists in their physical world and in their communities. From their paths of investigation, students make interdisciplinary connections while pursuing their courses of discovery in a manner similar to scientists, through exploring, questioning, observing, analyzing, and applying. This line of questioning arises from personal experiences that the students have in their communities. I agree with Mitchell when she says, "I thoroughly believe that the environmental approach gives the utmost immediate satisfaction to children and leads to the most fruitful lines of later interest" (Mitchell, 1934, p. 22). While Mitchell is referring to students as geographers in support of studying the world around them, her focus on the environmental approach supports science-based curricula because she is focusing on the world as the sphere of exploration. Students must be allowed to engage with new concepts and new environments in a manner they decide, and by so doing, they become accustomed to designing their own

paths of discovery. With a science-based curriculum, students are able to develop a manner of problem solving that they can utilize for the rest of their lives.

Jean Piaget worked to understand the developmental stages of children. His studies (1948) supports the idea that children do well with a science-based curriculum by explaining that a child learns best through:

> ...free investigations and spontaneous effort [and] will later be able to retain it; he will have acquired a method that can serve him for the rest of his life, which will stimulate his curiosity without the risk of exhausting it. At the very least, instead of having his memory take priority over his reasoning power, or subjugating his mind to exercises imposed from outside, he will learn to make his reason function by himself and will build his own ideas freely. (p. 93)

While Piaget is talking about general experiences in which children can freely engage with materials that are of interest to them, this reasoning applies to experiences discovered with the scientific method because this method will serve students later in their lives. While they learn the approach through curricula in school, this same problem-solving method works in everyday-life experiences. One significant part of the scientific method is the application component, which means that children make connections in one learning situation, and for the rest of their lives, they are able to apply these concepts to other questions they form.

As stated above, students are naturally inquisitive persons who want to explore their world. In fact, Lucy Sprague Mitchell (1934) discusses at length about the need to respect young geographers (i.e. inquisitive youngsters) as scientists in their own right: "Our plea is to bring the laboratory method, which is the method of geographers in common with that of other scientists, into geography even with very young children" (p.

4). Some take this to support the implementation of social-studies-based curricula, with which I agree, if we want to look at students as social geographers, yet I am arguing that these "young geographers" must be respected as scientists and instructed how to problem solve using the scientific method. Because students begin their inquiries from the moment of birth when they are exploring their bodies and those near them, I believe that students demonstrate their scientific thinking also from the moment of birth. Educators must share with them a way to successfully investigate their world – the scientific method. By respecting students as inquisitive persons, teachers can better assess the needs of the student and therefore design curricula better suited to these needs (Greene, 2000). In this way, a science-based curriculum is beneficial to all members of the classroom community because teachers and students alike can better learn by being observing scientists of their communities.

This approach appeals to children of many learning styles because children have various intelligences. These different aptitudes, as explained by developmental psychologist Howard Gardner's Multiple Intelligences (1983), include linguistic, musical, logical-mathematical, spatial, bodily-kinesthetic, natural, interpersonal, and intrapersonal. The logical-mathematical and natural intelligences are satisfied with the science-based curriculum approach due to the inherent reasoning demonstrated with these intelligences, but these are not the only intelligences for which the science-based curriculum works. A student with linguistic intelligence thrives with a science-based curriculum because a properly-implemented, science-based curriculum depends on the communication of ideas to other members of the exploration through spoken and written word. Similarly, a person with spatial intelligence tends to work well with the geographical and organizational aspects of a correctly-executed, science-based

curriculum, which needs the observational and analytical aspects to be organized in a way that is clear so that the study can be properly implemented. Because a science-based curriculum demands that the scientists be active researchers in their environments and be adroit managers of tools, students with bodily-kinesthetic intelligences are able to contribute to the group's learning. Students with interpersonal and intrapersonal intelligences are needed in these explorations because their skills of knowing oneself and knowing others means that the group of students is better able to work with one another in a way that capitalizes on everyone's strength. Perhaps most unique to this group of scientists is those with musical intelligences. These scientists are equally as important in a science-based curriculum because their learning styles enable them to learn best from musical experiences, so they are able to bring fresh perspectives to the learning process and can contribute learning that they receive from their high language abilities (Gardner, 1983). When students with different intelligences learn to work together and to respect one another's differences, the end results are richer for the students and for the teacher. A science-based curriculum is geared towards all of the multiple intelligences, and in fact, a science-based curriculum must have students in the communities with these various intelligences in order to benefit the most from the group dynamic.

We now examine how a science-based curriculum can help an individual child develop. As Dewey explains (1938), humans develop through a continuum of experience from the moment of birth to the time of death. These experiences allow the child to grow, or more specifically to develop physically, intellectually, and morally. This continuity is a central principle in scientific experiences because in the scientific method, the final step is further questions and the application of new information. In this same way, children are scientists in that even after they have answered their own questions,

they ask more so they are constantly deepening their understanding. Dewey's Experience Continuum demands that teachers take the responsibility to provide an environment for the child to construct learning so that the child can understand the world through his experiences (1938). Dewey (1938) explains the centrality of experience when he aptly enlightens, "It is held that education is a development within, by, and for experience" (p. 28). Young scientists must constantly be engaged with meaningful experiences from which they can develop questions and solutions so that they may continue on their path of development. Science-based curricula support Dewey's Experience Continuum because they strive for the same goal: to further questions that deepen understanding by the scientist.

Specifically, Dewey refers to the importance of the scientific method for students in Experience and Education (1938):

> It means that scientific method is the only authentic means at our command for getting at the significance of our everyday experiences of the world in which we live. It means that scientific method provides a working pattern of the way in which and the conditions under which experiences are to be experienced are used to lead ever onward and outward... The constant factors in the problem are the formation of ideas, acting upon ideas, observations of the conditions which result, and the organization of facts and ideas for future use. ... But at every level there is an expanding development of experience if experience is educative in effect. (p. 88)

Therefore, students utilize the scientific method in order to understand the world around them so that the method they use in a school-aged situation can be applied to everyday-world experiences later in life. Dewey's rationale explains how learning functions in a

spiraling method so that young scientists continue to reuse the same method of exploration – of questioning, observing, analyzing, and applying – to later experiences in their lives. However, the underlying message is that the experience given to the scientists is educational when it is meaningful, when the students can develop genuine questions that are interesting to them. If the teacher provides meaningful experiences, then the teacher and students can truly grow as scientists of their communities.

By shaping curriculum in the scientific-method context, teachers can help students develop into community members who can think critically and creatively. For example, if we want students, and indeed people in general, to become better at problem solving to fix the issues in our world, then we must rethink our educational structure. A good swimmer does not get better by practicing football but instead must practice swimming. A problem solver will not get better by completing worksheets but must engage in actively solving more problems that continuously increase in difficulty. A science-based curriculum accomplishes this aim by providing scientists with everyday-life experiences where they must utilize the scientific method in order to solve their questions. Teachers and students must work one another so that they can push one another's thinking deeper so that together, the group develops a critical consciousness that enables them to learn together (Greene, 2000). In order to do so, all members of this scientific community must utilize their imaginations in order to spur one another's growth in their capacities to think creatively; in that regard, the teacher must model to his students through imaginative experiments in their own lives that imagination allows new solutions to arise when solving difficult problems (Greene, 2000). Therefore, if the teacher and students work together on solving different problems posed by science-based curricula, then all members can continually grow and develop.

Most importantly, science-based curricula demand that students are the true constructors of information because they are the members creating new connections in their brains. As Bruner (1971) explains:

> Discovery teaching generally involves not so much the process of leading students to discover what is "out there," but rather, in discovering what is in their own heads. It involves encouraging them to say, "Let me stop and think about that; Let me use my head; Let me have some vicarious trial-and-error." There is a vast amount more in most heads (children's heads included) than we are usually aware of, or that we are willing to try to use. You have got to convince students (or exemplify for them, which is a much better way of putting it) of the fact that there are implicit models in their heads which are useful. (p. 72)

Bruner illustrates that the different intelligences among students is invaluable in learning because children have novel ideas that must be shared with the group. Science-based curricula utilize this component of sharing new ideas because the scientific community itself shares ideas in order to build off of new ideas and to develop further discoveries. This same model should be used in teaching where students use the scientific method because there are vast amounts of knowledge untapped unless new ideas are encouraged and shared in the learning community.

Bruner (1971) articulates that children are not principally learning about the central topic in a curriculum, or in this case, students are not principally learning about birds in "The Birds of New England and Costa Rica" curriculum. Instead, children are learning about their own feelings and ideas that they were not able to articulate previously. They are learning about making connections and larger relationships to other areas of information in their lives. In "The Birds of New England and Costa Rica,"

children are learning not only how to find out more information about birds in Costa Rica when that child lives in New York City, but they are also learning how to problem solve when confronted with questions that require knowledge they do not have. Students are learning how birds fit into any system and, further still, how all creatures are interrelated. Students are connecting areas of information with which they have no experience to knowledge they have previously acquired in a way that develops their problem solving skills.

Stimulating questions that stimulate a child's curiosity are better than comprehension questions that ask for repeated information, and this stimulation encourages a child to utilize creative problem solving. Students need to problem solve and deal with different parameters in the real world, and students must strive for what is possible and not only what is expected. Students are too often encouraged to only know a certain set of material. Instead, when students are encouraged to push past the boundaries of given information to search for more, they learn more. In that way, students forever pursue lifelong learning and search for the totality of possibility. As Bruner (1973) mentions, the pursuit of possibility is only possible in a culture that provides the means for this growth. We must give our students and our society avenues of inquiry that can be probed and further questioned in order to allow for continual development. If students are truly captivated by the learning material, then students are intrinsically motivated to go farther and deeper in their learning.

As a result, science-based learning can shock children into learning so that a line of questioning is so motivating to a student that he or she is impelled to question further. This type of learning utilizes the Developmental Interaction Approach, which educates the whole child by providing developmentally appropriate stimuli and experiences with

which the child can interact. By having these experiences, the child is able to progress in developmental stages by actively engaging with the material because the material is at a developmentally appropriate level (Franklin, 2000). Furthermore, because children can bring in their personal questions as motivation, children can also bring in concerns related to their own cultures into the curriculum. For example, if a child is from Costa Rica and is concerned about the deforestation that affects the Costa Rican rainforests, then the curriculum about the presence of birds in New York City takes on a multi-cultural dynamic by creating connections to the birds in Costa Rican rainforests. In this way, students become invested in their education. As Greene (2000) articulates, "The young can be empowered to view themselves as conscious, reflective names and speakers if their particular standpoints are acknowledged, if interpretive dialogues are encouraged, if interrogation is kept alive" (p. 57). Greene describes the dynamic learning environment that is possible when students look at their own ideas and individual cultures as important in the path of discovery; they realize that the conversations that ensue are meaningful and valuable to the learning of the community members and that any questioning of their ideas is only meant to deepen the group's development. Here, the active learner is "conceived as one awakened to pursue meaning and to endow a life story with meaning" (Greene, 2000, p. 132). Through the questioning which is part of the science-based curriculum, students realize that experiences in their life have meaning and are valuable. Students become motivated to learn because they are learning about their lives as important areas of study.

This motivation propels students past the pursuit of arbitrary school grades. If the impetus for learning is the student's curiosity, then the goal of the curricula is satisfaction of this curiosity instead of higher school grades. A science-based curriculum fosters

students' pursuit of knowledge for the sake of genuine knowledge instead of the goal of higher grades and easily forgotten material. Bruner (1971) says, "When children expect a payoff from somebody, they tend to be drawn away from or distracted from the behavior that provides intrinsic rewards" (p. 77). By realizing that their own ideas are valuable pursuits of discovery, students want to learn for the sake of understanding. A science-based curriculum, which capitalizes on the experiences of the young scientists, takes on a momentum that arises from the students' personal interests in learning.

Science-based curricula derive greater importance with the development of and greater access to technology. Technology can create a society in which students rely on machines to do thinking and communicating for them. With the challenge, teachers must work harder to provide meaningful learning experiences, which can be done through the use of science-based curricula, since the basis of these curricula already motivate students to learn. At the same time, technology creates a new challenge in learning. Bruner points out in The Relevance of Education (1971) that technological advances are changing the shape of education. We can no longer rely on students being able to do rote memorization because the jobs that flow from this type of activity can be performed by machines. Instead, individuals are needed for three main purposes: "research and development, unpredictable services, and the arts" (Bruner, 1971, p. 105). These processes inherently mean that in order to be of value in the common technological age, if a person cannot solve problems in a critical and creative manner, they are no better than a machine. If our schools are not teaching us to think in this manner, then where are we to learn this ability? Instead, schools can utilize science-based curricula that maintain the humanity in our children by employing their questions as the sources of motivation and using their ideas to solve problems.

C. How to Make This Style of Curriculum Work – Synthesis and Analysis of Ideas

A science-based curriculum shares many characteristics with a social-studies-based curriculum, which is why the benefits of a social-studies-based curriculum are also benefits of a science-based curriculum. Furthermore, the intrinsically motivating questions from the students and the ability to utilize the scientific method for problem solving and creative thinking strengthens the argument for using science-based curricula in several grade levels in schools. Schools that rotate between science-based curricula and social-studies-based curricula would provide students the benefits of both approaches. However, a science-based curriculum works best when educators keep several factors in mind while working with students to develop the curriculum. Dewey (1938) underscores the importance of educators' responsibility in making sure that the environmental conditions contribute to students' learning, not only the actual experience but also the physical environment.

The most important component of a science-based curriculum is making sure that it is done in a developmentally appropriate manner. Several theorists expound on this idea with several key facets. First, students explore independently with minimal guidance from teachers (Lawson, Abraham, & Renner, 1989). Students experience patterns and explore ideas on their own. Then, in the second phase, Term Introduction, children learn new vocabulary which refers to the patterns they experience during Exploration. Then, during Concept Application, students apply new knowledge to additional examples. This type of learning becomes central in science-based curricula because it means that children's learning spirals from the initial experience for deeper understanding in subsequent experiences and years.

In a larger capacity, students first explore individually in their own community in a manner that is a combination of both social studies and science. They form relationships and understanding about their own community and environment first before they can have any understanding of other communities. This approach is logical because young scientists first explore their immediate community – the home. They then branch out to make larger connections as they explore the places they visit with their families and other family members. As Piaget stresses in To Understand is to Invent (1976), teachers work with the language of the students so that the ideas make more sense to the students. Then, once the ideas are concrete in students' minds, the teacher can introduce new vocabulary to explain the phenomena that the children already observed. As children develop, they can make similar connections to other communities. Children inherently observe their surroundings, and when children make these observations, they can learn from them by making connections to and refining previous beliefs. In this way, students take an active role in constructing their knowledge, instead of just receiving knowledge as seen in the traditional educational model. Through the children's intake and output of information, children are able to increase their thinking from the simple to the complex (Mitchell, 1934). Therefore, students can deal with more abstract ideas after having more concrete experiences first.

If children are not first provided with immediate concrete opportunities as scientists, then their abilities to problem solve and to creatively think are impeded. As Sobel (1998) instructs, when environmental curricula are enacted in a developmentally appropriate way, students do not disassociate from nature. If large-scale problems, such as extinction, pollution, deforestation, etc., are shared with children at too young of an age, students can feel overwhelmed or helpless, and in turn, they may learn to turn off

personal reactions to these atrocities. Instead, when children are exposed to immediate natural environments first, they can develop a love for nature. Then, as students cognitively develop, they are better able to make connections from their immediate world to other communities that experience similar problems. Furthermore, they are better able to realize that these connections have larger scales, and in so doing, they are able to think of solutions that work better for these larger issues (Sobel, 1998, Nov 2). According to Sobel (1998), students are able to make connections to bioregions, nations, and beyond once they are eleven and twelve years old because they have the developmental capacity to do so. My study of birds in both New York City and Costa Rica is most appropriate for students in the fifth grade because they have the maturity to think about Costa Rica in terms of a real existence. This curricular framework supports the theory that children must first connect with nature before these young scientists can think about why they should want to fix it.

Once a curriculum's scope and sequence are roughly determined to be cognitively appropriate, there are details in a science-based curriculum that, when executed correctly, will enable children to learn and develop. When students are provided with interesting experiences from which they can form questions, these students then are inherently encouraged to think critically about these experiences. Greene (2000) expresses that an ability to be critical of literature and of life provides students with abilities to grow by enabling them to see the changes they must create in order to experience greater freedom in their learning and in their lives. Young scientists who are critical of their experiences open themselves to greater possibilities by realizing that an idea is either false or shallow, and as a result, they realize that greater contemplation is needed on any subject through the utilization of their imagination. Greene (2000) explains, "Without such an awareness

[of imagination], encouraging inventiveness, opening alternative possibilities, young people are liable to feel locked into a world others have constructed" (p. 12). By being critical, students realize that change is not only possible but needed, thus further motivating young scientists to explore and question.

Just as students learn to be critical and curious about their environments, teachers realize the importance of modeling this inquiry-based approach. Teachers are responsible for structuring the experiences for optimal growth by young scientists. Smith and Sobel (2010) underscore the importance of approaching experiences in the community through the scientific method by having children hypothesize about what they will see, collect data while on the field trip, share data, and talk about the importance of these data. Furthermore, a successful science-based curriculum depends on the working together of students to formulate solutions, and this may take the form of dramatic play. In this type of learning, dramatic play is integral in allowing children to "express their geographic thinking" (Mitchell, 1934, p. 18), so students work on a meta-cognitive level to express ideas in a different and meaningful way.

Some may argue that this approach to teaching and learning does not prepare students for standardized tests, which enable students to access to higher learning at colleges and universities. If students cannot pursue higher education, then they cannot be part of institutions of change when they become adults. Some may even argue that science-based curricula disregard adherence to grade-level standards in the prescribed form given by states' departments of education. Instead, I argue that science-based curricula accomplish these goals but in a less linear method than some traditional educators may desire. Standards are important because they ensure that students of different areas are receiving the level of education that they deserve, but the artificial

manner of textbooks, which some believe must be a part of education, do not provide students with the application skills they will need once they leave the confines of school. Instead, science-based curricula model experiential learning while supporting teachers in a way so that teachers are able to accomplish the goals of state standards and offer learning based on real-world experiences. For example, Standard One of the New York State Education Department mandates that students use scientific inquiry to "pose questions, seek answers, and develop solutions" (University of the State of New York, New York State Standards); through this science-based curriculum, students are encouraged to not only ask questions during a specific science class, but students are supporting in asking questions all day in all areas of study. Another science standard that is supported by a science-based curriculum focuses on the interconnectedness of math, science, and technology to other areas of study; a science-based curriculum can only work if the science curriculum is intertwined with other academic studies in order to support the growth of the whole child. This curriculum, "Birds of New England and Costa Rica," incorporates New York Science Standards in a meaningful way for students so that they are able to learn inquiry skills while preparing for their future experiences.

Schools have a responsibility to provide teachers with the professional development so that teachers can enact science-based curricula while having the support to know how to make interdisciplinary connections. In this way, students learn from the academic principles but in a way that is more appealing to the interests of the student. There are no textbooks for how to solve problems in everyday-life experiences, which is why students learn through creative problem-solving that utilizes the information found in literature but that couples this information with everyday-life application. A correctly-implemented, science-based curriculum not only prepares students to demonstrate their

knowledge adequately on state tests but prepares them to become the problem solvers of the next generation.

II. Curriculum – Birds

Framework:

Grade and age of children:	Ten and eleven year olds; Fifth Grade
Larger Curriculum Topic:	Protecting Our Environment
Unit #1:	Our Trees
Unit #2:	**Our Birds**
Unit #3:	Our Insects

Key Concepts and Organizing Ideas:

Key Concept: Similarities and Differences

Organizing Idea: Even among organisms that seem similar, there are important differences, and by observing these differences, we can learn about important patterns in order to answer questions and solve problems.

Key Concept: Evolution

Organizing Idea: We experience changes in our environment, and changes also occur over long periods of time. These changes may lead to evolution or extinction over time, depending on the strength of the variation.

Key Concept: Rights and Responsibilities

Organizing Idea: While we have the right to become integral members of this global community and to enjoy the beauty of birds, we also have the responsibility of protecting birds and their habitats.

Graphic Organizer: See Appendix A.

Curriculum Web

I. **Exploration into Local Birds of New England** - Mini-Field Trip to nearby park – *Know, Observe, Wonder* (*KOW*) Chart – See Attached Lesson Plan

1. Before trip to park, the class will discuss their previously held ideas about birds. Students will complete the "*Know*" component about what they know about birds;

this chart will be posted in the classroom for the duration of the study. This information can relate to any of the birds that they see around their community.

2. During the trip, students will share binoculars and observe (the "*Observe*" component) samples of New England birds in the nearby park. Students will pay attention to coloration, flight habits, roosting habits, eating habits, possible prey, and anything other topics that interest them.
3. At the conclusion of the trip, while still at the park, students will compile a class list of observations. From this list, students will use their curiosity to generate a list of ideas, relating to birds, about which they are curious (the "*Wonder*" component). This "*Wonder*" list functions to include what the students want to know, but the term "*Wonder*" encourages students to shape their ideas into questions as pathways of exploration. This list will guide the adjustment of the curriculum to suit the needs and interests of the children.

II. Coloration of Birds

1. Students will draw on their observations from the field trip to think about birds' colors. They may also include previous knowledge of camouflage into the conversation.
2. Students will make comparisons about the birds of New England; for example, they may notice that male birds are usually more brightly colored than female birds. Students will be encouraged to ask questions about inconsistencies, such as when male birds are not more brightly colored than female birds, as seen in sparrows and pigeons. This lesson will include a discussion about dimorphism among bird species.

3. Students will then be asked if birds would look the same in a drastically different environment; for example, in the Cloud Forest of Monteverde, Costa Rica. Students will have little information about the dynamics of the Monteverde forest, so students will split into groups to research the forest, using books, CD-ROMs, and bird guidebooks (with important passages highlighted - Students will have had previous experience with this research discovery from earlier curriculum units).
4. In these same small groups, students will make inferences about the colors of birds in Monteverde. Students will make comparisons between the colors of New England birds and Costa Rican birds; for example, they may realize that usually both male and female birds in Costa Rica are brightly colored while usually only the male birds of New England are brightly colored.
5. Students will start to add their questions to the class *KOW* list. This will serve as an inspiration list for later research projects.
6. Students' comparisons will be added to the class Venn diagram of the relationship between New England Birds and Costa Rican birds. (This is an ongoing comparison during this curriculum unit.)

III. Investigating Feathers - See attached lesson plan

1. Students will test different characteristics of feathers in order to understand this unique trait of birds.
2. Students will realize that there are certain characteristics of feathers that enable birds to fly and that suit birds for different regions.

IV. Mural Creation

1. Students will paint the New England and the Monteverde Cloud Forest ecosystems on butcher paper that borders the room.
2. Half of the room's mural will be painted using the students' accumulated knowledge of a New England deciduous forest, complete with drawings of New England birds. Birds that migrate will be painted in the middle of the mural as if they are flying to show that these birds do not stay in New England.
3. Half of the room's mural will be painted using the student's accumulated knowledge of the Monteverde Cloud Forest, complete with drawings of Costa Rican birds.

V. Virtual Birding

1. Students will go on a virtual field trip, since their simulation of the New England and Costa Rican environment, as created in "Mural Creation", surrounds them now.
2. Students will watch The Birds and Wildlife of Costa Rica (Superior Promotions, Inc, 1995) in order to see the Costa Rican birds in their habitats.
3. Students will continue to make connections between the living patterns of New England birds and Costa Rican birds.

VI. Field Trip to Museum or Zoo (i.e., The American Museum of Natural History)

1. Students will first revisit their *KOW* chart from the first field trip into a park. Students will have the opportunity to revise the thoughts they have about the coloration about New England birds.
2. Once on the trip, the students will create a "similarities and differences" chart comparing the birds found in the museum or the zoo. At the American Museum

of Natural History, students may see the Bird Halls, including local New York City birds, regional North American birds, Oceanic birds, and Birds of the World.

VII. Dissections

1. Now that students have an understanding of what birds in both New England and Costa Rica look like and of what the ecosystems consist, students can start to infer what these birds are able to eat.
2. Students will dissect owl pellets to learn about how birds eat their food and birds' inability to digest the food that they eat whole. If possible, some students will dissect owl pellets, while others will dissect the pellets of a Costa Rican bird. Furthermore, students will dissect pellets collected at different times of the year. Students will rearticulate the skeletons and compare the findings between Costa Rican and New England birds. Owl pellets can be bought at Carolina Biological Supply Company (Owl Pellets, Item #227880, heat sterilized). Costa Rican bird pellets may be acquired through zoo contacts.
3. Students will notice that the skeletons and insects found in the owl pellets change throughout the seasons. We will investigate further how the migrational path of birds determines what birds can eat. Students may realize that the rainfall in the ecosystem affects the ability of plants and trees to fruit, and as a result, birds need to travel not only from one part an area to another (for example, from moving east to west across Costa Rica) but also up and down mountains to different vegetation levels.
4. Students will then dissect a chicken in order understand why a bird produces pellets (to understand the digestion of birds and adaptations that the genus has accumulated over generations).

VIII. How Much Food Does a Bird Need? - Math Connection

1. Students will draw on their knowledge from the dissections to create a list of organisms that birds in each habitat eat.
2. Students will use a teacher-created chart that provides the energy content of specific bugs, fruits, and small amphibians and another teacher-created chart about how much energy each bird needs (information about birds and food in both ecosystems provided).
3. Students will work in groups to calculate how much food (simplified scenarios) different species of birds need. This information will be used for the Adaptations Project.

IX. Visits by Local Bird Experts

1. Throughout this study, bird experts from the area will have visited during morning meetings and will have provided answers to interview questions. These include experts of the New England deciduous forests and of the Monteverde Preserve who live in the New York City area.
2. Through these meetings, students have acquired new vocabulary.

X. How Do We Talk Like Ornithologists? - Spanish Language Connection

1. Through the research the students have done and the morning visits by local bird experts, students have expanded their scientific language.
2. Students will create working definitions that are posted around the room, and if possible, students draw arrows on the murals to the parts of the birds that are defined.
3. These words will also be taught in Spanish, so that students will become ornithologists in both New England and Costa Rica.

XI. Differences Across Regions – See attached lesson plan.

1. Students will organize their observations so that they can make generalizations about traits that birds have in certain ecosystems.
2. Students will realize that certain characteristics enable birds to live in an ecosystem while other characteristics do not enable birds to survive their ecosystems.

XII. Creation of Ideal Birds - Adaptation Project

1. Students will have observed that certain species of birds have developed adaptations over time, which enable birds to have better access to water, food, air, space, shelter, heat, and sunlight (students will begin to discuss birds' niches).
2. Students will pick their ideal niche, choosing between New England and Costa Rica. Then, students will create their ideal birds for a specific niche that they choose. Students will need to determine which coloration, beak size, foot development, mating season, etc., will enable their new species to survive in their chosen habitat.
3. Students will learn about optimization, in which there are certain trade-offs for certain developed characteristics. By realizing that some birds are not perfectly suited for their niches, students learn about the energy trade-offs that certain traits cause for birds.
4. Students will discuss wing shape in order to optimize the type of flight the bird needs.
5. Students will research to determine if there is a bird similar to the one they created in nature.

XIII. Introduce Darwin's Theory of Evolution

1. During "Creation of Ideal Birds," students will question whether a bird gains adaptations in its lifetime. This confusion will be alleviated with a mini-lesson about human genetics.
2. Students will discuss how they have some of the characteristics of their parents but not both, and that while humans develop into adults over time, humans are not able to gain new adaptations, like wings, within a lifetime. The class will look at the prevalence of red-headed students in the class in order to introduce the idea of recessive traits.
3. Students will discover that some traits are passed from parents while others are not. Students will explore traits shared with siblings and traits shared among parents, aunts, uncles, and cousins in order to become familiar with phonological genetic mapping. Students will then apply this information to birds and discuss the success of certain traits for birds in the wild.
4. Students will discover that some birds with unfavorable traits, like hummingbirds with shorter, non-straw-like beaks, will not be able to survive in their niche, so those birds will die out. This leaves birds with favorable traits, like hummingbirds with straw-like beaks, to survive and produce offspring, which are likely to have the same favorable traits.
5. Students will also explore the evolution of reptiles over large periods of time, which led some reptiles to take flight and become birds. Students will realize that evolution occurs because of a stress in the environment and that organisms with certain genetic traits are better suited to survive the new environment. These organisms are able to survive and pass along their genetic information to progeny. Students will realize that generally, evolution does not occur over one generation

but requires several generations or more for weaker traits to be eliminated from the genetic pool.

6. Once this conclusion is reached, students will learn that Darwin was a famous biologist who was one of the first scientists to discover this theory of evolution.

XIV. Who Can See Me? - Predation Activity

1. From the ideas presented in the previous lesson, students will start to gain the knowledge that certain birds develop camouflage over generations in order to avoid being detected by predators.
2. Students will compare bird predators in both New England and Monteverde forests in order to make inferences about the development of bird coloration in both ecosystems.

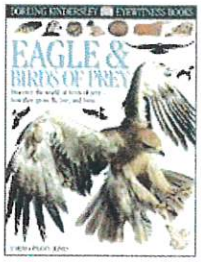
XV. Save These Birds! - Language Arts Focus and Social Studies Integration - Culminating Research Project

1. By this point in the curriculum, students may have developed interests for certain species of birds.
2. Students will form research groups with classmates, and they will delve more deeply into the issues surrounding these birds.
3. Students will discuss the adaptations that the bird specie has that make it well suited for its niche. Students will elaborate on the effects of a changed environment on these birds that are suited for a specific set of environmental conditions.
4. Students will then create a presentation that argues why these birds need to be protected since they are well suited for their environment. This presentation will be shared on a day when members of the bird-protection community visit the

classroom. These community members will be able to connect students to organizations that may use their presentations in the organizations' efforts. Students will also create maps of land that should be added to protected zones.

5. This project's goal is the empowerment of students so that students realize that they can address threats to the environment they encounter in the future. From this whole curriculum, students will learn "to research and analyze an issue, to educate and organize the public, to write and deliver statements at hearings or events, and to use media to advance one's cause" (Smith, 2010, p. 54). Students will realize that the knowledge they have gained, not only about birds, but about how species gain adaptations over generations in order to survive in their niches, will prove useful in their efforts in the future to become involved in their environment and to improve the world.

Annotated Bibliography



EAGLE AND BIRDS OF PREY.

By Jemima Parry-Jones.

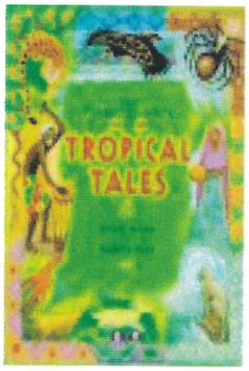
This field guide provides colorful action photos of eagles and other birds of prey that students may find in New England deciduous forests. Students will be able to research food of some New England birds in order to compare with food of Costa Rican birds, provided by other texts.

BIRDS OF NEW ENGLAND.

By Fred J. Alsop

Students will use this 368-page guide, with pages of importance marked by the teacher, to help research habitats and research

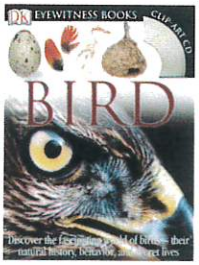
questions. Students will be able to have close-up observations of birds' adaptations and of birds' specific niches. The colorful pictures allow students to identify birds they have seen on the field trip and in their lives.



THE BAREFOOT BOOK OF TROPICAL TALES

By Mama Rouff.

This colorful book includes tales from African countries, Puerto Rico, Benin, Antigua, and Malaysia. It is suitable for students in grade 2 though 6, and it is a part of the study as a resource to demonstrate the rich art of various cultures that are too often forgotten in school studies. It includes trickster tales, which can be incorporated in an optional facet of the study based on oral storytelling and the lessons of cultures that are inherited from earlier generations. These stories are great inspirations for creative writings in order to approach fable writings in unique ways.



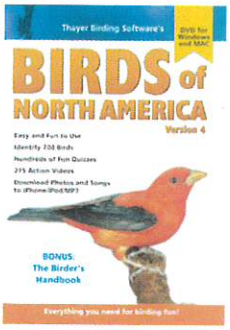
BIRD.

By David Bumie, Peter Chadwick, and Kim Taylor.

This book and 35-minute DVD has the body construction of birds, which can be applied to both New England and Costa Rican birds. It also shows feather construction, flight patterns, feeding habits, and adaptations of beaks and feet, which students can use in their research projects.

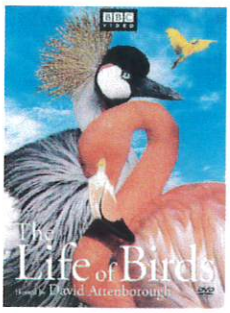
THE BIRDS AND WILDLIFE OF COSTA RICA VHS.

This VHS will provide students with the virtual birding experience of Costa Rica. This half-hour video will be shown in its entirety in order to give students a seamless experience in Costa Rica. Students will have a Costa Rican simulation since this video will be shown in the part of the classroom decorated with the Costa Rican mural.



BIRDS OF NORTH AMERICA: Thayer Birding Software, Ver. 4.

This electronic field guide will enable students to identify unknown birds based on color, size, habitats, location, or sound. Most importantly, it provides the songs of more than 660 species of North American birds, as well as range maps detailing the seasonal migration patterns. This will be used for students' initial research after the field trip and for research projects at the culmination of this unit.



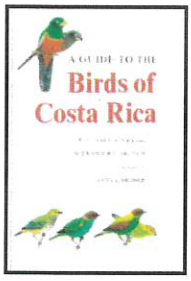
THE LIFE OF BIRDS SERIES ON DVD.

By David Attenborough.

This DVD will be used in segments in order to provide students with more information on the adaptations that birds have which allow them to live in diverse habitats. This DVD also gives students a look into birds' flight patterns, feeding habits, nest building, and birds' rearing of young.

HOOKED ON HUMMINGBIRDS DVD.

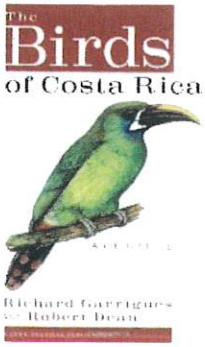
This DVD will provide students with an up-close view into hummingbirds' flying, eating, and caring for young by using slow and stop-motion photography. Furthermore, it looks into the adaptation of hummingbirds to feed while flying that offers them protection from predators while also providing them with a feeding niche that other perching birds cannot access. Only clips of this 53-minute video will be shown so that students can focus on hummingbirds without being distracted by the length of the movie.



A GUIDE TO THE BIRDS OF COSTA RICA.

By Gary Stiles and Alexander F. Skutch.

This comprehensive bird guide covers various birds fond in Costa Rica. It includes detailed images of male and female birds as well a discussion on the evolution, ecology, and behavior of Costa Rican birds.



THE BIRDS OF COSTA RICA: A FIELD GUIDE

By Richard Garrigues and Robert Dean.

This bird guide details the coloration, habitat, behavior, and vocalizations of birds found in Costa Rica. This also includes a quick reference book for vultures and raptors in flight as well as illustrations of over 830 resident Costa Rican birds.

III. Lesson Plans

I. Name of Lesson: Exploration into Local Birds of New England

II. Key Concept and Organizing Ideas:

A. Key Concept: Similarities and Differences

Organizing Idea: As we observe and record the characteristics of the birds in our surrounding environment, we notice similarities and differences as we categorize birds.

B. Key Concept: Places and Regions

Organizing Idea: By noticing the general characteristics of the birds in our environment, we can discern the necessary traits that organisms need to specialize and survive in our environment.

C. Key Concept: Diversity

Organizing Idea: Although the birds of New England may have certain traits in common, students notice the great diversity in birds in the environment.

D. Key Concept: Migration

Organizing Idea: Students will notice that they see some birds throughout the year in New England, and they will learn that some birds travel in the winter. Students will explore the ideas and benefits surrounding migration paths of birds.

III. Goals and Objectives of Lesson:

A. Goal #1: Students will observe the living patterns and characteristics of the birds in a New England forest.

1. Objective #1: Students will notice the type of environment in which New England birds live.

2. Objective #2: Students will discover the coloration, flight habits, roosting habits, eating habits, and possible prey. Since all of these dynamics of bird life may be hard to notice, students will use this experience as an introduction into these observations.
3. Objective #3: Students may discover flight habits and anything else that interests them.

B. Goal #2: Students will realize similarities and differences among New England birds.
   1. Objective #1: Students will begin to notice that birds in New England have certain things in common.
   2. Objective #2: Students will begin to notice that there are some things that are unique to certain birds, even if these birds share similar habitats.
   3. Objective #3: Students will categorize birds that migrate and birds that do not.

C. Goal #3: Students will organize information about birds into categories.
   1. Objective #1: Students will work together to create categories of similarities among birds.
   2. Objective #2: Students will work together to create categories of differences among birds.

IV. Preparation for Teachers and Materials Needed for Lesson:

A. Preparation for the Teacher:
   1. Walk the trail before the exploration trip to be sure that the path is accessible to all students, especially in regards to students with physical access needs.
   2. Make photocopies of student observation sheet.
   3. Request students to bring sneakers for the exploration.

B. Preparation before the lesson – This is the initial experience for the students for this curriculum, so the preparation needed for students it to encourage curiosity about their surroundings.

C. Materials:

1. Student Observation Sheets (Appendix B)
2. Clipboards
3. Pencils
4. Colored pencils
5. Whiteboard for classroom
6. Whiteboard markers
7. Binoculars

V. Procedure:

A. Introduction: Opening Conversation. The students and teacher begin by discussing, "Why might birds be the same or different in different geographic locations?" The resulting ideas will provide the guiding questions of the entire curriculum so that any areas of interest will become evident.

B. After discussing these general questions, the students and teacher will brainstorm information that they already know about birds, in order to complete the "*Know*" component in the *Know, Observe, Wonder* chart. This information can relate to any of the birds that they see around their community.

C. Students will receive their clipboards, pencils, colored pencils, and observation sheets. Every student will receive a pair of binoculars. There will be a quick demonstration about how to use binoculars.

D. Students will be given forty-five minutes to explore the birds around the nearby park. Students will be encouraged to leave interesting objects in their natural environment, but the teacher may choose to bring certain items, such as a bird's nest or a feather, back to the classroom for further exploration.

E. After students observe, the students and teacher will reconvene in the classroom to create a list of observations (the "*Observe*" part of the *Know, Observe, Wonder* chart). These observations will be recorded on the whiteboard in two columns, one for similarities among birds and one for differences among birds. Students may start to notice trends, and they will make conjectures about whether this list would change based on the season of observation.

F. Culminating Event: Finally, students will create a list of things about which they wonder (the "*Wonder*" part of *Know, Observe, Wonder* chart). This list will include the conjectures they made about the affect of seasons on bird patterns. This "*Wonder*" list is the motivation for the rest of the curriculum. Finally, the students and instructor will decide what style of bird feeder might attract the most types of birds. This style will be set outside the classroom window so that during class breaks, students may observe the bird feeder and take pictures of visiting birds.

VI. Adaptations for Children with Learning Variations:

A. The explorative component of this lesson allows students with attention issues to remain engaged and stimulated in the lesson. Because students decide their own courses of inquiry, they are able to observe the movement of birds that interest them.

B. Students who have problems with over-stimulation can be given a focus to observe. These students could focus on only one part of bird descriptions and serve as the "experts" of this observation.

VII. Assessment/Evaluation:

Students will be assessed in two different ways. Students' observation sheets will be collected and reviewed by the teachers in order to see what kinds of connections students are making among birds for their similarities and differences. For students who have trouble organizing their thoughts on paper, the teachers will engage in conversation with these students while exploring the course. Through these conversations, teachers can determine if students are able to make observations about what birds in New England have in common and what makes them different.

Extra Resources:

This day of observation should be in the fall when the birds are migrating. In the event that students are not able to see many birds on the day of observation, students will be provided with the following pictures and sites so that students can make observations through online research. The following information is about birds that are abundantly seen around Connecticut, according to the Greenwich Audubon (Note: the picture on the left is of the male, and the picture on the right is of the female):

American Crow

http://www.allaboutbirds.org/guide/American_Crow/id

American Goldfinch

http://www.allaboutbirds.org/guide/American_Goldfinch/id

American Robin

http://www.allaboutbirds.org/guide/American_Robin/id

Black-capped Chickadee

http://www.allaboutbirds.org/guide/Black-capped_Chickadee/id

Brown-headed Cowbird

http://www.allaboutbirds.org/guide/Brown-headed_Cowbird/id

Canada Goose

http://www.allaboutbirds.org/guide/Canada_Goose/id

Common Grackle

http://www.allaboutbirds.org/guide/Common_Grackle/id

Common Nighthawk

http://www.allaboutbirds.org/guide/Common_Nighthawk/id

Gray Catbird


http://www.allaboutbirds.org/guide/Gray_Catbird/id

House Finch


http://www.allaboutbirds.org/guide/house_finch/id

House Sparrow

http://www.allaboutbirds.org/guide/house_sparrow/id

Northern Cardinal

http://www.allaboutbirds.org/guide/Northern_Cardinal/id

Northern Flicker

http://www.allaboutbirds.org/guide/Northern_Flicker/id

Red-tailed Hawk

http://www.allaboutbirds.org/guide/Red-tailed_Hawk/id

Red-winged blackbird

http://www.birds.cornell.edu/Page.aspx?pid=1807

Song Sparrow

http://www.allaboutbirds.org/guide/Song_Sparrow/id

Tufted Titmouse

http://www.allaboutbirds.org/guide/Tufted_Titmouse/id

Turkey Vulture

http://www.allaboutbirds.org/guide/turkey_vulture/id

I. Name of Lesson: Investigating Feathers

II. Key Concept and Organizing Ideas:

A. Key Concept: Classification

Organizing Idea: As students analyze the characteristics of birds' feathers, students will realize that there are certain traits that are similar among all birds' feathers and that there are some differences.

B. Key Concept: Places and Regions

Organizing Idea: Students classify birds' feathers and distinguish characteristics based on birds' locations, whether the birds are from Costa Rica or from New England.

C. Key Concept: Diversity

Organizing Idea: Students will study the diversity among trait characteristics for birds, and students will analyze the benefits for diversity among birds.

III. Goals and Objectives of Lessons:

A. Goal #1: Students will explore the unique characteristics of feathers in order to gain a greater understanding of birds' traits.

1. Objective #1: Students will test characteristics, including feathers' abilities to float in water, fall to the ground, etc.
2. Objective #2: Students will compare coloring of feathers and will organize their information based on birds' origins.
3. Objective #3: Students will determine where different types of feathers would be found on birds as well as what feathers would belong to the birds of New York area and to birds of the Monteverde Cloud forest.

4. Objective #4: Students will explore the characteristics of bird feathers and will draw relationships between characteristics that all bird feathers must have and those that only certain birds have or that only appear on certain parts of birds' bodies.

B. Goal #2: Students will gain a better understanding of adaptations that happen to birds over time so that species have different trait characteristics.

1. Objective #1: Students will discover that the hollow shafts create a light feather for easier flight.
2. Objective #2: Students will briefly investigate how some dinosaurs had wings and will brainstorm possible reasons for this adaptation occurring among dinosaurs as well as birds.
3. Objective #3: Different types of feathers enable birds to keep warm, keep dry, stay camouflaged, etc. As students observe feathers, students will think about why a bird would benefit from the adaptation.
4. Objective #4: Once students understand that birds' feathers enable birds to do actions that they need to survive, students will be able to think about why birds have developed adaptations through investigations in later lessons. Students will explore how this differs from bats' abilities to fly.

C. Goal #3: Students will realize that certain characteristics change based on the ecosystem in which the birds live.

1. Objective #1: Students will start to discover that birds in one ecosystem may have different feathers or different arrangement or coloration of feathers than birds in other ecosystems.

2. Objective #2: Students will organize data so that they can see if there are patterns among New England Birds, among Costa Rican birds, and among birds in general.

IV. Preparation for Teachers and Materials Needed for Lesson:

A. Preparation for the Teacher:

1. Gather various bird feathers from New England birds by contacting representatives from the Greenwich Audubon Society (Connecticut). Gather various bird feathers from Costa Rican birds by contacting representatives from the Monteverde Institute. Be sure to have a variety even among birds from a similar ecosystem.
2. Assemble research tools (see "Materials" below).
3. Allot sufficient time for investigation (60 minutes).

B. Preparation Before the Lesson:

1. Students will review organization skills in order to feel comfortable in comparing and contrasting feather characteristics.
2. Students will review how to safely and efficiently use the investigative tools.

C. Materials:

1. Students' science journals
2. Various bird feathers from both New England birds and Costa Rican birds
3. Microscope
4. Hand lenses
5. Scale
6. Deep glass bowl, filled to within one inch of the top
7. Stop watches
8. Pencils
9. Tablet paper

V. Procedure:

A. Introduction: Students will draw on their knowledge of the coloration and habitats of birds in order to begin to understand the importance of feathers. Students will

contribute to the "*Know*" component of a *KOW* chart about bird feathers. Some questions include: "What parts of a feather are interesting and unique?" "Why do you think feathers look the way they do?" "What is special about feathers that enable birds to live in the way that they do, like being animals that fly?"

B. Students will start at different exploration centers. These centers include:
   1. Feather Observation Detail: Students spend time looking at colors within a single feather as well as different textures of feathers. Students will create their own exploration, using only feathers and their senses.
   2. Floating Ability of Feathers: Students will be provided with a deep, glass bowl of water, feathers, and stop watches. From these materials, students will construct their own way of learning more about feathers' interactions with water. Students will explore feathers' abilities to float in water as well as feathers' abilities to shed water.
   3. Barb Observation: Students will have hand lenses and a microscope to look closely at feathers. Students may notice the interlocking ability of feathers. If not, the teacher can provide scaffolding by encouraging students to "zip" up the feathers by running a hand with the grain of the shaft so that the barbs are connected and by encouraging students to compare this to feathers that are "unzipped," which happens when the barbs are pulled apart.

C. Students will use their science observation journals to record their observations at their stations. Students will spend fifteen minutes at each station, and students are encouraged to share their findings with their group mates, in order to complete the "*Observe*" segment of this lesson.

D. Wrap-Up Discussion/Share: Students will come together as a group to share observations about each station. The teacher will encourage questioning about the shape of feathers and the purpose to these components. Students will be encouraged to apply these ideas to birds' ability to fly while contrasting wing structures to structures used by other organisms to fly, i.e. dinosaurs' wings, bats' wings. "*Wonder*" statements will be added to the class's *Inspiration List* and used as questions to answer during the research projects.

VI. Adaptations for Children with Learning Variations:

A. For students who can be over-stimulated, this set-up must be very organized so that students do not become overwhelmed. Therefore, the centers must have clear work spaces, and investigative tools must have clear methods of use.

B. For students with time management issues, they will be grouped with peers who are able to investigate without becoming fixated on one characteristic. Depending on the needs of the child, the child with time-management issues may be assigned one specific trait to study (i.e. ability of feather to float in water). This student will then be the "Class Expert" on this characteristic.

VII. Assessment / Evaluation:

As students are working in groups, the teacher will converse with students to hear ideas. Students will be assessed based on their ability to come up with a method to test certain traits. Furthermore, students will be asked if they are noticing any similarities or differences between feathers. Their abilities to make connections will be noted. For students who are having difficulties making connections, the teacher will provide these students with sample relationships to help scaffold the child's connections.

I. Name of Lesson: Differences Across Regions

II. Key Concept and Organizing Ideas:

A. Key Concept: Similarities and Differences

Organizing Idea: As students compare and contrast the characteristics of both New England and Costa Rican birds, students will realize that there are certain characteristics that all birds have in common, yet there are other characteristics that change depending on the habitat of the birds.

B. Key Concept: Places and Regions

Organizing Idea: We realize that each place has its own environment, and birds have certain characteristics that specifically suit them to their habitat.

C. Key Concept: Diversity

Organizing Idea: Even within a habitat, there is a variety of organisms, and these organisms around the world represent the diversity of organisms that are possible.

III. Goals and Objectives of Lessons:

A. Goal #1: The students will compare the characteristics of New England and Costa Rican birds.

1. Objective #1: Students will compare the coloring of birds by looking specifically to see if the coloration changes based on sex and region of birds.
2. Objective #2: Students will compare the feeding habits of birds by looking specifically to see if the beak shape and the function changes based on the region of the birds.

B. Goal #2: The students will notice that there are differences among birds because different characteristics are beneficial in difference habitats.

1. Objective #1: Students will observe that many New England birds have different coloration between the sexes.
2. Objective #2: Students will notice that many Costa Rican birds have similar coloration between the sexes.
3. Objective #3: Students will learn that adaptations are characteristics that birds acquire after generations that enable that species to survive in a specific habitat.

C. Goal #3: Students will realize that some characteristics are based not only on where a bird lives (type of feathers, coloration) but also on what the bird eats (type of beak, coloration).

1. Objective #1: Students will experiment with and observe New England and Costa Rican birds' eating.
2. Objective #2: Students will realize that the most prominent adaptation among a bird species makes the bird specially suited to eat a certain organism.

IV. Preparation for Teachers and Materials Needed for Lesson:

A. Preparation for the teacher

1. Organize a visit date with a local nature center.
2. Prepare Student Observation Sheet.

B. Preparation before the lesson

1. Students will experience this trip to a local nature center after exploring the birds in the environment surrounding their school.
2. Students begin observing and categorizing the birds around the school grounds, so students will continue observing and categorizing during this trip.

3. Students are observing the birds near their homes in order to see if they notice anything unique about coloration and eating habits.

C. Materials
1. Clipboards
2. Pencils
3. Colored pencils
4. Student Observation Sheets (Appendix C)
5. Binoculars

V. Procedure:

A. Introduction: Students will draw on their observations from the exploration around their school to think about birds' colors. Students have previously learned about camouflage in earlier school years, so if students are having a difficult time recalling this word, the instructor will introduce the word to see if any students can recall the definition of camouflage. Students will review the observations made about New England birds, and they will focus on the observations about color and feeding patterns.

B. Trip to the local nature center: Once at the nature center, students will see a presentation by the nature center's curator on migratory birds, including local and tropical birds; i.e., a blue and yellow macaw, a spectacled owl, a screech owl, and a great-horned owl. Students, instructors, and nature center educators will discuss the differences and similarities. An instructor can ask, "Is there something about coloring that makes some of these birds unique? What about differences between species? What are you noticing about colors and why do you think that might be? Do your ideas about coloring hold true for all types of birds? Why do you think so or why not?" Students will ask questions about the different coloration between male and female tropical birds. (Blue and yellow macaws look similar

between the sexes. Spectacled owls have the same coloring for females and males, yet the juveniles have a different coloring. The screech owl and the great-horned owl also has similar coloring, regardless of the sex of the bird.)

C. Children will watch as the nature center workers feed the tropical birds. The teacher will draw their attention to the beaks by asking students to draw the beaks and corresponding food. Then, the teacher will ask them to draw the food source in their drawing. (Students may realize that different birds have different types of beaks to eat different food. Spectacled owls eat small animals and insects, so their stout beaks enable them to rip apart the larger organisms to eat them. The blue and yellow macaw also has a powerful beak of a slightly different shape which allows it to crack open seeds and fruit to eat. Screech owls and great-horned owls use their stout beaks to eat small rodents and some birds like quail.)

D. Students will then take time to walk around the nature center with binoculars to investigate the coloration and eating patterns of birds found in New England. Students will pick three different species and will draw a male and female of each species, if the students are able to observe different sexes. Using colored pencils, students will observe the various coloring characteristics. (Students should notice that male birds are usually more brightly colored than female birds.)

E. Next, students will be asked to make comparisons between the colors of New England birds and Costa Rican birds; for example, they may realize that usually both male and female birds in Costa Rica are brightly colored while usually only the male birds of New England are brightly colored. Students will be encouraged to utilize Venn diagrams in order to organize their comparisons.

F. Students will analyze their drawings of beaks and determine their appropriateness for eating prey. Students will be asked to think why a certain bird has acquired the adaptation of that specific beak for eating its prey. Students should realize that the stout beaks of the owls enable those birds to pull apart small mammals. The beak of the Canada goose is suited to enable that bird to pull at aquatic plants to eat them. If the students are able to see egrets at the nature center, they will see that straw-like beaks enable birds to eat smaller fish and worms in muddy environments. Students will create a class graphic organizer to state the different purposes of beaks.

G. Culminating Experience: The observations on color and eating habits will also be added to the class Venn diagram of the relationship between New England birds and Costa Rican birds. (This is an ongoing comparison during this curriculum unit.) Students will start to hypothesize why these differences occur. These hypotheses will serve as the guiding motivation for the research projects, which are part of this curriculum.

VI. Adaptations for Children with Learning Variations:

A. Students who cannot go to see the Costa Rican and/or New England birds at the nature center will be given sample "beaks." Straws will simulate the beaks of Costa Rican hummingbirds. A tea bag will function similarly to the beak of a Canada goose since it strains water from aquatic plants. The hooked beaks of macaws and owls can be simulated with a metal spaghetti spoon and a tablespoon for the top and bottom part of the beak. Chopsticks or tweezers simulate the function of the slender beaks of insect eaters. Pliers are like the beaks of animals

that crack open and eat seeds. Salad tongs mimic the beaks of egrets, which eat fish and larger insects. These simulations are good for all children to experience.

B. For children with color differentiation issues (color blindness, sight impairment, etc.), these students focus on the texture of the feathers. Certain birds have glossier coats than others because they have more oil on their feathers, yet these birds cannot dive deeply into water because the oil limits this movement. This way, these students will become the "experts" of another bird adaptation.

C. Because this activity has many small lessons put together to give children experiences with coloration and bird beak adaptations, students with attention issues will need guidance in order to be able to focus, and all children will be engaged with the activities. However, the relationship between all of the lessons will still enable students with transition issues to stay focused on the main idea of bird adaptation.

VII. Assessment/Evaluation

From this assignment, students should feel comfortable with graphic organizers, so students will be graded on their Student Observation Sheets. Students should be able to notice that there is not a large difference in coloration between male and female Costa Rican birds (both sexes have bright coloring), yet students should see different coloration patterns between the sexes of New England birds. Students should also have an awareness that the beak of a Canada goose would not be suitable to open seeds and that the beak of an owl is not good for a plant-eating bird. For those students with spatial organization issues, the teacher will have a conversation with the

student to access the student's understanding of the bird adaptations explored during the trip to the nature center.

Extra Resources:

http://www.fernbank.edu/Birding/bird_beaks.htm

http://www.nps.gov/miss/forteachers/upload/brjbba.pdf

http://www.birds.cornell.edu/AllAboutBirds/studying/feathers/color/document_view

http://centralamerica.com/cr/moon/mobirds.htm

http://www.zoo.org/animal-facts/spectacled-owl

http://library.thinkquest.org/CR0210360/macaw.htm

V. Application of Curriculum:

This curriculum is an interdisciplinary area of study which encourages students to question the world around them by making connections to another part of the world. Teachers in classrooms, in education departments of natural history museums, and in children's museums can use this curriculum in order to create a program of study that incorporates the ideas of a global learning community. Teachers can also use components of this study to bring in places they have traveled in order to make the material more applicable to their lives. Due to the academic rigors and comparing and contrasting components of this curriculum, this study is most suitable for students in the fifth grade because these students can think about abstract concepts, such as being able to understand the dynamics of another community with which they do not have first-hand experience. The most fundamental part of this curriculum is the inquiry-based approach in which students' scientific questioning furthers the progress of the curriculum, and it is this component which in integral in use of this curriculum.

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Appendix A

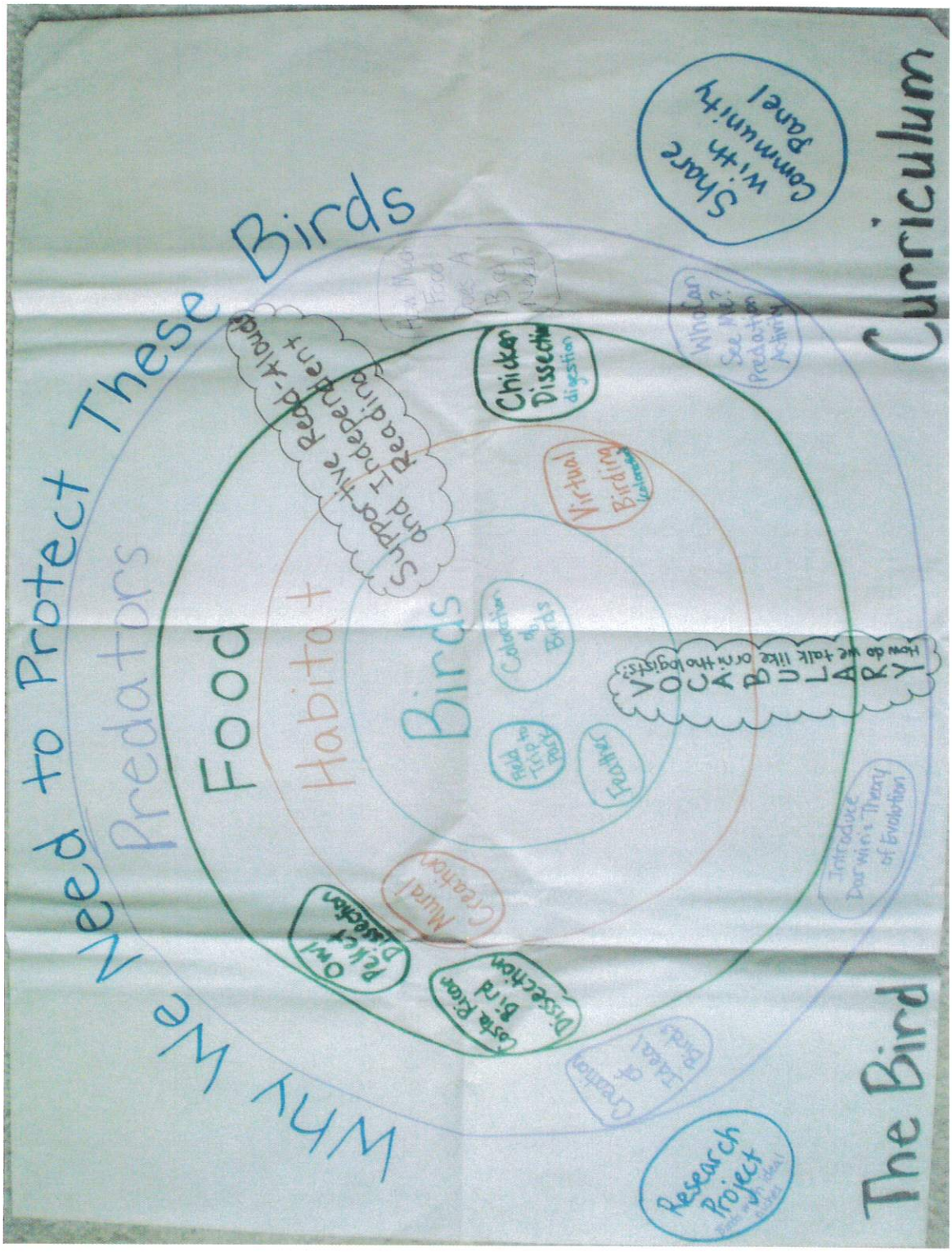

Figure 1: Pictorial representation of "Birds of New England and Costa Rica." This representation demonstrates the different levels of study and illustrate that the curriculum was built in a way that explored the more concrete ideas before more abstract ideas.

Appendix B

Student Observation Sheet, Exploration into Local Birds in New England

Name: _____
Date: _____

Bird Observations around Our School

Directions: As you walk around our walk, look around to observe the birds of New England. In order to remember your observations, use the chart below to organize your recordings. If there are certain observations that seem to be the same among the birds, write those characteristics in the "Similar" column. If there seems to be things that are different among every bird and you may be able to explain why this difference occurs, record those thoughts in the "Different" column.

		Similar	Different
Environment Did you see other birds in this same area?			
Coloration			
Flight Habits			

		Similar	Different
Roosting Habits			
Eating Habits			
Possible Prey			
Size			
Beak Shape			
Other Observations			

Appendix C

Student Observation Sheet, Differences Across Regions

Name: _____
Date: _____

Costa Rican Birds vs. New England Birds

Directions: As we listen to the educators at the nature center, pay attention to the similarities and differences between the coloring and bird types. Pay attention to any differences between Costa Rican birds and New England birds.

	Costa Rican Birds	New England Birds
Coloration	Females: Males:	Females: Males:
Beak Types		

Cornell Lab of Ornithology
159 Sapsucker Woods Rd.
Ithaca, NY 14850

Dear Sir or Madam,

I am a graduate student at the Bank Street College of Education in New York City. As part of my graduation requirement, I am preparing an independent study on "Birds of New England and Costa Rica: A Science-Based Interdisciplinary Curriculum." Two copies of each independent study are placed in the Bank Street College Library, one of which will be available for public access, including interlibrary loan. I would like to request permission to include a reproduction of the following images to supplement my thesis text:

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