Inquiry-Based Learning Using Everyday Objects

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Loudoun County Public Schools
Leesburg, Virginia

Bonnie Horning
Seventh Grade Science Teacher
Seneca Ridge Middle School
Sterling, Virginia

About the Authors

Amy Edmonds Alvarado has thirteen years' experience in the classroom and extensive expertise in helping educators improve instructional techniques and curriculum design in all content areas. She has an undergraduate degree in English and Secondary Education from the College of William and Mary and a master's degree in Educational Psychology with a specialization in gifted education from the University of Virginia. She is currently a doctoral candidate in Curriculum and Instruction at the University of Virginia.

Ms. Alvarado has been identified four times as one of the Agnes Meyer Outstanding Educators in Loudoun County, Virginia. Additionally, Ms. Alvarado is a National Board Certified teacher in the area of Middle Childhood Generalist.

For three years she has conducted workshops for the Smithsonian Institution's Naturalist Center on the development and implementation of object-based inquiry lessons in science designed to make students more careful observers, more thorough questioners, and more inquiry-oriented in their approach to science. She has worked as a mentor teacher for the Naturalist Center's IWonder program, helping other teachers learn to incorporate object-based inquiry strategies into their classrooms and to develop object-based inquiry lessons.

Patricia R. Herr has eleven years of experience in the classroom and has participated in curriculum design in all academic areas during that time. She has an undergraduate degree in Psychology and Social Science from Frostburg State University and a master's degree in Education from Marymount University. She also holds a certificate in Technology Education from George Mason University. She is currently teaching fifth grade at Ball's Bluff Elementary School and has done so for the past seven years.

Mrs. Herr has been identified twice as one of the Agnes Meyer Outstanding Educators in Loudoun County, Virginia. Additionally, she has mentored new teachers and supervised student teachers. Mrs. Herr has been actively involved in the Minority Achievement Committee countywide,

serving as the chair for two years, and the co-chair for two years. She helped develop a mentoring program that was implemented countywide. She has also been the recipient of a number of grants to further the practice of object-based inquiry teaching, which have benefited students with the addition of a museum exhibit area in the school. She has worked as a mentor teacher for the Naturalist Center's IWonder program helping other teachers learn to incorporate object-based inquiry strategies into their classrooms and to develop object-based inquiry lessons.

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Emily, Brent, Lexie, and Andrew Logan
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and to Tom and Martha Edmonds

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Introduction

Welcome to Inquiry-Based Learning Using Everyday Objects (Object-Based Inquiry)

Inquiry-based learning and *inquiry teaching* are phrases that mean different things to different people. For some, inquiry means turning students loose to investigate areas of interest to them. For others, inquiry means experimentation, even if the teacher provides all of the steps and students know the final outcome they are trying to reach—the so-called verification lab. Neither of these notions truly captures the essence of what inquiry teaching and learning is all about.

In this book, we seek to promote the notion of inquiry as a process, initiated by either teacher or students, in which students investigate central, essential questions while their teacher guides them through this process. Again, these essential questions can come from either the teacher or the students. Many teachers with whom we have worked believe that if the teacher poses the initial question, students are not truly engaged in inquiry. Certainly they are! Teachers must address curriculum standards and teach specific objectives. They cannot ignore these elements. But teachers can turn these standards and objectives into investigations which, while encompassing the concepts they must teach, honor the curiosity of the students themselves. Initial questions are just that—*beginning points* for student investigation. The students become responsible for the direction they go in pursuit of understanding the initial question.

Students' ability to pursue answers along different pathways does not occur naturally. We designed this book to help teachers begin to understand how to help students learn to truly engage in inquiry. We provide guidance in using an object-based approach to inquiry which will help

students become more observant, more inquisitive, and more reflective. Teachers must train students in this type of thinking and in the development of their reasoning abilities. Through the sample lessons we have provided, we hope to give teachers user-friendly models of this process. We have structured the lessons to increase both teacher and student success with the process and have provided tips on how to move along the continuum from more structured to more student-initiated. This book is intended as a stimulus for change in both teaching and thinking, and we offer object-based inquiry as a tool for teachers to add to their existing repertoire of teaching strategies.

Along this line, it is important to keep in mind that object-based inquiry is not suitable for every lesson or every concept you need to teach. Object-based inquiry is simply a strategy to enhance your skills as an instructor. It is ideal for encouraging students' observation and critical thinking skills such as classifying and categorizing. It is also an excellent strategy for lessons in which you are teaching for conceptual change. It is clear that students enter our classrooms with conceptions and beliefs in place. Although many of these beliefs are erroneous, students nonetheless interpret all new information in light of these previously held conceptions (Driver, 1989). Believing that teachers should strive to help students come to more accurate conceptions, we feel that it is important that teachers understand how this change is accommodated.

An excellent model for teachers to use is Posner's process of "conceptual exchange" (Posner, Strike, Hewson, & Gertzog, 1982). In this model, four conditions must be in place before a student will engage in "conceptual exchange." First, the student must experience a sense of dissatisfaction with his or her original idea. This occurs primarily when the student finds the original conception inadequate to accommodate some new knowledge. Second, the student must find the new conception intelligible. In other words, the idea should make sense to him or her. Third, the new idea must be plausible or in line with the student's view of the way the world works, and finally, the idea must be fruitful in that the student has good reason to adopt it (Posner, Strike, Hewson, & Gertzog, 1982). Object-based inquiry accommodates these four conditions necessary for conceptual change. This process allows students to investigate their own ideas about a topic under the guidance of a teacher who understands both the misconceptions students hold and the power found in students investigating their own ideas.

We hope that you enjoy discovering the power of using object-based inquiry in your classroom and find encouragement in the growth you will see in your students' reasoning abilities, insights, and ability to make connections.

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Part I

Object-Based Learning

1 What Is Object-Based Inquiry?

When you first enter the classroom, you are struck by the utter silence that pervades the room. Students are hunched over their desks for what surely must be the test of the year. You arrive at this conclusion by observing the intent looks on students' faces and the attention that they have focused on the paper on their desks.

A second look, however, reveals that the objects on which the students are focusing are not the papers on their desks, but rather ocean organisms, one of which is in front of each student. The paper is merely a means for students to record their observations and questions about their natural object. Perhaps, you think, this is not a test at all. Perhaps this is one of those "new-fangled" performance assessment tasks. After all, the students are extremely involved with these objects and are giving them an undue amount of attention.

Suddenly the silence is broken by a student question—"What are these 'pincher-things' on my animal?" Then another—"How heavy is this shell when the organism is living inside it?"

The teacher responds with, "Great questions! Write them down on your sheet!" Then she reminds the students of their task. "Your job is to determine what your organism is *and then figure out where in the ocean it lives. In order to do this you will need to examine your organism and come up with some guiding questions to help you reach the answer to the bigger questions I just gave you. Now that you have had some time to observe your specimen and determine some of your own questions, work with the others at your table to compare questions and formulate additional ones." Once again questions erupt as students eagerly engage in conversation and write out question after question:*

- How does it eat?
- What is its prey?
- How does it defend itself from predators?
- How strong does it have to be to survive in its environment?
- How cold can the water be where it lives?
- How does it move?
- Why does it have such a thick shell?
- Why doesn't mine *have* a shell?

During this experience, you watch as the teacher circulates, asking key questions as students observe and examine their organisms, refocusing students who seem to have become too intent on one aspect of their animal and directing students always to return to the original two questions—what is this organism and where does it live–and, of course, to the object itself. As the conversations reach an excited pitch, the teacher determines that it is time to bring her students back together as a whole group to share what they have brainstormed. Students protest and insist that they still have more questions which they did not have time to add to their lists. But the teacher insists, indicating that there will be time to add further questions during the next phase. Student groups then share their questions with the whole class, and all the children are eager to contribute their individual and small-group questions. Amazingly, you notice that few students appear hesitant to offer ideas, and all are enthusiastically participating. As students share their ideas, the teacher fills sheet after sheet of chart paper; question after question is added to the list of guiding research questions. You watch as eventually all the students contribute to the creation of a list of thirty to forty questions—all from one small ocean organism sitting on their desks. (See Figure 1.1.)

The next day when you return, the students move into the research phase of their lesson. Each student investigates the answers to some of the questions compiled by the class. The teacher then asks the students to use this information to classify their organisms into two groups—students determining from their research into which group their animal belongs. You observe students making hypotheses about environmental characteristics of their organisms' habitats and determining reasons for certain adaptations found in the animals, and you realize as the lesson ends that the students have essentially figured out for themselves not only the environmental characteristics specific to certain ocean zones, but also some essential information regarding adaptation and change.

Figure 1.1 Partial List of Research Questions Developed by a Fifth-Grade Class

What are its predators? Its prey?
Is it strong? Fragile?
Can it handle rough water? Calm?
Can it dig or burrow?
How much cold can it stand?
How much salt can it handle?
Is it flexible or stiff?
Can it harm humans?
What is its texture?
Can it handle being dry or out of the water?
Does it like dark or light?
Does it need dark or light?
Why does it have this particular shape?
Why is it this color?
Does it rely on camouflage?
How fast does it move?
How does its size or shape determine its movement?
How does it defend/protect itself?
Can it handle pressure?
How much does/can it weigh?

THE REALITY OF OBJECT-BASED LEARNING

The scenario described above may seem too good to be true. It may appear to be unrealistic, especially given today's classroom demands and problems. It may even strike you as a case of wishful thinking. The above scenario, however, is a description of a highly diverse class of twenty-seven fifth graders engaged in an object-based science experience during an ocean study. What makes a lesson such as this one successful? What leads students to deep understandings of the essential concepts embedded in a unit of study?

One critical aspect of the lesson is the use of a variety of objects which serve as the vehicle for the development of understanding of lesson concepts. But is this lesson the result of just giving students objects to observe? Indeed students are asked to observe their natural objects, but they are asked to do so much more than that. In object-based learning, the

objects themselves become central to developing the concepts which are essential to your unit of study. The objects are not merely an add-on component. They are not just used for display. They do not come with a "no touching" sign attached. The objects are *the* central component of the lesson and the overall unit of study.

Another critical component of this lesson centers on what students are asked to do with the objects. The teacher could have asked the students to conduct an experiment about ocean animals beginning with one common hypothesis and concluding with one set of results. Instead the teacher asks her students to utilize the natural objects to discover information through posing and investigating their own questions. The teacher uses students' natural curiosity and propensity for posing questions to guide her instruction. Students are given time to observe and develop questions independently, but when some students can no longer contain their questions, she allows time for small group interaction. When the excitement is still at a high level, she cuts the brainstorming time off, allowing that enthusiasm to carry over into the whole-class portion of the lesson. The class's response to the objects and their ability to utilize objects effectively is the result of their experience with object-based inquiry lessons. Likewise your students' ability to interact productively with objects will grow each time you do one of these types of lessons with your students.

So what exactly is the teacher's role in object-based inquiry? It is obvious that the teacher's job involves asking questions, but what types of questions are ideal? How are those questions developed? A third essential part of object-based learning involves utilizing well-thought-out questions which will stimulate critical, higher-level thinking by the students. These questions are critical in that they provide students with their thinking task. They are not questions for which a quick correct answer will be enough. These questions take time to develop if they are to be different from the typical, closed, low-level questions which are often used in classrooms and which do not stimulate student thinking. In addition to the critical initial questions, the teacher's role throughout the lesson is one centered around questioning. Rather than answering students' questions, the teacher's job is to lead students to their own answers to their questions either through an open-ended response question or through refocusing the students on their observations of the objects. In this way, the teacher is helping students avoid focusing on *one* correct answer early on in the investigation. In Chapter 4 we offer guidance in developing strong initial questions as well as a variety of questioning techniques designed to increase your students' higher-level thinking about objects.

Most important of all of the characteristics, object-based lessons are student-directed experiences where the teacher follows paths created by

Figure 1.2 What Object-Based Learning IS and ISN'T

Object-Based Learning IS . . .	*Object-Based Learning ISN'T . . .*
Using a variety of objects as central to the development of lesson concepts.	Using objects as display pieces.
Utilizing objects to discover information through posing and investigating questions.	Conducting science experiments that begin with one hypothesis and yield one result.
Utilizing well-thought-out initial questions to stimulate further critical, higher-level thinking.	Giving students answers or specific questions that can be answered simply with a quick, correct answer.
Using students' natural curiosity and propensity for question-posing to guide instruction in all subjects.	Teacher-directed learning where the teacher knows THE correct answer and THE way to get that answer.
Leading students to their own answers to questions by (a) responding with open-ended questions or (b) returning the students' focus to the object.	
Student-directed learning that follows paths created by the students.	

the students. These lessons do not involve the teacher knowing *the* correct answer and *the* one way to arrive at that answer. Instead students direct the course of their learning with gentle guidance from the teacher and, in the process, develop deeper understanding of essential concepts while using multiple paths to investigate the answers to their own questions.

WHY USE OBJECT-BASED INQUIRY?

Object-based learning involves using well-thought-out initial questions to stimulate student thinking and question development. It involves the teacher refocusing students on their objects and their questions through the use of guiding questions. It seems very different and very exciting, but it also seems very time consuming both in terms of planning and in the time it would take students to arrive at any conclusions. Additionally, many people—teachers, students, and administrators—may feel uncomfortable with these less defined tasks. Why would a teacher decide to use

object-based teaching and learning in the classroom? More important, how do students benefit from the use of such a strategy?

Planning Time

Yes, object-based inquiry lessons take time to develop. It *does* take time to develop collections that are appropriate for use in your units of study. There are, however, countless places for collecting specimens and many different and creative ways of going about it. Many are cheap, if not free, for teachers; and if you just ask, many people are happy to help you. Students and their parents can be a great resource! Chapter 2 contains many ideas for where and how to begin collecting and then, later on, for adding to your collections. Developing powerful initial questions also takes time, but, again, there are resources focusing on questioning that are available to teachers. Concentrating on the higher levels of Bloom's taxonomy is a familiar place to start with developing higher-level questions for these lessons. Additionally, strategies of Socratic questioning and Hilda Taba's work with inductive questioning both provide teachers with a vast store of questioning techniques that teachers can apply both to initial question development and to the use of guiding questions throughout your lesson. These techniques will be discussed further in Chapter 4.

You *will* invest a great deal of time preparing for an object-based lesson. The trade-off, however, comes during the actual lesson. Since the lesson is student-directed, the teacher is freed up during this time to observe students as they are working and interacting with other students. Through such observations, teachers can come to know better what students need. Teachers can determine which students are developing strong understandings of the concepts that are central to the unit and which students need further guidance. The teacher is not the "sage on the stage," presenting the information to students and hoping they "get" it. Instead students are actively engaged in their learning.

Student Understandings

When students are actively engaged in investigating their own questions and interests, several positive consequences occur. First, student motivation increases as students become absorbed in their study. Second, student understandings are deeper when they arrive at the answer(s) themselves with careful guidance from the teacher. Furthermore, these understandings carry over into other subjects where students begin to make other, deeper connections. Third, object-based learning allows the teacher to differentiate instruction more easily since student understandings arise out of the investigation of their own questions through their

own learning modality. Even if the lesson eventually leads to one correct answer, the teacher encourages students to use multiple paths toward that answer, and the focus is as much on the students' processing as on their final answer. The end result is that students "conclude" one unit of learning with deeper understandings of essential concepts central to the unit and subsequently carry those understandings over to future units.

Student Motivation

Although some students may be uncomfortable at first with the more abstract, open format of object-based lessons, students *do* become more and more comfortable with it as the year progresses. How could they not? Object-based learning plays on the natural curiosity about objects that every student possesses. Through these lessons, student are exposed to things they have never seen before, and all subjects become hands-on as the students explore the objects through all of their senses. Chapters 6 through 9 provide numerous examples of lessons that would be good to use with those students (and teachers!) just beginning to explore object-based learning. Beginning with lessons such as these will motivate students to further explore objects and will lead to participation in lessons of greater and greater complexity.

Instructional Time and Improved Student Competencies

Another big time issue in addition to planning time is the amount of instructional time needed for object-based lessons. Without a doubt, beginning object-based lessons do require longer periods of time. However, when you look at the amount of interdisciplinary teaching that you can accomplish through this type of lesson, you will see that the time spent on "one" object-based lesson is well worth it. In the course of one two-hour object-based lesson, you might include skills from science, language, reading, and art. If you are working in a middle or junior high school where you teach a single subject, consider teaming with colleagues in other disciplines to achieve interdisciplinary efficiency. Additionally, as mentioned earlier, by using this type of lesson you can encourage deeper levels of thinking and develop deeper understandings of concepts in your students. Thus you will find that there is less need to keep returning to concepts which you taught your students earlier but which they never really learned with any depth or thoroughness. Students begin to transfer these understandings to other subject areas as well, and soon you will find that you're actually saving instructional time. As the year progresses, you will also see an improvement in the quality of student thinking due to the

Figure 1.3 Advantages of Object-Based Learning

Student investigation arises out of student questions and interests, so students are more motivated.

Even if lessons eventually lead to one correct answer, value is placed on multiple paths toward that answer.

Focus is as much on the students' processing as on their final answer.

Student understandings are deeper when they arrive at the answer(s) themselves.

These understandings carry over into other subjects, so students begin to see more connections.

It plays on the natural curiosity about objects which all students possess.

Students are exposed to objects they may never have experienced before.

Teacher is freed up during the lesson to observe students as they are working and interacting with other students.

Quality of final product(s) is much higher than if students complete the product just because you asked them to. It has become their product, and they are invested in it.

Quality of student thinking improves since there is no one right way to approach the question you pose. Students must make decisions for themselves.

Quality of interactions improves. Students are working together to pose questions, find answers, and create products.

It addresses different learning modalities so that lessons are naturally differentiated.

It makes all subjects hands-on.

fact that there is no one right way to approach the question(s) you pose. The students must spend time thinking about the question(s) and making decisions for themselves. In addition to improved thinking, you should also see an improvement in the quality of student-to-student interactions as students work together to pose questions, find answers, and create products.

Improved Student Products

The quality of student products will naturally improve as they become more invested in their work. They are no longer completing the product because you asked them to or because you will be grading it but rather because it has become *their* product, and they are invested in it.

At first you may meet with some resistance to using object-based inquiry from people who do not see the connection to "relevant learning" (i.e. standards and objectives). As student products improve, even the most reluctant parents, students, colleagues, and administrators will be able to see the connections between these products and the documented state and local standards and objectives. After this you can invite these groups into your classroom to see the process at work and to observe the techniques students use to arrive at such great products! Usually resistance to something has its base in lack of knowledge or understanding of it. Offer yourself and your students as models of the many benefits that teachers and students can derive from object-based teaching and learning.

TIME TO BEGIN YOUR JOURNEY

Now that you have had a brief introduction to object-based inquiry, it is time to dive in and investigate each component more thoroughly. In Chapter 2 we will begin by exploring how you can begin to build your own collections to use with your students. Then in Chapter 3 we will move into issues related to setting up your classroom, preparing your students, and developing the lessons. In Chapters 6–9 we have included numerous sample lessons at different levels of complexity to help get you started. Included are both blank templates and actual student work samples so that you can see how real students responded to the tasks. Additionally we have identified national standards addressed in each lesson. These will be easy for you to also correlate to your state or local standards. We hope you enjoy this investigation and that you will find object-based inquiry learning a valuable teaching strategy for both you and your students.