

## **Insects: A Kindergarten Science Inquiry Story**

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**P**upils in the kindergarten class are often described as inquisitive and playful. These characteristics provide a great challenge to the kindergarten teachers who are aware that the particular developmental stage of the children is a critical stage for their lifelong educational foundation, especially in areas basic to science.

In terms of Piaget's cognitive development stages, kindergarten pupils are considered to fit largely into a preoperational stage. This means that the children's world is molded and reshaped by the realm of mental representations. Representing objects and thoughts symbolically is the major intellectual achievement of the stage. It is in this stage where language is developed and the child makes use of abstractions of language to convey thoughts (Martin 1997).

How can a kindergarten class in science be made interesting to children? How could it not be interesting if teachers were to deal with and use children's questions and wonderment? To these questions, a professional development program was implemented in one school in which teachers were helped to become constructivist teachers using the inquiry approach.

As defined by the 1996 US National Science Education Standards (NSES), inquiry is a multifaceted activity that involves making observations; posing questions; examining books and other sources of information to see what is already known; planning investigations; reviewing what is already known in the light of experimental evidence; using tools to gather, analyze, and interpret data; proposing answers, explanations, and predictions; and communicating the results. Results in the kindergarten class can be in the form of drawings to be explained and simple interpretation of observations. Inquiry requires identification

of assumptions, use of critical and logical thinking, and consideration of alternative explanations.

The Constructive Learning Model indicates that real learning results when individuals construct the meaning of objects and events that they encounter on their own as part of their human experience. Learning is dependent on experience and existing knowledge. Therefore, it is a social process (Tobin, et al. 1994). Shymansky (1990) further strengthened this relationship by stating that humans learn meaningfully only by connecting ideas with existing ideas and that active involvement of learners help them in the process of building their knowledge about the world around them through physical experiences and social interactions. Constructivist strategies depend greatly on determining learners' prior knowledge and the active interaction with other learners (Wheatley 1991). Some of the approaches include: 1) student-generated questions (Tobin, et al.); 2) concept mapping (Novak and Gowin 1984); 3) group learning (Osborne 1996; Tobin, et al.; von Glasserfeld 1987); 4) STS (Yager 1996); and 5) problem-centered learning with cooperative groups and class discussions (Wheatley 1991).

The five principles of constructivist pedagogy described by Brooks and Brooks (1993) support the teaching approaches mentioned. These principles are as follows: 1) posing problems which are relevant to learners; 2) structuring learning around major concepts; 3) giving value to students' points of view; 4) developing a curriculum concerning students' suppositions; and 5) evaluating student learning in the context of teaching.

In the learning process, problems posed by learners provide an initiator of mind engagement. These problems provide a disturbance that ideally causes the learners to seek for solutions and answers. The pedagogical basis of the problem-based learning is an approach that is also known as inquiry approach where "students may learn more if they are taught less and that they learn best by doing" (Ahern-Rindell 1998/1999). When students are given the opportunity to identify problems of interest, work by themselves, and propose their own solutions to their chosen problems, they tend to be more productive. The teacher can then recognize more variety in terms of questions and answers from all the students. This definitely shows that the inquiry approach can challenge students to work hard when the teacher acts as facilitator and not as lecturer.

Inquiry as a discovery method was not well accepted in the earlier research as it was found not to have real examples of success. A study in 1981 by Welch, Klopfer, Aikenhead, and Robinson showed that it was not an effective technique at that time in terms of teachers practicing it. However, as more research has been undertaken, more positive effects of inquiry as a method have been demonstrated (Gallagher and Tobin 1987; De Boer 1991; National Science Education Standards 1996).

The National Research Council (NRC) offered six general research findings supporting the inquiry-based learning in six categories. Such research categories are organized as follows:

1. Understanding science is more than knowing facts.
2. Students build new knowledge and understanding on what they already know and believe.
3. Students formulate new knowledge by modifying and refining their current concepts and by adding new concepts to what they already know.
4. Learning is mediated by the social environment in which learners interact with others.
5. Effective learning requires that students take control of their own learning.
6. The ability to apply knowledge to novel situations, that is, transfer of learning, is affected by the degree to which students learn with understanding.

Student-generated questions lie at the heart of scientific inquiry and meaningful learning (Chin et al. 2002). Question generation is an important cognitive strategy because it enables the student to focus on the content, main ideas and evaluation of learning. In the inquiry-based learning, more opportunities are given to students to ask questions, thus, allowing them to focus deeper into issues and problems which are of interest.

The role of the teacher in an inquiry-oriented class is to facilitate learning of science by students. As a facilitator, the teacher ensures that a proper learning environment is provided for the learners by designing and conducting their own activities such as raising questions that define activities, suggesting ideas and giving explanations (Ahern-Rindell). The learner's mental capacity, physical attributes, motivation, and affective status should be considered. Using the criteria should be helpful in creating an environment for student-led inquiry-based

lessons to achieve the 1996 goals of the US National Science Education Standards (Keefer 1999).

The 2003 Chautauqua Staff Development program is inspired by the constructivist teaching practices and the use of methods of inquiry in teaching-learning process. It is, therefore, the purpose of this study to look at the results of the staff development program and see how the teachers responded to the challenge of improving the teaching-learning process. The focus is primarily on the analysis of a model science class for kindergarten children from the constructivist perspective and inquiry approach. Three specific questions will guide the analysis:

1. What are the specific activities of the class that could show constructivist perspectives in the teaching-learning process?
2. What examples of class activities fit into the definition of inquiry approach?
3. Using the Constructivist Teaching Practice Scale (CTPS), what would be the rating of the kindergarten teachers in the use of the insect module?

### Methodology

**The 2003 Chautauqua Program:** the program is designed to promote the national Science Education Standards within primary and middle schools being served by Area Education Agencies (AEA) 2, 6, and 7, involving twelve teachers per AEA. Meeting the goal of improving science teaching can best be met through introducing and working with kit-based science programs, which include content developments related to kit topics, an emphasis on inquiry, and the creation of an internet-based webpage designed to foster greater participation of teachers involved in the project. Three districts were included in one AEA site. Some primary, middle school, and high school teachers participated in the program.

Through the local AEA, twenty-three teachers from Charles City, Iowa participated in the Chautauqua professional development project. One requirement of the development program is for the teachers to prepare a videotaped module. This module became the implementing guide in an actual classroom. It was this videotaped lesson of two kindergarten teachers that was observed in this study.

**The Class:** A group of twenty-five kindergarten pupils were requested by two kindergarten teachers to participate in the module presentation from the Washington School for the Charles City teachers (AEA 2). The presentation described experiences with five-day trial in the Chautauqua sequence of activities. The 2003 Chautauqua program includes a summer leadership workshop before an on-site workshop which were required prior to the five-day trial of the science module.

### First Phase:

The teacher reminded the class about the word "scientists" and when the pupils answered positively, the teacher introduced a "scientist" in the field of "bugology." Bugology is a new word and the teacher explained the work of the bugologist. The resource person then asked the pupils about what they know about tiny animals called bugs. To this question by the resource person, the pupils enumerated a worm, a fly, a beetle, a clam, bees, stick bug, spider, grasshopper, and butterfly.

The bugologist showed several models of insects starting with the butterfly and the moth. To make this part of the class interesting, the presentation involved identification and classification by the pupils.

At the suggestion of the resource speaker, the class proceeded to identify parts in order to classify insects from non-insects. The pupils were, then, able to differentiate insects from non-insects. All throughout this phase, pupils raised their hands to ask different kinds of questions and suggest possible answers.

### Analysis:

At this point the scientist allowed the pupils to ask questions and give answers showing their varied ideas in the form of giving different examples and offering other possibilities and explanations according to their own experience. The bugs they enumerated are the insects they have seen before around their house and in their backyard. This activity shows that pupils depend on previous experiences when they ask questions and also when they give answers illustrating a constructivist claim that learning is dependent on experience and previous knowledge (Tobin, et al.).

From the perspective of Piaget's Cognitive Developmental Stages (Martin), identification and classification of concrete examples are within the psychological stage capability of the kindergarten pupils so that the teacher presented concrete models in the classroom in preparation for

outdoor observation. The enthusiasm of the pupils, as evidenced by the raising of hands to ask questions or to give answers, shows that the topic was interesting and a source of wonderment to them. The teacher guided the pupils' progress through their various activities—although it was the ideas of the pupils that were used to move from the asking to the sorting of questions. Listening to pupils' ideas is an example of inquiry in the classroom. Throughout the activities observed, the ideas of the pupils were utilized for class discussion.

*Second Phase: (Not in video)*

Pupils were brought outside the class to observe living things and hopefully to find bugs. They went to the woods, prairie, and creek. Each pupil had a notebook and a pencil. After observing, the pupils made a drawing of anything that they found interesting. They also collected living bugs.

*Analysis:*

Field study is interesting to the children and the activity put their inquisitive mind to practice. Some pupils made the drawings but others merely enjoyed moving around and observing.

*Third Phase:*

A lively interaction occurred between teachers and pupils. Pupil responses to questions were interesting. The teacher wrote down all the questions on the board. Some questions asked were:

1. What do crickets eat?
2. What do grasshopper eat?
3. What do bees eat?
4. What do beetles eat?

The first group of questions was reduced into specific questions like:

1. What do insects eat?
2. How do butterflies fly?
2. What do butterflies do?
3. What do bugs do?
4. How do butterflies see?
5. What do moths do at night?
6. Why don't butterflies come out at night?
7. How do butterflies fly home?

The pupils, with the guidance of the teacher proceeded to group together similar questions resulting in fewer questions. Since most of the questions involved butterflies, the teacher suggested focusing on butterflies and the pupils enthusiastically agreed. Then the teacher provided a chart for questions and how to look for the answers. The pupils also suggested some tools they might need in finding out the answer to their questions.

*Analysis:*

At this stage of development, pupils should look at learning science as fun. Hence, the teacher should be encouraging pupils to participate by asking questions and suggesting their own answers. This would encourage pupils to express their own ideas that stimulate more questions. In the sorting and classifying of questions, the teacher provided the introduction and the pupils were encouraged to participate in the class activity.

*Fourth Phase:*

Questions were distributed by groups and pupils were asked how they can answer their questions. The pupils enumerated the following sources and materials: books, mom, grandma, binoculars, jar, and magnifying lens.

One group was brought to the library and another group to the laboratory. The pupils were all busy with what they were doing and the teacher was observing and guiding them all throughout the activities.

The pupils were then brought to the computer room for an internet search.

*Analysis:*

Group work provided opportunities for exchange of ideas that promote cooperative activities among group members. The pupils were challenged to plan their own laboratory activities. Those in the library were given books by the librarian and then were left on their own to go through the pages of the book to find information and ideas related to their search. Although some pupils have computers at home, most of the time they use them for games and children stories (Korpan, et al. 1997). The teacher then explained the technology in preparation for internet searches. Some pupils appeared restless. Perhaps they were not yet psychologically ready for this level. Another possible explanation is

that pupils felt they were not actively involved as there was only one big computer available with the teacher directing its use most of the time.

Although there were many questions, there was less inquiry involved and more lecture.

#### *Fifth Phase:*

This phase comprised the assessment of the pupils' learning. The main focus in the assessment is whether the pupils would be able to choose a part of or a whole butterfly correctly by looking at their live specimens. They would then draw the object, and tell their classmates about it later. The materials were placed on the table and the pupils worked together to prepare a report in class. While the pupils were sharing the result of their activities to the class, the teacher asked them to find out what they had learned from their own activity.

#### *Analysis:*

Through the guidance of the teacher, the pupils chose their own topics. When pupils chose their own topic from among the topics they themselves had enumerated earlier, it is a clear indication of the constructivist level of the assessment part. Pupils were made responsible for their identification of the problems and the subsequent resolution by allowing them to plan their own procedure, choose their materials, and derive their own conclusions.

The teacher's role in the class is to assess the level of understanding of the pupils as they answered the teacher's questions and shared their results. The pupils worked as a group. There was freedom of movement around the room, as well as freedom to consult other classmates. Most of the pupils were able to express what they wanted to say about the butterfly through their drawings. These constructivist practices are in congruence with the inquiry approach used in the class. When pupils are able to express their own ideas through inquiry, there is evidence that constructivist teaching practice is being used.

To analyze the level of constructivist teaching practices, a scale used in the Iowa Chautauqua Program for many years was provided for use. The constructivist rubric has been proven to determine the level of constructivist practices in the classroom in many researches in the past (Kumano 1993). To determine the averages, a self-analysis was made by the teachers in the insect module. Aside from their self-analysis, two

other outside raters determined the degree of constructivist practices that could be observed during the entire module.

The average of the ratings was determined and then plotted in a graph to show the relationship of the different practices.

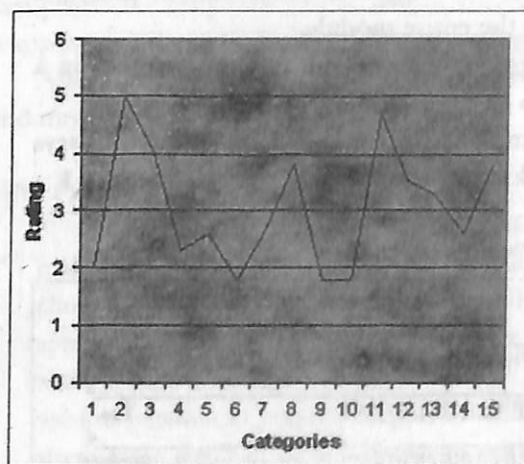
The constructivist teaching practices scale (CTPS) used to assess the constructivist level of the kindergarten class is shown in Figure 1.

Figure 1. The Constructivist Level of the Kindergarten Class

		Rating		
Teacher	IDENTIFIES THE ISSUES/TOPIC	Student 2		
No	ISSUE IS SEEN AS RELEVANT	Yes 5		
Teacher	ASKS THE QUESTIONS	Student 4		
Teacher	IDENTIFIES WRITTEN AND HUMAN RESOURCES	Student 2.3		
Teacher	LOCATES WRITTEN RESOURCES	Student 2.6		
Teacher	CONTACTS NEEDED HUMAN RESOURCES	Student 1.8		
Teacher	PLANS INVESTIGATIONS AND OTHER ACTIVITIES	Student 2.7		
No	TEACHERS USE VARIED EVALUATION TECHNIQUES	Yes 3.8		
No	STUDENTS USE VARIED EVALUATION TECHNIQUES	Yes 1.8		
No	STUDENTS PRACTICE SELF-EVALUATION	Yes 1.8		
No	SCIENCE CONCEPTS ARE APPLIED TO NEW SITUATIONS	Yes 4.7		
No	SCIENCE SKILLS ARE APPLIED TO NEW SITUATIONS	Yes 3.5		
No	STUDENTS TAKE ACTION(S) AS A RESULT OF THEIR WORK	Yes 3.3		
No	SCIENCE CONCEPTS AND PRINCIPLES ARE SOUGHT OUT AND USED BY THE STUDENTS	Yes 2.6		
No	EVIDENCE AVAILABLE THAT SHOWS SCIENCE LEARNING HAS IMPACT OUT OF SCHOOL	Yes 3.8		
1	2	3	4	5

The graph of the CTPS shown in Figure 2 represents the average ratings of the pupils in the kindergarten science class based on self-evaluations and evaluation of other raters.

Figure 2. Graph of CTPS of the Kindergarten Science Class



The ratings of 1 to 5 describe the degree of observable constructivist practices. Higher ratings mean more pupil activities and less of teacher activities. Although there are low ratings, the graph shows higher ratings in most of the categories. The young age of the pupils and their Piagetian psychological level require more teacher guidance in the inquiry. With minimal teacher guidance the class was involved with many activities, providing the pupils more opportunities to practice inquiry. These were some of the inquiry activities suggested by the National Science Education Standards (NSES) including:

1. making observations—pupils were asked to observe the features of some animals (insects) inside the classroom, as well as outside the classroom;
2. posing questions—pupils were asked to pose questions especially in the chart about butterflies and insects;
3. examining books and other sources of information to see what is already known—pupils were brought to the library to look at references and also taught how to use certain websites for research on butterflies and insects;
4. planning investigations—pupils were asked to plan for an investigation to answer some of the questions presented;
5. reviewing what is already known in the light of experimental evidence;
6. using tools to gather, analyze, and interpret data;

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7. proposing answers, explanations, and predictions; and
8. communicating results.

The inquiry lessons observed in the videotapes indicate that the teacher developed a cooperative classroom environment in which pupil results were considered in consultation with other members of other groups. The teacher's role as facilitator of science learning was made clear during all the inquiry lessons. While pupils were busy with their group work, the teacher moved around the class observing the work of the groups as they planned for their next activity.

### Conclusion:

Based on the results of the observations and analyses, the science inquiry class about the butterfly and other insects provided a source of wonderment for the kindergartners. Their wonderment is evidenced by the many questions they posed during the class activities.

The module on insects is a product of the teachers' summer exposure to constructivist practices and inquiry teaching. The influence of their summer Chautauqua experience is reflected in the constructivist activities implemented in the class. These activities are: 1) allowing pupils to pose the questions; 2) plan investigations from observations; 3) gather data by observation and drawing; 4) communicating with classmates in discussing results, and communicating to the class their own observations and interpretations.

The CTPS revealed some areas for improvement in the module observed. These areas of improvements may be viewed as the need to give more time to pupils for posing questions and more freedom in preparing reports. The response of the pupils to the approach is very encouraging for the teachers and the pupils themselves. While having fun, the pupils were exposed to basic science skills like observation, prediction, planning and communication of results which are all part of inquiry learning. Use of more constructivist teaching practices, such as more pupil involvement and more freedom for constructing ideas, would enable the pupils to think more for themselves even at this early age of the kindergarten level.

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