Deepening Project Investigations

Nancy B. Hertzog & Marjorie M. Klein

Introduction

Is a bulldozer the same thing as a crane? Is frost the same as snow? The answers to these questions are matters of consequence to 5- and 6-year-olds. Students in the midst of project investigations are motivated to pursue answers to their own questions. The teacher's role in facilitating inquiry is no easy task, and getting students *deeply* involved in a topic under study is even harder. This chapter will address how teachers can provide greater depth and complexity to project investigations. After all, it is the teacher who plays the critical role of designing activities that enhance the depth and complexity of project work.

The degree to which the students are engaged in critical thinking, designing, experimenting, and inquiring defines the richness of the learning experiences. We propose five specific strategies teachers can use to deepen the inquiry: (1) model curiosity, (2) promote and facilitate discussion, (3) hone questioning skills, (4) create contexts for experimentation and representation, and (5) use the language of thinking.

Model Curiosity

When teachers model curiosity, students have opportunities to reason. Notice in this example what the teacher said when a student shared his observation:

Konan: I dropped 3 apples in the pond. 2 apples floated and 1 sank.
Teacher: That's interesting. I wonder why.

Teachers model curiosity by listening carefully to what the students say, thereby demonstrating interest in the students' ideas and promoting the joy of wanting to learn more about something. The teacher can model curiosity by being open to students' ideas even though they may seem to be "far out" and not related to the topic at hand. By not ignoring the teachable moment, teachers place value on the child's curiosity and begin the process of facilitating the child's own investigation into the topic. The teacher probes students' thinking by asking students to elaborate upon their ideas and helps students to formulate ways to investigate their questions. For students who have questions that may diverge from the main topic, the teacher provides an independent investigation form that articulates a plan for the inquiry. Questions for the students on the form include the following:

What are you curious about?
What do you already know?
What do you want to know?

There is also a list of methods of investigation such as Interview, Internet Search, Read a Book, Experiment, and so forth, that students can circle. The last section on the form asks students how they would like to share their findings with the other students. This approach again places value on students' inquiries and demonstrates the worthiness of pursuing their own questions. Oftentimes, the teacher brings students' ideas to the whole group for discussion.

Promote and Facilitate Discussion

Discussion is one of the key features of project investigations, and it is important in all three phases of project work. Teachers who provide time for students to discuss and compare their ideas to those of others promote ways for students to further their inquiry and exploration. For example, in a discussion of how their ideas should be categorized, students argued over whether or not cranes or bulldozers should go into the same category:

CM: I think cranes should go with bulldozers because they are the same. They lift things.

BG: I disagree. Cranes are not the same as bulldozers because the crane has that thing that lifts that makes it different.

CM: They are the same, they do the same things. They just have different names.

JJ: Cranes knock down buildings and so do bulldozers. So they are the same.

WJ: Cranes help scoop up rocks.

Jay: Yeah. Bulldozers can't scoop, they are just for pushing things.

CM: Well, they are all machines that work on constructions.

AH: We could put tractors, machines, cranes all together. They are all machines.

Teacher: What do you think? AH is suggesting that all the machines go together in the same group.

WJ: No, I think the cranes should be separate from the others.

After arguing about whether or not cranes were the same as bulldozers, the teacher suggested that they survey students for their opinions. They graphed the results of their survey and brought it back to the group for more discussion.

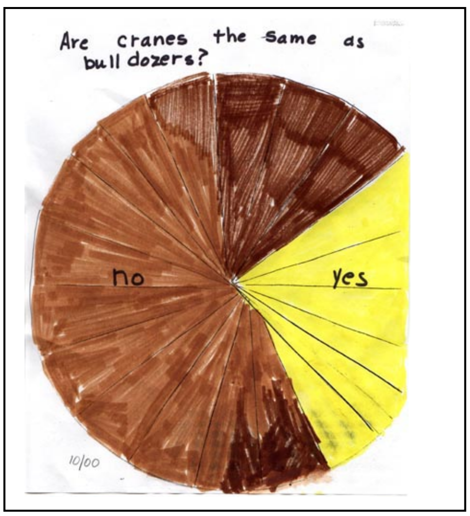

Figure 1. Graph of the responses to the question, "Are cranes the same as bulldozers?"

Facilitating discussion for young children can be rather tricky. Students often lose interest in what other children have to say. Keeping students focused on the discussion by eliciting their opinions and ideas makes for more lively and thoughtful discussions. Teachers can probe their thinking with questions such as these:

What do you think happened?
Would the same thing happen if we used other materials?
How do you explain this?

While discussing, children speak, listen, and respond to peers. By listening to the conversations during discussion, teachers can assess individual understandings and note misconceptions to prepare future contexts for learning. In the following discussion about frost, the teacher noted that many students had misconceptions:

T: What happens to get frost?

JL: I think it was raining and snowing last night. It was snowy cold last night. So rain and snow that is frozen makes frost.

KH: I agree.

SG: I agree.

IK: I agree.

JL: Frost means it's frozen.

ErK: I think it was raining and snowing. It was very cold last night because I was going outside and I felt some drops on my head. I was like, "Is it raining?" and then I started to see snow.

ElK: I think that it is just so cold that it just gets there.

T: How does the frost just get there?

ElK: In the summer, we saw a dead bunny and our dad touched him with a shovel, and it was dead because of the record. He was frozen. That's how it got frost.

T: The frost got there from the bunny?

ElK: No, the record.

T: Could you tell a little bit more about this record.

ElK: It means that it's a cold record. The weather's cold outside.

CAZ: Like a weather record.

DK: Last year it set a record.

ElK: That's what I meant.

T: So you mean that last night it set a record and that's how the frost got on the grass?

The teacher returned to this conversation later in the project and reminded the students about what they discussed:

T: On October 15, we had a conversation about frost. On that day, the conversation sounded like this:

ErK: I think it was raining and snowing. It was very cold last night because I was going outside and I felt some drops on my head. I was like, "Is it raining?" and then I started to see snow.

T: Is that still your thinking about frost?

ErK: Yes.

DK: I think frost comes from grass. It's white stuff before it turns into frost.

AS: I think it's some ice.

DK: It's there in mornings. It's called dew.

AS: Not in the summer.

MG: I've heard of that.

DK: Frost is made out of dew.

AL: Frost melts in summer. Frost is dew.

MG: No, it's not.

PF: Hail storms are white. Maybe it hail stormed in the middle of the night. But I didn't hear any.

LH: When I was getting ready, frost was on the roof. It can get on cars, too.

AL: My mom said dew comes from out of the ground and frost comes from the sky.

ElK: Your mom's wrong.

JW: I've got an experiment that uses a magnifying glass. Maybe that would tell us. This is how I think frost forms. I think dew is drops of water that gets formed on grass. Dew freezes and frost is formed.

T: What are the conditions for dew? Where does dew come from?

MG: From the ground. Maybe the ground on the other side of the world, and it comes through the earth (I don't know how it gets past the hot lava), and then it comes out of the ground as dew and then frost.

New vocabulary is appearing in the conversation, as well as, for some children, a beginning understanding of dew and its relationship to frost. The conversations reinforce that not all children learn at the same rate. Understanding is not a whole class understanding, but, rather, the conversation documents where individuals are in "making sense" of their world.

Teachers listen to the conversations and ask clarifying questions to help students articulate their thinking during discussion. These questions may include:

What do you mean?
How did you do that?
Why do you say that?
How does that fit with what she just said?
I don’t really get that, could you explain it another way?
Could you give an example?
How did you figure that out?
Can anyone help (name of child) figure out his/her problem?

Teachers help children think critically when revisiting key features of the conversation, reminding students what was said, and asking for their current thinking on the topic. Anderson (1996) contends that discussions promote further understanding:

> Teachers facilitate discussions where points of view are presented and debated by children to reach consensus on an answer. It is in the process of considering other children's solutions that they reach higher levels of understanding, learn more efficient procedures and/or clarify their thinking. (p. 37)

Duckworth (1996) also says, “To the extent that one carries on a conversation with a child as a way of trying to understand a child’s understanding, the child’s understanding increases “in the very process” (p. 96).

Discussions occur all throughout the phases of the project. In Phase 1, students brainstorm their previous experiences about the topic. They discuss, categorize, and label their ideas to form a topic web. Topic webs can be done several times during a project investigation—at the beginning, middle, and end. Critical thinking occurs during sorting and comparing of ideas during these discussions.

In Phase 2, students divide up into smaller study teams. Each team reports to the class in a large group meeting its observations and discoveries. This approach gives the investigators authentic opportunities to clarify their findings and speak before the group. It also gives the rest of the group the chance to ask questions, challenge assumptions, and express their own knowledge about the topic at hand.

Hone Questioning Skills

The teacher may need to help young students distinguish between something they know and something they want to know. Although some young students can write their own questions, others may need to dictate their questions to a teacher. Teachers should keep a list of all of the students' questions throughout the project and encourage students to make predictions about the answers to their questions before pursuing the answers. In this way, teachers can note misconceptions and areas for growth. Predicting what the answer might be is another opportunity for critical thinking in project work. Teachers have to set the stage for valuing the process and not the right answer so students are willing to take that risk when predicting. Langer (1997) said:

> If we respect students' abilities to define their own experiences, to generate their own hypotheses, and to discover new ways of categorizing the world, we might not be so quick to evaluate the adequacy of their answers. We might, instead, begin listening to their questions. Out of the questions of students come some of the most creative ideas and discoveries. (p. 135)

Students find out answers to their questions by collecting data through firsthand fieldwork. Students observe, draw, and describe what they see. Student data collection includes asking the opinions of others and developing questionnaires. They tally, count, graph, and chart their findings. They also could experiment and interview experts. Answering questions leads to formulating more questions.

Create Contexts for Experimentation and Representation

For young children, a project topic must be chosen that provides opportunities for hands-on inquiry experiences. Investigation and fieldwork are also key features of project work. Teachers must design and create the contexts for students to pursue data gathering. Here is an example of how the teacher takes the lead in suggesting that students may want to experiment to find out their answers. The students report their experiences upon their return from a nearby pond:

> *Konan:* I dropped 3 apples in the pond. 2 apples floated and 1 sank.
>
> *Teacher:* That's interesting. I wonder why.
>
> *Jeff:* A small apple is going to have less weight. It isn't as big so it would sink, and a big one has more place for the water to hold it up.
>
> *Teacher:* You may want to try to do an experiment in our classroom with water and try things to see if we can duplicate Konan's experiment and come up with a theory of why things float and sink.

The discussion continued with children sharing their theories of why one apple sank. Notice how the teacher again suggested students test their hypotheses by doing experiments, and a student modeled that behavior by suggesting another experiment:

> *Arnav:* Maybe the heavier the thing, the lighter... No. If the thing has much air, then it stays up. The thing that doesn't have air stays down.
>
> *Peter:* Deer like to eat apples. Maybe the deer took a bite out of the apple—a really small bite—and then the deer didn't like the apple and just left it. It was a really small bite, and Konan didn't notice it. And the bite filled up with water and sank.
>
> *Konan:* I didn't see any bites.
>
> *Teacher:* So we'll need to experiment with apples with and without holes.

Deren: You could do another experiment with apples the same size.

Throughout the project, the teacher focuses on how students approach and solve problems. Teachers should not emphasize whether students have right or wrong answers. This explicit interest in experimentation and problem solving empowers students to be young scientific investigators. Whole group discussions of students' experiments most always motivate other students to conduct more and varied experiments. The following example illustrates students sharing their findings about their shadow exploration:

Kay: Mine is short.

Teacher: Why do you think it's short?

Kay: Because I shone the flashlight on top of my person.

Amy: Hers is short because the light is far away.

Andrea: I think her shadow is short because the person she made is short.

Teacher: Sandy, do you have any explanation for why yours is a long shadow?

Sandy: I think the shadow is off the paper because the person I made is tall.

This conversation was documented, transcribed, and shared with the children to rethink or reaffirm their respective positions. After more opportunities for shadow observation, the conditions needed for a long shadow were again discussed.

Kay: The conditions needed for a long shadow are the light has to be far away.

Kathy: I agree, the sun is very far away from us.

John: I disagree.

The teacher brought a flashlight to the group and tested their theories. She asked, "What do you notice when the light is far above the model person?" Teachers should gently guide students' experiments by asking them to predict and hypothesize, getting them appropriate materials, and teaching them how to represent their findings and conclusions. Giving students time to design and build representations is another way to provide depth in project investigations.

Representation is also a key feature of project work. Students express their ways of knowing through representations. Representation may be explorative, integrative, emergent, creative, or playful for the students. Most always, creating representations are endeavors of problem solving. Students' favorite materials to build are "boxes and junk."

Teachers may enhance students' representations with digital photography so students can go back and look closely at what they are trying to reproduce or re-create. Students engage in higher-level thinking skills as they represent what they see. They evaluate materials, determine size relationships, design solutions to their problems, and demonstrate their understandings through their final product. Eisner (1997) said, "In short, the processes of thinking are engaged in the process of making, and the process of making requires the ability to see what is going on in order to make it better" (p. 350).

Students should be encouraged to make representations in all phases of project work. They may represent their memories, what they see in their fieldwork, and, finally, what they have come to understand.

Use the Language of Thinking

The teachers' role is to provide contexts for intellectual engagement. Teachers may model language of thinking by using vocabulary such as the following:

I wonder

What if

I predict

My theory is

My hypothesis is

Tishman and Perkins (1997) labeled three categories of language related to thinking: claim to knowledge, intellectual process, and kinds of ideas. The words associated with each are represented in the table below.

Claim to Knowledge	conjecture, conclude, believe, confirm, doubt,

	know, suggest, speculate, suspect, and theorize
Intellectual Process	analyze, contemplate, discern, interpret, investigate, ponder, examine, and recollect
Kinds of Ideas or Outcomes	conclusion, hypothesis, option, solution, reason, claim, and theory

Teachers may find these terms helpful as they model and encourage students to use them. Tishman and Perkins (1997) explained how using the language of thinking engages students in critical thinking:

> Frequent exposure to the language of argumentation, such terms as premise, reason, conclusion, evidence, theory, and hypothesis, draws learners into the values and commitments of critical analysis.... Using the language of thinking in the classroom helps develop learners' sensitivity to occasions for engaging in high-level thinking. Terms like claim, option, opinion, guess, and doubt alert learners to opportunities to do such things as probe an assumption, seek evidence, identify reasons, or look at a problem from a new point of view. (p. 372)

Throughout project work, teachers have the opportunity to engage students in the language of thinking. When they ask students to brainstorm their ideas, ponder new solutions, suggest new theories, make predictions, and examine their data, they are integrating the language of thinking into their daily routines. They are making students aware of how much thinking they are really doing!

Tishman and Perkins (1997) assert:

> When thinking-rich language pervades a learning environment—when it sees regular use by teachers and learners... it provides not only information but also an invitation to embrace and cultivate certain habits of the mind. (p. 372)

Conclusion

To facilitate learning and to deepen the inquiry of project investigations, teachers must make decisions about concepts that are valuable and appropriate to teach. They must become informed about the topic by gathering resources, talking to experts, and collaborating with others to seek ideas for creating the contexts students need to pursue their questions. They must provide opportunities for students to revisit their ideas and assumptions and develop activities to assess and reassess students' knowledge, skills, and dispositions. Teachers guide students to re-create and reflect upon their experiences, and help students to find meaningful ways to represent what they have learned. Teaching strategies that enhance the depth of inquiry include modeling curiosity, promoting discussion, honing students' questioning skills, creating contexts for experimentation and representation, and using the language of thinking. Teachers who want to deepen project work learn to probe, provoke, guide, provide, and assist students all along the way.

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