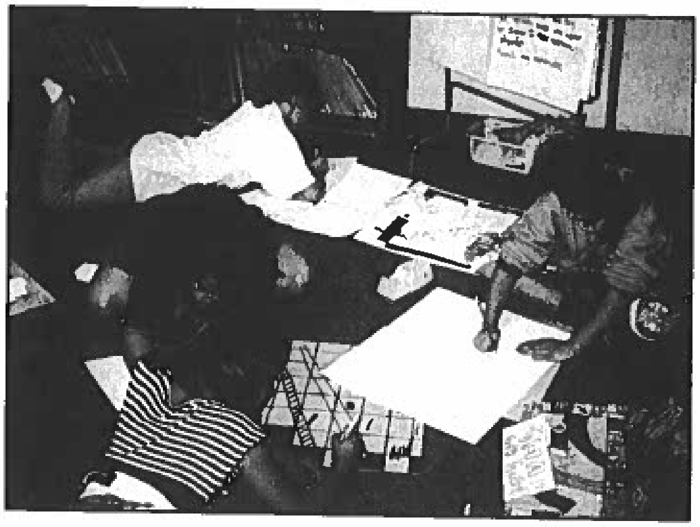
Seal Revenge

Ecology Games Invented by Children

Elaine Surbeck and Mary Kenner Glover



In a recent article, Kathryn Castle (1990) described the value of children's invented games as a means to promote reasoning. She explained how key components of a constructivist theory are implemented as children invent, create, cooperate, problem-solve, confront conflicting ideas and devise rules for games. Certain of the rich potential for children's inquiry, we used invented games as part of a classroom study on ecology. What follows is an account of classroom events as well as what we learned from observing the process of inventing games.

Eight-year-old Robert leans into his work with great concentration. On the table before him, in addition to the game board he is creating, are his books about seals and the notes he has taken of important facts he wants to incorporate. He sketches a first draft of his board game "Seal Revenge," a game designed to raise awareness of the mistreatment of seals. He begins to fill in the spaces with messages such as "Save a Seal/Go Again" and "Kill a Seal/Go to Jail."

Nearby, Bryce and Jacob are adding the finishing touches to their board game "Underwater Adventure." They have constructed their game to teach classmates and others what they have learned about whales during the class study of the environment. They discuss how to make the tiny krill (primary food source for many whales) necessary for playing the game. Sitting at the table together, they talk about several options. Robert suggests that they just make tiny lines on small pieces of paper for the krill. Bryce mentions something about squid being the favorite food of the sperm whale in addition to krill. They take Robert's suggestion and make orange marks on small pieces of paper. The discussion moves on to other aspects of the game. Later, as they share their progress with the class during one of the daily debriefing sessions, Shannon says, "I think you need an odd number of krill cards if you don't want it to end up being a tie." Nicholas agrees that they might tie if it were an even number. Shannon adds, "Now if you don't want a certain person to win, you could have an even number." Aaron suggests that they use a whale to mark the winner's spot. Bryce mentions that they are planning to include pictures of different whales for game pieces and on the blank spaces of the board.

Weeks later when the games are finished, we play Bryce and Jacob's game. The simplicity and clarity with which they have constructed "Underwater Adventure" is impressive. Their tiny krill add a nice touch, and their game board is easy to read. It has a single pathway around the perimeter of the game board with spaces that have messages such as: "You get all your opponents' krill" and "Go to jail,

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you killed a whale." The object is to get to the finish with the most krill. Along the way when players draw cards, they have opportunities to answer specific questions about whales. There is also a bonus question: "What do whales eat?" Answer: "KRILL." If you answer that one right, you get to move three extra spaces. The well-thought-out, easy-to-follow game is a true celebration of our environmental study.

Before the Games Began

Bryce and Jacob's game, along with Robert's and those of their classmates, was the culmination of a lengthy study of ecology by their 2nd/3rd-grade class. Initially planned to help raise awareness of environmental issues, the study began early in the school year by collecting all of the garbage from the children's lunches for a week. Trash was categorized as recyclable, nonrecyclable and questionable. The students then graphed the items on a large piece of paper that was hung in the school hallway with a brief paragraph written by the class about using recyclable containers.

When the topic of natural resources was discussed, students discovered that it takes 500,000 trees every week to make the Sunday newspapers in America. They helped assemble a gigantic wall graph of that many tiny green squares. It made sense that a more systematic approach to the study of the environment should take place, so the class made a web of their current knowledge (Figure 1). Since the subject was quite broad, children worked in teams to research specific areas and report to the class. The games evolved out of this individual research. Children received the idea of making a game to represent their knowledge with overwhelming enthusiasm.

One of the first steps we took was to plan how to proceed. Together, the class came up with the following procedure:

- Research—get information, collect facts
- Make a rough draft
- Make the game board and cards
- Write the rules
- Name your game
- Test your game

The children gathered books and other resources. An immediate challenge was to find books with sufficient information written at the children's level. Although many teams had at least one strong reader, it was often hard for them to find what they needed. This took time and patience, along with some whole group reading, individual reading with an adult and some additional research at home. As the children gathered their information, they wrote notes in their daybooks. Once they arrived at the stage where they were designing their

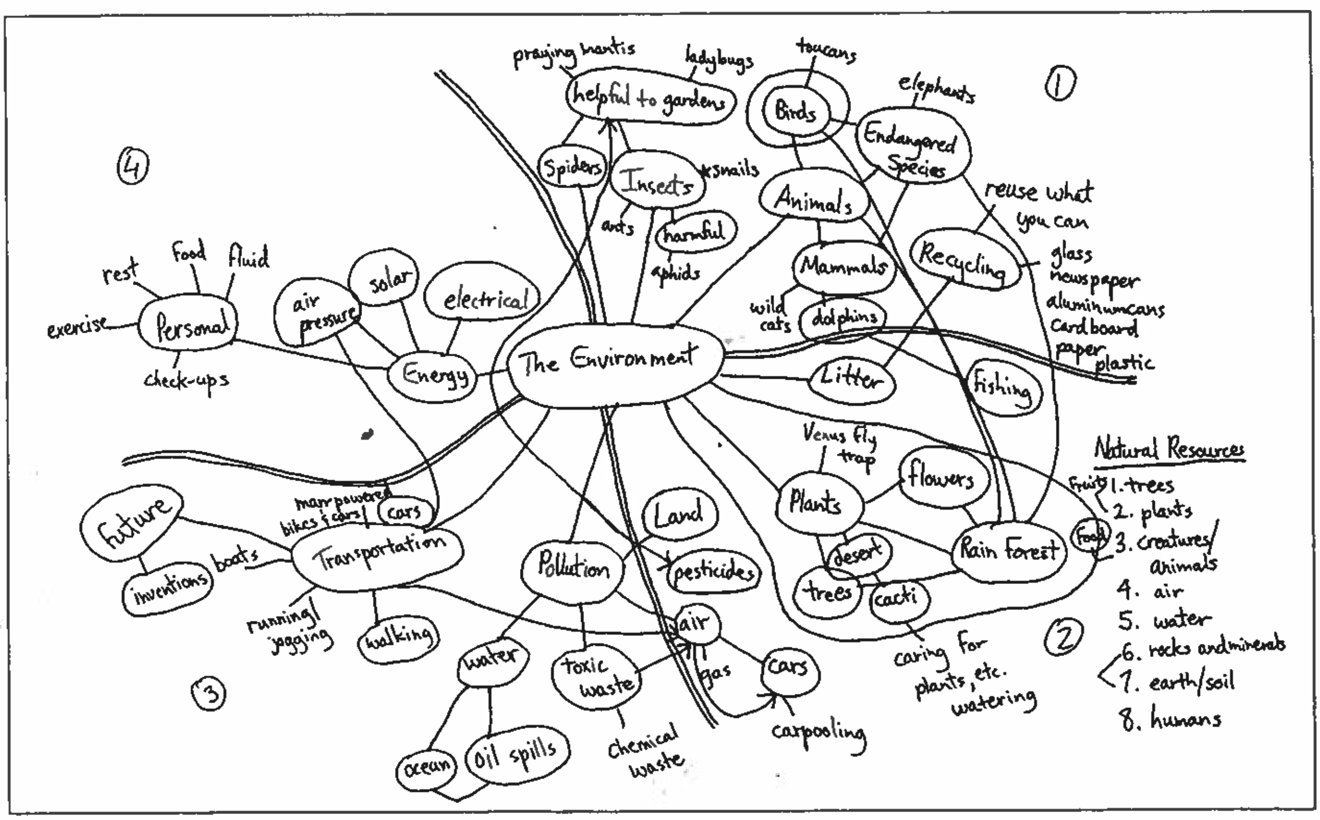


Figure 1

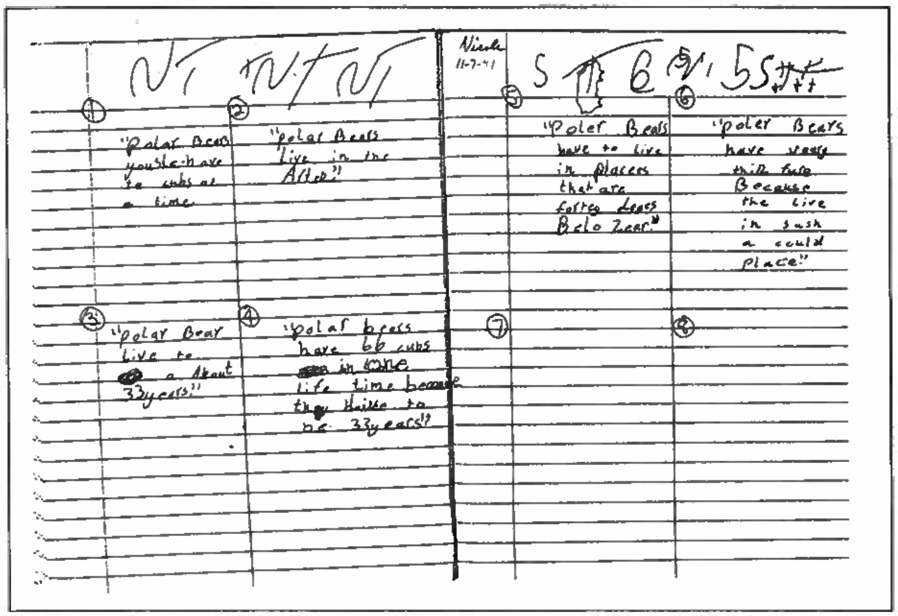


Figure 2

game cards, some of the children organized information in sections for each card (Figure 2). Some unexpected learning and conversations surfaced during this research phase.

Nicole and Libby, for example, reported that polar bears can have 1,000 babies in a lifetime. We pursued this further and discovered that polar bears actually only live to be 33 years old and usually have twin cubs each year. We decided to make it into a math problem for the whole class. After we learned that the most cubs a polar bear could have would be 66, we tried other problems. How many years would it take for a polar bear to have 1,000 cubs? If they had four cubs a year instead of two, how many years would it take to make 1,000? Although these problems were beyond many children in the class, some of them stayed with it until we calculated that it would take 250 years. When we were all finished Aaron announced, "I think we've outdone ourselves for one day!"

Another time Laura and Michael were telling us about elephants, and the issue was raised whether or not all elephants have tusks or just the males. Jeff got all excited and said, "It's true! In that *Babar* story, the mother got killed for her tusks!" It was suggested to Laura that she call the Phoenix Zoo to ask if all elephants indeed have tusks. She agreed it would be a good idea.

Although rich with possibilities, the game-making was not without problems. Some of the children had difficulty staying focused and transferring their information to the game format. Although Steffen had a good start on his game, he hadn't included anything about rainforests except for the trees on the board. He needed help organizing his information into squares and using the question-and-answer form. He had obviously been applying his mathematical thinking to his game's design, however, when he commented, "I decided to use only one dice because if I used two then nobody would ever land on the first square!" Michele struggled with the more abstract concepts related to air pollution. After making a list of things we do that are good and bad for the air, she began making sense of the information and applying it to her game. Witnessing the children struggle with these challenges and helping them find solutions added to the value of the game-making.

One day Shannon asked for ideas about how to get a lot of information on a small space. An accordian-type piece of paper attached to the space was suggested. Robert came over and advised her to use brass paper fasteners. She initially rejected these ideas, but later she and Stefanie used both ideas. Then Shannon approached Mary (her teacher) again and said, "I only had them learn three things. Is that a problem?" Mary suggested that she might want to incorporate some of the water conservation ideas she had read about into her game board, such as "You leave water running while brushing your teeth. Lose a turn." She liked that idea and walked back over to where Liz was working. Shannon said, "Mary has great ideas!" Liz replied, "Well, she went to college!"

Although many of the games were still in the rough draft stage, the children were encouraged to test them by playing with a partner. Some of the children just wanted to keep making accessories for their games (game pieces, props, traps, etc.) but found it enlightening when they actually did play their games. In the middle of the first run-through, Robert asked loudly, "But what if you want to make a change while you're playing the game?" As soon as he asked the question, he realized that this was exactly the point of testing the games!

At this stage the games began to take on a life of their own. Children included both informational and entertaining details. Nicole and Libby made money for their game about polar bears and wrote "The United States of

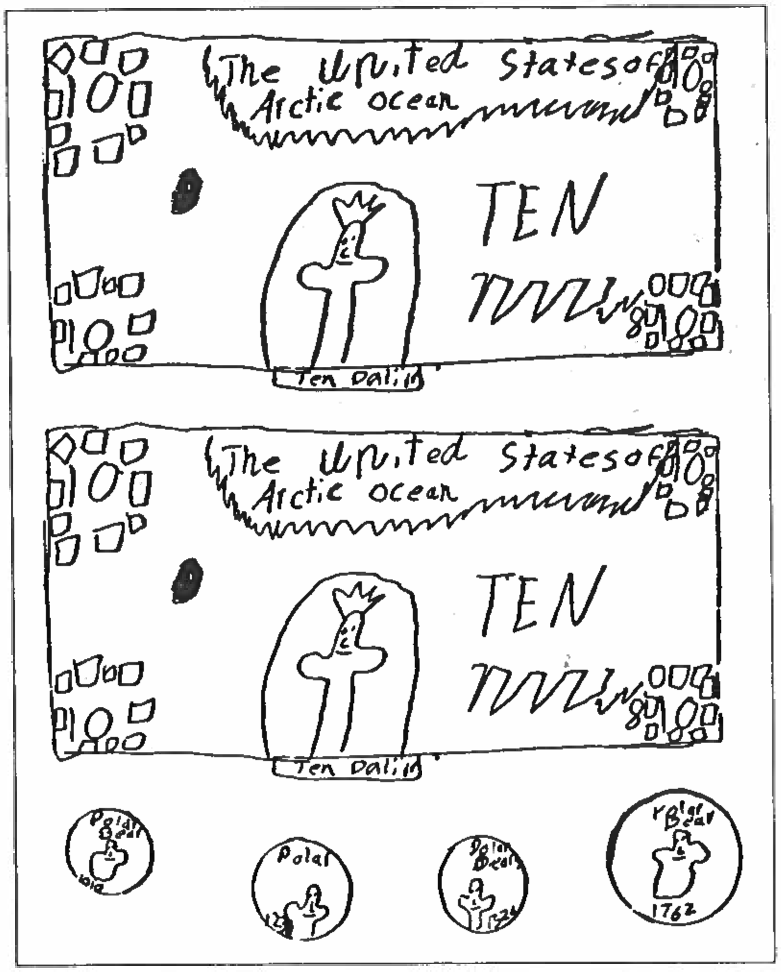
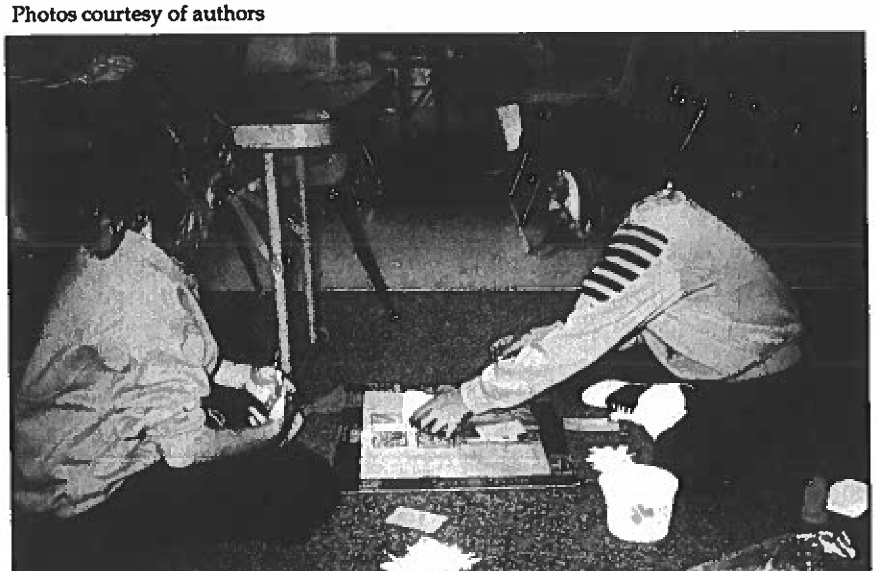


Figure 3

Photos courtesy of authors



Partners test ecological games developed by the students after extensive team research.

Arctic Ocean" on their bills. They also drew polar bears on their coins (Figure 3). Richard and Jeff incorporated the use of a VISA card in their game about trees. The point of the game was to buy up the rain forest in order to preserve it. On most spaces players had to pay cash, but if they landed on a special space they could use their VISA card to buy the whole rain forest. Deanna's "Rain Forest Information Game," visually one of the most impressive, had an interesting twist to it. She used four small markers per person and called them their "lives." If you landed on a space that said, "Lose your life," you got another chance. If you used up all your lives, then you lost the game. She also arranged it so that you would start with your new life where you lost your last one.

Aaron's "Crazy Volcano" was one of the most complex games. As he was putting the final touches on his game, he said, "I think my game could be turned into a real professional players' game." In the same breath he added, "I've finally memorized how to spell *erupting*." His game was played by rolling dice and moving markers of different sizes and values around the board. The idea was to reach the finish line without falling into various traps such as mud slides or lava flows. Survival cards provided help to players who had to answer question cards in order to advance (e.g., How big was the Mt. St. Helen's eruption? A: Half of the mountain; What is the biggest volcano in the solar system? A: Olympus Mons on Mars).

In Aaron's game, players could accumulate crystals worth points. It didn't appear, however, that anyone was piling anything up or writing anything down to keep track of how many crystals each had. When Aaron was asked about this, his immediate reply was, "It's a concentration game. You have to keep track of how many in your head. If you lose track, you lose the game." Later Aaron added, "These games have three things: math, teaching and fun!" Although nebulous at times, Aaron's game had rules (Figure 4). The children easily tolerated ambiguity in each other's games. It was a different story, however, when they played them with others outside of our class, especially their parents. After playing his game at home with his mother and receiving her feedback, Aaron decided he probably needed to write an instructional manual to go with "Crazy Volcano."

The evaluation forms sent home to parents provided feedback about the strengths of the games as well as suggestions for revision. They included comments such as:

- "We played long enough that we had to use quiz cards over. The designer may [decide to] create more quiz cards."
- "We decided it would be helpful to have a list of rules to read before starting the game."
- "I think having to make one's own table game is a terrific idea. I can see where it is a confidence builder, as well as fun for a student. Problem-solving is an effective tool that exercises different processes of the brain. Children have to break down and organize their thoughts (plan) and then create (put it all together)."

In addition to parents, we invited the 3rd- and 4th-graders to play and evaluate the games. Jessica's response to Shannon's game was typical (Figure 5).

Although most children didn't revise their games based on others' comments, they stored the information away for future use. When asked what he learned by making a game, Jacob said, "At first when you think you're done and when you play the game, there are some changes that have to be added." Jeff said, "At first I thought it was finished, but when the people played and asked me questions, I felt like the game needed more to it." He added that he had plans to make another game, "a sort of tic-tac-toe but you learn not to cut trees down and to recycle."

Contemplating this project after its culmination, we realized that the games had indeed provided for rich learning experiences, both for the children and for us.

What We Learned

As is often the case, children are capable of coming to content understanding with a broader perspective than we sometimes assume, though this is not true for every learner. Piaget suggested that games with rules encourage both sociomoral and intellectual growth in children (1932/1965, 1945/1951). We found that children varied con-

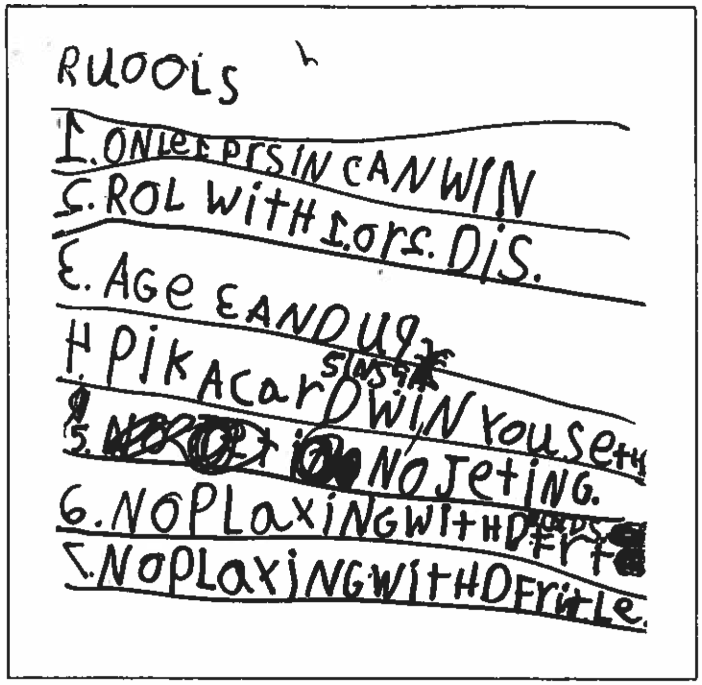

RUOOLS
1. ONLE PRSIN CAN WIN
2. ROL WITH 1 ORS. DIS.
3. AGE 3 AND UP
4 PIK A CARD WIN YOU SETH SINS
5. NO JETING.
6. NO PLAXING WITH DFRT CARDS
7. NO PLAXING WITH DFRitLe.

Figure 4

Rules: 1. Only one person can win; 2. Roll with 1 or 2 dice; 3. Age 3 and up; 4. Pick a card when you see these signs; 5. No cheating; 6. No playing with different cards; 7. No playing with different rules.

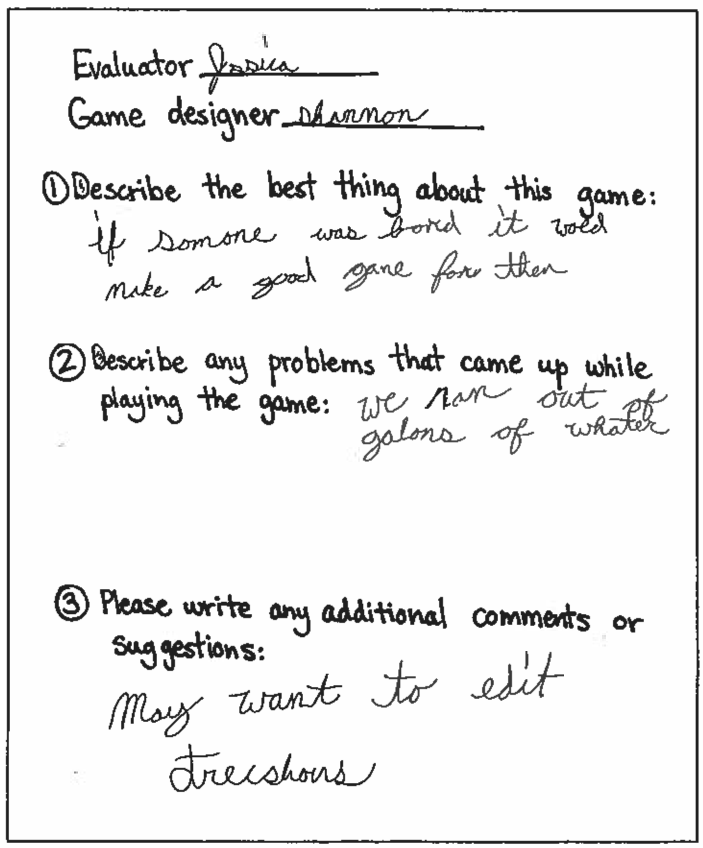

Evaluator Jessica
Game designer Shannon
1 Describe the best thing about this game: if somone was bord it wold make a good game for them
2 Describe any problems that came up while playing the game: we ran out of galons of whater
3 Please write any additional comments or suggestions: May want to edit drecshons

Figure 5

siderably in their mental and emotional responses to the environmental content and to the games. Although the majority of the class had some knowledge about ecological content and issues, a few children found this information new and challenging. Learning about ecology presented some of the following issues:

■ *Level of abstraction.* Some concepts encountered were too intangible for a few children to comprehend at more than an intuitive level. When interest lagged, this was frequently the cause. When Michele was struggling to make her game about air pollution, for example, she could not move forward on her game until the subject was broken into things we do every day that affect the air. For such children, guidance in choosing a concrete topic for the invented game was beneficial. Ways to make ecology familiar and relevant to all learners present challenges for teachers wishing to reach a broad range of students even within a single grade level.

■ *Presentation of factual information.* In the course of the study, there were times when discussions became frightening to sensitive children. During a class discussion of the ozone layer's deterioration, for instance, Aaron provided vivid details of the crisis and added, "I can tell you that if our atmosphere deteriorates, we're going to have a really hot time!" The graphic picture he painted upset some children. While honest and authentic depictions of the impact of natural events or human actions are important in understanding the concept of interrelatedness, such information needs to be shared with a sense of hopefulness and sensitivity. Children need to know they can be a part of improving our environment. Empowering children to have a voice in environmental discussions and to know ways to save the environment perhaps was the most crucial outcome of our ecology study.

■ *Importance of this content for study at school.* Lillian Katz (1989) made the point that not all content is equally appropriate for study at school. Teddy bears, for example, do not warrant a month-long classroom study. In contrast, ecology seems to be especially suitable for investigation in classrooms. One reason for studying this at school is that it promotes more sound ecological practices for both children and parents. In other words, it cultivates children's dispositions to conserve or recycle.

During the time the children studied ecology, trash at both home and school decreased, while use of recyclable materials increased. More children began bringing lunch items in reusable containers rather than foil or plastic wrap. One parent ordered large quantities of paper sandwich bags as an alternative to plastic. When social reinforcement for recycling is strong and positive, it increases children's likelihood of continuing the habit. In the case of reducing trash or recycling cans, the impact of a collective effort becomes clear to the participants. The challenge to reduce the amount of trash generated in the children's classroom every day, for example, resulted in such a significant decrease that one of the custodians commented on the change and even wrote notes on the chalkboard to the class. A further outcome was a schoolwide effort to reduce trash.

■ *Potential for sustained interest.* One of the most visible results of using invented games to study ecology was the children's warm delight in the learning process. The games and increased information were a source of pride, and student-sustained interest in the topics provided connections to other areas of information. Months after the study was completed, Jeff and Nicholas were organizing a collection of science books to be written by classroom authors about trees, rocks, seals, whales and a variety of other topics that came directly from the ecology study. As Duckworth (1972) observed:

> ... intelligence cannot develop without content. Making new connections depends on knowing enough about something in the first place to be able to think of other things to do, of other questions to ask, which demand the more complex connections in order to make sense of it all. The more ideas a person already has at his disposal, the more new ideas occur, and the more he can coordinate to build up still more complicated schemes. (p. 231)

While the content that children gleaned was itself impressive, the richest opportunities for learning occurred because the content was incorporated into the process of inventing. According to Chaillé and Britain (1991) "Real science (or true scientific inquiry) incorporates many things to which young children are most particularly open: creative thinking and problem solving, experimentation and invention" (p. 18). We certainly found this to be true as we observed children successfully integrating knowledge from multiple content areas. In the process of constructing a board game, children used multiple concepts and skills (Figure 6).

Concepts and Skills Used in Constructing a Board Game

likenesses/differences	probability (chance of landing on card space)
writing/reading directions	sorting and classifying
odd/even numbers	conservation (of trees)
sequencing	quantitative comparisons
number ordering	money notation ($500.00/ $5,000.00)
rules	money concepts (cash vs. credit)
taking turns	moral/ecological responsibility (saving water)
matching numbers (rolling exact numbers)	multiplication
problem setting and solving	mental arithmetic
place value	adding
revision	identifying coins
counting	memory
making predictions	one-to-one correspondence
light/dark shades of color	
spatial relationships	
length (size of krill)	

Figure 6

As we reflected on the process of inventing games, we realized the possibilities for assessment by both teachers and children. Game invention offers classroom teachers a way to document how children appear to be thinking by observing what they do as they create their games. Children typically are enthusiastic about inventing games, and they often choose to create additional games. This provides the teacher further opportunities to gain insight about their growth in reasoning over time. That children are frequently intrigued with this task perhaps attests to their desire to seek meaning and to further their thinking.

As the children looked back on their experience of game-making, they were able to assess the successes of their games as well as aspects that might need additional attention. They could also see possibilities for future games. Inventing and playing board games, combined with this ecology study, gave the children knowledge and a sense of power that felt almost tangible. Deanna confirmed the power of this learning experience when she said, "The game I made up about the rainforest was the best thing about being in Mary's class so far." Libby summarized it for all of us when she wrote, "When I was done, I felt like the best kid in the world." When children have this kind of confidence in their ability to create, solve problems and negotiate with other people, it prepares them for life in the present—as well as the future.

References

Castle, K. (1990). Children's invented games. *Childhood Education, 67,* 82-85.

Chaillé, C., & Britain, L. (1991). *The young child as scientist: A constructivist approach to early childhood education.* New York: HarperCollins.

Duckworth, E. (1972). The having of wonderful ideas. *Harvard Educational Review, 42,* 217-231.

Katz, L. (1989, July). *The project approach.* Keynote address, presented at K-3 Teacher's Academy, Arizona State University, Tempe, Arizona.

Piaget, J. (1951). *Play, dreams and imitation.* New York: Norton. (Original work published 1945)

Piaget, J. (1965). *The moral judgment of the child.* New York: Free Press. (Original work published 1932)