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An early childhood study of the water cycle

Jolynne Taylor Miner

University of Nevada, Las Vegas

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An early childhood study of the water cycle

Miner, Jolynne Taylor, M.S.
University of Nevada, Las Vegas, 1992

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AN EARLY CHILDHOOD STUDY

OF THE WATER CYCLE

by

Jolynne T. Miner

A thesis submitted in partial fulfillment
of the requirements for the degree of

Master of Science

in

Instructional and Curricular Studies

Elementary Education
University of Nevada, Las Vegas
December 1992
Approval Page

The Thesis of Jolynne T. Miner for the degree of Master of Science in Instructional and Curricular Studies.

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Abstract
Young children's understanding of the water cycle was investigated. Sixty children were individually interviewed using the "Survey of Understanding of the Water Cycle." The answers were then scored according to a scale of Four Levels of Understanding. A t-test and chi-square test were run. Answers were carefully examined to determine how much young children understand about the water cycle, to see what misconceptions they have about the water cycle, and to compare children's understanding of the water cycle between those children who live in a desert region and those children who live in a mountainous region. The results indicate that nearly half of the children are completely confused about the water cycle, according to my operational definition. Further explanations of their understanding are given. Other misconceptions are also found among the children. However, the findings support the hypothesis is that the children who live in the mountains better understand the water cycle than young children who live in the desert.
Acknowledgements

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CHAPTER 1 -- INTRODUCTION

An Early Childhood Study of the Water Cycle

A young child plays outside in puddles. The sun comes out and by late afternoon the puddles have disappeared. What happened to the puddles? When questioned, the five-year-old may say that the puddles "got lost" (Bar, 1989, p. 482). In his mind, the child's answer fits in perfectly with his conceptual network. To him, the answer is sensible, logical, and coherent (Gilbert, Osborne, & Fensham, 1982). Yet, what does a child really understand about the water cycle? How early does this knowledge begin to surface? What misconceptions might a child have and why? To what extent does the environment or region where a child lives affect his or her understanding of the water cycle?

Statement of the Problem

The purpose of this study is: (a) to determine how much 3-5 year olds understand about the water cycle (b) to see what misconceptions they have about the water cycle and (c) to learn how children's understanding of the water cycle differ between those children who live in a desert region and those children who live in a mountainous region.

Definition of Terms

To understand this study a prerequisite understanding of the term water cycle is necessary. The water cycle is understood as a series of steps: water evaporates from the
ocean, river and other water sources; "when the barometric low prevails this water vapor rises, cools and condenses into little crystals of ice and small droplets of water; these droplets increase in number, become heavy and fall down as rain; rain water flows back to the sea, sinks into the ground, becomes ground flow, or re-evaporates" (Bar, 1989, p. 481).

**Justification for Research**

This study will research the very young children from age 3-5 years old and investigate the research problems identified in the purpose paragraph above. This study is unique in the fact that it will not only be examining the understanding of very young children, but also be comparing their understanding from two different regions: a desert region and a mountainous region in the United States.

The research problems and study have been selected because they are of importance to science educators and other teachers of young children. Educators need to learn how children think and how they perceive the things around them, especially natural phenomena. Once educators know how children perceive things, then they can help children clarify and summarize what they already know.

Children have formed this understanding or knowledge by taking experiences with people and objects and constructing their own theories or views (Genishi, 1988). This early
understanding of their world should be the foundation on which educators can build more complex schema and networks of knowledge that connect with the foundation that is already in the child's mind (Pitcher, 1971). The children's naive views must be discovered and taken into consideration when planning lesson plans for the year and developing curriculum in terms of scope and sequence. Children's views should also be the foundation or starting point for teaching science (Driver & Easley, 1978; Osborne & Wittrock, 1985).

Textbook writers can also be assisted as they see how varied backgrounds and environments (desert, mountainous, or other) influence the understanding of the children. They can plan and adapt their books to compensate for varied environments, climates or backgrounds. Therefore, how children perceive and understand the environment and natural phenomena are important things for educators to consider (Za'rour, 1976).

**Literature Review**

In this section, we will discuss two ways children develop ideas about the water cycle and other phenomena. The first way is self-initiated learning that is acquired through natural stages, play experiences, and environmental experiences. The second way is teacher-guided learning. Then, we will examine studies that measure these ideas or understanding of the water cycle.
Self-Initiated Learning

Self-initiated learning refers to learning where the child is the facilitator of his own learning. The child may pass through various natural stages of understanding, as he plays and experiences his environment.

Natural Stages. Piaget (1951) has studied young children's understanding of rain, clouds, and other natural phenomena. He suggests that a child will naturally pass through three stages in his understanding of rain. First, a child believes that "the clouds and rain are independent" (Piaget, 1951, p.319). He may believe that God or people are the source of the clouds and rain. Second, a child holds the belief that the "clouds foretell rain" (Piaget, 1951, p.319). He may believe that the clouds are smoke containing no water. Somehow a separate entity, not the clouds, produce the rain. Third, a child believes that the "rain comes from the clouds" (Piaget, 1951, p.319). The clouds are filled with water and the water comes out.

Play Experiences. Gale (1985) states that play is the primary medium through which children learn. He feels that through a variety of materials and science-oriented play equipment, children will discover scientific concepts for themselves. Gale feels that once science concepts are experienced, they can be verbalized and solidified with the
help of the teacher. Some guided more systematic learning can occur at age 4 or 5 years old, but Gale believes that play and discovery are the main sources of knowledge and understanding for a young child (Gale, 1985).

Assuming Gale's notion is correct, children would also learn about rain, evaporation, condensation and other water concepts through play. This idea poses an interesting question. Would then children's play or lack of play with water in nature influence a child's understanding about the water cycle (i.e., desert region verses mountainous region)?

**Environmental Experiences.** Other experts believe that the environment around the child is the crucial element for a young child to understand and to learn. Children must explore their environment with their senses to truly understand their world (Jones & Shafer, 1987; Lloyd & Contreras, 1987; McIntyre, 1983; Monroe, 1990; Tephly, 1989). The Australians are also proponents of this environmental learning labeling it, "learning from the inside out" (Lloyd & Contreras, 1987, p.30).

Bruner (1970) believes that children need a rich surrounding. They need to have a rich variety of social and nonsocial experiences in which to interact. To learn children must go on their own and explore; but children need support in their activation. They need to know there is help
if they need it. "Our interventions must enable children to become richer in their intentions not in their environmental possessions (Bruner, 1970, p.115).

Young children need to "explore and test their environment" (Jones & Shafer, 1987, p.32). McIntyre describes the experiences of a young child in a rich environment similar to one that a child in a mountainous region would explore. The child would be observing water running off the slide, catching water, making patterns in water, seeing their reflection in water, jumping in water, listening to water, examining shrubs for water droplets, noticing insects and bugs in water, etc. (McIntyre, 1983).

Without the rich environment that these experts speak of with frequent water cycle experiences, how can a child in the desert environment manipulate, observe, "test, and explore" (Jones & Shafer, 1987, p.32) the water cycle?

Carmichael also emphasizes how important integration of science learning is to the child's daily experiences (Carmichael, 1982). "As a child watches, wonders, studies, and questions, he is experiencing science as a part of everyday living. He begins to understand the orderliness of the universe" (Carmichael, 1982, p.1). Through play, the environment, and passing naturally through stages, a child will initiate his own learning and understanding his world and the water cycle.
Teacher-Assisted Learning

Blank Slate Approach. Some theorists approach children as blank slates with the teachers being the dispensers of all knowledge. They assume that when the children come into school, they know nothing. It is the teacher's responsibility to fill the child's mind with teacher's science (Gilbert, Osborne, & Fensham, 1982). In this viewpoint, the children know nothing about science until they come to school. Unfortunately, many curriculum developers hold to this view.

Learning Replacement Approach. Other theorists believe that children may know a little about science before school, but this previous knowledge can be easily erased and changed once they are influenced by a teacher. This "teacher dominance" idea has also been proven to be only partially correct. Children may hold to their own science ideas and let a teacher's ideas coexist in their minds. Other children may completely reject any new scientific ideas and hold to their own unaltered ideas. Children in their teens may still hold to inaccurate scientific notions that they have formed (Gilbert, Osborne, & Fensham, 1982).

Process-Oriented Approach. One theorist, Althouse (1988), holds to the view that young children are taught how to learn and understand through the process-oriented teaching approach. In this approach children make
discoveries and become actively involved in their own learning. Through action with objects and first-hand experiences, children learn and understand their world. Teachers are to encourage independent thinkers and provide the environment without interfering to impart knowledge. Through this process-oriented approach, children are motivated to find out for themselves why things happen in the environment. The child should be physically involved using hands-on discovery teaching techniques with things for the children to manipulate and observe (Jones & Shafer, 1987; Tephly, 1989).

**Hands-On Approach.** Similar to Althouse, Lloyd and Contreras state that the best method they have found to build conceptual knowledge and the equivalent vocabulary has come through hands-on experiences (Lloyd & Contreras, 1987). These hands-on experiences are so highly recommended for young children that one is left wondering how children in different climates and environmental circumstances can find out about rain, snow, and the water cycle if they rarely see such natural phenomena occurring.

Would lesson demonstrations and nature centers suffice when the hands-on experiences are so limited? What misconceptions might children have who live in the desert compared to children who live in the mountains? Would there be a difference?
Is there a replacement for the actual experience of rain outdoors? Can the classroom adequately create the feelings and sensations of dark clouds, roaring thunder, flashing lightning, gentle or pounding rains, or the fresh washed smell that always follows the storm? Can the classroom have the visual, auditory, and sensual impact that the real environment can present? Can a simulated "cloud" in the classroom or water vapor on a jar create the understanding about the water cycle that real life experiences provide? (Althouse, 1988).

Misconception Creation. Smith (1984) believes that lesson demonstrations in the classroom are far too cognitively difficult for the child to process and therefore create many misconceptions in science and in particular the water cycle. She gives excellent examples of how confusing not only the classroom lectures and demonstrations can be, but also how confusing some of the experiences of rain, thunder, lightning and water can be.

She tells of typical experiments for the water cycle like the pan of boiling water with a pan of ice on top to create water vapor "collection on the underside of the pan" (Smith, 1984, p.5). How strange and confusing this must be to young children unable to draw in their mind the correct parallels to the real water cycle that was intended. Smith thinks that even nature itself can confuse the child because
it doesn't behave like the classroom demonstrations. She brings up many interesting points. Young children should not be taught through complicated experiments where they need to construct rules and transfer that to nature situations. Smith suggests working with young children in a way that evaluates their present schema, their memory capabilities, and their language understanding. Complex concept should be taught in very simplified isolated ways. Much research is still needed to find the best ways to teach young children and avoid creating misconception. (Smith, 1984).

These misconceptions that children have about science are important. It is through these misunderstandings that we are able to see the network of concepts and perceptions of children, so we can build upon their knowledge and eliminate misconceptions.

Despite the fact that experts disagree on how children learn and understand about water or other aspects of their world, a child's perception of his world should be examined and perhaps how he or she was able to arrive at such a perception.
Now that the importance of children's perceptions and misconceptions has been established, we will examine various studies that focus on a particular natural phenomena called the water cycle. We will be able to see what has been learned about children's perceptions and misconceptions about the water cycle. We will examine four studies in the following order: Lloyd & Contreras, Osborne & Cosgrove, Bar, and Za'rour.

**Study 1.** Lloyd and Contreras (1987) performed a study about the water cycle. Two groups were given different treatments to see how it affected their understanding of the water cycle. One group was given book work. The other group did hands-on experiments. The third group received no instruction at all. The results showed that the hands on group scored significantly higher than the other two groups (Lloyd & Contreras, 1987). Through this study, it is evident that greater understanding of the water cycle is obtained through hands-on experiences than in other ways.

**Study 2.** Osborne and Cosgrove (1983) have studied children's understanding of water phenomena involving water cycle processes, e.g., evaporation, condensation, and the melting of ice. They found that in-depth interviews were most effective. They used a clinical interview method known as Interview-about-Instances where the students observed
water evaporating, condensing, boiling, and melting. The
students were then asked to tell about what they saw and
were probed for deeper understanding through skilled
questioning. These students ranged from 8 to 17 years old
and were able to use scientific terminology. Yet frequently,
the students had a superficial understanding of water with
no sound basis to support the use of such scientific
terminology. Osborne and Cosgrove conclude that children
often bring strongly held views about natural phenomena to
school, which are not necessarily changed by science
lessons. They believe children should explore and observe
natural phenomena like water cycle, the weather, fish in a
frozen pond, etc. After children have had the chance to
explore, the scientific explanations can be given (Osborne &
Cosgrove, 1983).

Study 3. Varda Bar (1989) performed a study in Israel
where 300 students were interviewed to determine their views
about the water cycle. The students ranged from age 5 to 15
years old. The clinical oral interview method of Piaget was
used where actual demonstrations of the questions were shown
when possible and given orally when not. For example: The
examiner spilled water on the floor. When the floor was dry,
a question was presented, "What happened to the water and
where can it be found?" Questions relating to clouds were
presented orally, "Where do clouds come from? How do they start? What are clouds made of?"

Bar had each interview performed on a one-to-one basis. Bar used one main interviewer and an assistant. Bar demonstrates how the explanations of the water cycle fall into stages. She shows how these views are dependent on the understanding of the concepts about the phase of the water cycle. Bar creates topics of the water cycle and correlates these topics to the child's age and understanding of them. For example: "The water disappears (ages five and six). The water penetrates the floor or other solid objects (ages seven and eight)." (Bar, 1989, p.482). Then, she equates this understanding with their understanding of conservation. Bar concludes that children who do not conserve water or air (children under eight years old) give answers and explanations of the water cycle that demonstrate their lack of conservation, holding to the concrete. However, children older than eight years old combine their understanding of the water cycle with the laws of conservation to better explain evaporation, condensation, and other abstract ideas in the water cycle. (Bar, 1989).

Study 4. Za'rour (1976) was involved with a study where 220 Lebanese young school age children (age four-years old - nine-years old) were individually interviewed about natural phenomena. Rain was one of the topics.
One-half of the students noted the clouds or the sky as the cause of rain. Only 2% of the kindergarten students said that the clouds were important. Only 10% percent of first graders noted the clouds as a factor in rain. By fourth grade, about 9 years old, 38% of the students mentioned clouds being important in producing rain. The Kindergarten and first grade students, 5 and 6 year olds were the only age groups that attributed rain water to God.

Only the older grades seemed to have any idea about evaporation, condensation, and the whole water cycle. Of the third graders interviewed, 21% were aware of evaporation, condensation and the water cycle. Of the fourth graders interviewed, 25% were aware of the water cycle and its components. Confusion was prevalent among the rest of the children concerning evaporation and condensation.

Some of the children supposed a reverse process of the water cycle (rain goes down into the sea and not back up into the clouds). Other children said that it was impossible for the rain to be sea water because it wasn't salty. Then, the younger children attributed their misunderstandings to a supernatural being.

Za'rour states that it has been shown through research that 5 to 6 year olds do not "relate clouds to rain" (Za'rour, 1976, p.286). He says that most eight-nine year olds do not use descriptive words like "clouds." Za'rour
believes that the children who were able to answer about evaporation and use the scientific terminology were merely given rote responses they had heard adults use (Za'rour, 1976).

Za'rour found that children in the fourth grade and above had a much greater understanding of the basic idea of clouds and rain. At this age, they also began understanding evaporation and condensation. He pointed out that at 8 and 9 years old, a few misconceptions still exist with regards to evaporation and condensation. For example: some children still believe that water is absorbed in the floor or give a physical description of the water rather than an explanation, but over 60% attribute evaporation to the wind, sun, or drying up. However, it is at this age (8-9 years old) that children develop a clear understanding of the water cycle.

Summary of Literature Review

These studies support the theorists ideas about learning the water cycle through exploration. They show how stages in learning the water cycle could occur, i.e., correlating age to conservation or built stage upon stage. Most of all, these studies help us to see some of the conceptions children have and at what age.

Since studies and theories support actual exploration of the water cycle, what happens to the children of a desert
region who are left out on a lot of the "watching, wondering, and studying" (Carmichael, 1982, p.1) of the water cycle. Does this then mean that the children of the desert would lack in their beginning to understand the "orderliness of the universe" (Carmichael, 1982, p.1) because they lack this important everyday science living that so readily ties into their daily experiences?

It would seem that young children who grow up in a mountainous region where they experience frequent rain, mountain run-off, hail, snow, flood, and a variety of water experiences in nature would have a better understanding of the water cycle than those children in a desert region where they rarely experience rain and water experiences in nature.

It would seem that children in the mountainous regions would also have fewer misconceptions about the water cycle.

**Hypothesis**

Children (age 3 to 5 years old) who live in a western mountainous region of the United States will achieve a higher score on the "Survey of Understanding of the Water Cycle" than those children of the same age group who live in a western desert region.

**Research Questions**

1. How much do 3-5 year old children understand about the water cycle?
2. What misconceptions do they have about the water cycle?

3. How does the understanding of the water cycle differ in children from a mountainous region and children from a desert region?
CHAPTER 2 -- METHOD

Subject Selection

Subjects for this study were selected from the population of 3 to 5 year old children who attend preschool in an urban, mountainous or desert region of the United States, are of a middle economic status, and are taught by teachers with at least 3 years of experience. The population selected for generalization were young 3 to 5 year old children of a middle economic status who attend preschool in mountainous or desert region in the United States.

The sample for this study was taken from two regions of the United States. One region represented an urban, mountainous region, Central Utah (Orem/Provo area). The other region represented an urban, desert region, Southern Nevada (Las Vegas).

From each of these regions 28 subjects were randomly selected. The total number of subjects in the sample was 56 children.

<table>
<thead>
<tr>
<th>Mountainous Region</th>
<th>Desert Region</th>
</tr>
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<tbody>
<tr>
<td>Boys</td>
<td>16</td>
</tr>
<tr>
<td>Girls</td>
<td>12</td>
</tr>
<tr>
<td>Total</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>12</td>
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<td></td>
<td>28</td>
</tr>
</tbody>
</table>
Water Cycle Study

<table>
<thead>
<tr>
<th>Mountainous Region</th>
<th>Desert Region</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 years old</td>
<td>4</td>
</tr>
<tr>
<td>4 years old</td>
<td>4</td>
</tr>
<tr>
<td>5 years old</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>17</td>
</tr>
</tbody>
</table>

Randomization added to the control of this study, yet also added some unexpected age variations. Six-year-olds were not typically considered to be attending preschool, but there were two found randomly selected. At the recommendation of the examining committee, the two participants that were six-year-olds were dropped from the mountainous group and two participants from the desert group were randomly selected and dropped from the study. The original 60 subjects was thereby reduced to 56 subjects participating in this study.

**Preschool Selection**

The ten preschools selected were stratified with factors of socioeconomic status, teacher experience, and sex of participants. The preschools representing the mountainous region and the desert region were matched on the three factors listed above, so the groups representing each region were as homogeneous as possible. After each preschool was selected, the preschool randomly selected six subjects to be participants in the study.
Sampling Bias

Sampling bias was found in the relatively few numbers of racial minorities. There are very few racial minorities in Central Utah. It was difficult to find a significant number of minority students enrolled in preschool programs. Therefore, to create more homogeneous groups in the descriptive/comparative study, predominately white middle class subjects were used. As minority students randomly occurred, they were participants in the study.

Another source of sampling bias may be the fact that preschool is not mandatory. Parents who have enrolled their child in a preschool may not only have the money to do so, but also may have the interest in their child that may not be similar to the general population.

Instrument

In this section we will examine the definition of the instrument, the rationale for the instrument, the field test of the instrument, the development of the instrument and conclusions about the instrument.

Definition of the Instrument

For this study of young children's understanding of the water cycle, a one-to-one interview with each of the children was used to collect data for the study. An
interviewers' guide was developed called, "The Survey of Understanding of the Water Cycle." (See Appendix B)

This instrument was designed for this study to gather information about children's understanding of the water cycle. Responses of children from the mountainous region and responses of children from the desert region on the Survey of Understanding of the Water Cycle were scored using the Four Levels of Understanding (see Appendix C) and the Criteria for Concepts (see Appendix E) and then were compared. The interview instrument and results from the comparisons between the two regions helped to determine the extent in which the environment and region in which a child lives influences the development of understanding.

**Rationale for the Instrument**

The reasons for my choice of this instrument are:

1. The interview is most popular and most effective to elicit the understanding of children in a subject

2. In-depth interviews with children were also used in studies by Brumby, 1979; Tiberghien, 1980; Pines, Novak, Posner, & Van Kirk, 1978, to investigate the children's understanding of science.

3. The subjects are preschool age (3-5 years old) and would be unable to read or write, so an oral interview would be the most appropriate instrument.
4. Young children would need to be probed for their understanding of the water cycle and would need the kind of in-depth study that an interview would provide.

5. As Gay suggests, "With very young children, individual tests should be used, even if this requires a reduction of sample size." (Gay p.151) Interviews allow for the one-to-one attention recommended.

6. Young children need to have a person-to-person administration of the series of questions to feel comfortable, confident, and important in a new situation.

7. An interview would be flexible to the short attention span of young children.

8. Interviews provide the most accurate and honest response of self-report measures.

9. Clarification can be given during the interview to the young children who may not all have equivalent vocabulary skills. Demands on verbal skills for this age must be minimized to achieve more precise communication (Sedlak & Kurtz, 1981).

10. Rapport can be developed in an interview with the young child and explanations of the study will be provided to them.

11. An interview would provide the self-report research method that could be presented and responded to orally. Non-observable traits or constructs (i.e., anxiety, creativity,
Field Test of the Instrument

The field test was a survey of questions administered on a smaller scale to fewer individuals with fewer questions asked. The field test was a one-on-one interview with each of the six 5 year olds. The field test was performed in Nevada (See Appendix A). It helped to verified the effectiveness of the original five questions in the survey. The field test helped the interviewer realize that the children's attention span was longer than originally anticipated.

The experience of the field test helped the interviewer notice her own personal problems in interviewing and helped her to eliminate bias and errors. This field testing also helped to reveal major problems and deficiencies in the interview itself. Feedback from the students was carefully evaluated and revisions were made to the interviewing process. The data received appeared to be consistent with the targeted responses. The demonstrations and visual aids, used in the field test, seemed to confuse and put new ideas into the children's heads. Since the aim of this study was to describe the already existing knowledge
in the children's minds, the visual aids were eliminated.

The field test also helped to verify that the information collected could be analyzed with a t test and quantified. The instrument was then reexamined for additional changes before it was finally given to the targeted population.

Development of the Instrument

The instrument was developed using recommended questioning strategies by Jos Elstgeest (Harlen, 1985). It followed patterns set up by Bell, Osborne, and Tasker (Bell, Osborne, & Tasker, 1985). It used guidelines suggested by Sedlak & Kurtz in stimulating the memory by using familiar events, thus increasing the reliability and performance of the students' answers (Sedlak & Kurtz, 1981). It used some questions from the clinical oral interview method of Piaget (Bar, 1989). It was developed with considerations to the interview procedure "interview-about-events" developed by Roger Osborne where views of everyday phenomena are discussed (Osborne & Freyberg, 1985).

In developing the instrument, the survey was expanded to fifteen questions. The original five questions were used. An additional five questions probed for information the students might have about clouds, since clouds was mentioned by 50% of the children in the field test. An additional two
questions probed for additional information about precipitation, the least complicated of the concepts. Finally, three additional questions called for any extension on the children's understanding and encouraged discussion about the water cycle.

The instrument was performed on a one-to-one basis with verbal responses given from each of the subjects. The responses from the interviews were tape recorded because it was the most quick, efficient, and objective method to record the information. It took approximately 5 minutes to administer the instrument, which seemed consistent with the young children's attention span.

The visual representations were lacking in this particular instrument because it was found in the field test that the actual demonstrations of evaporation on a stove or cloud production on the stove seemed very confusing to young children. As Smith (1984) stated in her paper, too many misconceptions come about from the typical evaporation condensation experiments (See Literature Review). Due to these recommendations, the demonstrations were eliminated. As also found in the field test, the posters and illustrations of the water cycle were overly depended on by these young children who did too much pointing, especially when confusing concepts were discussed (i.e., evaporation, condensation). They seemed to think that the illustrations
were the answers. Due to dependence on the visuals, the actual instrument was designed as an oral one-on-one interview only.

Conclusions about the Instrument

The interviewer had a well-designed interview that was developed with questions that were brief and flexible, but still elicited the most honest, accurate response. Second, the interviewer had good interpersonal and communication skills. Effective communication is critical. Third, the interviewer was well-trained through participation in the field test and courses in early childhood education as well as being an experienced elementary teacher. Fourth, the interviewer spent the time necessary to gain confidence and build a rapport before the interview started. The interviewer was able to put these young subjects at ease. Often a member of the preschool staff observed the interview to aid in making the child feel comfortable. Fifth, the interviewer was sensitive to the reactions of subjects and reacted accordingly. The interviewer would pick up on the labels the children used in response to questions and proceed using their labels to help them better understand the questions. For instance, when a child would say that "big drops came out of the sky," then the interviewer would say, "What do you think these big drops are made out of?" When a child withdrew and refused to respond, another child
was selected or the director held the child if it was at all possible. Sixth, because one interviewer completed all 56 interviews using the exact same questions and the exact same approach with each child, consistency was obtained for each of the 56 interviews. Finally, the interviewer took suggestions from a checklist for interviewers to improve any skills that might be lacking (Bell, Osborne, & Tacker, 1985).

Although the instrument appeared to measure the understanding of the water cycle and used questions from the interviews of experts, the validity of the instrument could be increased through further scrutiny by experts. Since the instrument was measuring a non-observable trait construct (i.e., understanding), the repetition of independent studies is necessary to validate the instrument.

Research Design

The design of this study was a randomized post-test only control group design. This was a descriptive study describing young children's current understanding of the water cycle. Randomization occurred to select the subjects participating in the study. No special treatment was given to these individuals. The subjects were interviewed on a one-to-one basis to determine their current status of understanding of the water cycle, according to my operational definition (see Appendix C). Responses from the
Survey of Understanding were compared from two regions of the United States (desert region - Las Vegas, Nevada and mountainous region - Orem/Provo, Utah). No pretesting, treatment, or posttesting was necessary for a descriptive study. Young children's current understanding of the water cycle was evaluated from two different regions of the United States to identify possible relationships and recommendations for further studies.

**Procedures**

In this procedure section, we will examine an overview of the ten procedures that were performed in administering and evaluating the study.

1. Five preschools were selected in a desert region of the United States (i.e., Las Vegas, Nevada) by stratifying the factors of socioeconomic status, teacher experience, and sex.

2. Five preschools were selected in a mountainous region of the United States (i.e., Orem/Provo, Utah) by stratifying the factors of socioeconomic status, teacher experience, and sex.

3. The preschools were contacted and written permission granted from each preschool to participate in the study.

4. Six students from each of the 10 preschool were randomly selected by the teachers choosing at random six students. I explained to the teachers the importance of not
selecting the top or bottom students, but truly randomizing the selection. Some of them chose every other student on their roll. Others had me choose a boy and then a girl in the room. Others randomly chose a table of children or the most available students.

5. A field test was conducted in Nevada with 6 five-year-olds.

6. Written permission was then obtained from the subjects' parents to participate in the study and to release the results. Two of the ten directors felt they wanted to take full responsibility for the parents and signed the release forms.

7. The 56 subjects were then interviewed using the "Survey of Understanding of the Water Cycle" as a guide.

8. The interviews were tape recorded for the most quick, efficient, and objective method to record the information.

9. The responses on the "Survey of Understanding of the Water Cycle" were compared. Four students were dropped from the study to equalize the groups (i.e., the 2 six-year-olds and 2 children randomly selected from the desert group). The original 60 subject became 56 subjects after the adjustment.

10. Results were examined for relationships that may exist. Recommendations were given for further studies that
could be conducted. Implications of this study were also stated.

Data Analysis

To evaluate a child's understanding of the water cycle, 15 questions were developed. These questions are the instrument called Survey of Understanding of the Water Cycle (see Appendix B).

The instrument was designed to not only compare the overall understanding of the water cycle, but also to compare the understanding of concepts within the water cycle so that misconceptions and weaknesses could be more clearly pinpointed.

The Four Levels of Understanding (see Appendix C) set the criteria to compare the overall understanding of the water cycle. The Criteria for Concepts (see Appendix E) set a criteria to evaluate understanding of the specific concepts within the water cycle.

Each of the 15 questions in the instrument correlates with a specific concept within the water cycle. The three concepts are: precipitation, evaporation, and condensation.

These concepts were evaluated individually through the questions in the instrument (see Appendix B). The understanding of precipitation was evaluated through questions 1, 2, 3, 5, and 6. Evaporation was evaluated through questions 7, 8, 9, and 10. Condensation was
evaluated through questions 11, 12, and 4. An extension of the child's understanding and comprehension beyond the basic understanding of the water cycle was evaluated through questions 13, 14, and 15. A combination of the concepts for further analysis required running statistics on various question combinations. Precipitation and evaporation were evaluated through questions 1, 2, 3, 5, 6, 7, 8, 9, and 10. Precipitation and Condensation were evaluated through questions 1, 2, 3, 4, 5, 6, 11, and 12. Evaporation and condensation were evaluated through questions 4, 7, 8, 9, 10, 11, and 12.

**Statistical Analysis**

For the statistical analysis section we will examine the statistical procedures followed, examine the null hypothesis tested, look at the t test procedures and results, and look at the chi-square test procedures and results.

**Statistical Procedures**

The subjects were randomly selected from ten different preschools. The 56 subjects were administered the Survey of Understanding of the Water Cycle (see Appendix B). After this survey was scored on each of the 15 questions according to the Four Levels of Understanding (see Appendix C) and the
Criteria of Concepts (see Appendix E) by the same interviewer, the \( t \) test and the chi-square test were applied.

**Null Hypothesis**

Statistics were run to support the null hypothesis: There will be no significant difference between the scores of the 3-5 year old children who live in a mountainous region and the scores of the 3-5 year old children who live in a desert region on the "Survey of Understanding of the Water Cycle."

**T-Test Procedures**

The first test applied was the independent \( t \) test where two independent groups (the mountainous group and the desert group) were compared on the same variables. The same variables were concepts about the water cycle derived from the Survey of Understanding of the Water Cycle, i.e., precipitation, evaporation, condensation, combinations of these, and extension of their understanding.

This independent \( t \) test was two-tailed to see which group would score higher on the Survey of Understanding of the Water Cycle (see Appendix B). The alpha level was set at \( p < .05 \).
### T Test Results

The results from the two-tailed $t$ test are as follows:

<table>
<thead>
<tr>
<th>Component</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>2-Tail Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Precipitation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mountain</td>
<td>15.39</td>
<td>4.52</td>
<td>.046</td>
</tr>
<tr>
<td>Desert</td>
<td>13.00</td>
<td>4.25</td>
<td>.046</td>
</tr>
<tr>
<td><strong>Evaporation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mountain</td>
<td>10.07</td>
<td>3.31</td>
<td>.543</td>
</tr>
<tr>
<td>Desert</td>
<td>9.57</td>
<td>2.78</td>
<td>.543</td>
</tr>
<tr>
<td><strong>Condensation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mountain</td>
<td>7.75</td>
<td>2.91</td>
<td>.110</td>
</tr>
<tr>
<td>Desert</td>
<td>6.50</td>
<td>2.84</td>
<td>.110</td>
</tr>
<tr>
<td><strong>Extension</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mountain</td>
<td>6.89</td>
<td>3.30</td>
<td>.054</td>
</tr>
<tr>
<td>Desert</td>
<td>5.36</td>
<td>2.48</td>
<td>.054</td>
</tr>
<tr>
<td><strong>Precip/ Evapor</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mountain</td>
<td>25.46</td>
<td>7.06</td>
<td>.120</td>
</tr>
<tr>
<td>Desert</td>
<td>22.57</td>
<td>6.64</td>
<td>.120</td>
</tr>
<tr>
<td><strong>Precip/ Conden</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mountain</td>
<td>23.14</td>
<td>7.08</td>
<td>.051</td>
</tr>
<tr>
<td>Desert</td>
<td>19.50</td>
<td>6.57</td>
<td>.051</td>
</tr>
<tr>
<td><strong>Evapor/Conden</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mountain</td>
<td>17.82</td>
<td>5.83</td>
<td>.240</td>
</tr>
<tr>
<td>Desert</td>
<td>16.07</td>
<td>5.16</td>
<td>.240</td>
</tr>
</tbody>
</table>
Chi-Square Test Procedures

The second test applied was the Chi-Square Test of Independence to see if the responses from the children were independent of the children's geographical location. The chi-square test compared the expected frequency of responses, supporting the null hypothesis, to the actual responses seeing if any significant differences were found in the proportions reported. Significant differences were found in the expected responses and the actual responses of children in the mountainous region and children in the desert region. The chi-square test helped to reject the null hypothesis that there would be no relationship between where the children lived and where they rank on their level of understanding.

The chi-square test was also used for multiple comparisons. The chi-square test compared the group variable (mountainous group versus desert group) to the response on the Level of Understanding and found significant difference between the two groups. The overall chi-Square test yielded $P = .000167$. The expected frequency of response was arrived by taking the average of the actual responses from group one and group two. Three degrees of freedom were used for this test. The alpha level was set at $p < .05$. It not only examined overall differences between the groups, but also compared each level of understanding between the two groups.
Significant differences were found between the mountainous group and the desert group on Level 1 and on Level 4.

Chi-Square Test Results

The results of the chi-square test are as follows:

<table>
<thead>
<tr>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
<th>Level 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete</td>
<td>Confusion</td>
<td>Partial</td>
<td>Complete</td>
</tr>
<tr>
<td>Mountainous</td>
<td>37%</td>
<td>3%</td>
<td>17%</td>
</tr>
<tr>
<td>Desert</td>
<td>50%</td>
<td>1%</td>
<td>19%</td>
</tr>
<tr>
<td>Combined Group</td>
<td>43%</td>
<td>2%</td>
<td>18%</td>
</tr>
</tbody>
</table>

(Note: See Appendix C for definitions of these Four Levels of Understanding.)
CHAPTER 3 -- CONCLUSION

Discussion

In this discussion we will examine each of the three research questions and what information was found to answer each of the three questions.

Question 1: How much do 3-5 year old children understand about the water cycle?

Answer: The range of answers on the Four Levels of Understanding (see Appendix C) helps us to answer this question. The answers on the Survey of Understanding (See Appendix B) were distributed as this graph demonstrates.

Comparison On "Four Levels of Understanding"

Looking at the combined group, we can see how the 3-5 year olds did as a whole group. Forty-three percent of the 56 children were completely confused about the water cycle. Two percent of the 56 children were partially confused.
Eighteen percent of the 56 children partially understood the water cycle. Thirty-seven percent of the 56 children completely understood the water cycle, according to my operational definition in Appendix C.

Question 2: What misconceptions do they have about the water cycle?

Answer: As the subjects explained what they understood about the water cycle, holes and misconceptions in their understanding emerged as they attributed some natural behaviors to the unknown, to God or to a strange anomaly. When the subjects scored at the Confusion Level or at the Complete Confusion Level on the Four Levels of Understanding (See Appendix C), then some serious misconceptions were occurring. We will examine each of the 15 questions on the Survey of Understanding (See Appendix B) and what misconceptions were found. The following views were compiled directly from the written transcript of the oral interviews with the children. The views were ranked in order of most frequent occurrence (ie. View 1 -- the most frequent response, View 2 -- the next frequent response). When a view was subscribed to by fewer than 5 students, it was not listed as a major view of the children.

1. Have you ever seen rain fall?

   View 1 Yes
   View 2 No
Twice as many children in the desert region compared to the mountain region said that they had never seen rain.

2. What is rain?
View 1 Water
View 2 Drops of the rain
View 3 Experience getting wet

Misconceptions surfaced mostly among the mountainous children where some children incorrectly believed that rain was drips of black clouds, drips of water out of a sink, stuff and paper. Although many of the ideas of the mountainous children were uncertain, 95% of the children had an explanatory answer. The remaining 5% stated that they did not know.

Fewer misconceptions were stated by the children from the desert region, but fewer children (66%) had an explanation. The remaining 33% of the children in the desert region answered, "I don't know."

3. Where do you think rain comes from?
View 1 The sky.
View 2 The clouds
View 3 God or Jesus

An overwhelming majority of the answers from both groups supported view one and view two. Five out of the 56 participants thought rain came from God or Jesus. Only two participants thought that lightening was where rain came
from, both of those participants were four-year-old boys. Only one additional view was suggested by a five-year-old. He said that rain came from snow.

4. How do you think rain is made?

   View 1  Because of clouds
   View 2  With water
   View 3  Out of ice
   View 4  The sun made it.
   View 5  God made it.
   View 6  Because of snow.

   About one-third of the 56 children believed in the first two views. View 3-6 were held by one-fifth of the children. Then, other misconceptions were phrases like: "kind of mooshy," "people make it with big machines," "from colors," "from plastic," and "from thunder and lightning." 

5. Where do you think rain goes after it falls to the ground?

   View 1  On to the grass, plants, and trees.
   View 2  Back up into the sky or clouds.
   View 3  Under or inside the ground
   View 4  On the sidewalk
   View 5  Into streams, water, or puddles.

   About 25% of the children thought that rain fell on the grass and plants after it fell on the ground. Then, one-third of the students supported view 2 and view 3. Another
10% of the children felt that rain fell on the sidewalk after it fell on the ground. Then, another 10% of the children thought that rain went into streams, water, or puddles after it went on the ground. Other students held to the ideas that rain fell down in the sewer. Interestingly enough, only the children from the desert mentioned rain falling on cars and floods.

6. What things are made out of raindrops?

View 1 Water
View 2 Ice
View 3 Clouds
View 4 Snow

The majority of the children who answered this question said that water was made from raindrops. Nearly 20% of the mountainous children knew that water was made from raindrops. Less than 10% of the desert children mentioned water made from rain. Ice and clouds were equally thought to be made from raindrops by desert and mountain children. Only the mountainous children commented that snow was made from raindrops. The desert children answered this question with mostly, "I don't know." Most of the mountainous children had a response. Some unusual misconceptions included raindrops making umbrellas, candy, lightning, peppers, peppermint, and "raindrops grow like a house inside of a circle."
7. Where do you think the water goes when puddles and water on the ground dries up?
   View 1  Back up to the sky or clouds
   View 2  Down into the ground
   View 3  Back to the sun
   About 25% of the children thought that the water went back up to the sky or clouds. About 20% of the children subscribed to view 2. Nearly half of the children in each group seemed confused where the water might have gone.

8. Have you ever seen a cloud before?
   View 1 Yes.
   View 2 No.
   All but 5% of the children remembered seeing clouds before.

9. What do you think clouds are made of?
   View 1  Descriptors of clouds i.e., soft, white, fluffy, white dry, dark, stuff.
   View 2  Cotton
   View 3  Rain
   View 4  Snow
   View 5  Air
   Many of the children in the desert thought that clouds were made of snow or cotton. Very few other ideas were given for what clouds were made of. None of the children mentioned
air. Only one child mentioned water. Misconceptions included clouds made from rock, the sun and trees, and a bunny and a man made it.

Most of the children in the mountains used descriptors to tell what clouds were made of. About 20% of the children thought snow, air, and rain were what clouds were made of. About 8% of the children mentioned air as important in cloud composition. Other misconceptions included clouds made from salt, out of colors, circles, and mountains.

10. How does water get in the clouds?

The answers to this questions were so inconsistent among the 60 children that it was impossible to categorize them into specific views. Answers were a large variety of misconceptions. Students said things like: "water drops on the clouds," "when the rain falls then it all soaks into the clouds like a sponge," "the clouds drink the water from the sea," "rain is made in heaven and then it drips into the clouds," "there were too many clouds so water got in there," "water flew up," "it's magic," "a rain guy put water in the clouds," "Heavenly Father and Jesus put the water in the clouds," and "God did it." There was very little consistency among the answers. The range of answers showed how confusing the concept of evaporation is to this age group.

11. Have you ever noticed that clouds look different on some days?
Water Cycle Study

View 1  Yes
View 2  No

One-third of the desert children said that they hadn't noticed a difference in clouds. Only one-eighth of the mountainous children said that they hadn't noticed a difference in clouds. Most of the children said that they had noticed a difference in clouds. The interview proceeded to ask what differences they had noticed.

12. How do clouds look different when it rains?
   View 1  They look black.
   View 2  They look grey.
   View 3  They get dark.
   View 4  They are brown.
   View 5  Other colors are mentioned.

Most of the children felt that the clouds looked darker or a dark color when it rained. One-third of the desert children mentioned a darker color in the clouds. One-half of the mountainous children mentioned a darker color in the clouds. Both groups had children that mentioned unusual colors of the clouds when it was going to rain like: pink, blue, red, orange, and silver. Four children in the desert said that the clouds looked the same when it was going to rain. Only one child in the mountainous region said that the clouds look the same. It seemed unusual that both groups mentioned lots of colors of the clouds when it rained.
13. What would happen if it didn't rain?
View 1  The trees, plants, flowers, and gardens wouldn't grow or would die.
View 2  It would be summer or sunny.
View 3  It would snow.
Many of the children felt that it would be fine if it didn't rain because they could go out and play. They wanted it to be warm and sunny. Other children, twice as many in the mountain as in the desert, felt that rain was important for the vegetation. Other ideas included "there would be no puddles," "the clouds would be white," and "the water wouldn't fall on us." Very few children from either group, only 10%, mentioned the importance of water for human survival. One four-year old girl said without the rain we would die. Another four-year old boy said that without rain we wouldn't have any water.

14. What other reasons might we need rain?
View 1  Rain helps the grass, trees and flowers grow.
View 2  Rain gives us water to drink
Most of the children thought that the rain was important for vegetation. About 10% of the children mentioned the rain being used for our water to drink. One boy, who was five-years old, said that "some people don't get much water and eat the rain." The rest of the answers were not incorrect, but less important and less frequently
mentioned. Other answers include: "to make Kool Aid," "for the lobsters and crabs in the ocean," "rain is good for your jacket," "we need rain to wash the streets and sidewalks," "for the ducks to drink," and "for your umbrella and your coat." Almost all of the answers were either "I don't know" or a valid use for the rain.

15. Could you tell me what other things you know about rain?

This extension question didn't elicit very many different or new responses. Most of the answers to this question were either "I don't know" or some unusual misconception, e.g., "I want to say something. When it always thunders. It scares me." "I know about rain. It comes down and then the grass is wet. My mom had to carry me over it because it was so wet." "I know a lot of stuff about clouds. When they are made, then God has all his angels to fluff up the clouds and after all the angels fluff up the clouds, they're going to be real, real, real, happy." "Rain makes the street grow and the cars too." "It makes us happy." "I bring toys out into the rain." This question was to help children finally add any last knowledge they had about the water cycle, but the other questions pretty much elicited their knowledge.
There was a greater variety of misconceptions than was anticipated. Occasionally, the child had the right idea, but lacked sufficient vocabulary and knowledge to put their ideas into words. In examining the various misconceptions listed, educators can see where children need to be guided. Teachers can also see what ideas most children hold and upon what basis to build new concepts.

Question 3: How does the understanding of the water cycle differ in children from a mountainous region and children from a desert region?

Answer: Many differences in conceptions and misconceptions were already pointed out in the previous answers from the children. In addition, 15 questions on the Survey of Understanding of the Water Cycle (see Appendix B) were evaluated according to Four Levels of Understanding. (see Appendix C). Then tests were run to see if significant differences did occur in the understanding of the two groups. These differences in understanding of the mountainous group and the desert group are recorded in the Table of Means below.
TABLE OF MEAN SCORES

(Mean scores by region and concept)

<table>
<thead>
<tr>
<th>Concepts</th>
<th>Group 1 Mountainous</th>
<th>Group 2 Desert</th>
<th>T Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precipitation</td>
<td>15.37 4.52</td>
<td>12.87 4.25</td>
<td>.016*</td>
</tr>
<tr>
<td>Evaporation</td>
<td>10.10 3.31</td>
<td>9.60 2.78</td>
<td>.266</td>
</tr>
<tr>
<td>Condensation</td>
<td>7.83 2.91</td>
<td>6.43 2.84</td>
<td>.033*</td>
</tr>
<tr>
<td>Extension of Understanding</td>
<td>6.83 3.30</td>
<td>5.47 2.48</td>
<td>.041*</td>
</tr>
<tr>
<td>Precipitation/ Evaporation</td>
<td>25.47 7.06</td>
<td>22.47 6.64</td>
<td>.0495*</td>
</tr>
<tr>
<td>Precipitation/ Condensation</td>
<td>23.20 7.08</td>
<td>19.30 6.57</td>
<td>.016*</td>
</tr>
<tr>
<td>Evaporation/ Condensation</td>
<td>17.93 5.83</td>
<td>16.03 5.16</td>
<td>.095</td>
</tr>
</tbody>
</table>

*Significant at the .05 level of probability

The difference in understanding between the two groups is rather evident. The variance in the mean scores between the mountainous and desert group suggest that significant difference exists between the groups.

This t test provides an answer to research question three that children of the mountains do, in fact, understand precipitation, condensation, precipitation/evaporation, and precipitation/condensation significantly better the children who live in desert regions. There is a difference in their understanding. To further test the geographic aspect along with the conceptual aspect, the chi-square test was run. The
The chi-square test compared the group variable (mountainous group versus desert group) to the response on the Level of Understanding and found significant difference between the two groups. In other words, geographic location did make a difference in the way the children responded, according to this test. The chi-square test also compared the expected frequency of responses to the actual responses. Significant differences were found in the expected responses between the actual responses of children in the mountainous region and children in the desert region. See the Comparison on "Four Levels of Understanding" below.

(Note: the expected responses would support the null hypothesis that there would be no difference between the responses of the two groups.)
The graph helps us to see visually the differences in understanding between the mountainous group and the desert group. In the desert group, 50% of the participants answered at a level of complete confusion, whereas, only 37% of the mountainous group answered at that same level. The two groups were about the same on the level of confusion where a superior being or unnatural explanation is given. The two groups were also close in their levels of partial understanding. However, nearly half of the mountainous group answered at a level of complete understanding and only 37% of the desert group scored at the level of complete understanding. (Note: The level of complete confusion and complete understanding are levels set in the Four Levels of Understanding. See appendix C).

These two different tests support the notion that the mountainous group has a more complete understanding of the water cycle not only because of their location, but also because of their supposed richer experiences of the water cycle in the mountain environment. Those who live in a desert region have some understanding of the water cycle, but half of them are at a level of complete confusion about the water cycle (according to my operational definition, see Appendix C).

Although the results of the study support the original hypothesis, a major problem can be found in using very young
children in a study. Young children will often answer whatever comes to their minds when presented with a novel question. It poses a problem to the validity of this study when children's answers may not reflect a true, genuine measure of their understanding.

In other studies it has been found that children under five are more likely to give answers that are unrelated to the questions asked (Za'rour, 1976). Very young children also tend to be very egocentric, viewing everything in relation to themselves and human experience (Gilbert, Osborne, & Fensham, 1982).

Young children will often give human characteristics to objects. Personification and metaphors used in common language can confuse a young child in his understanding of scientific notions. Therefore, a young child's explanations may include unwarranted descriptions of natural phenomena (Gilbert, Osborne, & Fensham, 1982). Young children do not take the perspective of the listener and often leave out descriptive, necessary details. (Genishi, 1988). Other findings suggest that "the types of answers given by the subjects were influenced more by the nature of the problem, the way the question was worded, the child's background or experience, and his vocabulary than by any so-called mental structure for a given age" (Oakes, 1947, p.93).
There are so many factors that come to play when using very young children. They want to please adults. They are adept at latching on to nonverbal cues of what is expected of them. They notice the raise of an eyebrow, the praises of correct answers, and the rephrasing of questions to elicit correct responses. (Bell, Osborne & Tasker, 1985).

Characteristics of this young age may alone threaten the validity of this study. However, they are often very blunt and honest in their responses, not feeling like they need to hide their ideas. When thirty-seven percent of the children completely understanding the water cycle (according to my operational definition, see Appendix C) at such a young age, questions need to be asked. Why did Za'rour, whose research dealt with 4 year olds to 9 year olds, find that children under five years old do not relate clouds to rain, answer more bizarre responses, and attribute natural occurrences more frequently God than any other age group? Why did so many 3-5 year old children in our study respond with answers that showed greater understanding than the children of Za'rour's study? Perhaps children understand more in the United States than in Lebanon. Perhaps children know more now in 1992 than they did in 1976. Perhaps the Four Levels of Understanding needs more testing and validating. Further research is necessary.
Implications

This study helps us to realize the importance of not only specializing instruction for young children, but also providing supplemental information to enrich what is learned through the environment.

In teaching young children, complex experiments should be eliminated. Young children do not have the memory capabilities to handle difficult experiments. The instruction of young children should begin at their present schema and build upon that schema, no matter how they obtained this understanding. They should be carefully assessed as to what they know. Children's misconceptions should be examined, so reteaching can begin. Teachers can help to build their memory capabilities. Teachers can simply lessons to focus on small factors in more difficult concepts. Teachers should use concrete examples rather than complex pictures and confusing representations. This study helps guide teachers of young children how to better assess and instruct their students.

No matter where a child lives, he cannot experience all climates and environments in the world. Children in the desert may not understand the water cycle like children in the mountain. Children in the mountain may not understand the importance of rain forests like children who live in the tropics. Children in the arctic may not be able to
understand the desert region. This study helps us to understand how the differences in environment influence a child's understanding.

In this study, one small aspect of natural phenomena, the water cycle, was examined. A supplemental guide for teachers could be added to textbooks that would give teachers ideas to enrich their environment. Preferably ideas would include hands-on, physical techniques that simplify concepts for young children. Teachers of the desert region could take children out during a thunderstorm, make puddles on the sidewalks to watch evaporation occur over a period of time, visit a nearby mountain with snow, play in the rain or snow when it occurs, monitor clouds in the sky, etc.

Further Research Recommendations

When science lessons are presented, children's thought processes could be examined to see what they in fact are learning and what they are misunderstanding. Older children in desert and mountainous regions could be interviewed to see if equal understanding between the two groups is achieved through maturity. The same study could be given during a rainstorm in the desert to see how the children's responses would differ. Supplemental lessons could be presented to the desert children to see if their responses would be different. Other water cycle studies could be done
in other climates, tropical or arctic, to compare their understanding with the desert and mountain children.

**Summary**

Through the answers to the questions on the survey and the two different tests that were run, we can see how the mountainous group has a more complete understanding of the water cycle not only because of their location, but also because of their experiences with water in the mountain that provided a greater understanding. Those who live in a desert region have some understanding of the water cycle, but half of them are at a level of complete confusion about the water cycle.

This study not only supported the hypothesis that children in a mountainous region will better understand the water cycle than children of a desert region, but also has helped us to understand the importance of the hands-on experiences with nature. It has shown how greater understanding of nature, and in particular the water cycle, was obtained through location and experiences. Although the mountainous children were not free from misconceptions, their misconceptions were fewer with regards to precipitation and condensation. Children in the mountain area also had greater abilities to discuss and extend their responses beyond the standard questions.
CHAPTER 4 -- APPENDICES

References


Appendix A

Field Test for Water Cycle Study

The field test took place at a preschool in Nevada with the five-year old class. The questioning series was set up in the following pattern:

1. Have you ever seen rain fall?
2. Where do you think rain comes from?
3. How do you think rain is made?
4. Where do you think rain goes after it falls?
5. Can you tell me what other things you know about rain?

Danielle seemed to have the least understanding about the rain. Perhaps she was shy or afraid to answer. No matter what I asked her, she said, "No." or "I don't know." I encouraged her to try and just tell me what she thought, but I received the same repeated, "No. I don't know."

When I asked the other children where rain came from, they knew that rain came from the sky. Ryan, Brett, and Shane mentioned that clouds were present when they rain fell. The other half of the children did not seem to feel clouds were important to make the rain. I can see that at least half of them need to learn about clouds.

When I asked each of them about how rain was made, I found the most unusual misconceptions. Ryan felt electricity made rain. Eric made wild motions and mounds with his hands
to illustrate to me how rain was made, but couldn't put it into words. Jesse thought rain was made out of ice. Brett was sure that it was made out of water, but wasn't sure how. Shane had no idea or even guesses. All of the children need to learn what rain is made of and how it is made.

When I asked them where rain goes after it falls, I got answers like on the car, on the umbrella, on my raincoat, and only Ryan came up with on the ground. None of them mentioned rain going back up into the sky or any hint of evaporation or condensation, although previously some of them had mentioned clouds. It was interesting to me to see what role the water cycle seemed to play in their lives. I would like to further investigate their understanding of clouds and how much they really understand. I think perhaps the desert climate has something to do with the extent of their understanding of the water cycle.
Appendix B

SURVEY OF UNDERSTANDING OF THE WATER CYCLE

1. Have you ever seen rain fall?
2. What do you think rain is?
3. Where do you think rain comes from?
4. How do you think rain is made?
5. Where do you think rain goes after it falls to the ground?
6. What things are made out of raindrops?
7. Where do you think the water go when puddles and water on the ground dries up?
8. Have you ever seen a cloud before?
9. What do you think clouds are made of?
10. How does water get in the clouds?
11. Have you ever noticed that clouds look different on some days?
12. How do clouds look different when it rains?
13. What would happen if it didn't rain?
14. What other reasons might we need rain?
15. Could you tell me what other things you know about rain?
Appendix C

Four Levels of Understanding

Level 4: Complete Understanding

Subject will understand all of the concepts of precipitation (where rain comes from, what it is made out of, and where it goes after it falls, i.e., rivers, streams, puddles etc.) Subject will understand all of the concepts of evaporation (what clouds are made of and how water from the earth evaporates into the sky). Subject will also understand all of the concepts of condensation. (how water droplets combine in the sky to form heavier droplets that darken the clouds and fall). Subject attributes phases in the water cycle to the occurrences in nature.

Level 3: Partial Understanding

Subject will understand one or two of the three phases of the water cycle (precipitation, evaporation, and condensation) and be able to explain those concepts completely. i.e., see Level 4 for more details about the concept knowledge. Subject attributes phases in the water cycle
Water Cycle Study

mostly to the occurrences in nature. Subject understands concepts completely pertaining to at least one phase of the water cycle.

Level 2: Confusion

Subject does not understand any of the phases of the water cycle. Subject attributes all occurrences in nature to the supernatural with no attempts to explain. (i.e., God makes it rain. God is crying. Because that is the way God did it).

Level 1: Complete Confusion

Subject refuses to answer. Subject says, "I don't know." Subject is completely off task and answers some bizarre unrelated answer.
Appendix D

Sample Interview Transcriptions

Nevada Preschools: Representative of desert region.

Sample Preschool, Las Vegas

Benjamin 5 years old

1. Have you ever seen rain fall before?
   One time I saw the snow.
   Did you ever see rain fall before?
   Yea.

2. What do you think rain is?
   It's water.

3. Where do you think rain comes from?
   From the sky.

4. How do you think rain is made up in the sky?
   From nature.
   Do you have any idea how it is made?
   No.

5. After the rain comes down and hits the ground, then
   where does it go?
   It goes down inside the dirt.
   Anywhere else?
   Sometimes it also makes puddles.

6. Can you think of anything that is made out of raindrops?
Water. And snow turns into water if I got it in a glass.

7. Sometimes you see puddles of water on the ground and then the next day the puddle is all gone. What do you think happened to the water?
   It all dried up from the sun.
   Where did the water go?
   It just dried up and went all the way up to the sun.

8. Have you ever seen a cloud?
   Yes.

9. What do you think clouds are made out of?
   Cotton.

10. How does water get inside the clouds?
    When the rain falls then it all soaks into the clouds like a sponge.

11. Have you ever noticed that clouds look different sometimes?
    Yes, some are white and some are grey.

12. How do the clouds look different when it is going to rain?
    Grey.

13. What would happen if it didn't rain?
    Then there would be no water around here.

14. Can you think of reasons why we need rain?
So you can drink it. I don't know all the other reasons.

15. Can you tell me anything else you know about rain?
I don't know. I'm not really a nature kid.

Adam 5 years old

1. Have you ever seen rain fall before?
No.

2. What do you think rain is?
Water.

3. Where does rain come from?
The sky.

4. How is rain made up in the sky?
Out of ice.
How does that happen? Do you know?
No.

5. When rain falls down onto the ground, where else does it go?
The sewer
Anywhere else?
No.

6. What things are made out of raindrops?
I don't know.
7. Sometimes there is a puddle on the ground and then the next day the puddle went away or dried up. Where do you think the water went?
   No response.
8. Have you ever seen a cloud?
   Yes.
9. What do you think clouds are made out of?
   Cotton.
10. How does water get inside the clouds?
    No response.
11. Have you ever noticed that sometimes clouds look different?
    No.
12. Do clouds look different when it is going to rain?
    No, they look more grey.
13. What would happen if it didn't rain?
    Nothing would grow.
14. Can you think of any reasons we need rain?
    No.
15. Can you tell me anything else you know about rain?
    No.

Kaylynn 4 years old
1. Have you ever seen rain fall before?
   Yes.
2. What do you think rain is?
   Water.
3. Where do you think rain comes from?
   The sky.
4. How do you think rain is made?
   I don't know.
5. Sometimes rain comes down on the ground, then where does it go?
   On the grass, on the street,
6. Can you think of anything that is made out of rain?
   No.
7. Sometimes there is a puddle on the ground and then the next day the puddle went away or dried up. Where do you think the water went?
   It dried up.
   Where did all the water go?
   I don't know.
8. Have you ever seen a cloud before?
   Yes.
9. What do you think clouds are made out of?
   Cotton.
10. How do you think water would get up inside the clouds?
    I don't know.
11. Have you ever noticed that sometimes clouds look different?
12. How do clouds look different when it is going to rain?
   They look black.
13. What would happen if it didn't rain?
   'Cause the sun was coming out.
   Anything else?
   No response.
14. Can you think of any reasons we need rain?
   To drink.
   Anything else?
   No response.
15. Do you know anything else about rain you can tell me?
   No.

Toni (girl) 4 years old
1. Have you ever seen rain before?
   Yes.
2. What is it?
   It's what you drink and what you take a bath.
   What is it?
   Water.
3. Where does rain come from?
   The sky.
4. How is rain made up in the sky?
Made out of ice.
Anything else?
No, just ice.

5. Where does rain go after it falls onto the ground, then where does it go?
To the water that you drink and wash your hands with.

6. What kinds of thing are made out of raindrops?
Ice and that's all. Just ice.

7. Some days there are puddles on the ground and then the next day the puddle all dried up. Where did the water go?
It goes down into the sewers and out into the ocean.

8. Have you ever seen a cloud?
Yea.

9. What are clouds made out of?
White coloring wet.

10. How do you think water gets up into the clouds?
When it drain and it goes up to the clouds.

11. Have you ever noticed that the clouds sometimes look different?
Yes.

12. How do they look different when it is going to rain?
Black.
13. What would happen if it didn't rain?
   It would be nice outside.
14. Can you think of any reason we need rain?
   For the fish to live in the ocean
   For the plants to live in the ocean and for the
   lobsters and the crabs.
15. Do you know anything else about rain you can tell
   me?
   No.

Boy 4 years old
   1. Have you ever seen the rain fall?
      Yes.
   2. What do you think rain is?
      I don't know.
   3. Where does rain come from?
      Over there in the sky.
   4. How do you think rain is made?
      The flowers need water.
      How is rain made?
      Like a water.
   5. After the rain goes down on the ground, then where
      does it go?
      It gets people wet.
      Anywhere else?
      Right over in the trees.
6. Do you know anything that is made out of raindrops?
  Yep. Water goes on the grass and in the trees.
7. Sometimes there is a puddle on the ground and then
   the next day the puddle went away or dried up. Where
do you think the water went?
   It flew up.
8. Have you ever seen a cloud before?
   Yes.
9. What do you think clouds are made out of?
   Put down lots of water
   What are they made out of?
   They are all dry.
10. How do you think water gets inside the clouds?
    It flew up.
11. Have you ever noticed that clouds sometimes look
different?
    Yes.
12. How do they look different when it is going to
    rain?
    They're done to rain.
13. What would happen if it didn't rain?
    They get jackets on.
    What would happen if it didn't rain?
    They don't put water on them.
14. Can you think of any other reasons we need rain?
    For flowers, they need water on them.
Do we need rain for anything else?
   They can all be done through the rain.
15. Can you tell me anything else you know about rain?
   Rain is going to be water on the flowers and on the grass.

Kurt 4 years old
1. Have you ever seen rain fall before?
   Yes.
2. What do you think rain is?
   Kind of like a circle thing.
3. Where does rain come from?
   The sky.
4. How do you think rain is made in the sky?
   Just made.
   Do you have any idea how it might be made?
   No.
5. Where does rain go after it falls on the ground?
   It doesn't go anywhere it just dries.
6. Can you think of anything made out of raindrops?
   Yea, grass, plants.
7. So when puddles all dry up, where did the water go?
   Onto the grass.
8. Have you ever seen a cloud?
Yes.

9. What do you think clouds are made out of?
   Rock.
   Anything else?
   No.

10. How do you think water gets inside of a cloud?
    Rain.
    How did the water get inside the cloud, though?
    It drops onto the cloud.

11. Have you ever noticed that sometimes clouds look different?
    Yea.

12. How do clouds look different when it is going to rain?
    Um... they get dark.

13. What would happen if it didn't rain?
    The grass wouldn't grow.

14. Can you think of any other reasons we need rain?
    The grass would grow long.

15. Can you tell me anything else you know about rain?
    No response.
March 16  Sample Preschool, UTAH

Steven Durrant  4 years old
1. Have you ever seen rain fall before?
   Yea.
2. What is rain?
   It's at ...(pause) and it turns into snow.
   What is rain made out of?
   Snow.
3. Where do you think rain comes from?
   Clouds.
4. How do you think rain is made?
   With water.
   Okay, then it turns into snow?
   Yea
5. Where do you think rain goes after it falls to the ground?
   The sidewalk.
   Anywhere else?
   Our head.
6. What kinds of things are made out of raindrops?
   Water
7. Where do you think the water and the puddles go when
it all dries up on the sidewalk? Where does the water go?
   In the sewers.
8. Have you ever seen a cloud before?
   Yea.
9. What do you think clouds are made out of?
   Soft.
   Made out of soft what?
   No answer.
10. How does the water get up into the clouds so it can come down?
   It goes in the sewers.
11. Have you ever noticed that clouds look different sometimes?
   Yea.
12. How do clouds look different on days that it rains?
   Different colors.
   It looks different colors. Like what color does it look like when it is going to rain?
   Black.
   What color are the clouds when it doesn't rain?
   White.
13. What would happen if it didn't rain?
   The flowers wouldn't grow.
   Why else do you think we need rain?
   To help the garden grow.
14. Can you think of any other reasons why we might need rain?
   To make apples grow and we can eat them.

15. Do you know anything else about rain?
   Yea
   What?
   It makes us happy.

Eric Seckletstewa 4 years old

1. Have you ever seen rain fall before?
   Yea.

2. What is rain?
   Little drops.
   Little drops of what?
   Of rain.

3. Where do you think rain comes from?
   The clouds.

4. What do you think rain is made out of?
   Water.

5. Where do you think rain goes after it falls on the ground?
   Up in the sky.

6. What kinds of things are made out of raindrops?
   Water.
7. When the water comes down and makes puddles on the ground and then the puddles all dry up, where do you think the water goes?
   Up to the sky.
   Where in the sky does the water go?
   In the clouds.
8. Have you ever seen clouds before?
   Yea
9. What do you think clouds are made out of?
   Fluffy.
   What do you think is inside of them?
   No response.
10. How do you think water gets up in the clouds?
    Evaporates.
    Who told you that?
    He pointed at the teacher.
    Oh, your teacher here.
11. Have you ever noticed that clouds look different sometimes?
    Yea.
12. How do clouds look different when it is going to rain?
    Do they look different when it is going to rain?
    What color are they or how do they look different?
    They are blue.
13. What would happen if it didn't rain?
It would snow.

14. Why do we need rain?
   To make our flowers grow.

15. Can you tell me anything else about rain?
   To make pussywillows grow.

Colby Dimick 4 years old
1. Have you ever seen rain fall before?
   Yes.

2. What do you think it is?
   Water.

3. Where do you think the rain comes from?
   Clouds.

4. How do you think rain is made?
   That is a hard question. You're not sure.
   No answer.

5. Where do you think rain goes after it falls to the ground?
   The sewer.
   Where else does it goes on the ground.
   The sewer pipe.

6. What kinds of things are made out of raindrops?
   Water.

7. Where do you think the water goes when it all falls down and makes puddles and then it dries up?
   Where does the water go?
It goes back in the sewer.

8. Have you ever seen a cloud before?
   Yes.

9. What do you think clouds are made out of?
   White.
   What is inside of the clouds.
   Rain.

10. How does water and the rain get up into the clouds?
    No answer. I don't know.

11. Did you ever notice that clouds look different on different days?
    Yes.

12. How do the clouds look different when it is going to rain?
    Brownish.

13. What would happen if it didn't rain?
    Then we wouldn't have water.

14. Can you think of any other reasons why we might need rain?
    To make Kool Aid.

15. Can you tell me anything else you know about rain?
    I know that they have little things inside the rain?
    What kind of things?
    I don't know.
Forrest MacSparren 4 years old

1. Have you ever seen rain fall before?
   Yes.

2. What do you think it is?
   Water

3. Where do you think rain comes from?
   The sky.

4. How do you think rain is made up in the sky?
   Clouds.

5. Where do you think the rain goes after it falls to the ground?
   Stays on the ground.
   Does it go anywhere else on the ground.
   Other raindrops come down.
   Then what happens when there are a lot of raindrops on the ground?
   No answer.

6. What kinds of things are made out of raindrops?
   Clouds.
   Anything else?
   No answer.

7. Where do you think the water goes when all the puddles on the ground dry up? Where did all the water go?
   It went away.
8. Have you ever seen a cloud before?
   Yes.

9. What do you think clouds are made out of?
   Clouds.
   What do you think is inside of the cloud?
   Rain.

10. How does water get inside the cloud?
    I don't know.

11. Have you ever noticed that clouds look different on some days?
    Yes.

12. How do they look different when it is going to rain?
    They move.
    Any other way they look different?
    No response.

13. What would happen if it didn't rain?
    No response.

14. Can you think why we might need rain?
    What do you use rain for?
    I don't know.
    I need my shoe tied.

15. Can you tell me anything else about rain?
    No response.

Jesse Glover  5 years old
1. Have you ever seen rain fall before?
   No.
2. Do you know what rain might be?
   Water.
3. Where do you think rain comes from?
   Snow.
4. How do you think rain is made?
   It comes down.
   It comes down from where?
   Then sun.
5. Where do you think rain goes after it fall on the ground?
   On the grass.
6. What things are made out of raindrops?
   Ice.
   Anything else?
   I think, water.
7. Where do you think the water goes when puddles are on the ground and then they all dry up or disappear?
   Where does the water go?
   Back to the sun.
8. Have you ever seen a cloud before?
   Yes.
9. What do you think clouds are made out of?
   I don't know.
10. How do you think water gets up inside the clouds?
It disappears.

11. Have you ever noticed that clouds look different sometimes?
   Yes.

12. How do they look different when it is going to rain?
   New.

13. What would happen if it didn't rain?
   It would be summer.

14. What other reasons might we need rain?
   To grow our grass and flowers.
   Do we use rain for anything else?
   For water.

15. Can you tell what other things you know about rain?
   I think when the water goes down then it goes back up to the sun.

Shawn Clark  4 years old

1. Have you ever seen rain come down before?
   Yes.

2. What do you think it is?
   Rain.

3. Where do you think the rain comes from?
   The clouds.

4. How do you think rain is made up in the clouds?
   Because of snow.
Is that how it is made?
Yes.

5. Where do you think rain goes after it falls on the ground?
   In the grass.
Does it go anywhere else?
   Other grass.

6. What kinds of things are made out of rain?
   I don't remember anything.

7. Sometimes the rain makes puddles on the ground and then the puddles disappear. Where do you think the water went?
   It went back in the sky.
   Where in the sky?
   It went in the clouds.

8. Then you have seen clouds before?
   Yea.

9. What do you think clouds are made out of?
   Dark.

10. How does the water get up into the clouds?
    The sun comes out.
    Does it make the water go up into the clouds?
    Yes.

11. Have you ever noticed that clouds look different sometimes?
    Yes.
12. Do they look different when it's going to rain?
   Like water, kind of silver.

13. What would happen if it didn't rain?
   There would be no puddles.

14. Is there anything else we need rain for?
   Water.

15. Do you know anything else about rain you can tell me? How does the water get up into the clouds?
   The sun comes out.
   Does it make the water go up into the clouds?
   Yes.
Appendix E

CRITERIA FOR CONCEPTS

1. Have you ever seen rain fall?
   Level 4 - (Complete Understanding)
       Yes.
   Level 3 - (Partial Understanding)
   Level 2 - (Confusion)
   Level 1 - (Complete Confusion)
       No, I don't know, or no response.

2. What do you think rain is?
   Level 4 - (Complete Understanding)
       Water or drops of water.
   Level 3 - (Partial Understanding)
       Student mentions the clouds, lightening, or thunder. Answer is related to the rain.
   Level 2 - (Confusion)
       Student attributes answer to supernatural being, magic, or some mystic power. God made it in heaven. It's magic.
   Level 1 - (Complete Confusion)
       I don't know, no response, or bizarre unrelated answer eg. Its made out of paper, made out of bear, made out of green stuff, soda pop, etc.
3. Where do you think rain comes from?

   Level 4 - (Complete Understanding)
   From the black clouds or from the clouds.
   This answer shows specific attention to detail. It also sets rain production within the limits of the clouds. It shows more advanced understanding.

   Level 3 - (Partial Understanding)
   The sky.
   This answer is too general to know if the child realizes the importance of clouds in rain production. The answer is incomplete.

   Level 2 - (Confusion)
   Students answer is related to a supernatural being.
   For example: God. God makes it come down. Rain comes from heaven. Jesus makes it come down.

   Level 1 - (Complete Confusion)
   I don't know, no response, or bizarre response.

4. How do you think rain is made?

   Level 4 - (Complete Understanding)
   The dark clouds make water that drops down.
   Little water droplets get together in a cloud and then come down.
For 3-5 year olds it is highly unlikely that a more precise explanation of condensation will occur.

Level 3 - (Partial Understanding)

Students mention clouds or water. Student's answer is too general. His answer shows some understanding of what rain is and where it comes from, but is incomplete lacking any ideas relating to condensation.

Level 2 - (Confusion)

Student attributes occurrence to supernatural. For Example: God made it.

Level 1 - (Complete Confusion)

I don't know, no response, or bizarre answer like: from colors, from plastic, kind of mooshy, made with big machines.

5. Where do you think rain goes after it falls to the ground?

Level 4 - (Complete Understanding)

Water goes into streams, puddles, lakes, and rivers. Some water goes back up to the clouds or sky.

Level 3 - (Partial Understanding)
Students talk about all the things the rain falls on i.e., grass, flowers, sidewalks, under the ground, down in the sewer etc.

Level 2 - (Confusion)
Students attributes the water flow to God.

Level 1 - (Complete Confusion)
I don't know, no response or some bizarre unrelated answer like watching a video about thunder.

6. What things are made out of raindrops?

Level 4 - (Complete Understanding)
Students mention water, streams, lakes, drinking water, puddles, and rivers being made from raindrops.
This question is probing for understanding of precipitation. The question is trying to see if children understand that it is water that comes down for our use and for other purposes.

Level 3 - (Partial Understanding)
Students say that ice, snow, or clouds are made of raindrops. These answers show ideas, but not direct contact and use of the raindrops.

Level 2 - (Confusion)
Students attributes occurrences to God.

Level 1 - (Complete Confusion)
I don't know, no response, or bizarre answers like: candy, peppers, umbrellas, and strange things made of rain.

7. Where do you think the water goes when puddles and water on the ground dries up?

Level 4 - (Complete Understanding)
Back up into the clouds or sky. The sun could also be mentioned in this process, but is unexpected for this age. Water going back up into the clouds from a puddle shows elementary understanding of evaporation.

Level 3 - (Partial Understanding)
Down in the ground, down in a hole, up to the sun down in the sand, down in the sidewalk, back to the sewer, etc. Students understand some absorption and perhaps some evaporation with the sun involved, but are unsure of the complete process.

Level 2 - (Confusion)
God took it away. It went to heaven. The angels flew the water home.

Level 1 - (Complete Confusion)
I don't know, no response, or bizarre answer. It is gone. It went home.
8. Have you ever seen a cloud before?
   Level 4 - (Complete Understanding)
      Yes.
   Level 3 - (Partial Understanding)
   Level 2 - (Confusion)
      Attributes to a supernatural being.
   Level 1 - (Complete Confusion)
      No, I don't know, or no response.

9. What do you think clouds are made of?
   Level 4 - (Complete Understanding)
      Water and air.
      Although students may come up with this answer, it is hard to determine how they arrived at this answer and how much they really understand about cloud composition with such a limited vocabulary and at such a young age.
   Level 3 - (Partial Understanding)
      Snow or rain.
      Students understanding that water or snow comes from the clouds, but their understanding is incomplete if they do not mention air being in the clouds.
   Level 2 - (Confusion)
      Students attribute to supernatural. Jesus made them.
Level 1 - (Complete Confusion)

I don't know, no response, or bizarre response like cotton, fluff, white, color, salt, or salt.

10. How does water get in the clouds?

Level 4 - (Complete Understanding)

Students give answers that explain in simple terms how the water, sun and clouds interact with each other to complete the evaporation process. Ideally, the water, sun, and clouds would be mentioned. However, at such a young age, an elementary understanding of water going from the earth back up into the clouds is all that is expected to receive level 4.

For example:
The sun makes the water go up into the clouds.
The clouds get the water from the sea and rivers.
Rain falls and then it soaks back into the clouds like a sponge.

Level 3 - (Partial Understanding)

Students understand part of the evaporative process when the water disappears, but state incorrect ideas and cannot completely describe the rest of the evaporative process.

For example: Water splashes back up in the sky.
The sun makes water go into the sidewalk.

Level 2 - (Confusion)
Students attribute supernatural powers to accomplish this. Water from heaven drops into the clouds. Heavenly Father and Jesus put water in the clouds. God did it.

Level 1 - (Complete Confusion)
No, I don't know, or no response.

11. Have you ever noticed that clouds look different on some days?

Level 4 - (Complete Understanding)
Yes.

Level 3 - (Partial Understanding)
Level 2 - (Confusion)
Attributes to supernatural being

Level 1 - (Complete Confusion)
No, I don't know, or no response.

12. How do clouds look different when it rains?

Level 4 - (Complete Understanding)
They are black, grey, brown or dark.

Level 3 - (Partial Understanding)
They are a different color. They change.

Level 2 - (Confusion)
Attributes change to God.
Water Cycle Study

Level 1 - (Complete Confusion)
No, I don't know, or no response. Any other strange color like red, purple, orange is most likely guessing.

13. What would happen if it didn't rain?

Level 4 - (Complete Understanding)
The trees, plants, flowers, and gardens wouldn't grow. We wouldn't have water to drink. Responses such as this would describe our dependency on water and a greater understanding of water cycle.

Level 3 - (Partial Understanding)
It would snow. It would be summer or sunny. The clouds would be white. Although these answers are true, students would not really understand our use and dependency on water. The responses lack understanding.

Level 2 - (Confusion)
Student places the supernatural as the answer to all.
God would take care of us.

Level 1 - (Complete Confusion)
No, I don't know, or no response.

14. What other reasons might we need rain?

Level 4 - (Complete Understanding)
Students answers accurately describe our use of water.
For example: We can drink water. The flowers and grass need water to grow. Ducks need water to swim.

Level 3 - (Partial Understanding)
Students answers are partially correct.
Students answers describe functions of rain, but not a need for rain.
For example:
Rain is in the black clouds. We need black clouds.
We need rainbows that are made by the rain.

Level 2 - (Confusion)
Students attribute our need and use of rain to God

Level 1 - (Complete Confusion)
No, I don't know, or no response.

15. Could you tell me what other things you know about rain?

Level 4 - (Complete Understanding)
A scientifically correct response that further supports and extends their understanding of the water cycle. For example: Rain makes water for us to drink. When the sun comes out, it makes the water go up into the clouds. Rain is not hard. The rain make the grass very wet.
Level 3 - (Partial Understanding)

Student attempt to further discuss their understanding of the water cycle, but the information is incomplete or partially incorrect. For example: It is dark when it rains. The child does not continue to explain if it is night or if the clouds are dark. The thunder and lightning scares me when it rains. The child has noticed events when it rains, but cannot explain anything else about the how or what he thinks is the cause of these occurrences. The child just emphasizes his fear.

Level 2 - (Confusion)

Student attributes occurrences to the supernatural.

For example: I know lots of stuff about clouds. When they are made then God has his angels to fluff the clouds and after all the angels fluff up the clouds they're going to be real, real, real happy.

Level 1 - (Complete Confusion)

No, I don't know, no response, or bizarre answer like: Rain can make the streets and cars grow.