THE PROCESS CURRICULUM

Cognitive Competence

Physical Causality

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AUTHOR'S NOTE ON CAUSALITY

A vast number of events constantly occur in the world. All these happenings are interrelated or connected to each other in some way. Any one event then can be understood only in relation to any other or all of the other events. This reflects the fundamental onotological principle of relativity of which causality is one expression. Causality means that there is a necessary connection of events through a cause and effect relationship. The happening of one event (effect) always depends upon the occurrence of another event before it (cause).

Philosophically there are two basic kinds of causality: efficient and final. Efficient causation refers to a direct transfer of energy that creates a change known as the effect. Final causation refers to the aim or purpose that may precede efficient causation. For instance, a person's intentions or purpose act as a cause of behavior which in turn may be the efficient cause of a particular effect. When a person establishes an ideal, it may function as a purpose or final cause in determining his behavior over long periods of time. This may be referred to as psychological causality.

This specification will be dealing with efficient physical causality only.

DEFINITION

Physical causality is a cognitive process that underlies the understanding of a cause and effect relationship between two or more phenomena in the physical world. The essence of this relationship is that one event (B) occurs only, and always, when it is preceded by a certain other event (A) or events. Event A is then said to cause event B. The relationship always involves a change or transfer of energy in some form which necessarily connects the two or more events.

Such a relation between events can be complex in that a single cause may result in multiple effects, or a single effect can be produced by a variety of causes. A thorough understanding of these fundamental relationships inherent in phenomena leads ultimately to an appreciation of the existence of complex natural laws which operate in the physical environment.

DESCRIPTION

Throughout history man has been driven by his quest for rational answers or explanations about the phenomena around him and how they are related. Using the process of inquiry he seeks to formulate explanations for the existence of these phenomena and other events. This involves an understanding of the sequential order of events. Essential to this realization of how events are related are "cause and effect" relationships. When something different occurs or there is a deviation from the expected, the tendency is to look for the cause of the event. This knowledge of causal relations (not only of physical causality) is based on a knowledge of every form of dependence and interdependence of things.

In the physical world, the elucidation of the interrelatedness of events in terms of cause and effect results in the formation of certain laws of nature, e.g., the laws of motion, laws of gravity. Knowledge of the laws which govern the occurrence of events in the physical environment enables man to be in charge of his own destiny and his physical well-being because understanding the mechanisms underlying natural phenomena enables him to predict and control these events, including those which have effects on him. Consequently, his potential for guiding the course of his future evolution is greatly increased. Understanding causation increases the probability that survival will be guaranteed and its quality perceptually improved. Maintenance of a high quality of survival is characterized by the continuous translation of potentiality into actuality at an optimal rate.

Understanding, predicting and controlling events in the physical world not only provides practical solutions for living but it also sustains the intellectual evolution of man so that he continually makes what Whitehead terms the "creative advance into novelty". This gives him the power to anticipate novel events, to conceptualize hypothetical situations and to be able to predict the consequences and plan his interactions with the physical environment accordingly.

The notion of efficient and final cause is central to one's understanding of causal relationships. The idea was set forth by Aristotle. Efficient causes are associated with physical connections or relations of events whereas final causes introduce the element of purpose or goal towards which events progress. Aristotle's example of a marble statue of Venus exemplifies these concepts. The sculptor, or the artist, is the efficient cause for he gives form and shape to the marble. The final cause is the purpose or end for which the statue of Venus was created. This purpose depends upon the sculptor's motivation, i.e., he did this to earn a living or satisfy his aesthetic or creative impulses. Thus, both efficient and final causes are implicated in this work of art, even though the latter may not be so readily perceived. In the same way, these two types of causes are involved in the understanding of physical causality. The efficient causes involving knowing how events occur are related in the physical environment. As an example, to understand a watch is to understand what it is and how it works. The efficient cause involves defining the engineering principles by which the watch operates. The final cause is to have an idea of what the watch is for or its purpose. So, for a complete understanding of the universe, not only should the efficient causes be identified and studied but the final causes must be taken into account as well.

Children have an insatiable desire to know the "why" and "how" of events (i.e., efficient causes). Nathan Isaacs (1930) treats the subject of children's "why questions" in great depth. He shows how the child builds from his experience certain anticipatory schemes or beliefs regarding reality. The child uses these shcemes until something strange occurs and then realizes that something is missing in his knowledge. Innumerable "why questions" are asked to resolve this conflict. In these situations, children appeal to adults for help in extending or revising their original knowledge.

Isaacs (1930) identifies three basic types of "why questions"—questions seeking information, justification and explanation. Depending upon the level of the child, the answers that will satisfy him will vary.

<u>Informational Questions</u>

These questions seek to discover the purposes, uses, functions and motives of events. Physical explanations based on efficient causation are not really sought. Typical questions and possible answers may be as follows:

"Why does it rain?" Because the rain gives us water.

"Why do birds fly?" Because they have wings.

"Why is it so dark at night?" Because we do not have any light.

<u>Justificatory Questions</u>

The child demands the grounds for rules, commands, prohibitions and beliefs. Causes or motives of events are not sought but the principles or reasons which presuppose some standard for making a judgement, e.g., moral, social or conventional standards. A question such as "Why is this a cat?" is explained by a universal convention that a cat is an animal which is small, furry, has four legs and a tail, and it meows. Another example of this is "Why is water a liquid?" Again, the convention is that matter is divided generally into three categories: solids, liquids and gases. Children ask this type of question because they are probably not aware that so much of the foundation of knowledge in science is definitional or axiomatic.

Explanatory Questions

These questions probe the particular circumstances or relationships resulting in an event. The child really wishes to know the reason for the contradictions in his observations and seeks an explanation in terms of physical causality. For example, the following types of questions seek the cause of the effect that is observed so readily—"Why don't the clouds fall down?"; "What makes a bicycle go?"; "How does a car move?". Answers to these questions are not necessarily simple because they involve many complex factors and ultimately the laws of gravity and the laws of motion. A young child, however, is only able to focus on a single cause or aspect of the event to the exclusion of others. It is possible that a particular effect may have several causes or that a certain cause may produce a variety of effects. Once the concrete-operational child makes the transition to a formal level of reasoning, he is able to deal mentally and conceptually with possible combinations.

Causal inquiry if carried right through to its logical goals becomes eventually the basis for our most systematic and comprehensive investigation into the reality of our universe. It also becomes the very essence of the pursuit of science wherein the one-to-one correspondence between reality and appearance is continually tested. Whitehead (1925) decisively states, ". . . that every detailed occurrence can be correlated with its antecedents in a perfectly definite manner, exemplifying general principles," and that without this belief the labors of scientists would be without hope. The task of science, then, according to Whitehead (1929) is the discovery of those relationships which exist within the flux of perceptions, sensations, and emotions which forms our very experience of life itself.

THEORETICAL JUSTIFICATION: ANISA

Whitehead touches the essence of the "Stage of Romance" of a child's life when he states that "Ideas, facts, relationships, stories, histories, possibilities, artistry in words, sounds, in form and in color, crowd into a child's life, stir his feelings, excite his appreciation, and incite his impulses to kindred activities." (Whitehead, 1929). Powers of observation and of manipulation are also very keen at this young age. It follows then that the understanding of how and why events occur and their relationships to one another is crucial in the development of the child's thinking about the world.

Children interact with the environment constantly. They search, explore, investigate and discover. This is a powerful form of intrinsic motivation which enables them to gain competence in dealing with the environment. According to Robert White this form of intrinsic motivation is effectance (White, 1959). It is this that drives an individual to continually explore new possibilities and create new interests. This innate desire, then, allows for the continual process of the actualization of potentialities.

A lively, enquiring curiosity is seen in children even as young as three or four years of age. They believe that matter behaves according to certain rules (Kulsan and Stone, 1968). This is their way of coping with the world. If children's "why" questions are not anwsered, their spontaneous, active and dynamic interests will shrivel away. Adults should endeavour to guide, reinforce and develop this curiosity of how things work, what they are and how they are made by giving answers that are accurate and appropriate to the level of the child. Isaac reports that the adults around a child determine progressively his quality of explanation (Isaacs, 1930). The child then learns what is attainable or considered valid in terms of explanation, i.e., he is weaned away from dogma, magic or superstition. This results in the creation of competent learners. In a causal event, a child will be able to consciously differentiate the cause from the effect, integrate this information into a meaningful pattern of knowledge which is then generalizable to other situations.

An understanding of physical causality is essential to the development of moral competence in the child and the concept of self. Initially, the child makes no distinction between his "self" and the physical environment. Gradually, he differentiates himself from the environment. At first the child regards his own view as absolute. He then realizes that there are other points of view held by other people as well as his own, and learns the correspondence between the two. Finally, the child discovers that all things are dependent upon each other through a universe of relations. In all these stages a clearer knowledge of the self and of others is gained. A child has to learn how to relate to other and to relalize what kind of an effect he has on another person's work, happiness, etc. For example, if a child knocks down another's block building, he should realize that he was the cause of such an effect. Understanding the cause and effect of one's behavior can show children how to cooperate more harmoniously and happily. Being selfish or domineering means that one is the cause of someone else's distress, discomfort or unhappiness. Sharing one's things or helping each other can be a cause of unity in the classroom. Thus, understanding physical causality is prerequisite to the development of social awareness and understanding the dynamics of interpersonal relationships (psychological causality) (Muss, 1961).

The spontaneous interest in science that emanates from children has been documented by Byers (1964). She found that during the unstructured sharing periods in the classroom, the largest number of items discussed by both boys and girls were under "science and nature". An understanding of physical causality then is of crucial importance for the science curriculum as more advanced work is based on the knowledge of this fundamental notion. Similarly, a careful structuring of the science curriculum for young children is a necessity as the planned activities can foster and enhance an understanding of physical causality. According to various researchers, explanations of physical events in terms of cause and effect relationships should be an integral part of science education at the pre-school and elementary school level. Through manipulating objects and producing simple cause and effect changes, discovering and stating elementary rules, children should begin their study of science. The types of causal explanations which the children give would then give the educator some idea of the developmental level of their thinking.

A potentially valuable contribution to the development of a science curriculum can be made by identifying the various intellectual abilities that pertain to a child's understanding of causal relations. Berzonsky (1975) has identified component abilities of children's causal reasoning, namely, understanding chance events, detecting incongruous causal relations, completing "because" statements and displaying a skeptical attitude. His results suggested that concrete experiences with familiar objects and phenomena may be necessary before a child can understand causal relations.

All these experiences and activities in science will contribute to the development of inductive and deductive reasoning in the child. The process of induction is strengthened when observations of events are made and then verified by experiments thereby providing empirical evidence. A child can test and identify for himself the cause and effect of an event, e.g., if he forgets to water his plants (cause), they will wilt and die (effect). Children are great inducers as they notice things, test them out and arrive at some conclusion. In addition to inductive reasoning, learning to think deductively is very important in the process of acquiring knowledge. The process of deduction involves first the articulation of a statement and then on the basis of this, other propositions, theories and hypotheses are derived in a logical and consistent manner. However, the deductive formulations must then be supported by the process of induction. In science, principles and laws are derived deductively from the theories and then their validity is tested, e.g., the effects of the law of gravity can be demonstrated by experiments. With children, it is this attitude of wishing to test out ideas that should be encouraged.

DEVELOPMENTAL CONSIDERATIONS

An understanding of how the concept of physical causality develops in the child can be an invaluable tool in teaching. Most of the developmental research has been documented on children from the age of four and very rarely on younger children. Some investigators have attributed a rudimentary form of causal orientation to the exploratory and manipulatory activities of the infant.

As early as a few weeks after birth, a baby explores his physical environment both visually and physically. His interactions aid in the construction and reconstruction (assimilation and accommodation in Piagetian terms) of his mental structures. When children discover regularly that one thing or action invariably leads to another, the notion of causality is born. Stern (In Huang, 1943) reports that after the age of three months, the infant plays with objects and gives himself a lesson in physics and geometry. When about nine months old the child through ceaseless manipulation acquires the groundwork of physics. This occurs through his acquaintance with the most elementary properties of things (Gesall and Thompson, in Huang, 1943). The presence of the rudiments of causal orientation have been shown in infants as early as 28 to 40 weeks of age. In a string-toy experiment, the infants always pulled the string to bring the toy within their reach.

Children, as they mature, begin to perceive the existance of causal relationships in physical events, particularly those in which they themselves participate. Following this there is a certain sequence in the development of their thinking about causal relations. To gain some idea of the child's evolving views of the natural occurances in the physical environment, many investigators have presented children with various questions about the origin and activity of events around them.

Piaget (1930) studied the development of the notion of physical causality in children with the express purpose of diagnosing the underlying cognitive structures. He presented questions and demonstrations on such phenomena as the nature of air, clouds, water, floating objects, shadows, dreams and how machines work. Seventeen types of explanations were identified. The first nine types were characteristic of children before seven or eight years of age and were basically non-naturalistic explanations, namely, motivational, finalistic, phenomenistic, participation, magic, moral, artificialist, animistic and dynamic. This is the stage of pre-causality and the child interprets the world through these structures of mind. Huang (1943) states that for the sake of simplicity these nine types may be collectively termed animism or anthropomorphism—children tend to treat physical phenomena like animal or human behaviors. The latter eight types of explanations are naturalisitic or physical and mechanical in nature. They appear at about seven or eight years of age but are not prevalent until ten or eleven years of age. This is the stage of causal thinking characterized by explanations that refer to spatial contact, mechanical contact, logical deduction, etc.

Precausal Reasoning

These developmental stages are described in great detail by Piaget (See prototypical learning experiences for brief description of all stages.). At this point, it would be pertinent to draw out the salient features that are of pedagogical relevance. Piaget sought to enquire into the relationship between the thought of the child and his construction of the reality of the external world. He emphasizes that the child builds his own concept of reality and will not readily accept the adult's point of view. As the child develops his intellectual abilities he gradually pases from an initial stage of ego-centrism to a state of objectivity. Explanations of the concept of physical causality provide some idea of where the child is along this developmental continuum from egocentric thought to objective thought.

To be objective, there has to be a conscious recognition of the "I" or self. Initially there is a lack of differentiation between the self of the child and the external world. This leads to a confusion about internal and external, objective and subjective, physical and mental. The external world shares the characteristics of the self, e.g., awareness, purposiveness, feeling, etc. Differentiation occurs in a parallel fashion. The child gives structure to the external environment and also becomes aware of his own self. As the thought of the child matures, there is progressive rationalization and objectification.

During the pre-causal stage, explanations of physical events are based on psychological reasons. There is a tendency to see the physical world in terms of human and animal behavior and this is expressed in a variety of cognitive dispositions. The major dispositions are termed phenomenism, finalism, artificialism, animism and dynamism.

1. Phenomenism. This is the most primitive form of representation of reality by the child. A causal connection is established between phenomena which are contiguous either in space or in time and which bear some relationship for the child. For example, everything is linked to anything such that the color of an object explains why it floats.

2. Finalism. In this form of precausal thinking the world is organized along well-determined plans and centered around human activity. The finality implied in the explanations is not tied to usefulness. A child often relates the origin of events to motives of a psychological or moral nature, e.g., dreams exist to entertain or punish the dreamer; large mountains exist for adults and small ones for children.

3. Artificialism. This is an extension of finalism but adds the explicit action of a maker at the origin of certain things. It is either God or men who are held responsible for the existence of all objects in the world, be they natural or artificial. For example, lakes are thought to be dug out by men.

4. Animism. Through this form of explanation, the child gives life and consciousness to inanimate objects and events, e.g., the moon follows me.

5. Dynamism. This attributes energy similar to man to inanimate objects. They are therefore capable of movement and action, e.g., clouds choose to go and move without any help.

This stage of precausality as posited by Piaget has created a controversy among developmental psychologists. Many studies have been conducted trying to prove or disprove Piaget's work in physical causality. A major study supporting and confirming Piaget's results was carried out by Laurendeau and Pinard (1962). They reinvestigated, under controlled conditions, Piaget's studies and discovered the definite existence of stages of precausal reasoning among 500 children (4-12 years old). These investigators have pointed out the need for cautious interpretation of results in the area of physical causality, particularly in relation to the methods of examination, type of questioning, types of subjects and techniques of analysis of results.

Opposing views on the existence of precausality have been put forward by many researchers. Huang (1943) studied American and Chinese children. He found that mystical and anthropomorphic explanations were almost completely absent. Huang's contention is that children only sometimes explain natural phenomena in animistic, dymanic or magical terms. Deutsche (1937) reported similar results and also found mechanical and logical explanations at a young age (Kindergarten children). In her work with the Manus tribes on Admirality Islands, Margaret Mead (In Huang, 1943) found that children did not use animistic thinking but instead used a more practical form of cause and effect explanation, i.e., related to their experiences.

Causal Reasoning

Before one can investigate the process of causal reasoning, it is necessary to identify the influence of relevant situational factors. Baldwin (1955) and Russell (1956) have suggested that children revert to non-naturalistic causal explanations (based on animism, magic, etc.) when the phenomena in question are unfamiliar and are therefore unable to explain it in any reasonable way. Berzonsky's (1971, 1975) studies have also supported the fact that a child's familiarity with objects or events is a decisive factor in causal reasoning.

The role of experience in causal thought has been well established by the work of Mogar (1960), Huang (1943) and Berzonsky (1975). Mogar in her work with six year olds used an experimental group of children who were allowed to play with floating and sinking objects, and a control group who had no exposure to the activity. She found positive evidence that young children can induce causal relationships from repeated observations of the phenomena.

The influence of experience and familiarity in children's causal thinking has been substantiated by Inbody. He found that phenomena with which children had physical contact were explained correctly (Inbody, 1963). Children should be taught to observe phenomena carefully and helped to find the correct causative factors (see paragraph in prototypical learning experiences on guiding interaction).

Various investigators have concluded that young children do not give proper causal explanations because their language skills are not highly developed. In work done with deaf children, Furth (1964) has relegated language to a subsidary role in the development of concrete operational thinking. Verbal responses attributed to linguistic sophistication did not give hearing children any advantage over deaf children. This means that a child can understand physical causality even though he does not speak about it. However, it is helpful to encourage the child to articulate his explanation as this is a great asset in clear and logical thinking.

Several studies on physical causality with children with psychological problems have been conducted. Berger et al (1969) found that children with severe psychogenic learning inhibitions used developmentally less mature concepts than normal children. The disturbed parent-child relationship retarded the initial development of causal concepts through a distortion of reality, secrecy and deception. Nass (1959) studied withdrawn children and found that the personality of the child affected his understanding of cause and effect relationships. The nature of causal thinking of the withdrawn child was at a significantly less mature level than normal children. The children find the environment threatening and retreat into their world, thereby reverting to prelogical modes of thought.

Perhaps the safest conclusion that can be drawn from the literature on causal thinking is that the development of the child progresses in an orderly, sequential and predictable manner. All children learn to crawl, sit, stand and then walk and in so doing follow the same sequence in the process of maturation. However, in areas that are strongly influenced by the environment and experience, such as causal reasoning, it seems unlikely that the sequence of development can be attributed to the factor of maturation alone. The research has amply shown that the preparation of the environment can have a definite influence on the child's capacity to observe and understand the causal relationships of natural phenomena.

EDUCATIONAL OBJECTIVES

A crucial aspect of the ANISA curriculum is to assist the child to become a competent learner through an understanding of various processes. Knowledge of the process of physical causality allows for the correct interpretation of physical phenomena in the world. It also serves as a basis for action, not only in pursuing one's purpose in life but also in how one relates morally and socially to other people. This emerging competency endows the child with a powerful tool for investigating and understanding the world in which he lives.

With these notions in hand, the following educational objectives can be a valuable aid in developing and strengthening the process of physical causality. Stated from the point of view of the learner and what he should be learning, they include:

1. Developing and sustaining the desire to seek explanations of physical events in the environment.
2. Developing the technique of asking "why" questions.
3. Identifying the sequence of temporal order, i.e., beginning and end, intermediate stages, first and last.
4. Familiarizing oneself with many simple observable phenomena.
5. Learning how to observe simple phenomena so that the cause and effect can be differentiated.
6. Repeating observations of various phenomena so that the idea of a definite, predictable sequence is grasped.
7. Generalizing the observations to form a hypothesis that can explain these observations.
8. Experimenting in concrete situations so that by the manipulation of materials cause and effect changes can be produced and the validity of the hypothesis tested.
9. Verbalizing observations so that a cause and effect relationship can be conceptualized more clearly.

10. Learing to predict what might happen given all the necessary information.

PROTOTYPICAL LEARNING EXPERIENCES

The child's ability to handle concepts of reality depends upon the growth of his cognitive structures through interaction with the environment. It follows, then, that this interaction is crucial in the understanding of the process of physical causality which in itself is an integral aspect of the development of the notion of reality in the child. Repeated observation of simple physical phenomena, familiarity with these phenomena and simple prediction and experimentation will enable the child to consciously differentiate cause and effect and integrate the elements so that they are generalizable. This concrete approach has been amply substantiated in the literature. Inbody (1963) found that when children did not have direct involvement with events they were likely to do any or all of the following:

1. Confuse cause with effect.

2. Attribute causation to animistic or metaphysical agents.

3. Consider an event unique without causation.

These factors have important pedagogical implications. the environment should be so arranged that it invites the child to interact with various materials and to investigate, explore and ask questions. A skillful teacher can guide this interaction so that the child can always be taken a small step further in his thinking and reasoning capabilities. First answers should not just be accepted as the end of the matter. The child should be led to justify and explain his answers through a series of probing open-ended and counter-questions, and even some suggestions to test the limit of his comprehension. Science activities can then become not only a matter of enjoyable play but also of growth in intellectual understanding about the world which involves logical, mathematical and scientific thinking.

Grasping the ideas inherent in the process of physical causality also strengthens other related cognitive processes, e.g., observation, prediction, hypothesizing, generalizing, experimenting, induction, deduction and measurement as well as space, time and velocity relationships.

Knowledge of the developmental stages involved in physical causality can help a teacher to diagnose a child's level of functioning and so individualize instruction. Although the literature in this particular area is controversial, it would be safe to venture that children do progress sequentially in their cognitive development. Piaget's age norms for particular stages are only approximate and the range of variation among children can be quite wide. Some children when five years old are capable of explaining events in a logical manner whereas others who are eight years old may not do so. However, the following breakdown of stages may serve as an approximate guide in diagnoisng children's stages of development.

Age (Years)	Explanations may be:
3-5	Motivational phenomena, finalistic, magical, moralistic, participation (pre-causal).
6-8	Artificialistic, animistic, dynamic (pre-causal).
9-11	Mechanical, logical (causal).

Pre-causal reasoning

1. Motivational:	Human motivation is the cause of everything, e.g., nightmares come because we have been bad; rain falls to make us feel cool.
2. Finalistic:	Things are so because they just are, e.g., fish have fins because they are part of fish; trees have leaves because they should have them.
3. Phenomenistic:	Relates two facts that occur close together in time or space, e.g., the boat floats because it is red.
4. Participation: Magical:	One's thoughts and gestures and words influence people and events, e.g., sun and moon follow me when I walk.
5. Moralistic:	Events occur because they have to, e.g., the sun must set so we can go to sleep; boats float so that they will not sink.
6. Artificialistic:	Believes that objects and occurences are man-made, e.g., man makes waves, the sun, etc.; man makes clouds move and wind to blow.

7. Animistic: Shows non-living things behaving as if they had life and consciousness, e.g., clouds move so that they can get to different places; heavy objects sink because they like to.

8. Dynamic: Attributes energy similar to man's to inanimate objects, e.g., clouds choose where to go and move without any help.

Causal Reasoning

1. Mechanical: Attributes some mechanical cause to events, e.g., pedals make a bicycle go; cars go because of their steering wheels.

2. Logical: Gives sufficient and adequate reasons for events, e.g., clouds stay up in the sky because they are light.

Guide for Planning Prototypical Learning Experiences

1. Decide on the process underlying the learning competence to be strengthened and the experience (guided interaction with the environment) required for that strengthening.

2. Plan the arrangement of the environment:

   a. Decide the number of children at any one time to be presented with the experience.

   b. Decide on the physical space and conditions needed for the experience (mats on floor, table facing wall, chairs in semi-circle, dim lighting).

   c. Decide on the amount of time the experience may take.

   d. Plan other activities which might take place at the same time to enable the teacher to devote full attention to the prototypical learning experience presentation (decisions on a., b. and c. are needed for all activities).

3. Plan the guided interaction:

   a. Prepare and assemble the materials for the prototypical learning experience.

b. Prepare the demonstration.

1. Work with the materials.

2. Decide on the layout, sequence and end point of the experience.

3. Rehearse hand movements, eye contact, etc.

4. Rehearse the presentation:

Go through the complete experience, step by step, with team members and teacher aids alternating roles as the child and teacher.

5. "Go through" the real experience with children.

6. Critique the presentation, discussing all preparatory steps in light of the actual child responses.

Experience I:

Objective:

To enable the child to understand that there is a logical relationship between the composition of clouds and the reason why they do not fall down from the sky.

Materials:

Pictures showing clouds in the sky or else look outside and observe clouds above.

Activity:

Ask the child to describe objects in the sky. Continue initial questioning e.g., are they big or small; do you think they are light or heavy; what color are they, etc.

Once the white objects have been identified as clouds, ask the child why they do not fall down from the sky, i.e., how do they stay up there? This activity will be most suitable for very young children as it will indicate their level of thinking.

Evaluation:

These are possible answers that children of different ages might give to the question, "Why don't clouds fall down from the sky?"

Age (Years)	Answer	Stage
3-5	God holds them.	Magical
6-8	The sky holds them there.	Phenomenistic
9-11	The air (or wind) lifts them up.	Mechanical
	They cannot fall down because they are light.	Logical

Experience II:

Objective:

To enable the child to grasp the idea that various parts of a bicycle interlock and work indepenently to create the overall result of movement.

Materials:

Clear large picture of a bicycle showing particularly the wheels, pedals and chain, or bring in a bicycle.

Activity:

Ask the child to look at the bicycle and then name the various parts, particularly the wheels, pedals and chain.

Ask how one rides a bicycle, i.e., what movements are involved on the part of the child.

The major question is: "What makes the bicycle go?" Various suggestions should be given if the child does not know. If a bicycle is present, roll it along to see what happens.

Variation:

An eggbeater (old-fashioned type) can be used to demonstrate that the turning of the handle causes the large vertical wheel to rotate and this causes the two smaller horizontal wheels to rotate which in turn finally make the large bottom wheels rotate to beat the mixture.

Evaluation:

Explanations as to "What makes the bicycle go?" can vary greatly depending on the experience of the child.

Age (Years)	Answer	Stage
3-5	The wheels	Phenomenistic
6-8	You pedal with your feet	Mechanical
9-11	When you pedal, it moves the chain and the wheels turn.	Logical

Experience III:

Objective:

To enable the child to understand that a pebble when placed in water displaces a volume of water equal to its own volume and this is the reason why the water level rises.

Materials:

Clear drinking glass
Pebble
Water

Activity:

Half-fill the glass with water.

Show the child the pebble and discuss its size, shape, etc.

Ask the child to predict what will happen to the water when the pebble is put into it, i.e., will the water go up, or down or stay the same.

After the prediction, allow the child to put the pebble into the water and observe the effect.

Ask the child why the water rises once the pebble is put into the water.

Evaluation:

This is a difficult concept for young children to understand. Conservation of volume is only attained at about 11-12 years of age but a 5-6 year old can be shown that the water will rise. To do this, the level of water can be marked with chalk before and after the pebble is placed in the water. The older child will have to learn that any object occupies a certain amount of space because it has a particular volume. When the pebble is placed in the water it then displaces the amount of water that is equal to its own volume.

Age (Years)	Answer	Why?	Stage
3-5	Will stay the same.	It has to stay the same.	Mechanistic
6-8	Will go down.	Because the stone is heavy.	Mechanistic
9-11	Rise or go up.	The stone takes up space in the water.	Logical.

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