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ABSTRACT

This document describes a project designed to explore the possibilities of children's learning in mechanics. The principle of the lever, one example of a simple machine, was used in the form of a balance toy. The apparatus was set up as a game in a specially devised learning center. The children made non-verbal predictions as to which way the bar would tilt when various weights were placed at either end. After completion of a pilot study, 22 kindergarten children were chosen as subjects. Half of the groups received orientation to provide a clear replicable procedure for introducing the materials. A criterion test was developed. The apparatus was then placed in the classroom with no restrictions as to who could use it or for how long. Observers noted the children's behavior, recording anecdotal information and use of the balance. On the fourth day, all children were posttested. Results indicated that both groups (with or without orientation) performed similarly on the posttest. Discussion centered on the use of learning centers in open classrooms for facilitating learning, and the possibilities of teaching scientific principles to young children. (DP)

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A LEARNING CENTER ON THE LEVER FOR YOUNG CHILDREN

by

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Appreciation is expressed to the Brentwood Presbyterian Church Nursery School, Mrs. Jane Gruber, Director, and Mrs. Jean Smiley, Head Teacher; and the Santa Monica Children Centers, Mrs. Docia Zavitkovsky, Director, and the Ocean Park Children's Center, Mrs. Libbie Ranslem, Head Teacher and Mrs. Betsy Laumillet, Kindergarten teacher, for their interest and participation in this study.

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LEARNING ABOUT THE LEVER

Every young child's encounter with the physical environment offers a potential contact with the field of science. A rich experience is always available to cultivate the child's wonder and exploration of his environment. In particular, one door, often opened by teachers, is the world of biology: children in a nursery school frequently participate in projects in which they observe the ways pets grow and plants germinate. The physical sciences have also been introduced through projects which are created for and by the young child; children are fascinated to learn about how flashlights work, why it rains, or the mystery of ice.

It was the purpose of this project to explore the possibilities of children's learning in another field of physics, specifically, the branch of mechanics. It was the principle of the lever, one example of a simple machine, which was selected for this project. This idea states that a small force acting over a large distance can be transformed into a large force acting over a small distance and vice versa. The principle is reflected in many ways in the child's own personal world. For example, his tricycle, the see saw, a can opener, and his own arm all involve the principle of the lever. It would seem most appropriate to help young children explore this world and thus increase their understanding and sense of mastery.

In this study children were introduced to the use of a simple lever in the form of a balance through a specially devised learning center. They were helped to explore this relationship in several ways by playing with apparatus as a game. The goal posed was to make predictions as to which way a balance would tilt when weights were placed upon it. Children on a see-saw soon discover that sitting out on the very edge pulls them down and raises their partner on the other side, who is sitting closer to the center. This simple idea was demonstrated by the apparatus. By restricting the number and arrangements of weights, the difficulty of the problem was adjusted so as to be appropriate for young children.

In this center children played with two equal weights, which could be placed one on each arm of the balance, as on a see-saw. Weights could be placed only on pegs, three on each side. The principle which was to be learned was simple: the way the balance tilted depended solely on which weight was farther from the center (the fulcrum).

The same principle of the lever was illustrated in a variety of ways by giving the child an opportunity to play with other equipment. For example, a model see-saw was created where dolls could sit in one of three possible positions on each side. Another balance provided only two positions on each side of the fulcrum. On a third balance a doll was raised or lowered by sliding a weight on the opposite side; in the far-out position the weight caused the balance to tilt one way, but when slid into the center the balance tilted in the opposite direction. Still another toy involved the use of a

lever in which the child's own weight on a small "crowbar" permitted him to lift up a metal plate otherwise held tightly against a magnet; unless the child adjusted the lever properly, he could not budge the plate.

For all of the experimental toys, the balance bar or lever was painted yellow while the rest of the apparatus was green. In this way it was hoped to call the child's attention to the lever and its point of support, and thus see the relationship involved in many examples.

The major study was carried out only with the first balance described, a learning center called the Monkey Balance Game. The other items were used for general observation of children's play but no quantitative information was obtained. The purpose was to discover whether young children would play with these materials in ways that would help them learn the principles of the lever as demonstrated by their ability to predict.

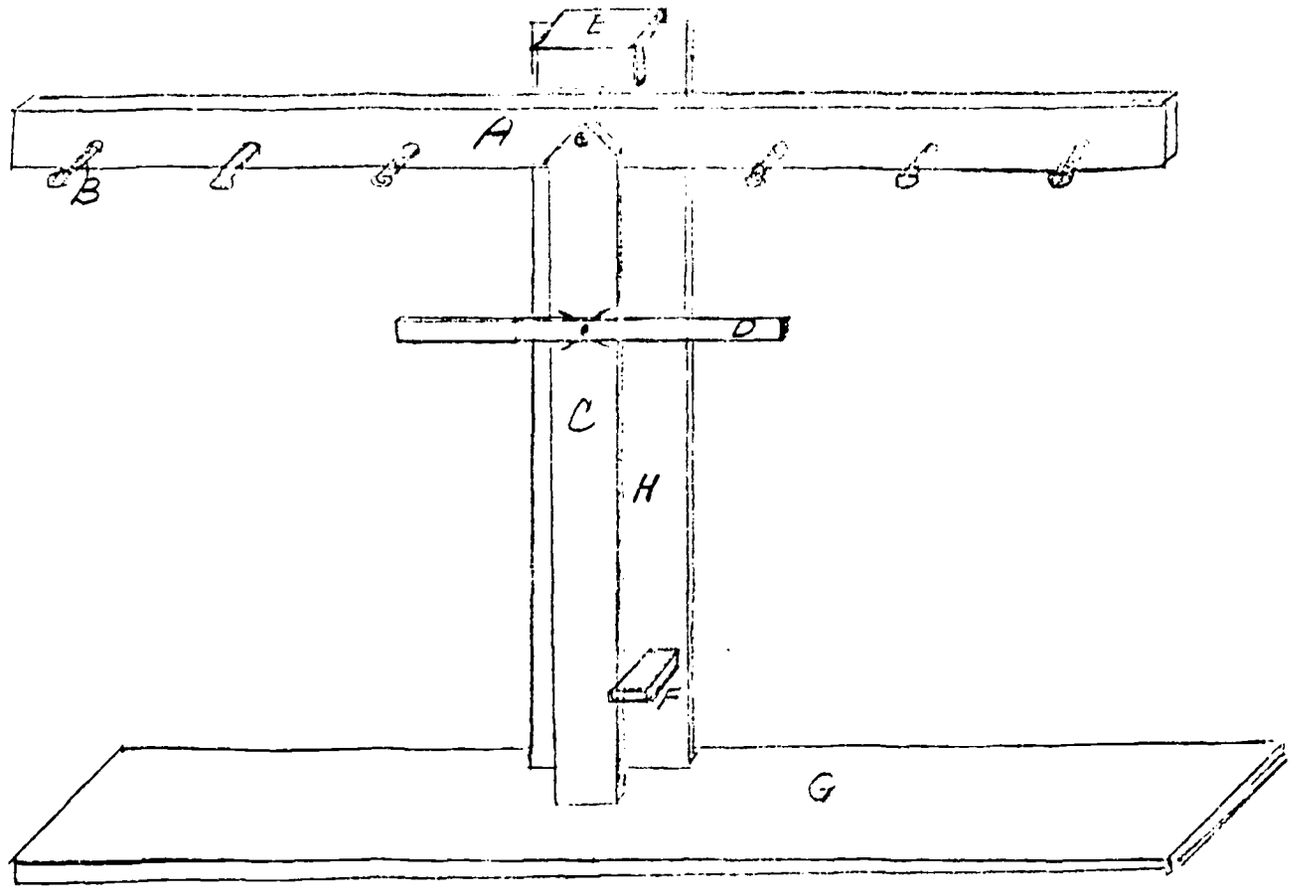
The Monkey Balance Game

The apparatus used for the Monkey balance Game consisted of a 30" balance, mounted on a post, which was in turn fastened to a platform, 10" x 30" in size. In Figures 1 and 2 drawings are presented to show the apparatus in detail. On each arm of the balance three pegs were inserted at intervals of 4-3/4" from the center. Weights could therefore be suspended from any of six positions.

Weights for this game consisted of two small wooden monkeys obtained from an import shop. (An illustration is presented in Figure 3.) It was easy for a child to hang either monkey, by its outstretched arm or tail, from any of the pegs. By inserting as many lead pellets as needed, the weights of the two monkeys were made equal, so that when they were placed on pegs equidistant from the center the balance would remain in a level position. When the monkeys were placed in any other positions, the balance would tilt at a 45° angle. However, a brake on the lever kept the balance fixed in a level position until the child was ready to test it. In order to find out which direction the lever would tilt, or if it would tilt at all, the child pressed down on a handle to release the brake. When he let go of the handle, it locked the balance again.

The game consisted of making predictions as to what the lever would do when the monkeys were placed on the pegs in different arrangements. To help the child make predictions in a visual, motor, and non-verbal fashion, a small "prediction bar" was placed on the post below the balance. This bar, fastened in the middle to the post, could be moved only to three positions, a 45° tilt to the left, level, and a 45° tilt to the right. The small prediction bar was also painted yellow so that the child could easily tell whether the bars were or were not parallel, and thus whether the prediction he had made was confirmed. To play the game, the child placed the two monkeys on any of the pegs he wished, set the prediction bar the way he thought the balance would tilt, and pressed the brake handle to check out his prediction.

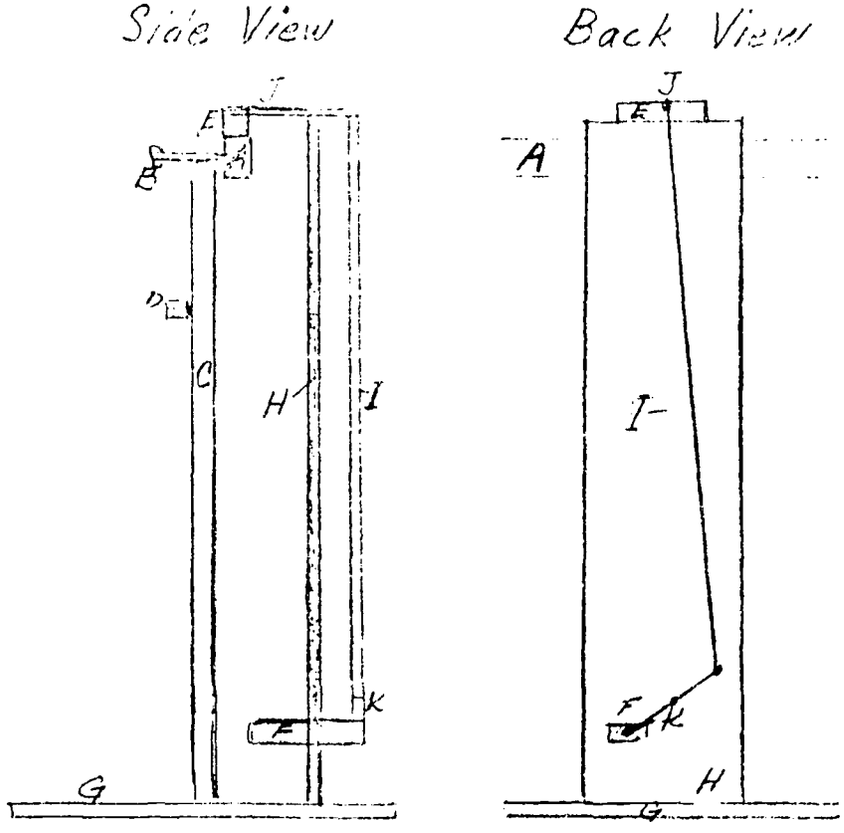
Monkey Balance Game



A - Balance - 30" x 1 3/4"
B - Peg & knob - 2"
C - Fulcrum - 16 3/4"
D - Prediction Bar - 12"
E - Brake
F - Brake Release
G - Stand - 30" x 10"
H - Plate to hide brake mechanism

Figure 1. Front view of Monkey Balance Game.

Monkey Balance Game



A - Balance
B - Peg
C - Fulcrum
D - Prediction Bar
E - Brake
F - Brake Release
G - Stand
H - Plate to mask brake mechanism
I, J & K rods of brake mechanism

F pressed, pivots K, lowers I, pivots J and raises E to release A

Figure 2. Side and Back View of Monkey Balance Game.

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Figure 3 . Monkey used in Monkey Balance Game.

Pilot Study

The balance game was first pilot tested with 22 four and five year old children in a private nursery school. Children were introduced to the Monkey Balance Game first in an individual setting. Then in one corner of the play yard a center was created using the entire set of equipment previously listed.

As a result of the pilot study a number of important developments were initiated:

1. Modifications in the apparatus were made to make the principle clearer to the children.

2. An orientation was produced to provide a clear replicable procedure for introducing the materials. In the orientation procedures the experimenter made sure that the children understood that the balance was free when the brake handle was pressed and that it moved into three possible positions. A complete description of the orientation is presented in Appendix A.

3. A criterion test was developed as a result of exploring the value of several kinds of questions. This test in final form consisting of 13 questions is given in Appendix B. In the first eight questions, the experimenter placed the red and blue monkeys at various positions on the opposite sides of the balance and the child was asked to use the small bar to predict the direction the large bar would tilt when the brake was released. Then, in the last five questions, he was asked to use the monkeys to make the balance tilt in the direction indicated by the prediction bar as set by the experimenter.

4. On the basis of results of criterion testing and observation it was decided that five years old would be the most appropriate age for use of these materials.

Major Study

A more formal study was then conducted with 22 children in a public school kindergarten class. Half the class was selected at random for orientation and criterion testing. They were taken individually into a classroom, given the orientation and test, and then allowed to play with the apparatus for about 10-15 minutes. When the child asked the experimenter questions, he was told to "try and see what happens".

The game apparatus was then placed in the open classroom for three two-hour sessions during the free play period. All children in the class were encouraged to play with the game by the teacher, just as she would encourage the children to play with any other toy or resource in the school. Meanwhile, after the first day, the other related toys were introduced to the learning center: the see-saw, the sliding balance, the crowbar, and the simple balance. There were no restrictions as to who or how many could play.

An observer was stationed nearby to note the behavior of children during their play at the center. Anecdotal information and the extent of use of toys were recorded.

On the fourth day, all children were posttested on the monkey apparatus using the same question in the criterion test. For half the subjects, the non-oriented children, this test was encountered for the first time. In addition 12 children were asked the same criterion test questions for the see-saw game, the experimenter acting as the "brake".

Results

In Figure 4 are presented the results of the pretest and posttest for the oriented children and in Figure 5 the results of the posttest for the non-oriented children. It should be noted that non-oriented children who were given no special instruction, but who were allowed to play the game in the open classroom, performed on the posttest almost as well as oriented children who were given an individual opportunity to explore and play with the materials. This second group was given no pretest and thus received no special set to learn. Of course, the non-oriented group undoubtedly observed their peers and appeared to profit from the experience fully as much as those given special individual orientation. Figure 6 presents the results of the see-saw test. Although no pretest scores are available for the see-saw, the posttest scores were as high as those of the Monkey Balance Game.

Throughout the three days of free play with the equipment there was much interest in the learning center especially when another new toy was introduced. With the exception of a few 3-5 minute periods, the materials were in constant use by one or more children. However, wide individual differences were noted. Some children played at the center a good deal, others participated only slightly. While there was some sense of turn-taking by the children, there was quite a bit of mutual help and even competition on more than one occasion. Children on two different pieces of equipment raced to see who could do all the possible positions first, taking turns calling them out. One girl even drew a picture of each of the positions and wrote in the words "straight", crooked", and "down" as descriptive labels.

Discussion

The results of this study have suggested the possibilities of introducing young children, at the kindergarten level, to principles of mechanics which are involved in their personal world. Furthermore, by simply providing the opportunity to explore materials which illustrate the principles, the youngsters were able to learn salient relationships, with little or no teacher intervention. The materials provided were fun to play with as reflected in the children's eagerness to play each time. This in turn made the center more popular and encouraged peer tutoring and peer interaction.

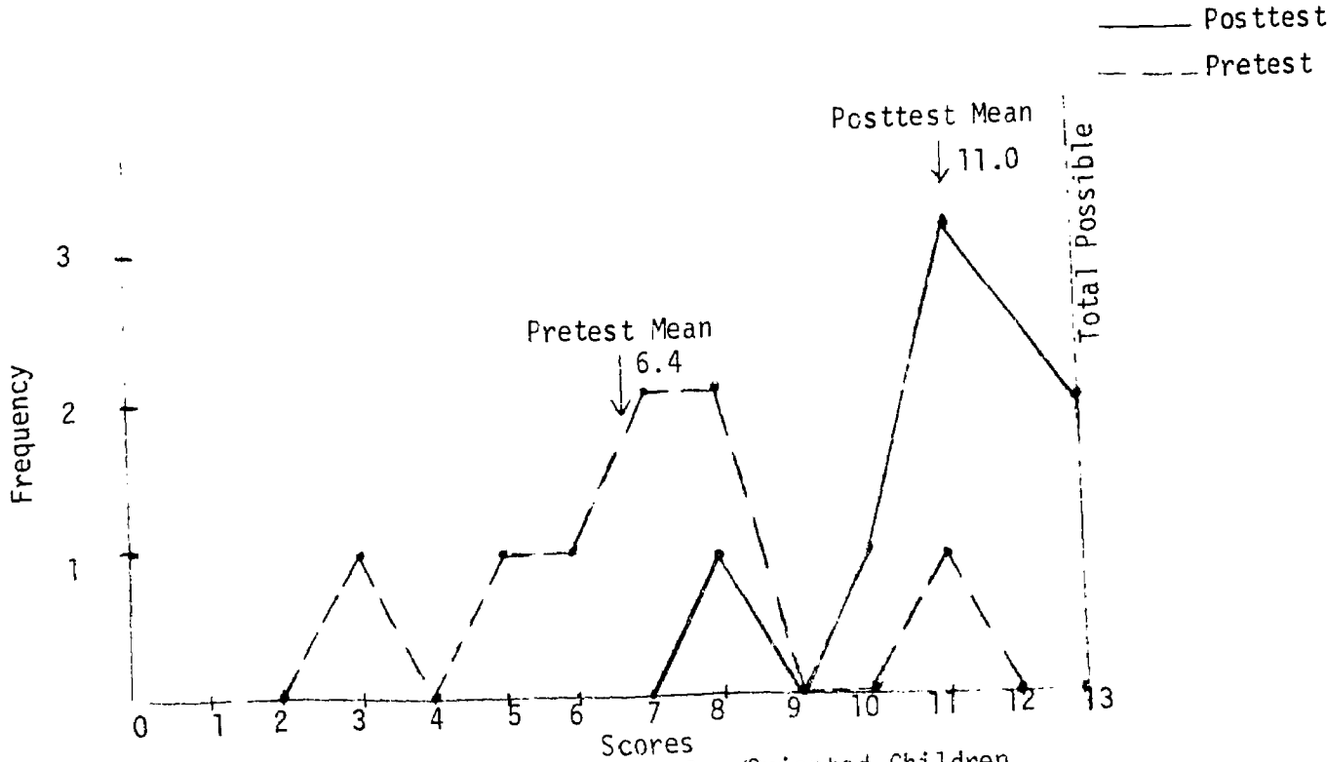

Figure 4. Pre- and Posttest Scores for Oriented Children .

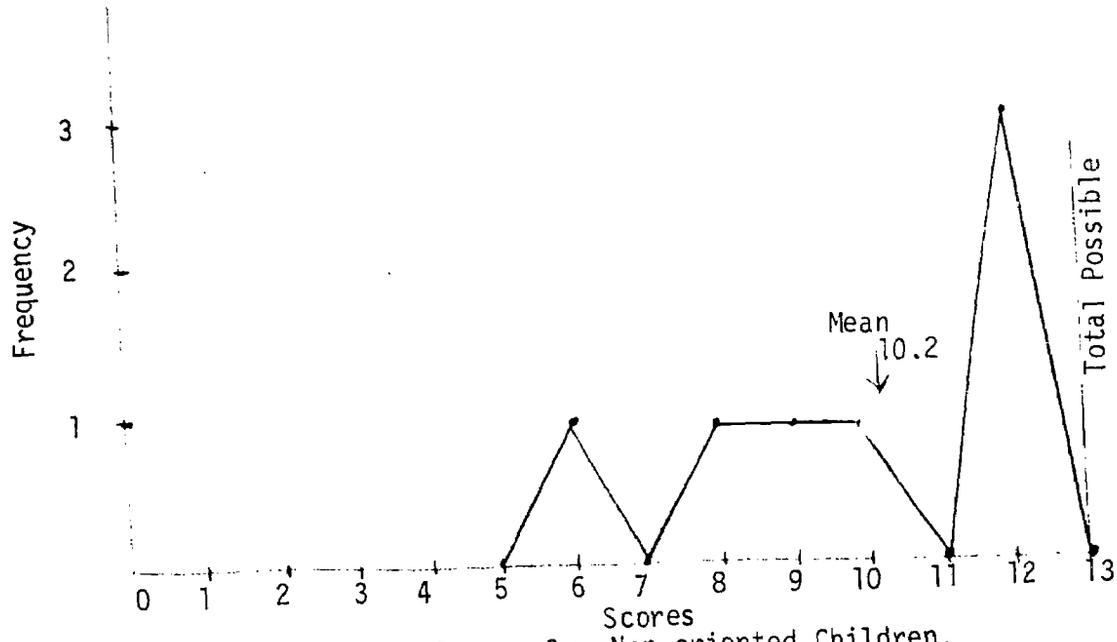

Figure 5 . Posttest Scores for Non-oriented Children.

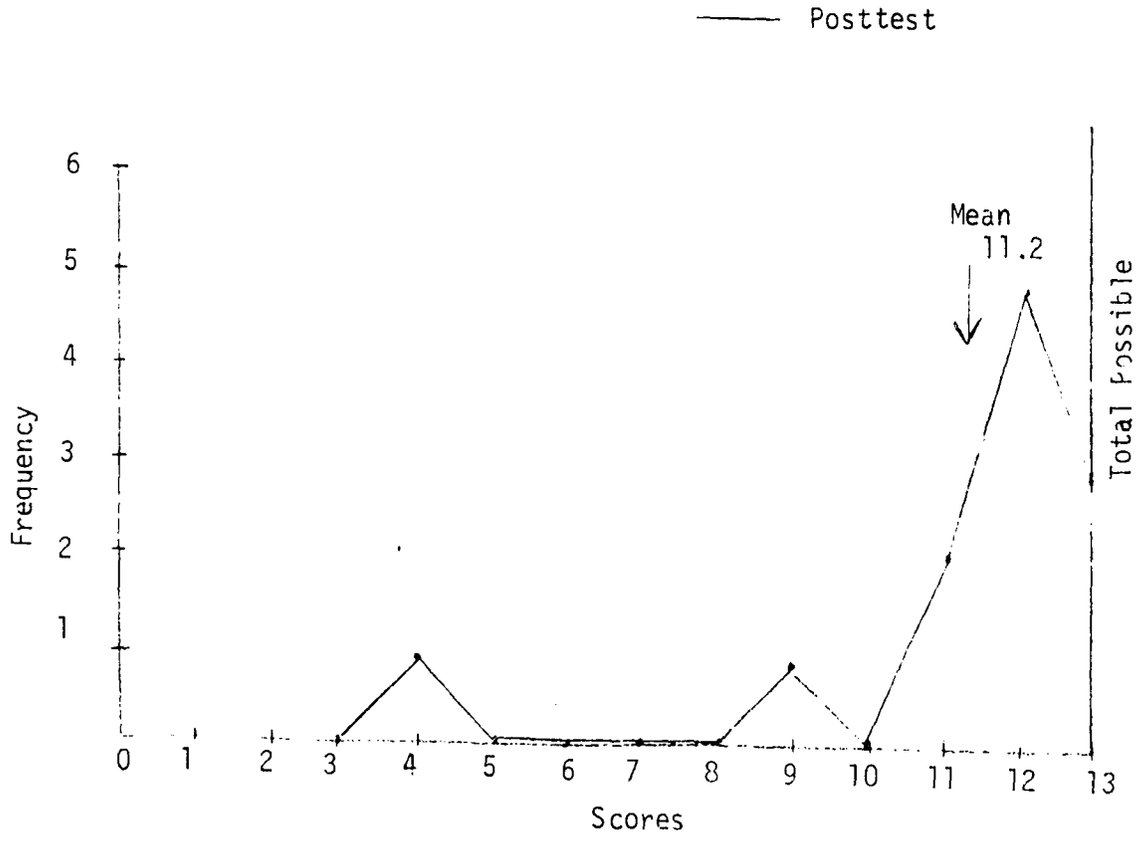

Figure 6. Scores of 12 kindergarten children on see-saw posttest.

The creation of learning centers illustrating principles of mechanics for young children need not be a costly enterprise. The materials used in the present investigation were simple and inexpensive. They can easily be made by parents or high school shop classes. Additional kinds of equipment can be introduced to provide a richer variety of illustrations of the principle of the lever or other principles may be introduced. For example, it is possible that some children even in kindergarten will wish to explore the use of more than two weights on the balance used in the present study.

One value of the field of mechanics for young chidren is the dynamic aspect of the exploration. The youngster can make things move; forces are being observed and compared. The principles are illustrated in phenomena which are attention getting and yet they are simple enough to be understood by young children. The field of physical science may need further attention in curriculum development for the young child.

Appendix A

ORIENTATION TO MONKEY BALANCE GAME

I. Instructions:

A. Orientation: (Purpose: To make sure the child understands that the balance is free when the handle is pressed; that it moves into three possible positions. Do not use terms like left and right.)

1. I want to show you how to play this monkey game. This is a balance. It works like a see-saw.

2. When I press this handle, (E presses) see how it moves. You move the balance (E presses handle again.)

3. It moves in different ways. You press the handle. When I push here (left) it moves this way.

4. (E presses the handle again). When I push here (right), it moves this way.

5. Sometimes it stays level. (No push but press)

B. Use of bar: (Purpose: to have child understand that he can move the bar to show where the balance will move.)

1. Now, here is a little bar.

2. You can make it move just like the big balance moves. You can move it here, or here, or here.

3. (E presses handle and tilts balance) Now you move it. (Make sure child moves it to the three positions.)

4. Now make the little bar look just like the big balance. (Press handle and move the balance to the left) Does it look like the big balance? Right!

5. (E presses handle and moves the balance to the right) Now make the bar look like the big balance. Does it look like the big balance? Right!

6. (Have balance level) Now make the bar look like the big balance.

Repeat above sequence until child can match.

C. Prediction of balance. (Purpose: to have child understand and set the bar to show the way the balance will look when handle pressed)

1. (Push balance, then child sets bar) Now I'm going to push here (E pushes left) Make the bar look like the balance. Is it the same? Good. (reset to level).

2. Now I'm going to push again, but you move the bar first. (Child sets the bar, then E pushes balance) Is it the same? Good.

3. (Repeat on other side - right)

4. (Leave bar tilted to right) Now I won't push. (E presses) See, the balance is level. Make the bar look like the balance. Is it the same? Good.

5. (Tilt the bar again) Now, I'm not going to push. How will the balance look? Will it move or will it stay level? Make the bar look like the balance.

Repeat if necessary.