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SELECTED DIMENSIONS OF SPACE AS CRITERIA FOR THE
SELECTION OF (PLAYGROUND) EQUIPMENT FOR CHILDREN
IN AN OUTDOOR LEARNING ENVIRONMENT

DISSERTATION

Presented in Partial Fulfillment of the Requirements for
the Degree Doctor of Philosophy in the Graduate
School of The Ohio State University

By
Donna Jean Thompson, B.A. in Ed., M.A.

* * * * *

The Ohio State University
1974

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Approved by
Margaret Mordy
Adviser
Department of Physical Education
Dedicated to children who

use space in more than one way

in directions unlimited

in ranges unbelievable

in levels unequivocal
ACKNOWLEDGMENTS

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VITA


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Studies in Research. Professors Donald Mathews, Delyte Morris

Studies in Teacher Education. Professor Lewis Hess

Minor Field: Curriculum

Studies in Curriculum. Professors Alexander Frazier, Elsie Alberty, Ralph Ryler, Paul Klohr

Studies in Supervision. Charles Galloway
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CHAPTER I

INTRODUCTION

Children like to move. Babies propel themselves through space in order to ascertain how their own body parts work and to explore their environment. Children need opportunities to discover the nature and capabilities of their bodies. They also need to become aware of their own anatomical structure which limits movement. Since children are curious, they soon begin to invade increasingly larger areas around themselves.

The kind of facilities provided may enhance or inhibit movement and an understanding of the body and its movement capabilities. The type of environment may encourage children to reorganize its parts to provide more appropriate opportunities for their movement interests. Their surroundings may also allow increased understanding of those environmental factors which must remain fixed. Thus, the children must learn both to control portions of their surroundings and also to adjust to certain situations (Piaget's assimilation and accommodation process). They need opportunities to play in both fixed and adjustable
environments so that they may become efficient movers. Thus, given children whose movement capabilities are equal, the one who is given more opportunity for producing activity in a wide variety of movement environments will probably become the more proficient in movement tasks.

Rationale
Concern about the environment in which children learn prompted the investigator to explore equipment available for children to use both in the gymnasium and on the playground. It might be more appropriate to call the gym an indoor learning center, but that term might be confused with the library. Likewise, the playground might be called an outdoor learning center, but that term is used by outdoor educators and environmentalists. Another alternative is in or outdoor movement learning center. In order to be consistent with the investigator's emphasis on using resources for educational purposes, the area commonly known as playgrounds usually will be called outdoor learning centers. A great variety of equipment is available for use in the elementary school gymnasium, and much equipment has been reduced in scale to better fit children's small sizes. Parallel bars, Swedish boxes, balls and bats are smaller and lighter than equipment for older children. Such equipment as cargo nets, small trampolines, and a wide range of sizes of playground balls is now available for children.
It is no longer necessary for a five year old child to sit in the middle of the gym crying because "the balls are too damn big."2

The outdoor area should also be considered part of the learning environment and the playground is part of that space. A playground has equipment on it. But, why should a study be concerned with criteria for the selection of equipment?

(1) Children deserve an outdoor environment that is the most conducive to learning and development.

(2) There have been no studies to determine criteria for the selection of playground equipment in conjunction with curriculum.

(3) People who are responsible for purchasing playground equipment need guidelines for doing so.

(4) Physical educators will be consulted about playground equipment and have little background information at present on which to base decisions for purchasing playground equipment.

Consider the following directives posted on playgrounds at different times in the history of the United States. One set of rules reads:

A. No horseplay
B. No jumping from moving equipment
C. No standing on swings
D. No pushing and shoving when in line
E. No throwing of equipment
F. No throwing sand, stones, rocks
G. No play allowed outside of regular playground areas.3

Another poster admonished children with these negatives:

1. No swearing
2. No fighting
3. No throwing litter or playing with fire
4. No running up the slide
5. No football or other ball games
6. No smoking by children
7. No throwing sand or stones, etc.
8. No bullying
9. Do not go into the closed gardens
10. No prejudices of any sort will be tolerated.

'Fifty dollar fine for anyone passing on this yard after school hours'--this foregoing sign was on the side of a school building in a middle-sized city in Arkansas, but certainly is not unique to that locality. Unfortunately, it represents an attitude that has been very nearly universal.

The school yard has been one of the least utilized of our educational resources. It has practically belonged to the janitor--surfaced with a view to his convenience, and used mostly in accordance with his desires. I do not know that there are any cases where he has used it to raise potatoes and family vegetables, but he might as well have done so for any advantage that has come to the school or the kids.

Not a few of the school yards in our great cities are surfaced with brick. I suppose that this surfacing must have been chosen by the janitor. It is an admirable yard for his purposes . . . causing him the least possible amount of annoyance.

Lest the reader assume that the cited examples only reflect the past, consider the next episode. The investigator visited Manhattan, Kansas, in April of 1974. While there, an architect who had designed a playground at an elementary school invited the investigator to visit his creation. As the visit progressed, the architect pointed to places on the equipment and eroding parts of a hill which needed repair. He attributed the deteriorating situation to a change in the custodial staff and
administration. Within a period of six months, something relatively new had begun to reflect the indifferent attitudes of those whose concerns are more for ease of maintenance by adults than for movement and adventure for children.

The attitudes toward the use of outdoor learning centers in the above examples are negative. Too often these attitudes are reflected by the kind of equipment which is built or installed in the school yard. The outside environment should reflect what is important to the educator and what he thinks is important to children.

Attitudes toward playgrounds are reflected in their history. Closely connected to their development was the growth of the recreation movement which Nash divides into four stages:

1890-1900 - Charity stage which was directed toward the poor and developed by private means;

1900-1910 - Park stage which stressed the importance of conservation;

1910-1920 - Playground and recreation commission stage in which civic organizations and the National Recreation Association ran recreational surveys in order to establish commissions for governance;

1920- School stage in which officials made provisions for more adequate physical education and recreation facilities and activities for pupils.6
Preston verified the school stage mentioned by Nash by indicating that state statutes began to provide for recreation and playgrounds and that large cities such as New York, Newark and Boston began to establish outdoor learning centers.

Interestingly enough, the rules of the Board of Education in 1916 in Cleveland forbade children to remain on or revisit school playgrounds after the afternoon dismissal. Sand bins were worn and empty. It is reported that some principals actually shoveled sand into pails and carried it to the trash.

While she gives no dates, Lady Allen of Hurtwood summarizes the evolution of playgrounds in the following manner:

1. Prison period—nothing on the playground
2. Iron-mongery period—proliferation of bars on equipment
3. Concrete-pipe period—lots of concrete and pipes
4. Novelty period—equipment has little lasting attraction; use of individual play sculpture and transportation vehicles as play apparatus
5. Maze period—uniformity of playground design by standardized, confining mazes
6. Do it yourself period—junk playgrounds; adventure playgrounds.

Playgrounds are developed primarily for two settings. One is recreational and usually found in parks and public play areas. The other is educational and generally found in a school setting or a combination school-park setting. It is amazing that both areas look so nearly
alike, if not identical on occasion, considering their logical differences of purpose. Perhaps neither the physical educator nor the designer are sophisticated enough to persuade the public to consider a change of format. Certainly a child can learn in either setting, but the crucial question is this: what does he learn? If the playground at the school is to reflect the educational philosophy of the community (as a specialized learning environment developed from curricula and programs consistent with that philosophy), why is it that the resources found on playgrounds seem to be primarily for recreational purposes? Where are the educational needs of children considered, and how, and by whom? If it is the case that educational purposes are simply not considered by those responsible for planning school playgrounds, perhaps children are being shortchanged by the learning environment provided for them. Perhaps playground planners need to reflect more carefully on purposes for which outdoor learning centers can be used.

Michael J. Ellis suggests that there are at least two kinds of playground users—(1) those who visit a playground once, and (2) those who return again and again. The question that concerns many of us is: Why are so many playgrounds—supposedly built for both recreational and educational purposes—built as though a child were only going to play on them once? For example, one might find animal sculptures, slides, and teeter-totters in both
recreational and educational settings. Each of those pieces is designed for a single purpose. When a child has exhausted his interest in performing on the object in the one way in which it was intended to be used, he begins to play on it in less safe although more ingenious ways.

What is the teacher's role in the development of an appropriate outdoor learning environment designed for children? Certainly it is the teacher who should design and implement a curriculum based on the needs of children and of the society in which they live. The teacher must implement what is worth learning, and when those decisions have been made, it is he who adapts the subject matter to the level of children's understanding. The teacher then needs to decide what processes will help children learn about themselves and their environment, and which resources they could utilize to develop the broadest understanding of curricular concepts. Hopefully the children will be able to participate in some of the decision making as well. However, it is the teacher who makes the difference. How effectively purposes are reached depends on the teacher. In order to develop physically, intellectually, socially and emotionally, children need a wide range of challenges built into the curriculum. Children need:

An appreciative teacher who uses every clue kids give her to provide safe and exciting materials capable of including many children, varying kinds of readiness, interest and competence. The teacher needs to recognize social potential. The teacher
needs to be responsive to ideas and alert to what sets kids off, that concepts develop gradually out of deep personal discovery and experience. Teachers can help kids recognize and appreciate feelings and help kids cope with them. Thus, although this paper concentrates on large equipment as one viable class of appropriate curricular resources, the investigator recognizes that decisions which the teacher makes regarding the needs of the children, the curriculum, content, and curricular processes may be of equal or greater importance than those concerned with resources to utilize in pursuit of content and process. The other decisions should be made first and should influence the choice of resources rather than the availability of resources influencing the choice of curricular content and processes.

One of the areas in curriculum in which teachers are vitally interested is the contribution which non-directed and free play activities make towards motor achievement. Of equal interest is the contribution that movement makes to a child's understanding of himself, and of his environment. Another interesting relationship under investigation is that between a child's ability to move and his ability to read or manipulate mathematical concepts. It seems reasonable to assume that non-directed play and physical education activities will be most effective in a well-planned environment which will elicit purposeful movement responses from children. The ability to
structure the environment in such a way as to elicit purposeful activity would be particularly important in situations where physical education activities are conducted by the elementary classroom teacher who, in most cases, has had limited professional preparation in physical education. Neither the classroom teacher nor the physical educator has had much preparation in selecting appropriate outdoor play equipment for children.

Thus, it seems reasonable to turn to research for guidance about the nature of children, movement concepts, and resources (in this case, playground equipment) which children may utilize in order to learn most effectively about themselves, their movement, and their surrounding. What can research contribute? According to Michael J. Ellis:

Research is value free and concerned with developing laws, systems of laws (theories), that best describe, predict and where applicable control events. Applied to children's play, research proceeds from descriptions to laws that predict events and finally to systems of laws that will enable both experimenter and practitioner to control the play behavior of children. It is the researcher's task to develop these generalizations and the practitioner's responsibility to apply them to maximize an outcome in his particular situation in a direction determined by the value judgment.12

Research can help describe how children use equipment and provide assistance for choosing specific pieces for children to play on when they are ready to cope with a particular movement idea. Further, in a parallel case, Carl H.
Stoltenberg asserts that a recreation specialist may assist a client in several ways:

1. To identify various activities and facilities that could be used to achieve program objectives.

2. To help a client evaluate various activities and facility alternatives.\(^{13}\)

A physical educator might well apply the suggestions given above to the selection of playground equipment for educational purposes. Stoltenberg suggests to the researcher that prior to conducting research, he should weigh the benefits of various alternative solutions for a problem by using appropriate criteria and assign priorities to solutions. The benefits to the playground planners can be determined by answering the following questions:

1. How many clients have this problem?

2. How poor is the information they are currently using to solve it?

3. Will our clients use the answers we obtain?

4. Comparing the . . . research of others with our own, do we have any unusual research capabilities that would enable us to be more effective than others in conducting research on certain kinds of problems such as personnel, collaborative groups, facilities, location, client contact?\(^{14}\)

In order to determine the current situation in regard to answering Stoltenberg's questions, it would only be necessary to survey students in any current elementary physical education methods class or classroom teachers in any school. The answers would reveal a dearth of informa-
tion about facilities and equipment and their relationships to curriculum. What little information is available is derived from popular articles, ads in magazines, and from salesmen for equipment companies. The primary method of research in recreation has been the survey, and recreation has been the area that has contributed the majority of current research regarding playgrounds. Sears and Dooley conclude that: "Research does not give much guidance regarding the effectiveness of different types of equipment." Jeannette G. Stone stresses that:

There is an absence of rigorous research about playgrounds and indeed about the whole outdoor environment. Testing could be done regarding safety and traditional equipment. It could occur at foundations, at universities, at centers of research and via other professional efforts to spur information gathering with a camera, notebook, parents, teachers, and volunteers.

Playground Corporation of America is one of the newer playground companies and emphasizes equipment with non-moving parts. Asher B. Etkes, its president, expresses concern for practical application rather than a scientifically staged play routine:

Do we, in fact, extract much benefit from being enlightened on what is happening? Is not the issue why it is occurring of far higher priority? There is concern because we have failed to ask questions like:

7. What has been the quality of the subject's playground experience and how has conventional
play equipment structured his response toward demand? In fact, what is quality?

8. How does creative play, or the absence of it, influence the classroom experience?  

Thus, those concerned with the possible relationships between child development and children's play equipment express a need for research regarding the outdoor learning environment. It would be encouraging if progress had been made to resolve some of the questions, but little has occurred. In 1917, H. S. Curtis expressed a need to establish standards for large and small cities, for schools and municipal sites (such as heights of equipment, whether to use wood or steel), and expressed the opinion that equipment was not as essential on school grounds as in municipal areas.

Whether or not our clients (public school personnel responsible for designing outdoor learning centers and for buying equipment for them) will use the information provided from research remains to be seen. Some landscape architects have expressed a need to know what ideas are emphasized in curriculum in order to better design play areas. Others, such as Asher Etkes, have nearly given up trying to persuade college students and professors that some reasons for purchasing playground equipment which restrict movement may be better than others. For example, clients have selected slides and swings in lieu of abstract pieces of aluminum with many spaces in which
children can move in a variety of ways. The shiny new slide looks more attractive and appeals to the client's memory of his own childhood. People tend to buy what they want or what looks good rather than what research says is better.\textsuperscript{20}

Research can help resolve issues regarding whether or not a piece of equipment with a single-purpose design is more valuable than one which is designed to have a multipurpose function. Law and Way remind us that:

One piece of equipment for one use can lead only to one discovery. If it can be used in many ways, hunches may gradually mesh. An idea begins to develop, an experiencing 'within' process which the child integrates his knowledge for meaning.\textsuperscript{21}

Law and Way also suggest that it is not the equipment which is creative, but the children and that the teacher's goals relative to children's needs are revealed in his selection of equipment.\textsuperscript{22} Common sense suggests that these opinions may be true. Research has yet to verify that hunch.

Additional research should be undertaken to answer the following questions developed by Ellis (1970):

(1) Which piece of equipment manipulates the child in the greatest variety of ways?

(2) Which allows the child to manipulate it in the greatest variety of ways?

(3) Which pre-empts the behavior of the child the least?
(4) Which allows for cooperation among the children as they play?

(5) Which seems likely to teach the most, and which seems likely to teach what teachers decide is appropriate for children to learn?

(6) Which combination of equipment maximizes the variability in behavior exhibited?

(7) Which set or combination allows different ages to re-arrange the setting to extend the possibilities for play, either by the introduction of change or by increasing complexity throughout a season?23

Work at the University of Guelph and at the Children's Research Laboratory at the University of Illinois focuses on answers to the above questions.

In addition, rational criteria need to be developed to guide architectural students who design playgrounds and patrons who sponsor contests for designing playground equipment (McCalls,24 Parents,25 and Life26 magazines), as well as teachers who are more consistently involved with children's needs in relation to learning.

However, because research has thus far been inadequate to fully answer Ellis' questions (and many others), the following description of a playground by William Whyte is far too often accurate:

Children between six and twelve, for example, will push the others around (younger) if they don't have room for games, and they usually don't. Most play areas tend to be too small for them and too large for the younger ones. They're designed for a sort of all-purpose child.27
Whyte further suggests a method of research to determine how children use spaces provided for them:

We study the traffic to find the recurring patterns. Why not a study of children's traffic by children? They see much that we do not and much that designers fail to see because they fail to return to their finished products and thus suffer from a strong occupational capacity to see what they believe.28

Why do children seek non-planned areas? Sometimes they choose them out of sheer perversity, but sometimes they choose for some quite sensible reasons as well. What are those reasons? Perhaps a study of the "traffic patterns" of children on various pieces of equipment could help answer those questions.

In addition, little research has been conducted to determine criteria for equipment in conjunction with curricular ideas. For example, if physical education stresses the movement concepts of time, space, force, and flow, which pieces of equipment should children play on in order to develop greater understanding of those ideas in relation to movement? Which pieces of equipment can increase the variety in children's movement responses? When are children most active when playing on equipment--just after they begin, in the middle of their play period, or toward the end of the time they spend on a particular piece?

In essence, the following study is an attempt to find the answer to Ellis'29 first question, "Which piece
of equipment manipulates the child in the greatest variety of ways?" The movement dimensions of space (level, range, and direction) and the body factor of base of support will be employed to evaluate the movement responses of children while playing on three selected pieces of playground equipment. Variation in movement will be observed by analyzing selected dimensions of space as one of the elements of movement (others being time, force and flow—see Chapter 2, Figure 1). In order to study the ways a child uses his body, the body factor of bases of support (see p. 22). Other body factors include body parts, body relationships and body control.

Statement of the Problem

This study is designed to explore how kindergarten boys move on three selected pieces of non-moving equipment. Movement is measured by the usage of the spatial dimensions of range, level and direction and by the variety of bases of support as the body factor.

The major questions I seek to answer are:

(1) Which piece of equipment allows children the greatest variety of movement as related to the spatial dimensions of (a) level, (b) range, and (c) direction?

(2) Which piece of equipment allows children to use the greatest variety of bases of support?
Hypotheses

I. There are no significant differences in kindergarten boys' uses of gross movement while working on each of the three selected pieces of playground equipment.

II. There are no significant differences in kindergarten boys' total amounts of use of the spatial dimension of range while moving on the equipment.

III. There are no significant differences among the body parts in relation to range while kindergarten boys move on selected pieces of equipment.

IV. There are no significant differences in the bases of support utilized by kindergarten boys while moving on three selected pieces of playground apparatus.

V. There are no significant differences in kindergarten boys' uses of the spatial dimension of direction while working on three selected pieces of equipment.

VI. There are no significant differences in the uses of high and low levels among kindergarten boys while working on three selected pieces of apparatus.

Assumptions

These assumptions are made:

(1) The children will be familiar with their surroundings. They will be familiarized in a single session one day prior to the filming sessions.

(2) The boys will be acclimatized to the filming procedures and to the investigator during the familiariza-
The boys will become involved with gross movement activity rather than passive play activity on the equipment.

(4) The boys will move on the pieces of equipment in a variety of ways.

(5) The possible carryover effects from one piece of equipment to another will be minimized or eliminated by randomizing the boys within each group that uses each piece of equipment.

**Limitations**

These limitations are seen:

(1) The study is limited by the particular space patterns and positions of equipment on the playground areas where the pieces of equipment are selected for use in the study.

(2) The study is limited by lack of information relative to the ideal time period for children to spend on each piece of equipment. It is further limited by lack of knowledge about the prior experience of the subjects with equipment similar to that used in this study.

**Definition of Terms**

Outdoor Learning Centers

Spaces adjacent to schools in which equipment has been placed specifically for children to move on and learn
about curricular concepts.

**Playgrounds**

Spaces adjacent to schools or in parks which have equipment placed there specifically for children to play upon.

**Playground Equipment**

Categorized by Wade in 1968 in the following manner---(1) non-moving apparatus, (2) realistic apparatus, and (3) moving apparatus.

*Frequency of Uses of Range:* the number of times within a three minute interval in which a child initiates near or far range with a specified body part (hand, foot, head, trunk).

*Frequency of Uses of Level:* the number of times within a three minute interval in which a child initiates movement at a high or low level with a specified body part (hand, foot, head, trunk). A pictorial presentation of these terms is available in Appendices G, H, I, J.

*Frequency of Uses of Direction:* the number of times within a three minute interval in which a child uses various directional patterns with a specified body part (hand, foot, head, trunk).

*Frequency of Uses of Base of Support:* the number of times within a three minute interval in which a child
uses various combinations of body parts used as a bases of support.

**Space Utilization**

The manner in which people move about in the space surrounding them in relation to other people, [to boundaries, and to objects within those boundaries] (Snyder, 1971). The current study deals with these space dimensions as related to movement:

**Range:** generally considered to be the distance of a specific body part from another or from the center of measurement. Terms used to describe range as used with children include near, medium, and far, long and short, and wide and narrow. As used in this study, range will be measured from the central point of measurement known as the midpoint (see Appendix G).

**Level:** the vertical distance from the midpoint of the child (above indicated by + and below indicated by -) (see Appendix H).

**Direction:** analyzed from the orientation of the child to the equipment from a designated view (from one of the four cameras). As used in this study, directions will include forward, backward, sideways, up and down, and various diagonal patterns, and will be measured for the hands, feet, head and trunk (see Appendices I and J).
Base of Support: those parts of the body which suspend the body weight from a piece of equipment or the body parts on which the body weight is concentrated.

Central Point of Measurement: the navel and a point as nearly opposite the navel on the spine to be marked by iron-on-tape as the reference point for some of the range measurements.

This chapter has indicated that children deserve an environment which will stimulate movement, and has noted that such an environment has not been provided often enough on playgrounds. Further it has suggested that playgrounds might be developed for a variety of purposes. The teacher's role, the curriculum, and the role of research were explored as influences which need to be considered prior to selecting playground equipment, although little research has been done to help a buyer decide which pieces of equipment cause children to move in various movement patterns. This chapter also designated the writer's framework from which to analyze the movement of the children in the current study. The next chapter will examine information synthesized from related literature and show what other authors contribute to this study.
Footnotes for Chapter I


4 Robert C. Utzinger, Some European Nursery Schools and Playgrounds (Ann Arbor: Architectural Research Laboratory of the University of Michigan, 1970), front cover.


14 Ibid., p. 157.


22 Ibid., pp. 21-22.


28 Ibid., pp. 261, 263.

29 M. J. Ellis, *loc. cit.*


CHAPTER II
REVIEW OF RELATED LITERATURE

The Environment

The quality of the environment in which man lives has received increasing attention during the past decade—contamination of salmon spawning grounds in the Northwest, slum housing in Chicago and New York, the Weston atomic generator project near Chicago, numerous burning ordinances, dumps and waste disposal. Each kind of contamination resulted in a kind of crisis, which precipitated analyses and the formation of alternative solutions including such things as temperature controls for factories emitting warm water into rivers and lakes and the formation of ski slopes over local dumps. Since man's perception of his spacial environment has been offended both via his distance receptors (eyes, ears, nose) and his immediate receptors of touch, he requires action to change the environment into one which will encourage him to develop rather than hinder his progress. Regarding schools and their play areas, for example, how many playground planners remember that although teachers and students share the same space, they view it from different
perspectives? How many architects have spent a day on the playground looking at life through eyes at a three-foot child-size level rather than from a six-foot adult height?

As planners have continued to design living environments, they have given increasing attention to the following factors: changeable spatial requirements, differences in kinds of space as the causation of problems for people, Americans' need or desire for chunks of space with definite boundaries, the differences in usage of play space between boys and girls, children's preferences without exception for natural playgrounds instead of city playgrounds. Evidence of increasing concerns about the environment is shown by the formation of the Environmental Design Research Association of landscape architects. One of the themes at its fifth annual conference dealt with "Childhood City"--new designs in play environments.

Concern for the environment tacitly assumes that the quality of man's behavior is influenced by the environment in which he lives. If that is so, in what ways can changes in school environments influence the quality of children's behavior and what implications do such changes have for the development of outdoor learning centers. At this point, two educational environments must be considered. One is the physical setting in which children
learn and the other is the curriculum content with which children must cope.

During the past twenty years, school and classroom spaces have been studied considerably. Elliott\(^6\) found that elementary school planners gave little attention to the educational program in the development of the school site. Instead, existing standards for school site sizes were based arbitrarily on square feet per pupil. Rolfe\(^7\) studied the variable of classroom space on the pattern of teaching and found that it did not alter the pattern. On the other hand, Brunetti\(^8\) not only found a dominant trend toward open space—sometimes produced by a curricular alternative called open education—in the 1971 AASA Architecture exhibit, but also discovered that children were able to exercise a greater degree of self-direction, work with their peers to a greater extent, and were bored less because there were more activities, different groups, and teachers with which to work. He\(^9\) also found that growth in open space was greater in social traits such as peer relations, adult relations, independence, and emotional maturity. This same author concluded that space was highly important in elementary schools since over 50 percent of the students in the two open-space schools studied reported that they could find an adequate place to study by themselves, as compared to only 24 percent of the students in
conventional schools.\textsuperscript{10} In contrast to Brunetti, LaForge\textsuperscript{11} stated that specific open-space school designs did not significantly affect elementary students. Amote's investigation\textsuperscript{12} of two-to-five year-olds revealed evidence of an increase in aggressive acts as space for free play was reduced. Anifant\textsuperscript{13} found no significant sex differences among sixth, seventh and eighth graders on a measure of risk-taking behavior when compared across traditional versus open-space school settings. Risk-taking increased with age and open-space learning experiences seemed more conducive to risk-taking than did those of a traditional setting. Tucker\textsuperscript{14} concluded that a person's mental health was inversely related to the distance between a self-referent figure and another human figure. Thus, the kind of space available to a child may very well affect his social relationships, independence, and emotional maturity, but it is not clear whether or not open-space structures have more positive overall influence on children than traditional settings. And, although it is generally agreed that a school's physical plant should mirror its educational philosophy, methods for achieving this goal are elusive. As related to outdoor learning centers then, one might propose that there should be enough space to promote healthy physical, social, emotional, and intellectual growth.
A second influence on children within the school environment is curriculum, which is popularly assumed to be subjects such as reading, writing and arithmetic. Since World War II, however, there has been a phenomenal gain in knowledge about man and the universe. The increase has resulted in thousands of new books and changing information about ideas. Technology has revolutionized physics, chemistry, and mathematics and has increased the number of subjects within the child's curriculum. As a result, high schools now offer courses in Russian and child development, junior high schools provide cooking classes for boys, and elementary schools give lessons about drugs, sex education, and interpersonal relationships. If information about man and the universe continues to increase at the phenomenal rate which Toffler projects, there will be pressure to add even more areas of study to the curriculum. In addition, the computer has increased the availability, analysis, and dissemination of information in unbelievable quantities and at mind-boggling speeds. Thus, increased information and technological changes have caused the elementary curriculum to be far more complex than it was thirty years ago.

Because of increased knowledge, curriculum and learning experts such as Taba and Bruner have suggested that a conceptual framework is a tenable possibility for helping children learn to cope with geometrically expanding knowledge.
If Bruner's hypothesis . . . is true that any subject can be taught to any child in some honest form, then it should follow that a curriculum ought to be built around the great issues, principles, and values that a society deems worthy of the continual concern of its members.

Conceptual changes have touched elementary physical education: one sees basic movement and movement education appearing as content in some curricula. Individually prescribed instruction (IPI), modular units, videotape, cassettes, and loopfilms are some of the applied technological innovations which allow youngsters alternatives for learning about movement. Conceptual frameworks such as those suggested by Allenbaugh, Barrett, Jewett, and others, are a partial answer to concerns about coping with expanded knowledge and providing viable outdoor learning environments for movement.

It is this investigator's contention (and others also) that the content of physical education is based on two threads: (1) what is known about children and how they learn, and (2) the four basic movement elements visualized by Rudolf Laban. (Information about the characteristics of children will be discussed in the next section.) Movement can be analyzed in terms of the four elements of space, force, time, and flow, from which the content of physical education can be built, with the movement elements as cornerstones. Figure 1 illustrates the relationships among these elements as seen by the investigator.
Each movement element has its own dimensions as shown below:

**SPACE**  
Range—near, medium, far  
Level—high, medium, low  
Direction—up, down, forward, backward, sideways, diagonal  
Shape—round, twisted, etc.  
Pathway—straight, curved

**TIME**  
Fast  
Medium  
Slow

**FORCE**  
Hard—Soft  
Strong—Weak

**FLOW**  
Bound—Free  
Smooth—Interrupted

Figure 1
Spatial Elements Model
What kind of environment can be provided to help children increase their understandings and uses of these elements? If one accepts Piaget's premise that primary children need to manipulate objects in order to develop cognitive skills, then the kind of environment children experience is of vital importance. Next to the gymnasium, the outdoor playground may be the area most suitable for developing ideas about movement and efficient patterns of movement, according to Godfrey and Kephart. Thus, the spatial needs of the physical education program are derived from its curricular content. This content should emphasize values which may be utilized by children in settings far broader in scope than school. It also seems reasonable that in a rapidly changing world variety and flexibility should be established as important goals in a building program. As Sommer suggests:

Variety means multiplicity of settings and spaces a person can select to suit his individual needs. Flexibility is expressed in such terms as multi-purpose, multiuse, convertible spaces. These ideas are closely tied in with personalization since it permits a man to adapt a setting to his unique needs. Both variety and flexibility inherently increase the range of individual choice. A necessary corollary of these two values is that we must establish institutional arrangements, rules, procedures and personal practices—that enable individuals to exploit the variety and possibilities for flexibility in their environment.
Perhaps Sommer is suggesting that we make greater educational use of portable playgrounds, such as the ones which New York has recently initiated.  

Child Development

In this section, four-, five-, and six-year-old children, their characteristics, and their needs will be described. Ways of meeting these needs will be suggested as well as the results of deprivation. As a result of the description of children, an appropriate outdoor learning environment for movement will be suggested. Last, the way in which children use space and develop concepts about space will be explored.

Children who are ages four, five and six will be described since it is apparent from Mitchell's study that children at any one age exhibit a skill level which extends at least one year in either direction of the group being considered. According to Jones, a study of children from twenty-one to forty-eight months of age showed that they engaged in varying amounts of play depending on the kind of equipment, and that four-year-olds are most interested in four activities: propelling, pushing and pulling, combining pushing, pulling, and propelling, and manipulating parts.

Jones also suggests that four-year-olds use materials to get acquainted with other children, to gain power, and to make a large continuous imaginative enterprise.
In a study of four- and five-year-olds to investigate the role of color on spontaneous behavior, Gramza and Witt\(^\text{28}\) found that the preferences for position of the blocks were more important than the color preferences.

Investigating factors which influence the play behavior of two- through five-year-olds, Van Alstyne\(^\text{29}\) found that the five-year-olds were also very interested in playing with blocks, clay, and dolls and that their attention span had doubled (from ages two to five) to thirteen and one-half minutes on the eight most popular items. She found more similarities than differences between boys' and girls' interests in activities, although boys tended to choose materials that produced more active play. Materials which produced the most active cooperation included wagons, dishes, hollow blocks, assorted blocks, doll corners, colored cubes, dump trucks, and parallel bars. In another study to determine the movement characteristics of children from two to six, Sinclair\(^\text{30}\) discovered that five-year-olds made notable but erratic improvement in opposition and symmetry, and achievement was evident in total body assembly, dynamic balance, rhythmic two-part locomotion, and agility. However, improvement in selected characteristics from age five to six was inconsistent, with gains being made only in dynamic balance, rhythmic two-part locomotion, and total body assembly for speed and power.\(^\text{31}\) Davis\(^\text{32}\)
observed that kindergarten children do something different every five or ten minutes and when most interested, spend little more than an hour at any occupation. He found that boys are a little more active than girls, and that boys play with vehicles while girls are more interested in humans and furniture. He also observed that boys spend a longer time at their favorite occupation, which he infers to show a greater singleness of purpose. In a study investigating the effectiveness of a play environment to improve climbing ability among kindergarten boys and girls, Hottinger found that all kindergarten boys and girls could climb a five-foot rope, but that boys could climb greater distances than girls on overhead inclined ladders and on ropes when using hands only. Castaldi reports that kindergarten children exhibited the following average measurements:

- 46.1 pounds in weight
- 45" height in shoes
- 35" eye height standing above the floor
- 30.6" shoulder height standing above the floor
- 9.8" seat height above the floor
- 26.6" eye height seated above the floor
- 13.5" elbow height seated above the floor.

As children become six, Ledermann and Trachsel found that they begin to enjoy games governed by rules and learn to win and lose, and adapt to small groups. In a survey of children's play interests (six to twelve), Orloske found that as the age increased, girls participated in more difficult individual or self-testing play
activities while boys were more interested in fundamental movements that were aggressive. He also found that children of differing weights and heights of a similar age participated in about the same number and type of games, but with differing degrees of frequency. However, taller children were slightly more competitive and preferred greater team sports participation than lighter, shorter children of a similar age. That conclusion was confirmed by Lewis who also predicted that extremes of weight in either direction could affect motor competence. In another study of six- to fourteen-year-olds in Israel, Eifermann concluded that in unsupervised play, the group size increases with age and socioeconomic level with the most frequent size being two (with the exception of the top grade socioeconomic level for whom the dominant size was four). Thus, group size and sex interests need to be taken into consideration when looking at children's play characteristics.

In a study of kindergarten boys on large apparatus in a gym, Lewis found that the most active boys performed movement skills in more integrated patterns, at slightly higher levels from the floor, displayed decisive body movements (especially at higher height levels), used their upper bodies for support more frequently, displayed less need for a stable base of support, and appeared to feel comfortable at all height levels
more than those who were less active. If placed in an outdoor setting with large apparatus, would the same characteristics predominate?

Apprecably children like to take risks. But according to Allen, adults prevent exploration because of over-concern. If children's abilities were carefully observed, then varying degrees of risk could be planned for a play area. A child could be challenged at his own level of competence. As Berlyne suggests, environments could be designed to produce a certain rate of stimulation and challenge to their inhabitants. And, since the degree of participation and thus skill is largely determined by a child's past success or failure, the latter might then be avoided.

Frank suggests two principles to apply to assure continued development of a child in a sequential progress toward maturity:

1. There is a regular orderly pattern from infancy to adult life along which each child will move if given opportunity and encouragement; for negotiating these transitions, he requires teaching which is appropriate for each stage in this sequential development, at his rate of progress, to ascertain his own size and shape, and to exhibit the capacities of which he is individually capable.

2. Each child is a highly individualized organism--a personality with his own cognitive style--with aptitudes, capacities, and potentialities rarely so distributed that he can achieve equally well in all different subject matter areas or modes of physical achievement.
Children exhibit various characteristics, which have been summarized by Chess:

1. Activity level
2. Regularity
3. Approach or withdrawal to a new situation
4. Adaptability to change in routine
5. Level of sensory threshold
6. Positive or negative mood
7. Intensity of response
8. Distractability
9. Persistence and attention span

What needs do they exhibit as derived from these attributes? From the characteristics which children exhibit, perhaps their needs can be determined. If needs can be described, then it may be possible to develop environments where needs can be met.

Children need to have sensory stimulation (in changes of texture, space and temperature\textsuperscript{44,45}) to become aware of themselves, their world, and to assure adequate intellectual performance. Children need much exercise to develop suitable posture and adequate musculature to cope with movement activities.\textsuperscript{46,47} According to Jones,\textsuperscript{48} the most extrinsic factor influencing progress in the development of skill is the opportunity to have experiences with objects and various textures. Further, children need opportunities to develop their understanding of the body, its parts, and how it functions in its environment, and they need full opportunities for acquiring a large repertoire of action responses.

Children need opportunities for exercise in both free play and in structured learning situations, such as
physical education classes. Aaron and Winawer have suggested that:

Up to age twelve, children spend about 1,000 hours per year at school. They play about 300 hours at school and 500 at home per year. Much of the time and energy of teachers is devoted to the 1,000 hours, but very little to the 800 hours.

In fact, Beveridge indicates that at the beginning of World War I, the United States only spent ten cents per person for play and recreation for children. According to Lewis current trends in the study of child development combined with recent interest in movement education and its focus on childhood characteristics suggests that programs of physical education have potential for nurturing child growth and development in a manner different from the conventional or traditional programs.

If exercise is important to develop a child's growth, what happens if it is denied a child? According to those who have studied child growth, development, and movement (Almy; Universal Opportunities . . ; Erikson; Hurlock; Schultz), deprivation can cause gross disturbances in functioning. Since the period of most rapid growth extends through the early primary years and since children have the greatest susceptibility to environmental influences during that period, it seems most important to provide an atmosphere, materials, resources, and settings which will foster significant learnings. That kind of situation is one in which Moustakas says:
The threat to the self is at a minimum while at the same time the uniqueness of the individual is regarded as worthwhile and is deeply respected; and the person is free to explore the materials and resources available to him and to select his own experiences in the light of his interests, desires and potentialities.

What kinds of playgrounds or outdoor learning centers can provide experiences and resources to help children continue to grow and develop in a normal healthy way? How do children use the spaces provided for their outdoor play?

According to John Holt, children respond to various kinds of space—big, open, small, cozy, and especially hidden private places. Holt's comment is obviously an opinion, but there is research to explain how children respond to given sets of circumstances and the relationship of varying kinds of spaces to other data. Jones studied the body awareness in space as reflected in the ability of six-, seven- and eight-year-old boys and girls to discriminate and to move in designated coordinates in space such as directions, levels and pathways. In all three measures of body awareness (of level, direction and pathways), statistical differences in performance were found between first and third graders. There were no statistical differences between boys and girls on any measure. The results suggested that children in grades one to three find it easier to perform motor tasks related to horizontal, sagittal, oblique, and vertical than cognitive tasks related to the same ideas. Thus motor
development precedes cognitive ability requiring proficiency with those tasks. Development appears to proceed from the combined coordinates of pathways and lines to vertical coordinates of levels to those of direction. It seems reasonable to plan activities with those guidelines in mind. Perhaps playgrounds should be planned in ways to capitalize on the ways that children change their perceptions, concepts, and uses of space.

In a study of the behavioral effects of high and low spatial density on four- and five-year-old boys and girls, Loo discovered that there was significantly less aggression and less social interaction in high density areas of free play in groups of six. Low density areas used 44.2 square feet per child while high density areas included 15 square feet per child. If varied kinds of social interaction are important for children's learnings, then varied sizes of space need to be provided on playgrounds.

In a similar study about the relationship of the social maturity and the size of the play area for four- and five-year-olds, Gilligan found no relationship between the social maturity of the child and the amount of space he used. However, the lack of relationship may be attributed to limited variation in the sizes of the playgrounds. On the small playground, 83 square feet was allowed per child; on the medium-sized playground, 130
square feet was allowed per child; on the large playground, 178 square feet was allowed per child. The pieces of equipment stayed in the same relationship to each other as the size of the playground was varied. Perhaps more varied spatial sizes of playgrounds need to be explored.

Mulhauser\textsuperscript{63} investigated five-year-olds' space utilization with reference to perceptual motor development, body size, body concept, body image, fine motor performance, graphic production, and home space. Data were analyzed for space utilization and for non-structured, self-initiated locomotor movement in the horizontal plane. The total distance a child moved was recorded in linear feet; the total space utilized was recorded in square feet; and the percentage of the area used was recorded using the Cartesian coordinate system. Mulhauser found that measures of space utilization during self-initiated locomotor movement have a significant positive relationship to perceptual motor development, fine motor performance, and space utilization in graphic production, and a negative relationship to body size concept, body image, and home space. Thus, kindergarten children can be differentiated by the amount of space they use.

In a study which explored the relationships among various aspects of space utilization and the educational achievement of four- and five-year-olds, Snyder\textsuperscript{64} found that the ways that four-year-olds used space was different
from five-year-olds, that girls and boys used space differently, and that there were significant differences between children who traversed the most total distance and those who used the least total distance as related to frequency of directional changes in pathways established, but not in frequency of directional changes backward, sideward, upward or downward.

Others who have studied children's use of space suggest that other kinds of abilities can be predicted from the way space is used. Ferguson and Maccoby\textsuperscript{65} claim that children who are high in spatial ability show sex-inappropriate behavior: boys are rated low by their peers in aggressiveness, masculinity, and mastery, while girls are rated high on the same measures. Guanella\textsuperscript{66} claims that children reveal their memory for kinesthetic impressions, their ability to translate verbal symbols, and creative imagination by the way they act in space. Bing\textsuperscript{67} suggests that high numerical and spatial abilities develop from interaction with the physical rather than the interpersonal environment. Such abilities require independence to investigate and explore the environment. Although Johnson and Medinnus\textsuperscript{68} believe that spatial ability (such as the ability to visualize objects in three-dimensional space) appears to be determined largely by heredity--and thus training in spatial ability is less fruitful than training in reasoning--they fail to recognize that training is different from exploration.
Since it is apparent that children use space differently when placed in a variety of settings, and that there tends to be a developmental pattern in the way they move in space, it seems reasonable to assume that children might also develop concepts about space in some orderly manner. Indeed, child psychologists, primarily Piaget, tend to support that conclusion. Werner\textsuperscript{69} suggests, for example, that a child's ontogenetic development of a spatial idea may be understood in terms of a gradual widening of the gap between his ego and the external world as he becomes increasingly objective. When he is very young, his understanding of space ends at the edges of himself, enclosed within his own skin. Piaget suggests\textsuperscript{70} that a child's understanding of space begins to develop during the sensory motor stage as the child begins to understand proximity, separation, the relation of spatial succession, enclosure, and continuity in that order. On the basis of studies, Piaget further suggests\textsuperscript{71} that by the ages of five and six, a child is able to master the ideas of proximity, separation, order, and continuity. In contrast to a child's understanding of velocity, which relates to time and is not understood until he is ten or eleven,\textsuperscript{72} he is able to relate objects on the basis of proximity and separation by five or six.\textsuperscript{73}
In relation to speed and movement, a child who is four to six can retrace a path without inverting the order, place things in a rigid order, and traverse the length of a path in terms of the intuitive order of the points of arrival. He may lack an understanding of succession.\textsuperscript{74}

From five to seven, he may still underestimate distance.\textsuperscript{75}

Since children seem to develop not only concepts about space in an orderly fashion, but also use space in a pattern which reflects their stage of development, it seems reasonable to plan playgrounds which capitalize on such progression. Children at the ages of four to six are still within the concrete operational stage of development, which means they still need to manipulate objects in order to increase their understanding of abstract ideas. Massey\textsuperscript{76} substantiates the premise that children are able to show additional understanding of concepts through the use of manipulative materials, that children’s understanding of space is developmental in nature, and that temporal concepts are more difficult for children to understand than spatial concepts. Williams\textsuperscript{77} concurs that children can learn a great deal more about space than we suspected.

How many outdoor learning centers provide a variety of objects which children can manipulate in a variety of ways to find out more about space?
Playground planners have a responsibility to find out what children are like and how they learn prior to providing both equipment and areas in which to play.

**Playgrounds**

Consideration of the topic of playgrounds for the present study is divided into the following areas: values of playground equipment, categories of playgrounds, equipment on playgrounds, criticism of playgrounds, methods of evaluating playgrounds, and criteria for the selection of playground equipment.

**Values of Playground Equipment**

Playground equipment has value not in itself so much as in the way it benefits children who play on it. Children benefit physically, socially, emotionally, intellectually. Burke, a playground manufacturer, claims that playground equipment has value because it will develop the body of the child, develop muscular skills, and provide an outlet for basic physical skills, but the claims are not substantiated by evidence from research. Others (Johnson; Butler) suggest that physical vigor and health can be increased through the use of playground equipment and that the use of the equipment provides an opportunity to teach safety. Schurr suggests that creative and developmental equipment provide opportunities to develop strength, balance, and skills, and to be
imaginative. She implies that equipment can enhance development and creativity and that it can be provided for various stages of development and creativity. There are claims that specific pieces of equipment have specific values. An article written to administrators suggests benefits from using the following pieces of equipment:

- Merry-go-rounds, ocean waves, giant strides— their value may be questioned because they provide little exercise and may be harmful (e.g., injuries from falling off, etc.);
- Horizontal bars and ladders—good for 'large children';
- Slides, jungle gyms, sandboxes, building blocks, wading pools, crawling tubes—good for 'small children';
- Swings and teeters—mild exercise, but hazardous unless supervised.

Two studies have explored the physical values of using playground equipment. Hutinger explored the effect of systematically exercising third grade children on the horizontal ladder over a three month period. He found a significant increase in the upper body strength of the children. In a similar study, Morris investigated the use of a doorway bar, parallel bars, a combination of horizontal and vertical ladders, parallel and horizontal bars, and rings and trapezes used by children in grades one through three. Over an eleven-week period, she found that arm and shoulder girdle strength were affected by the use of the equipment. That is the extent of the research which has tried to determine the physical values of equipment.

Both Curtis and Morse suggest that playground equipment has social value, including a way to entice
children to come and stay on a playground and to care for the play of a large number of children—a caretaker approach.

Curtis also suggests that the chief value of the swing is emotional. In order to prevent fights, Bertelsen suggests that there needs to be sufficient material and possibilities for play.

Dattner suggests playgrounds have intellectual value in that children can learn about themselves and the universe. He also criticizes physical education teachers for being only concerned about the physical values involved.

Edwards found some creative, aesthetic values for children who used non-conventional play equipment such as planes, fire trucks, and trains, as contrasted with the use of traditional equipment. However, the values were assigned by recreation leaders in a survey and not measured by the children's actual use of the equipment.

It is obvious from the information reported here that there is a dearth of material from which to make judgments regarding the value of playground equipment. Curtis expressed that concern many years ago. Unfortunately, it is the children who lose when they continue to use equipment whose value is unknown. Grey summarizes this concern and suggests a remedy:
What kids learn from repetitive sliding and swinging is grossly inferior to what they learn from interacting with a world structured by adults who understand about learning in play. We can with judicious planning turn playgrounds into effective learning grounds. Growing children need changing equipment. The world changes and the children in a changing world need changing equipment. As we have libraries of books, recordings, films, so we should have libraries of playground equipment.

Kinds/Categories of Outdoor Play Environments

Since the value of playground equipment is unclear, it is not surprising that the terminology used to classify both playgrounds and types of equipment is less than transparent. In fact, the communications problem is similar to the one in elementary physical education regarding terminology. The classification of playgrounds will be discussed briefly and then will be followed by a discussion of equipment categories.

Playgrounds

There are four kinds of playgrounds which seem to be defined by location, activity, and the age of the child for whom they are designed. Playgrounds may be categorized as recreation, preschool, school, and adventure playgrounds. Playgrounds defined for recreation purposes are usually sponsored by a city recreation commission and built to accommodate people whose ages range from preschool through adulthood. For an extended discussion
of recreational playgrounds, see Brown, Butler, Bengtsson, and National Recreation Association. Playgrounds are also designed especially for preschool children and these often called totlots or playlots. For a more extensive description of play areas designed for infants and children up to age six, see Planning Facilities, and Parks, Baker, and Lueck. Another type of playground that has increased in popularity in Europe since World War II, and in the United States since 1960, is the adventure playground. An adventure playground is one where a permissive atmosphere is encouraged; many raw materials are provided for children themselves to build an environment to suit their needs. Usually adventure playgrounds have been recreational in nature or built for preschoolers. Europe has stringent requirements for its adventure playgrounds, whereas in the United States adventure playgrounds include almost anything that has non-conventional equipment on it. A great deal has been written about adventure playgrounds and extended information about them may be found in Bengtsson, Stone, Allen, and Friedberg.

Although certain aspects of the adventure playgrounds deserve consideration in more detail, this section will deal primarily with outdoor learning centers. Those few authors who discuss school playgrounds suggest that they should provide for various types of physical education,
recreation, and outdoor education activities (Nash, Planning Facilities, Hendey). Where possible, it is recommended that a school facility be combined with a park or recreation facility in order to conserve space and finances and that they be located near the center of the population, according to Butler and Planning Facilities. The major discussions about school playgrounds have revolved around the size recommended for the play area.

The recommended size of the total elementary school plant, including the playground, varies from one acre per one hundred children to fifteen acres per school (Physical Education; Outdoor Recreation; Rolfe). The total recommended size for the playground itself varies from 625 square feet to two acres (Aaron and Winawer; Van Alstyne; Duchaine; Stecher). This diversity in size is dependent on at least three factors. Rolfe suggests that curricular needs of the particular school is one consideration. Another factor is provision of areas with a wide variety of textures, sun and shade areas, and activity centers to accommodate various size groups. The most popular reason given to determine the size of a playground is a space allotment per child. That recommended measurement varied from twenty-five square feet per child to 2000 square feet per child (Stecher, Hammer). In reality, Arthur found
that it varied from three and one-half feet per child to 395 feet per child. While variety and diversity are generally to be encouraged, in this case such variance suggests that state standards for schools and recommendations for playground space per child are based on perceived adult judgment rather than knowledge of actual needs of children (Travers\textsuperscript{122}).

**Playground Equipment**

When individual pieces of equipment are considered, it seems logical to discuss recreational pieces, school pieces, or adventure playground pieces under the assumption that the pieces would be different to function for specified purposes. However, such is not the case and instead one reads about pieces which are labeled traditional, non-conventional creative, home-made, manufactured, sculptured, gymnastic, architecturally improvised, novel, and modernistic, as well as movable, non-movable, and realistic. Holme\textsuperscript{123} suggests that traditional equipment includes swings, slides, ocean waves, see-saws, sandpits, and pools. Tradition, also called standard by Bruns,\textsuperscript{124} in addition includes parallel bars, merry-go-rounds, giant strides, and horizontal ladders. Non-conventional equipment includes equipment that has become obsolete in other fields and is used in play areas as play equipment, such as telephone cables, cars, locomotives, and airplanes, according to Edwards.\textsuperscript{125} Mott suggests that creative
equipment is unique and unusual and encourages play by stimulating the child's imagination. Holmes describes climbing frames and parallel bars as examples of gymnastic equipment. She also defines architecturally improvised equipment as play sculptures, concrete pipes, tree trunks, and old cars. Novel equipment, defined as supplemental to the standard playground, includes boats, logs, airplanes, cars, locomotives, culverts, and trucks (Bruns). Bruns categorizes modernistic equipment by division of design and colorfulness rather than kind in order to cater to the child's imagination. It is immediately apparent from the survey of categories just listed that the criteria for inclusion in one area or another is ambiguous and confusion is the immediate result. Clarification was needed and Wade appears to have generated the clearest classification scheme for equipment. Its basis is whether or not the equipment moves in addition to a miscellaneous category called realistic which might well have been included in the other two categories. Wade's classification is listed below with examples of equipment placed in each category:
1. Moving apparatus—the category in which the children play on those pieces of playground apparatus which are not stationary in use but require momentum, attained and utilized by the user or his companion; for example swings, merry-go-rounds, and teeter-totters.

2. Realistic apparatus—the category in which the children play on those pieces of playground apparatus which resemble real objects and remain stationary; for example, turtles, fire engines, and stage coaches.

3. Non-moving apparatus—the category in which the children play on those pieces of playground apparatus, except realistic, which remain stationary in use; for example, slides, monkey bars, and ladders.

With some appreciation of the terminology problem which plagues discussion about playgrounds and with a feasible solution in Wade's classification, individual pieces of equipment can now be considered.

As specific pieces of equipment are discussed, factors such as size of the equipment, recommended pieces of equipment, placement of the equipment, and surfacing under the equipment should be considered. What size should playground equipment be for elementary children? Other than information in playground equipment catalogues which suggest which pieces are appropriate, there are no guides suggesting that various heights or lengths of pieces are more appropriate for one age than for another. Some catalogues suggest that a six foot length ladder is long enough for elementary children, but careful observation suggests that that length is no challenge for twelve-year-olds. Why are slides which are ten feet high placed in
equipment areas for young children along with climbing apparatus whose first rung is two and one-half feet from the ground, when research tells us that the distance from the ground to a six-year-old's knee varies from ten to thirteen inches (Astaldi)? Why are pipes of three inch (rather than one or two inch) diameter used to make equipment when even casual observation suggests that the latter is more comfortable for children to play on because of their small hand size? (No wonder the Columbus Public Schools limit the height of any piece of playground equipment to seven feet.) Help in playground equipment design must be obtained from careful observation of children and from child development specialists.

Specific pieces of equipment recommended by various authors are indicated on the following chart (Figure 2) of the ten pieces most often recommended. Please note that the authors may recommend other pieces of equipment than those on the chart. The authors selected were those who gave any recommendations at all for equipment and were gleaned from the investigator's extensive search of the literature from 1900 on. Other pieces of equipment recommended but not in the "top ten" included: climbing ropes, climbing poles, parallel bars, sculptured forms, merry-go-rounds, ocean wave, water, tree trunks, wood blocks, creative equipment, mobile equipment, pipes, earth forms, truck tires, cargo nets, scaling walls, and jumping
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standards. Van Hagen, Dexter, and Williams did caution that teeters, swings, ocean waves, merry-go-rounds, and the like not be installed until equipment of greater physiological value was purchased. By way of comparison, Worley found in the 105 schools he surveyed that the ten items most often found on school playgrounds were (from first to tenth):

1. Teeter totters
2. Slides
3. Sandboxes
4. Horizontal ladders
5. Swings
6. Jungle gyms
7. Benches
8. Merry-go-rounds
9. Tables
10. Giant strides, packing boxes, bouncing boards, climbing trees.

He noted that of the 105 schools, thirty-five had no equipment at all. Perhaps the reason for such a void is cost, as suggested by Georgiady and Savage. It appears that the most popular items have changed little since 1945: swings, slides, sand, and see-saws. However, the question still remains: Despite their popularity, which pieces of playground equipment have more educational value than other pieces?

Another factor to consider in order to determine the value of equipment is its placement in relation to other pieces of equipment within the defined play area. What guidelines are there to determine where or how equipment should be placed on the playground? Does it really
make any difference where a piece is installed on the playground? Churchill suggests that the equipment should be placed around the border of an area with the center left free for activities and games, and that large apparatus be placed toward the center to separate the sexes and economize supervision. Butler adds that there should be separate sections for younger and older children as well as boys and girls. In order to conserve space, Duchaine recommends that equipment be placed in a line—it is more orderly, neat, and attractive in appearance. The National Safety Council recommends that there be enough space to avoid accidents. "Enough space" implies knowledge of the spatial requirements of children as they move and of various pieces of equipment which is available from manufacturers on request and through the courtesy of the National Recreation Association. In contrast to these recommendations, Godfrey and Kephart suggest that the specific arrangement of a playground as an activity area depends on the size, location in relation to the school, fences, roads, type of surface, and frequency of availability for the program. Others (Ledermann; Brown) suggest that it is important to show the relationships between the parts of the playground. Witt and Gramza studied the position preferences of four- and five-year-olds for playground equipment, concluding that children most preferred which-
ever piece of equipment occupied the center of the room. The center piece received the most attention in contrast to those placed in corners or in the edges of the room. Although opinion appears mixed regarding the importance of placing equipment in various parts of the room or in relation to other pieces, and although there is only one study directly investigating the issue, the evidence suggests that placement is important and should be considered. Certainly, the placement and relationships of equipment can affect the amount of movement which results. How can equipment be arranged to promote the most movement and the kind the teacher wants the children to learn about?

The last element which affects playground equipment is the surfacing that is placed beneath each piece. Numerous articles (Nation's Schools; Butler; Rawid and Fox; Chase; Taylor) have been written about surfacing and usually are motivated by an injury which would have been less severe had the surface been more resilient. The surface provided under equipment may be the factor which makes the piece most functional or least used. The surface needs to provide good drainage—from one-half percent on paved to two percent on unpaved areas—and it needs to be resilient. Figure 3 summarizes the attributes of various types of surfaces. The type of surface chosen will depend on a number of factors, including the height of the equipment under which it is
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<th>SURFACES</th>
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<th>Dustless</th>
<th>Fine grain/non-absorbant</th>
<th>Low maintenance</th>
<th>Multiple Use</th>
<th>Pleasing Appearance</th>
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*Ten-year life span.

Note: + = Advantage; 0 = Disadvantage

Figure 3

Qualities of Playground Surfaces
placed. The proper surface may increase its utility whereas inadequate surfacing may result in the removal of the equipment from the playground and from the children.

Evaluation of Playgrounds and Equipment

Evaluation is an activity which is performed to discern how well goals, objectives, or criteria have been met. For example, a physical educator might want to determine how well children learned to move. He might want to compare the effectiveness of various methods, or techniques, or determine the contribution various pieces of equipment made toward efficient movement in relation to levels or directions. The example assumes that the teacher had an objective or goal which was observable and measurable. Evaluation can be a useful tool to determine how to change either methods or materials to make the learning situation more productive. With this background regarding the purpose of evaluation, techniques of evaluating playgrounds will be discussed and suggestions will be made for future evaluation. Suggestions for designers' evaluations will be noted and a conclusion will consider the problems of evaluating playgrounds.

The most popular technique utilized for evaluation has been the survey. The National Recreation Association suggested that its playground leaders list the equipment
in order of popularity used, decide whether or not enough equipment was available to do a good job, and then determine what pieces or types should be added. Consumer Reports queried 750 parents to determine which piece of playground equipment was used most often and found it was the swing set. Consumer Reports' other contribution was to place equipment from various manufacturers outside for two years in order to observe the effects of the environment on the finish. The sole result of their efforts was that they found that it rusted. Bliss tried to determine the desirability and effectiveness of playground apparatus commonly used in elementary schools. He sent a questionnaire to 214 schools in the San Francisco Bay area and visited fifty schools. Among others, he drew the following conclusions:

1. Although it is considered desirable, playground apparatus falls short of its potential contribution to the school program.

2. Educational effectiveness of apparatus in use is largely dependent on the amount of planned, skillful teaching given the children in its proper use.

3. Non-standard items of play equipment, although not well known to school administrators, apparently stimulate creative, dramatic, and imaginative active play.

While the questionnaire gives some useful information about the adult opinions about playground equipment, it does not provide information about how children actually use equipment.
Clegg suggests a series of questions might be asked of various groups to determine the success of the playground, but he does not suggest techniques to use in order to answer the questions:

1. Are the boys and girls who use the playground satisfied?

2. Is the play leader or teacher enthusiastic and convinced that he has a real playground, or is he always suggesting important changes?

3. Are the tax payers satisfied with the return on their investment?

4. Do neighbors look at the playground as a nuisance or a benefit?

The questions listed might well be used by designers to help determine the actual effectiveness of playgrounds. Answers to those questions correlated with architectural concerns identified by Hayslip (including design sensitivity, contemporary expressive form, technical design, and functional quality), and growth of knowledge relative to children and children's activities might provide more accurate bases for future play area design.

The observation technique has been utilized to determine the safety of a particular piece of equipment. Allen suggests problems which may cause hazards. Keeran also utilized the observation technique but added a rating scale to refine the data observed. The observer was instructed to watch how the children played on the equipment and then categorize his use by: rejection, recognition-exploration, skill acquisition, or
successful, effective, appropriate use of the equipment. Although this scale, once standardized, could be used to explore the age at which various skills are utilized by children, the point at which various skills can best be taught, it would be equally important to determine the criteria for placement of equipment in specific categories, such as developing spatial concepts.

At best, the evaluative techniques which have been used to determine the value of playground equipment have been unsophisticated. Concern for lack of research and the quality of that which is being done is expressed by Friedberg and Ellis. Friedberg, a landscape architect and playground designer, suggests that research regarding child development, learning, and environment points toward a multifaceted environment including physical, social, emotional, and intellectual stimuli in order for a child to develop all phases at once, but he is disturbed about research regarding playgrounds and playground equipment:

It is rare. It is easier to justify research for a sick, retarded, or disturbed child than for the 'normal' one. Evaluation of existing playgrounds is also rare. The little that is done is a seat-of-the-pants operation and suffers from several defects:

1. If equipment is new, it is dangerously overused.
2. If accidents occur, it is entirely removed rather than improved.
Ellis shares the concern from an educator-researcher's point of view:

How do you evaluate whether or not a playground has what counts? It is difficult and expensive. There is a need to educate the content of playful interactions for each item and not many people are available to do it at this time. Almost no respectable applied research is being funded by the playground equipment industry. It is critical to convince people that there is a problem.

The evidence reviewed suggests that there is a great deal to be done, and since there is very little research to use as a guide, much of the present and future investigation would be highly innovative. Research could be the basis for constructive criticism or criticism could point out new areas needing rigorous research study. Both processes could increase information needed to provide playground equipment which helps children learn to move in the most efficient manner.

**Criticism of Playground Equipment**

Criticism can serve two purposes. It can cause the recipient to strengthen the case for his point of view and explain it more carefully to his critics. And criticism can also precipitate an alteration in the defendant's viewpoint to a position that is more realistic or accurate. Each of these purposes can benefit both theoretical position and practical application. It is in the spirit of trying to fulfill these two purposes that the following criticisms of playgrounds are discussed. Criticism will
be presented to show how playgrounds fail to meet children's needs: physical, emotional, social, intellectual, aesthetic. In addition, specific criticism directed toward designers will be noted. Criticism is generally leveled against playgrounds and only occasionally discussed in reference to specific pieces of equipment.

In what ways have playgrounds failed to meet children's physical needs? Many pieces are designed with a single purpose in mind for use. The teeter totter may strengthen the legs; legs are also strengthened as a child climbs to the top of a slide; the merry-go-round may increasing gripping ability, but how many pieces of playground equipment increase more than one physical attribute? Thus, much playground equipment is inflexible and prevents children from developing in more than one way.

Equipment offers children little choice: either they play on it the one way the designer intended or some other way which the designer did not intend and is possibly unsafe. Few pieces of equipment offer challenge. Rather than complex movements, many pieces of equipment tend to elicit simple and repetitive motions. They offer no motivation to increase the child's level of skill, his repertoire of skills, nor his patterns of movement. Equipment is oftentimes not only fixed in place but appears to be so secured as to denote its location as a final resting place and as if the relationship of its
parts were never to be changed. For example, according to Friedberg,\textsuperscript{161} the slide is restrictive since it only allows one person at a time to play on it; it offers no alternatives and a child's balance is threatened as he changes from a standing to a sitting position. Aaron and Winawer criticize the whirl for causing those children who are less coordinated to be hurt—the very ones who need the activity most.\textsuperscript{162} For a more extensive discussion of equipment which fails to meet children's physical needs, see also Etkes;\textsuperscript{163} Ellis;\textsuperscript{164} and Friedberg, 1969.\textsuperscript{165}

Some playground equipment fails to meet children's emotional needs. It is criticized for offering passive amusement, for being bereft of stimulation or inspiration, and for its existence being justified on the basis of offering fun alone. Sometimes children just don't like some equipment. Why should equipment rob children of the emotional security and stimulation they need? For a more extensive discussion of equipment which fails to meet children's emotional needs, see also Allen, 1964;\textsuperscript{166} Brook;\textsuperscript{167} and Rasmus.\textsuperscript{168}

Playground equipment is also criticized for failing to meet children's social needs. Pieces such as swings, slides, and teeter-totters require the development of social skills of turn-taking and self-discipline while waiting. Young children do not like to wait, but such equipment prohibits more than one or two using the
equipment safely and simultaneously. Equipment which is designed to be used by a single child prevents cooperative play and when children are forced to wait in lines, experience suggests that it is primarily negative socialization which occurs. Equipment is not designed to develop a range of social skills which increase in complexity. For a more extensive discussion of the ways playground equipment fails to meet children's social needs, see Aaron and Winawer; Perin; and Stone.

What intellectual stimulation does playground equipment offer? According to critics, very little. They describe equipment as being dull, boring, and limited so that it offers little choice to children who delight in discovery. Since much equipment is single purpose in design, it prevents children from making decisions which they might were several possible uses "built in," and if they do decide to explore equipment in another way, accidents are likely to occur which result in psychological damage (Etkes). Risks which children take are not planned into design and thus accidents are much more serious than skinned knees when equipment is used improperly. For further discussion of ways which playground equipment fails to meet children's intellectual needs, see Ellis; Friedberg; and Holme.
Playground equipment has also been criticized for its lack of aesthetic appeal. Some pieces are described as ugly. Some pieces such as animals are chastised for being too literal, thus leaving children little room for imagination to decide what a piece is or how they can move in relation to it. What else can a child do with a turtle besides sit on it or crawl under it? Some critics feel sculpture is unsuitable: it is not good art nor is it good play equipment (see also Friedberg, 1970; Stone). Other criticisms concern the exorbitant cost of equipment. Without careful shopping, a buyer can pay double the price value of a piece of equipment (Thompson). Many years ago, an administrator was overheard to refuse to purchase playground equipment for a school because it was an unjustifiable expense. That may still be a valid criticism.

Designers have also felt the lash of critics. They have been accused of failing to secure consultation about children's needs, of producing poor designs and making suggestions for arrangement of pieces on the playground which lack purpose except for aesthetic appeal to adults. Designers are accused of being blinded by conceptions of traditional equipment and of having more interest in providing a maintenance-free area than an area that stimulates movement in children. Lastly, designers are criticized for lack of concern about liability.
If planners and producers of playgrounds and equipment in reality fail to attend to the needs of children, the criticism which has been leveled against them may well be true.

It is time to respect children's needs and to produce outdoor learning centers which are varied in design instead of based on one design which claims to meet all the needs of all children. Just as there are no "all-purpose" children, there is no one outdoor learning center which is capable of meeting all of children's physical, emotional, social, and intellectual needs. Instead of accepting single novel pieces of playground equipment and rejecting the new total playground conceptualizations (Brown) as some administrators, parents, and designers do, and instead of perpetuating a "square of sterility" (Friedberg), critics are calling for criteria which reflect the needs of children and the purposes of education (Thompson; Friedberg; Ellis).

Photography

Improvement in technology has greatly increased the accuracy in obtaining data and the variety of ways by which to measure selected aspects of human movement for study. Both movie and still film have been utilized for years. Advancements in the chemistry of film allow more realistic pictures of movement to be obtained. Motorized
cameras have recently made it possible to take pictures without the cumbersome task of advancing the film by hand. The 250 exposure film packs have made it possible to take over seven times as many pictures as the normal thirty-six exposure roll for slide cameras. These techniques were used to great advantage in studies by Herron and Frobish. Other techniques such as a fish-eye lens which enables the camera to take pictures of a full $360^\circ$ area, multiple cameras and superimposed grids have enabled researchers to look at movement and analyze it from a two-dimensional perspective (Mitchell; Snyder; Karlsson and Ellis). Time-lapse photography was utilized by Wuellner at 10-second intervals and later at 4-second intervals, the latter of which was determined to be the more accurate time sampling technique to preserve maximum information. Haith utilized Cartesian coordinates to plot images of changing position and developed an instrument to transfer the data to the computer for analysis.

Peterson, Bishop, Michaels, and Rath used pictures of playground equipment and a forced choice instrument to determine children's preferences of playground equipment with eight- and nine-year-old boys. Time-lapse photography was used to film children's actual usage of the equipment. Results indicated that children have stable preferences for equipment and that these preferences
correlated with actual usage of the equipment. Continued advances in photographic technology will make it possible to collect data more accurately and increase educators' understanding of children's movements.

**Criteria for the Selection of Equipment for Outdoor Learning Centers**

In order to have a frame of reference from which to talk about criteria for pieces of equipment, it is first necessary to talk about outdoor learning centers as whole units. They are the scene in which each single piece of equipment is to be placed. Following a general discussion about outdoor learning centers, consideration will be given to the contribution which equipment can make to the development of the four general characteristics of children: emotional, social, intellectual and physical. Characteristics of quality equipment will then be examined. Examples of contemporary playground planners and educators will be included.

The outdoor learning center is the setting in which children will play on equipment. Prior to placing equipment on the play area, a designer needs to consider the purpose of the playground, what the children are like who will play on the playground, the environmental conditions, and the resources available. Some writers place a great deal of stress on the importance of determining the purpose of the playground (Ellis;\textsuperscript{195} Friedberg;\textsuperscript{196} Allen;\textsuperscript{197} Dattner\textsuperscript{198}),
although this emphasis is not always evident in reality. Perhaps a comprehensive plan for total development would alleviate the piecemeal productions in many play areas. Environmental considerations include the size and topography of the area. The resources include the equipment and materials provided for the area. It may be that the careful placing of resources in the environment may be the unifying link between education and recreation. Whether or not that link is strong will depend on the planner's understanding of children, and his ability to translate his perceptions clearly into a purposeful play area. There are a number of criteria suggested for the development of playgrounds. However, research does not clearly indicate data from which to determine an hierarchical order for these criteria. That is yet to be determined. The following chart (Figure 4) is the investigator's conception of the relationships among the various criteria for playgrounds.

If a piece of equipment is to be worth investing in, it should contribute positively to a child's educational development in one or more ways, either emotionally, (S.L.R. 199 Butler; 200 Lueck 201) socially, intellectually or physically. Emotionally, there are two ways that equipment can contribute toward a child's development. First, it can appeal to his emotions in some way and secondly, he can respond to the appeal of the piece.
CHILDREN

Accommodates a large number
Meets children's needs

ENVIRONMENT

Complex, but not chaotic
Fenced-in
Hills no greater than 4:1 slope--prevents wear on grass
Location of the area
No standard arrangements of equipment possible or desirable
Size of the area
Varied topography

PURPOSE

Allows learning to be relevant
Based on active development in program
Basic elements for natural play expressed
Comprehensive plan for development
Creates interesting learning situations
Evaluation is planned
Expresses concepts of the world
Permits variety in program
Recreation and play needs are accommodated
Relates to educational program in nature and scope
Unifying link between education and recreation

RESOURCES

Adequate amount
Provide variety of devices
Provide natural materials
Quality material
Variety of kinds of materials

Figure 4

Criteria for Outdoor Learning Centers
Under these two broad headings, contributions to emotional development can be categorized according to the chart in Figure 5 [see Figure 5]. Hopefully, equipment is selected by its appeal to the children and not to the adults. Which pieces will help develop emotional stability rather than promote discord, tension, and rejection?

In what ways can equipment stimulate social development? What desirable responses should equipment promote? Perhaps the equipment should help a child develop responsibility for others, participation with others, and in return an opportunity to learn from others. All of these responses might be utilized to develop social interaction. Although surprisingly little is written about social development (Garrison; Grey; Miller) as an outgrowth of utilizing playground equipment, at least two men have focused on this idea. Joe Brown, a teacher at Princeton, has developed play equipment which requires interaction with others to use it. When playing on the equipment, children must be acutely aware of the actions of others as well as his own for they affect one another. By the same token, Friedberg emphasized a concept called interplay: between people and things and between people and people. His playground equipment designs set situations to encourage both types
APPEAL

Aesthetically attractive
Color: improves appearance
    harmonizes with nature
Encourages sense of mastery
Provides an outlet for
    children's interests

RESPONSE

Adjusts to self within adverse environment
Develops a positive self-concept
Develops emotional stability
Enjoys learning on the equipment
Extends creative experiences
Focuses attention on the equipment

DESIRE

To use equipment

Figure 5

Contributions to Emotional Development
of these interactions to occur. Figure 6 is the current investigator's conception of the social interaction components.

Playground equipment can contribute to the intellectual development of a child (Friedberg; Dattner; Worley). It can stimulate the child's imagination by providing him with circumstances in which he must make choices. Joe Brown's designs are an excellent example of providing children with choices while children are in the process of moving. Choices are programmed to provide alternatives for movement, rather than to result in dead ends into frustration. The circumstances can challenge a child to use sound judgment to decide which way to move next. Through the use of equipment and materials, a child can rearrange situations to learn more about concepts of movement and about the relationship of his own body parts to one another and to the equipment. In those ways of experimenting, a child can learn more about life, about his own abilities, limitations, and about important concepts about the world. Lady Allen of Hurtwood stresses the importance of exploration of the environment as a way to learn more about life. Both Ellis and Friedberg encourage children to deal with environments which will stimulate the imagination and produce intellectual creativity as well as a variety of movements.
RESPONSIBILITY FOR OTHERS
Respect

PARTICIPATION WITH
OTHERS
Develop relationships
Develop teamwork

LEARN FROM OTHERS

Figure 6
Contributions to Social Development
Social Interaction
Figure 7
Contributions to Intellectual Development
The most obvious children's attribute that a piece of playground equipment should develop is physical. It should produce opportunities to interact with a variety of textures and environmental conditions. Both Shaw\textsuperscript{213} and Bowers\textsuperscript{214} have highlighted variations of textures in playgrounds they developed to provide stimulation for perceptual-motor responses. Shaw's\textsuperscript{215} goals, which were utilized as criteria for a playground, included:

1. Body balance
2. Body awareness
3. Laterality
4. Integration of body sides
5. Directionality
6. Spatial relationships
7. Depth perception
8. Linearity
9. Tactile awareness
10. Kinesthetic awareness
11. Temporal awareness
12. Spatial relationships of objects in space
13. Judgment and decision
14. Motor planning
15. Concepts about space.

Varied textures and conditions should promote good body development and use of the muscles in a variety of ways which in turn should produce a variety of movement resulting in self-control and self-reliance. If one of the goals of physical education is to help children learn to move as efficiently as they can with their own bodies, perhaps more stimulating equipment can help provide the environment in which that goal can be accomplished. Figure 8 provides a description of the contributions that playground equipment can make to physical development.
Opportunities to interact with a variety of equipment which is:

Varied in texture:
- Elastic
- Maleable
- Resilient

Varied in light-dark patterns:
- Color
- Space

Multipurpose
Stationary
Child-sized in:
- gripping surface
- height of steps

Educationally valuable

In order to develop the body:
- Acquire basic skills
- Develop balance
- Use muscles a variety of ways
- Develop coordination
- Develop dexterity
- Develop agility
- Provide all-around exercise
- Use the five senses

To produce:
- Self-reliance
- Active play
- Self-control
- Adaptation to environment
- Variety of movement experiences
- Modification of the environment
- Progression from single to complex

Figure 8
Contributions to Physical Development
Figure 9 shows a list of questions which might be asked about the physical description of a piece of equipment.

There are a great number of goals which could be utilized as criteria for the selection of equipment. Those selected for a particular school will depend on the purpose for which the area is planned. It is crucial that the playground have purpose and that it is planned with care to meet children's needs. Vinciguerra\textsuperscript{216} captured the spirit of the writer's concern when he poetically described a playground as:

Not a collection of isolated single use pieces of equipment arranged in a haphazard fashion. Rather, it is a symphonic arrangement of shapes, colors, forms and textures which when engaged by little children will result in a kaleidoscope of activity and learning.

In order to provide a symphony which is harmonious rather than cacaphonic, the instruments must be chosen with care and directed by a conductor who is sensitive to the total sound. The same is true of outdoor learning centers. Each piece must be chosen with care in order to blend with the purpose of the whole playground for the benefit of children.

It is the purpose of this project to evaluate a few goals in order to discern whether or not they are realistic for criteria for the selection of equipment for outdoor learning centers.
In order to determine the quality of a piece of equipment, one could ask: Is it . . .

Durable
Easy to supervise
Economical to maintain
Home-made or manufactured
Indestructible
Low cost and good dollar value
Mobile or immobile
Modular in construction
Safe
Serviceable
Serving a number of students
Suitable for the climate
Usable year around
Well designed
Well finished?

Figure 9

Physical Characteristics of Equipment
In Chapter II the writer has noted how the effects of variations in environments operate on children in learning situations. To cope with the enormous increases in knowledge, a conceptual approach to curriculum was suggested as one way of condensing and ordering information. Specifically in relation to children's education in movement, Laban's spatial elements were discussed with particular emphasis on the child's need for manipulation, as pointed out by Piaget.

The characteristics of four-, five- and six-year olds were described with reference to the implications about children's need for movement and their ability to learn about space. Studies about children's use of space on playgrounds were examined, and resultant implications for playground planning noted.

Playgrounds were considered from the viewpoints of the values of equipment, categories of playgrounds, types of equipment found on playgrounds, criticisms of playground planning, methods of evaluating playgrounds, and finally criteria suggested by numerous authors for the selection of playground equipment. The literature relative to the advances in photographic technology which made this study possible was reviewed.

The next chapter will set forth the specific procedures by which this study explored children's use of different pieces of equipment as shown by their movement patterns.
Footnotes for Chapter II


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27 Ibid., p. 100.


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32 Louise F. Davis, "Reactions of Kindergarten, First and Second Grade Children to Constructive Play Materials," Genetic Psychology Monographs (Worcester: Clark University, 1930), p. 446.


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CHAPTER III

METHODS AND PROCEDURES

Many questions about the ways children use space on playground equipment challenged the investigator. How do children utilize space in general? How do children utilize the spaces created between pieces of equipment and within a piece of equipment? Are the movements which children produce on one piece of equipment the same or different from those produced on other pieces of equipment? Which piece of equipment would be more appropriate to recommend for the use of children participating in a movement education approach to physical education? How can the movements which children make be recorded and analyzed? Is playground equipment built to an appropriate child-sized scale? Which kind of equipment produces more variation in the movements of children: equipment with moving parts or stationary equipment?

Since it is not possible to answer all of these questions within the scope of one study, the investigator limited this project to searching for answers to the following questions:

1. Which of the three pieces of equipment selected...
produces the greatest variation in the utilization of space as measured by children's use of level, direction and range?

2. Which of the three pieces of equipment selected produces the greatest variation in the children's use of bases of support?

Over a period of years, the researcher has observed children playing on equipment in various school and park settings. Children of all ages seem to play on the same pieces of equipment. Most equipment, however, appears to have been produced for younger children, or at least manufacturers claim that equipment is primarily for younger children.

The researcher observed that basic movement as a content area is most often taught in public schools at the primary level rather than in the intermediate grades. And, although children in K-2 interact with playground equipment at recess, it is rarely employed in the physical education setting. Why?

**Selection of Subjects**

The review of literature suggested a number of criteria for the selection of subjects, and others were dictated by the uniqueness of the study. The following criteria were established. The subjects should be:

1. boys because they are more active
2. in the same school and the same class, taught by the same teacher
3. the same age (5 years old)
4. familiar with the same play areas and equipment at school

5. physically normal (exhibiting no visible physical handicaps)

6. able to participate on all three days of the study.

The subjects selected for the study were kindergarten boys attending Worthington Hills Elementary School during the spring of 1974. It was not possible to find a sample of only five year-olds so five and six year olds were utilized. The boys were chosen from both morning and afternoon sessions of Kindergarten taught by the same teacher and met all other selection criteria.

Permission for the children to participate in this study was obtained from the superintendent of the Worthington Public Schools. Letters were sent to all parents of kindergarten boys in Worthington Hills asking for permission to allow their boys to be in this project. A sample letter is included in Appendix A. From the affirmative responses, twelve boys who met the criteria were selected, as well as two substitutes in case of illness or emergency. More specific instructions were then sent to parents of the participants. A sample copy is included in Appendix B. The parents were also asked to complete the Ohio State University Research Involving Human Subjects Authorization Form (see Appendix C).

On the basis of the review of literature, the investigator limited the sample size to twelve and placed
the subjects in playing groups of four (M. G. Wade, Ellis, and Bohrer) for interacting with the playground equipment. However, each boy's movements were analyzed separately. One group was composed of boys from the afternoon Kindergarten session. The second and third groups attended the morning session. Complete randomization was not possible because filming occurred just prior to or just after school sessions and the investigator did not want the boys to miss school. Additional factors in the non-random subject selection were the 10 mile distance of the testing sites from schools and the transportation problems inherent in mothers' car pools.

The subjects were identified by wearing football shirts with different numerals, colors and sleeve lengths. Where possible, the shirts were tucked in to allow for maximum visibility of the midpoint marking. Otherwise, the boys wore the shirts over their own shirts. This generally caused the numeraled shirts to remain stationary on the boys' bodies as did tucking them into the waistband of their jeans. Contrasting colored markings of 1-1/2" x 1" patches were ironed on the shirts at the level of the navel and at a spot on the spine opposite the navel, to mark an arbitrary midpoint on the boys' bodies.

The shirts worn by the boys for identification purposes were passed out in random fashion. Care was taken so that duplicate numbers did not occur in the same group.
Sample size was limited to twelve subjects due to the enormous amount of data to be collected and analyzed. One thousand two hundred and ninety-six slides were obtained during nine three-minute filming sessions using a five-second interval time sampling procedure. Each slide was analyzed for four boys and six marked body parts on each. Although a digitizer and computer assisted in the analytical process, a tremendous amount of experimenter time to handle the raw data phase was invested (an estimated seventy-two hours).

Selection of Playground Equipment

On the basis of the review of literature and the interest and experience of the investigator with elementary children and playgrounds, the following criteria were established for the selection of the equipment:

1. Each piece of equipment should have non-moving parts.
2. Each piece should have a single-purpose design.
3. Three varied pieces of equipment should be provided:
   a. One piece should be solid in nature
   b. One piece should encompass large open spaces
   c. One piece should be smaller than the others and have narrow vertical and horizontal dimensions.
4. A variety of textures should be provided.
5. Each piece should be safely constructed: all screws will be tight and any wood will be smoothly sanded.

6. Each piece will have appropriate ground materials under it to provide for a safe landing place.

7. Each piece will provide a different spatial design.

Because of possible inclement spring weather in Columbus, the investigator flew to Tampa, Florida, to explore a playground being designed by Louis Bowers at the University of South Florida, Department of Physical Education. Although the Bowers playground might be appropriate, the first construction would not be completed in time to run the study. The investigator also consulted with Leland Shaw in the Landscape Architecture Department of the University of Florida at Gainesville. Shaw’s playgrounds are modular in construction, and although they have been built at elementary schools and do provide a variety in textures, they lack the variety in spatial design that the researcher required. Thus, the Columbus, Ohio area was selected with the hope that the weather would be warm enough for filming. In addition, professional and technical assistance were more readily available to the investigator in the Columbus area.
Three pieces of playground equipment were selected at two school playgrounds in or near Columbus. One piece was a piling structure manufactured by the Play Timber Company which was made of 1' x 1' wood pilings of various heights ranging from one foot to six feet. One ten-foot vertical piling extending from the top of the total structure secured a six foot horizontal beam. That beam, normally utilized to support a tire swing, was not attached during the study. The two slides attached to the pilings were not used in the study. The top edges of the pilings were beveled, and the structure measured 9' x 10' at its base. (See Figure 10 and Appendix D.) A six inch layer of tan bark-like material and sand provided adequate ground cover.

A second piece of equipment consisted of three horizontal metal bars of differing heights connected by vertical poles. The bars were 9'10" in total width, and the vertical posts were 6'6" high. One horizontal bar was 5'7" above the ground level, a second one was 4'11" high, and the third bar was 4'1" high. The pipe was 1-1/4" x 14 gauge zinc-grip steel. The bars were called Three-Muscle Bars and were attached to an Outdoor Muscle Man unit manufactured by Game Time, Inc. Tanbark material provided an adequate ground cover. (See Figure 11 and Appendix D.)

A geodesic dome was the third piece of equipment. It was constructed of 1-1/4" x 14 gauge zinc-grip pipe,
Figure 10
Wooden Pilings
Figure 11

Muscle Man Bars
and was bolted together with rust-resistant bolts. The dome was 17'1" in diameter, 6'10" high, with each triangular section measuring two feet on a side. The dome, called the Eagle's Perch, was manufactured by Game Time, Inc. Six inches of sand provided an adequate ground cover. (See Figure 12 and Appendix D.)

The pilings were located at Northam Park in the Upper Arlington Park District, which is located adjacent to the Tremont Elementary School which provided a source for electricity. Permission was secured from the recreation division to use the pilings during the study. (Other equipment located on the playground included cement animals, a curved ladder, and a twirl.

The horizontal bars and geodesic dome were located on the play field attached to Northtowne Elementary School, Columbus Public Schools. Permission was secured to use the equipment during the study from the principal, and the school also provided a source for electricity. The equipment was located in two separate areas. Other equipment near the bars included four swings, three large (4' diameter) concrete conduits, and a slide. Additional equipment close to the dome included a slide, four swings, and a 4-seated bouncing piece. One hundred fifty feet separated the two areas, although each was easily visible from the other.
Figure 12
Geodesic Dome (Eagle's Perch)
Collection of Data

A professional photographer took charge of the technical details. A research assistant started the clocks and gave the boys the signal to start playing. The investigator manipulated the switch which controlled the release button and rate of film exposure.

On the basis of the review of literature and consultation (1) with various members of the Photography Department or Teaching Aids Laboratory at The Ohio State University; (2) with professional photographers at Photogenesis, Inc.; and (3) with technical representatives of the Ehrenreich Photo-Optical Industries, Inc., in New York (see Appendix D), the following pieces of photographic and miscellaneous equipment were utilized:

A. Four Nikon Motor Drive F-36 Cameras. The Motor Drive attachment permitted the camera to automatically advance the film for a sequence of single exposures. Eight AAA batteries provided power. Remote control was possible via an AC plug on the Motor Drive unit. A fifth camera was available if needed in case of mechanical malfunction.

B. Four 50-mm lenses.

C. Thirty-six rolls of Kodak Ektrachrome-X (EX 135-36) for color slides of the three-minute movement sessions.

D. One roll of Kodak Ektrachrome-X (EX 135-36) to take slides and make prints of the twelve boys for identification purposes.
E. One light meter to determine the shutter aperture for proper exposure of the film.
F. Four tripods to support the cameras so the top of all four cameras measured 4'1" from the ground.
G. One Helix Pulsar unit as a power source for tripping the release buttons on the cameras.
H. One Archer 274-291 2-conductor phone plug, subminiature type, to adapt the Pulsar unit to the Nikon system.
I. Six feet of light weight speaker wire to connect the phone plug to the line switch.
J. One line switch.
K. Two hundred feet of 18-gauge 2-conductor AC wire.
L. Four AC plugs.
M. Electrical tape, solder.
N. Five hundred feet of 16-gauge 2-conductor AC wire.

Procedures for Data Collection
Although when slides are generally processed, they are mounted and numbered in chronological order, large swimming timing clocks with sweep second hands were placed in view of each camera to provide a check on sequencing of the pictures. Four hundred feet of 16-gauge, 2-conductor AC wire ran from one clock to the AC power source in
each school building. An extender plug and one hundred feet of 16-gauge, 2-conductor wire connected the two clocks (see Appendix D). All electrical connections were made by a technical assistant skilled in electrical wiring assemblies.

In order to identify the cameras, symbols for each camera were placed on the clocks in view of that camera, in addition to session numbers and subject group symbols, according to the following code system:

2. Subject groups: A, B, C
3. Sessions: 1, 2, 3, 4, V, 6, 7, L, IX

On the basis of the review of literature, observations, and slides which the experimenter had taken of children playing on equipment, a five-second time sampling interval between pictures was selected.

Cameras were placed at 90° angles from one another and at distances measured exactly from the midpoint of the equipment. These exact measurements were necessary for the digitizer phase of the analysis. Placement allowed full view of the children's movement actions on the equipment as well as a view of one clock placed midway between two other cameras. Camera placement distances were thirty feet from the center of the wood pilings, twenty-five
feet from the center of the horizontal bars, and thirty-four feet from the center of the geodesic dome.

A cross-hatch marking for the digitizer analysis process was placed on the top of the pilings and on the ground under the central point of the geodesic dome and the horizontal bars. The cross hatch was used as a central reference point for locating the exact three-dimensional positions of each body part for each boy on each slide.

Since the equipment had to be moved between the sessions on the second day of filming, the equipment locations (of tripods and clocks) were marked with tape and secured with nails to ensure exact re-location (see Figure 13).

The National Weather Service at Port Columbus International Airport provided official weather conditions for the familiarization session and the two filming days during which the study was conducted. Weather conditions reported were as follows:

<table>
<thead>
<tr>
<th>Day and Date</th>
<th>Time</th>
<th>Temperature</th>
<th>Wind</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monday, April 15</td>
<td>10:00 AM</td>
<td>43 °</td>
<td>W 17, Gust 30</td>
</tr>
<tr>
<td>April 15</td>
<td>11:00 AM</td>
<td>43 °</td>
<td>WSW 17</td>
</tr>
<tr>
<td></td>
<td>12:00 PM</td>
<td>43 °</td>
<td>WSW 17</td>
</tr>
<tr>
<td>Tuesday, April 16</td>
<td>10:00 AM</td>
<td>46 °</td>
<td>NE 5</td>
</tr>
<tr>
<td>April 16</td>
<td>11:00 AM</td>
<td>50 °</td>
<td>NE 3</td>
</tr>
<tr>
<td></td>
<td>12:00 PM</td>
<td>52 °</td>
<td>WNW 5</td>
</tr>
<tr>
<td>Wednesday, April 17</td>
<td>10:00 AM</td>
<td>51 °</td>
<td>Calm</td>
</tr>
<tr>
<td>April 17</td>
<td>11:00 AM</td>
<td>55 °</td>
<td>SW 5</td>
</tr>
<tr>
<td></td>
<td>12:00 PM</td>
<td>57 °</td>
<td>SW 6</td>
</tr>
</tbody>
</table>
Figure 13
CAMERA PLACEMENT, CLOCK PLACEMENT, ELECTRICAL
WIRING SCHEMATIC
LEGEND FOR FIGURE 13

N
W
S
E
directions from which cameras took pictures

C₁
C₂
swimming clocks with sweep second hand

I = Intervalometer

PGE = Playground equipment

-- = distance from center of equipment to each camera.

from pilings = 30'
from dome = 34'
from bars = 25'
On Monday (familiarization session), the weather was generally cold and cloudy. On Tuesday and Wednesday (filming sessions), it was warm and sunny with no clouds.

**Preliminary Investigations**

The investigator took slides of a group of four boys playing on a jungle gym at a neighborhood elementary school to determine whether or not five-second intervals seemed appropriate and to determine the distance the camera should be placed from the equipment. Markings were placed on the equipment and on the boys to determine whether or not they would be visible on film.

The investigator spent one session measuring the sizes of the equipment and determining the distances the cameras should be placed from the three pieces of equipment.

On the Friday prior to filming, the investigator spent one-half hour in each of the Kindergarten sessions where the subjects attended school to partially familiarize the subjects to her. Friday evening, the investigator, the photographer, the research assistant, and the technical assistant in charge of electrical wiring checked all equipment and completed all wiring connections.

On Saturday, the investigator, the photographer, and one research assistant spent the morning making final measurements and marking distances with bottle caps and
nails into the ground. The markings were easily visible on the actual filming day. The four cameras were loaded with black and white film and a dry run was taken to check distance and film exposure. Four boys with numbered shirts played on the equipment while the pictures were taken.

On Monday, the subjects attended a familiarization session at each playground. The investigator initially allowed them to explore the entire play area around each designated piece of equipment. The shirts were distributed and marked at the midpoints. The investigator later attached the iron-on tape at these places. The subjects played on the equipment for one minute in their filming session groups of four. (Due to the cold weather, it was impossible for the boys to play longer.) The position of the cameras was explained and the boys looked at the timing clocks. Two of the subjects were ill and thus missed Monday's familiarization session.

Description of Data Collection Sessions

On Tuesday, the investigator, the photographer, and one research assistant arrived at Northam Park one hour prior to filming in order to set up all the technical equipment and make final measurements. One hour was ample preparation time. Markings were made on the pilings to help determine its midpoint for use in the subsequent digitizer analysis.
When the boys arrived, a special familiarization session was held for those who had been absent the day before. The shirts were distributed. The boys visually located the four cameras and two clocks, and were then reminded about how the cameras and clocks would function. They were shown the special markings on the equipment and asked not to disturb these markings when they played. The subjects were then given special instructions: on the signal (given by the research assistant), they were to move on the equipment in as many different ways as possible. They were to stay on the equipment until the investigator asked them to get off. The boys were given opportunities to ask questions and the investigator asked some follow-up questions to ascertain that they were really familiar with the procedures they were to follow. At that point, the investigator stationed herself at the South camera where the switch was located and signaled for the research assistant to start the clock and to send the boys to the equipment. The boys played on the equipment for three minutes while pictures were snapped at 5-second intervals. The photographer was free to check photographic equipment, take light meter readings and made minor adjustments. The investigator controlled the filming intervals with a line switch. She watched the same clock for all the sessions to determine the 5-second intervals. The research assistant watched the clocks for technical problems. At the
conclusion of the three minutes, several pictures of the boys in their groups were taken for identification purposes, and the boys were free to play on any of the playground equipment in the area. The shirts were collected between sessions to prevent forgetting to wear them the next day.

On Wednesday, a similar procedure was followed. Again, special familiarization sessions were held for the two boys who were ill on Monday. Instructions regarding use of the equipment, markings, clocks, and cameras were repeated. While the one group took its turn for filming, the mother who had driven the boys to the site took the other group away from the filming site. Pictures were again taken for identification purposes. The groups were filmed in the following order:

**Tuesday**

<table>
<thead>
<tr>
<th>Film Session</th>
<th>Group</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A</td>
<td>Pilings</td>
</tr>
<tr>
<td>2</td>
<td>B</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>C</td>
<td></td>
</tr>
</tbody>
</table>

**Wednesday**

<table>
<thead>
<tr>
<th>Film Session</th>
<th>Group</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>A</td>
<td>Geodesic dome</td>
</tr>
<tr>
<td>5</td>
<td>A</td>
<td>Horizontal bars</td>
</tr>
<tr>
<td>6</td>
<td>B</td>
<td>Horizontal bars</td>
</tr>
<tr>
<td>7</td>
<td>C</td>
<td>Horizontal bars</td>
</tr>
<tr>
<td>8</td>
<td>C</td>
<td>Geodesic dome</td>
</tr>
<tr>
<td>9</td>
<td>B</td>
<td>Geodesic dome</td>
</tr>
</tbody>
</table>

A flatbed coordinate digitizer was utilized to plot the positions of each boy's head, hands, feet, and
body midpoint from each series of four slides as they were flashed on the flatbed. The flatbed was an opaque screen mounted on a wooden frame at a forty-five degree angle to the horizontal. A slide projector was set up at a 90° angle to the flatbed, and produced an image 8-3/4" x 12-11/16" in size. A scanner, similar to a sight on a gun, was motorized to move vertically with a separate motor causing it to move horizontally. When both motors were engaged, the scanner moved diagonally. A "joy stick" similar to that in an airplane controlled the scanner's movement. The digitizer was designed to plot Cartesian coordinates: thus vertical movements changed the y-coordinate and horizontal movement changed the x-coordinate, each point being accurately ascertained to the nearest 1/10,000 of an inch.

The researcher ran the digitizer and controlled the scanner in order to plot the boys' body parts and midpoints, while a research assistant controlled the computer terminal which entered the Cartesian coordinate data and the coding number giving the apparatus, subject, slide, and view. Approximately 10,000 IBM computer cards were generated by the total process which took two people approximately 72 hours.
Footnote for Chapter III

CHAPTER IV

ANALYSIS OF DATA

Analysis for Spatial Dimensions
and Bases of Support

In order to determine the total amount of gross movement which occurred for the six body parts, including midpoint, for all twelve subjects on each of the pieces of apparatus, a three-factor repeated measures analysis of variance was computed. The unit of measurement is inches.

Three significant sources of variance were determined. The first F (main effect for apparatus) of 5.0852 was significant at the .05 level as compared to a Table F of 3.44. The second F (main effect for body parts) of 32.8593 was significant at the .01 level as compared to a Table F of 5.18. A third F (interaction effect between the equipment and the body parts) of 8.8369 was significant at the .01 level as compared to a Table F of 2.47.

Since the F values were significant for both the equipment and for the body parts, the Scheffe' test was applied to F values in order to determine exactly where the differences were.
When the Scheffe' procedure was applied to the F values for the equipment, the pilings as compared to the dome had a computed S of .4064 at the .05 level as compared to an expected S value of .3588.

The Scheffe' computation with the F values for the body parts yielded significant differences as found in Table 1.

Table 1
Results of Scheffe' Test as Applied to the Body Parts for Gross Movement

<table>
<thead>
<tr>
<th>Body Part</th>
<th>Body Part</th>
<th>( \alpha = .05; )</th>
<th>( \alpha = .01; )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right Foot</td>
<td>Head</td>
<td>.1711</td>
<td>.1578</td>
</tr>
<tr>
<td>Left Foot</td>
<td>Head</td>
<td>.1711</td>
<td>.1578</td>
</tr>
<tr>
<td>Right Hand</td>
<td>Head</td>
<td>.0828</td>
<td>.0756</td>
</tr>
<tr>
<td>Right Hand</td>
<td>Left Hand</td>
<td>.0828</td>
<td>.0756</td>
</tr>
<tr>
<td>Right Hand</td>
<td>Midpoint</td>
<td>.0803</td>
<td>.0817</td>
</tr>
</tbody>
</table>

The means were computed for the total amount of movement which occurred on each piece of equipment. The mean for the pilings was 1.66941 inches in terms of the projected image of the slide on the digitizer screen. The mean for the bars was 1.60267 inches and the mean for the dome was 1.26296 inches. In order to convert the distances on the tables to linear inches, subtract 20 and multiply the resultant figure by 12. For example, the mean for the total distance moved on all three pieces of apparatus for
the first subject on Table 2 was 1.50 rounded to the nearest one-hundredth inch. In order to convert that figure to linear inches moved on the ground, use the following conversion formula: 12 (N-20). Thus, in this example, 12 (1.50-20): -222.00 inches. Disregard the negative sign in front of 222 because the original numbers from the raw data were given in positional Cartesian coordinates in relation to a central point of measurement for each slide. The negative sign thus is a positional sign rather than a numerical value sign. The resultant 222.00 is then the mean in linear inches for the total distance that subject one moved on all three pieces of equipment.

Table 2
Means for the Total Movement Occurring on All Three Pieces of Equipment for Each Individual Subject (Unit of Measurement: inches)

<table>
<thead>
<tr>
<th>Subject</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.49549</td>
</tr>
<tr>
<td>2</td>
<td>1.47873</td>
</tr>
<tr>
<td>3</td>
<td>1.73259</td>
</tr>
<tr>
<td>4</td>
<td>1.45088</td>
</tr>
<tr>
<td>5</td>
<td>1.44692</td>
</tr>
<tr>
<td>6</td>
<td>1.87612</td>
</tr>
<tr>
<td>7</td>
<td>1.59496</td>
</tr>
<tr>
<td>8</td>
<td>1.50766</td>
</tr>
<tr>
<td>9</td>
<td>1.17621</td>
</tr>
<tr>
<td>10</td>
<td>1.36088</td>
</tr>
<tr>
<td>11</td>
<td>1.45869</td>
</tr>
<tr>
<td>12</td>
<td>1.56125</td>
</tr>
</tbody>
</table>
The means for the subjects' movements are found in Table 2 while the means for the movement which occurred in the intervals between slides is found in Table 3. The mean for all 12 subjects during the first minute which covered intervals 1-11 is 1.58248. The mean for the second minute which covered intervals 12-22 is 1.48380. The mean for the third minute which covered intervals 23-33 is 1.45899. The means for the total movement made by each of the six body parts is found in Table 4.

Table 3

Means for Total DistancesMeasured for Each Interval Between Slides on All Three Pieces of Equipment
(Unit of Measurement: inches)

<table>
<thead>
<tr>
<th>First Minute Interval</th>
<th>First Minute Mean</th>
<th>Second Minute Interval</th>
<th>Second Minute Mean</th>
<th>Third Minute Interval</th>
<th>Third Minute Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.45895</td>
<td>12</td>
<td>1.36955</td>
<td>23</td>
<td>1.37077</td>
</tr>
<tr>
<td>2</td>
<td>1.41213</td>
<td>13</td>
<td>1.72800</td>
<td>24</td>
<td>1.14463</td>
</tr>
<tr>
<td>3</td>
<td>1.32377</td>
<td>14</td>
<td>1.62826</td>
<td>25</td>
<td>1.45922</td>
</tr>
<tr>
<td>4</td>
<td>1.62877</td>
<td>15</td>
<td>1.26066</td>
<td>26</td>
<td>1.59921</td>
</tr>
<tr>
<td>5</td>
<td>1.49036</td>
<td>16</td>
<td>1.46863</td>
<td>27</td>
<td>1.62364</td>
</tr>
<tr>
<td>6</td>
<td>1.68087</td>
<td>17</td>
<td>1.83100</td>
<td>28</td>
<td>1.45082</td>
</tr>
<tr>
<td>7</td>
<td>1.35987</td>
<td>18</td>
<td>1.41124</td>
<td>29</td>
<td>1.86745</td>
</tr>
<tr>
<td>8</td>
<td>1.39096</td>
<td>19</td>
<td>1.45104</td>
<td>30</td>
<td>1.86843</td>
</tr>
<tr>
<td>9</td>
<td>1.57306</td>
<td>20</td>
<td>1.30310</td>
<td>31</td>
<td>1.09571</td>
</tr>
<tr>
<td>10</td>
<td>1.84777</td>
<td>21</td>
<td>1.37993</td>
<td>32</td>
<td>1.23956</td>
</tr>
<tr>
<td>11</td>
<td>2.24073</td>
<td>22</td>
<td>1.60034</td>
<td>33</td>
<td>1.32948</td>
</tr>
</tbody>
</table>
Table 4

Means for Total Distances Measured for Each Body Part
Moving on All Three Pieces of Equipment
(Unit of Measurement: inches)

<table>
<thead>
<tr>
<th>Body Part</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right Hand</td>
<td>1.52417</td>
</tr>
<tr>
<td>Left Hand</td>
<td>1.44864</td>
</tr>
<tr>
<td>Head</td>
<td>1.44140</td>
</tr>
<tr>
<td>Midpoint</td>
<td>1.44429</td>
</tr>
<tr>
<td>Right Foot</td>
<td>1.61246</td>
</tr>
<tr>
<td>Left Foot</td>
<td>1.59914</td>
</tr>
</tbody>
</table>

The statistical analysis for movement which occurred on each piece of equipment seems to indicate that the greatest amount of movement occurred on the pilings, less movement occurred on the bars, and the least amount of movement occurred on the dome. Thus, if a piece of equipment were to be selected for the purpose of providing more movement, of the three pieces involved in this study, the findings seem to suggest the pilings.

When the means are compared for each of the minutes the subjects were on the equipment, the data indicate that the more movement occurred during the first minute, less during the second minute and the least during the third minute. One may suggest from that information that filming might best be spent during the first minute subjects are playing on the equipment to capture the greatest total amount of movement.
Table 4 indicates that of the six body parts measured for movement the right foot moved most, then the left foot, followed by the right hand. The left hand, head and midpoint moved less and about the same total distances. Thus the data seem to indicate that measuring the movement distance of the right foot, left foot, and right hand would be the most appropriate to utilize if a study were investigating which body part is most active.

In order to determine the total amount of range of movement which occurred for the five body parts from the midpoint (including all twelve subjects and all three pieces of apparatus), a three-factor repeated measures analysis of variance was computed.

Three sources of variance were determined to be significant. The first F (main effect for apparatus) of 160.5955 was significant at the .01 level as compared to a Table F of 5.72. The second F (main effect for the body parts) of 243.6133 showed significance at the .01 level as compared to a Table F of 3.83. A third significant F (interaction effect between the equipment and the body parts) of 24.9554 at the .01 level compared to a Table F of 2.82.

Since the F values were also significant for both the apparatus and the body parts for range of movement, use of the Scheffe' test allowed the investigator to find the
exact location of these differences. For the equipment, the bars as compared to the dome had a computed $S$ of .3021 at the .01 level as compared to an expected $S$ value of .0683 while the bars compared to the pilings had an $S$ of .3239 at the .01 level compared to an $S$ value of .0683.

For body parts, significant differences were also revealed, as found in Table 5.

Table 5

Results of Scheffe' Test as Applied to the Body Parts for Range of Movement

<table>
<thead>
<tr>
<th>Body Part</th>
<th>Body Part</th>
<th>$d = .01; (S = .0842)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right Hand</td>
<td>Left Hand</td>
<td>.4902</td>
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<tr>
<td>Right Foot</td>
<td>Left Foot</td>
<td>.4865</td>
</tr>
<tr>
<td>Right Hand</td>
<td>Left Hand</td>
<td>.1426</td>
</tr>
<tr>
<td>Right Hand</td>
<td>Head</td>
<td>.0862</td>
</tr>
</tbody>
</table>

The means were computed for the total range of movement which occurred on each piece of equipment. The mean for the pilings was .84147 inches while the mean for the bars was 1.16539 inches and the mean for the dome was .86332 inches (measurements all projected in terms of the image on the digitizer screen).

The means for each subject's range of movement are found in Table 6 while the means for the range of movement which occurred for each slide are found in Table 7. The mean for the range of movement for all twelve subjects
Table 6
Means for the Total Range of Movement Occurring on All Three Pieces of Equipment for Each Individual Subject
(Unit of Measurement: Inches)

<table>
<thead>
<tr>
<th>Subject</th>
<th>Mean</th>
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<td>1.00048</td>
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<td>.87313</td>
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<tr>
<td>12</td>
<td>.92724</td>
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Table 7
Means for the Range of Movement Measured for Each Interval Between Slides on All Three Pieces of Equipment
(Unit of Measurement: inches)

<table>
<thead>
<tr>
<th>Interval</th>
<th>First Minute Mean</th>
<th>Second Minute Mean</th>
<th>Third Minute Mean</th>
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</thead>
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<td>.94579</td>
<td>.96627</td>
<td>.98307</td>
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<td>2</td>
<td>.92486</td>
<td>.98558</td>
<td>1.03359</td>
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<td>3</td>
<td>.92984</td>
<td>1.08047</td>
<td>.99360</td>
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<tr>
<td>4</td>
<td>.95815</td>
<td>.98432</td>
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<tr>
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<td>.94301</td>
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<td>.90752</td>
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</table>
during the first minute (involving intervals 1-11) is .9462; the mean for the second minute (intervals 12-22) is .9658; and that for the third minute (intervals 23-33) is .9602. The means for the total range of movement made by each of the five body parts as measured from the midpoint is found in Table 8.

Table 8

Means for the Range of Distance Measured from the Midpoint for Each of the Five Body Parts Moving on All Three Pieces of Equipment
(Unit of Measurement: inches)

<table>
<thead>
<tr>
<th>Body Part</th>
<th>Mean</th>
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<tbody>
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<td>Right Hand</td>
<td>.86420</td>
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<tr>
<td>Left Hand</td>
<td>.72165</td>
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<tr>
<td>Head</td>
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<td>Right Foot</td>
<td>1.20807</td>
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<tr>
<td>Left Foot</td>
<td>1.21179</td>
</tr>
</tbody>
</table>

On all three pieces of equipment the subjects used the right and left hands and head at a near range more than at a far range, while, in contrast, they used the feet at a far range more than the near range.

In order to determine whether or not the subjects used their body parts near to their midpoint more frequently than far from their midpoint, a test for binomial differences in two proportions was performed. Then the pilings were compared with the bars, the test revealed that there were significant differences in the ranges of movement.
which the subjects used, in that far range was utilized more on the bars than on the pilings for all body parts. The differences in ranges of movement of the right and left hands were significant at the .05 level and those of the head, right foot, and left foot were significant at the .01 level.

When the bars were compared with the dome, the analysis indicated that the subjects used far range significantly more (at the .01 level) for all the body parts.

A mixed pattern occurred when comparing the dome and the pilings. The right and left hands moved in the far range more on the dome than the pilings (significant at the .01 level). The head and the right foot utilized far range more on the pilings than the dome (significant at the .01 level). For the left foot, however, even at the .05 level of significance, there was no difference in the range used on the pilings or the dome. See Table 9.

The statistical analysis for the range of movement which occurred on each piece of equipment seems to indicate that the greatest range of movement occurred on the bars with somewhat less range of movement on the dome, and the least amount on the pilings. Thus, if a piece of equipment were to be selected for the purpose of providing a great range of movement for children as they played, the bars would appear to elicit the greatest possibility for range of movement.
Table 9

Z Scores for Binomial Difference in Two Proportions
Test for Each of the Five Body Parts Moving on the Equipment

<table>
<thead>
<tr>
<th>Body Part</th>
<th>FAR RANGE*</th>
<th>FAR RANGE</th>
<th>Z Value***</th>
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<tbody>
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<td></td>
<td>for Pilings</td>
<td>for Bars</td>
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<tr>
<td>Right Hand</td>
<td>.316**</td>
<td>.380</td>
<td>-1.9111, .05 level</td>
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<tr>
<td>Left Hand</td>
<td>.056</td>
<td>.096</td>
<td>-2.114, .05 level</td>
</tr>
<tr>
<td>Head</td>
<td>.071</td>
<td>.419</td>
<td>-11.557, .01 level</td>
</tr>
<tr>
<td>Right Foot</td>
<td>.539</td>
<td>.926</td>
<td>-12.500, .01 level</td>
</tr>
<tr>
<td>Left Foot</td>
<td>.615</td>
<td>.941</td>
<td>-11.207, .01 level</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>for Bars</th>
<th>for Dome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right Hand</td>
<td>.380</td>
<td>.221</td>
</tr>
<tr>
<td>Left Hand</td>
<td>.096</td>
<td>.007</td>
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<tr>
<td>Head</td>
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<td>Left Foot</td>
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<table>
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<th>for Dome</th>
<th>for Pilings</th>
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<tr>
<td>Left Foot</td>
<td>.637</td>
<td>.615</td>
</tr>
</tbody>
</table>

*Near range can be calculated by subtracting far range proportion from 1.000.

**% out of 408 possible moved on apparatus

***.05 Table Z = ± 1.645 - 1 - Tailed Test
.01 Table Z = ± 2.33 - 1 - Tailed Test
When the means are compared for each of the minutes during which the subjects moved on the equipment, the data indicate that the most range of movement occurred during the second minute, with a little less during the first minute, and the least during the third minute. One may suggest from that information that filming might best be done during the second or third minutes the subjects are playing on the equipment to capture the greatest range of movement.

Table 9 indicates that the left foot used the most range, the right foot ranking second, followed by the right hand, head, and left hand utilizing lesser amounts of range in descending order. These data seem to show that measuring the movement distance of the left and right feet would be most appropriate in a study whose designer was investigating which body part used the most range. However, if one were to study near range only, the data also appear to demonstrate that the right hand, left hand, and head would be more interesting body parts to examine.

If one were to choose one piece of equipment, one part of range, and one body part, the data suggest that one might choose the bars, far range, and the right foot for the most parsimonious analysis of the extremes.

In order to determine the variation in the bases of support used by the subjects, the experimenter first recorded all the combinations of bases of support which
appeared on the slides. A reliability check to verify these observations was performed by an untrained observer, resulting in an overall mean reliability of 88 percent, with agreements ranging from 79 percent to 100 percent. Frequencies of occurrence for each combination of bases of support were tabulated (see Table 10).

Correlations for the combinations of bases of support used on the three pieces of apparatus were computed with a non-parametric Kendall correlation coefficient. A correlation of .2999 (significant at the .01 level for differences) was found between the pilings and the bars; .2367 was the computed correlation coefficient between the pilings and the dome (significant at the .01 level for differences); and a third correlation of .3108 compared the bars and the dome (also at the .01 level for difference). Since the correlations were low, the data seem to indicate that the subjects do indeed use different bases of support on each of the three pieces of equipment.

A non-parametric Wilcoxin Signed Rank for Matched Pairs Test was applied to determine whether or not children use different combinations of bases of support when playing on the three pieces of equipment. There were 146 different combinations of bases of support exhibited on the three pieces of equipment. Those pairs of body support combinations which showed no differences in the frequencies of
Table 10

Frequencies of Combinations of Body Parts Utilized as Bases of Support on the Three Pieces of Equipment

<table>
<thead>
<tr>
<th>Frequencies</th>
<th>Bases</th>
<th>Hand</th>
<th>Hands</th>
<th>Elbow</th>
<th>Elbows</th>
<th>Knee</th>
<th>Knees</th>
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139
Table 10  
(Continued)

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<th>Hands</th>
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Table 10
(Continued)

<table>
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<th>Frequencies</th>
<th>Bases</th>
<th>Hand</th>
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<th>Elbow</th>
<th>Elbows</th>
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<th>Knees</th>
<th>Foot</th>
<th>Feet</th>
<th>Shoulders</th>
<th>Hips</th>
<th>Seat</th>
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</tbody>
</table>

A total of 146 combinations of bases of support were revealed by the data. The combinations were derived by combining the following parts: left hand, right hand, left elbow, right elbow, left knee, right knee, left foot, right foot, shoulders, hips, seat. The fact that a child used no bases of support was also recorded. Table 10 displays the frequency with which various combinations were utilized on the three pieces of equipment.
between equipment were deleted before the statistic was computed. For example, if the pilings and the bars both elicited five occurrences of a right foot body support, these were subtracted from the 146 total and the Wilcoxin Signed Rank for Matched Pairs was determined from the remaining 141 pairs. When a one-tail test was applied at the .05 level a non-significant $T$ of -.2417 was found for combinations of body supports used on the pilings and the bars (computed from the 103 pairs remaining after deletion). When a one-tail test at the .05 level was applied to the 111 remaining pairs between the pilings and the dome, a non-significant $T$ of .2587 was found. A one-tail test at the .05 level was applied to the 100 pairs between the dome and the bars, and a non-significant $T$ of .3451 was found. The same test was run on the 21 pairs of combinations of bases of support which had a frequency uses rate of 10 or more on the three pieces of apparatus, significant differences were not found at the .05 level. Thus, it seems apparent from the inferential statistical treatment of data that the subjects did not utilize different combinations of bases of support on the pilings, the bars, and the dome. However, the descriptive analysis of data seems to support the idea that the subjects do indeed use somewhat different combinations on the equipment. Of the 146 possible combinations of bases of support, 24 were used
only on the dome, 24 were used only on the bars, and 30 were used only on the pilings.

Table 11 indicates the frequency of the top ten combinations of bases of support used by the subjects on the three pieces of equipment.

Table 11

Frequency of Bases of Support used by the Subjects on the Equipment

<table>
<thead>
<tr>
<th>Combination of Bases of Support</th>
<th>Frequency of Use on:</th>
<th>Pilings</th>
<th>Bars</th>
<th>Dome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. L Hand, R Hand, L Foot, R Foot</td>
<td>40</td>
<td>104</td>
<td>104</td>
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</tr>
<tr>
<td>2. L Foot, R Foot</td>
<td>75</td>
<td>27</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>3. L Hand, R Hand</td>
<td>3</td>
<td>30</td>
<td>42</td>
<td></td>
</tr>
<tr>
<td>4. L Hand, R Hand, R Foot</td>
<td>26</td>
<td>24</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>5. L Hand, R Hand, L Foot</td>
<td>21</td>
<td>25</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>6. R Hand, L Foot, R Foot</td>
<td>29</td>
<td>18</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>7. L Hand, R Hand, Seat</td>
<td>3</td>
<td>29</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>8. L Hand, L Foot, R Foot</td>
<td>18</td>
<td>14</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>9. L Foot</td>
<td>14</td>
<td>20</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>10. R Foot</td>
<td>21</td>
<td>10</td>
<td>8</td>
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</tr>
</tbody>
</table>

The analysis of data from both the descriptive and statistical point of view shows that the combinations of bases of support used were different for each piece of equipment with which the subjects interacted. That is, since low correlations were found, one might infer that different combinations of bases of support were used on the pilings, the bars and the dome. The foregoing statistical measures, do not, however, indicate where the differences (between which pieces of equipment) occur. The data support the idea that a rather large number of
combinations were stimulated by the use of the three pieces of apparatus. If one is interested in encouraging particular combinations of body parts to be used as bases of support one would do well to consult the tables to determine which equipment seems to stimulate those desired combinations.

In order to determine the differences in the way the subjects used directional moves on the equipment, a Chi square was run which yielded the frequencies for various directions including no change, left, right, down, up, backward, forward, true diagonals, diagonally up, diagonally down, diagonally forward and backward. True diagonals refer to a body part which moves from the true corner of the cube to farthest edge of another true corner (see Figure 14). For example, if a hand were to move from the arrow in cube 2 to the arrow in cube 6, the movement would be classified as a true diagonal. On the other hand, if a hand were to move from the zero on cube 7 to the zero on cube 1, a diagonal on the same plane would have been executed, such as diagonally back or diagonally forward.

Table 12 indicates that of the eleven possible directional moves that no movement from the initial quadrant received the highest frequency of use. Next highest directional move was left followed by right, down, up, diagonally up, diagonally down, backward, and forward in descending order.
Figure 14
Quadrants
Table 12

Z Scores for Binomial Difference in Two Proportions
Test for Each of the Eleven Directional Moves
on the Equipment

<table>
<thead>
<tr>
<th>Directional Move</th>
<th>FREQUENCY for Pilings</th>
<th>FREQUENCY for Bars</th>
<th>Z Value**</th>
</tr>
</thead>
<tbody>
<tr>
<td>No change</td>
<td>.601*</td>
<td>.707</td>
<td>-7.653, .01 level</td>
</tr>
<tr>
<td>Left</td>
<td>.115</td>
<td>.038</td>
<td>-9.969, .01 level</td>
</tr>
<tr>
<td>Right</td>
<td>.109</td>
<td>.048</td>
<td>7.713, .01 level</td>
</tr>
<tr>
<td>Down</td>
<td>.069</td>
<td>.032</td>
<td>5.752, .01 level</td>
</tr>
<tr>
<td>Up</td>
<td>.056</td>
<td>.034</td>
<td>3.716, .01 level</td>
</tr>
<tr>
<td>Backward</td>
<td>.000</td>
<td>.004</td>
<td>-3.166, .01 level</td>
</tr>
<tr>
<td>Forward</td>
<td>.003</td>
<td>.007</td>
<td>-2.137, .05 level</td>
</tr>
<tr>
<td>True Diagonal</td>
<td>.000</td>
<td>.003</td>
<td>-2.831, .01 level</td>
</tr>
<tr>
<td>Diagonally Up</td>
<td>.031</td>
<td>.027</td>
<td>Not significant</td>
</tr>
<tr>
<td>Diagonally Down</td>
<td>.016</td>
<td>.038</td>
<td>-4.553, .01 level</td>
</tr>
<tr>
<td>Diagonally Forward and Backward</td>
<td>.000</td>
<td>.003</td>
<td>-1.891, .05 level</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Directional Move</th>
<th>FREQUENCY for Bars</th>
<th>FREQUENCY for Dome</th>
<th>Z Value**</th>
</tr>
</thead>
<tbody>
<tr>
<td>No change</td>
<td>.707</td>
<td>.085</td>
<td>-7.902, .01 level</td>
</tr>
<tr>
<td>Left</td>
<td>.038</td>
<td>.034</td>
<td>Not significant</td>
</tr>
<tr>
<td>Right</td>
<td>.048</td>
<td>.028</td>
<td>3.628, .01 level</td>
</tr>
<tr>
<td>Down</td>
<td>.032</td>
<td>.037</td>
<td>Not significant</td>
</tr>
<tr>
<td>Up</td>
<td>.034</td>
<td>.045</td>
<td>-2.014, .05 level</td>
</tr>
<tr>
<td>Backward</td>
<td>.004</td>
<td>.005</td>
<td>Not significant</td>
</tr>
<tr>
<td>Forward</td>
<td>.007</td>
<td>.003</td>
<td>Not significant</td>
</tr>
<tr>
<td>True Diagonal</td>
<td>.003</td>
<td>.000</td>
<td>2.336, .05 level</td>
</tr>
<tr>
<td>Diagonally Up</td>
<td>.027</td>
<td>.017</td>
<td>2.270, .05 level</td>
</tr>
<tr>
<td>Diagonally Down</td>
<td>.038</td>
<td>.011</td>
<td>6.016, .01 level</td>
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<tr>
<td>Diagonally Forward and Backward</td>
<td>.003</td>
<td>.0010</td>
<td>Not significant</td>
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</tbody>
</table>

*% out of 2,376 possible moves on the equipment

**.05 Table Z = ± 1.96 - 2-Tailed Test
 .01 Table Z = ± 2.57 - 2-Tailed Test
Table 12  
(Continued)

<table>
<thead>
<tr>
<th>Directional Move</th>
<th>FREQUENCY for Dome</th>
<th>FREQUENCY for Pilings</th>
<th>Z Value</th>
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</thead>
<tbody>
<tr>
<td>No change</td>
<td>.805</td>
<td>.601</td>
<td>15.398, .01 level</td>
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<tr>
<td>Left</td>
<td>.034</td>
<td>.115</td>
<td>-10.718, .01 level</td>
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<tr>
<td>Right</td>
<td>.028</td>
<td>.109</td>
<td>-10.977, .01 level</td>
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<tr>
<td>Down</td>
<td>.037</td>
<td>.069</td>
<td>-4.920, .01 level</td>
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<tr>
<td>Up</td>
<td>.045</td>
<td>.056</td>
<td>Not significant</td>
</tr>
<tr>
<td>Backward</td>
<td>.005</td>
<td>.000</td>
<td>3.468, .01 level</td>
</tr>
<tr>
<td>Forward</td>
<td>.003</td>
<td>.003</td>
<td>Not significant</td>
</tr>
<tr>
<td>True Diagonal</td>
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<td>Not significant</td>
</tr>
<tr>
<td>Diagonally Up</td>
<td>.017</td>
<td>.031</td>
<td>-3.115, .01 level</td>
</tr>
<tr>
<td>Diagonally Down</td>
<td>.011</td>
<td>.016</td>
<td>Not significant</td>
</tr>
<tr>
<td>Diagonally Forward and Backward</td>
<td>.001</td>
<td>.000</td>
<td>Not significant</td>
</tr>
</tbody>
</table>
A true diagonal and diagonally forward and backward directional moves were scarcely used. See Figure 14 which pictures the quadrant from which a move might be initiated and the quadrant in which the move terminated on a piece of equipment. If one were to compare the directional moves made on the bars with those made on the pilings, the data seem to indicate that the following directional moves are made more frequently on the bars than the pilings: no change, left, and diagonally down. In contrast, right, down, and up are used more frequently on the pilings.

When the directional moves are compared between the bars and the dome, the data reveal that the following directional moves are made more frequently on the dome than the bars: no change, and up. In contrast, diagonally down, right, diagonally up and true diagonal moves are made more frequently on the bars.

When a comparison of directional moves is made between the dome and the pilings, the data suggests that the following directional moves are made more frequently on the pilings than on the dome: left, right, down, and diagonally up. In contrast, no change and backward are the directional moves made more frequently on the bars.

Correlations for the combinations of directional moves (see Table 13) used on the three pieces of apparatus were computed with a non-parametric Kendall correlation
Table 13
Frequency of Occurrences of Directional Moves Used by Subjects on the Equipment

<table>
<thead>
<tr>
<th>Directional Moves</th>
<th>Pilings</th>
<th>Bars</th>
<th>Dome</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Change</td>
<td>1428</td>
<td>1679</td>
<td>1913</td>
</tr>
<tr>
<td>Left</td>
<td>274</td>
<td>91</td>
<td>80</td>
</tr>
<tr>
<td>Right</td>
<td>258</td>
<td>115</td>
<td>67</td>
</tr>
<tr>
<td>Down</td>
<td>164</td>
<td>77</td>
<td>88</td>
</tr>
<tr>
<td>Up</td>
<td>133</td>
<td>80</td>
<td>107</td>
</tr>
<tr>
<td>Backward</td>
<td>0</td>
<td>10</td>
<td>12</td>
</tr>
<tr>
<td>Forward</td>
<td>6</td>
<td>16</td>
<td>7</td>
</tr>
<tr>
<td>True Diagonal</td>
<td>0</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>Diagonally Up</td>
<td>74</td>
<td>64</td>
<td>41</td>
</tr>
<tr>
<td>Diagonally Down</td>
<td>39</td>
<td>90</td>
<td>26</td>
</tr>
<tr>
<td>Diagonally Forward and Backward</td>
<td>1</td>
<td>6</td>
<td>3</td>
</tr>
</tbody>
</table>

A correlation of -.5375 (significant at the .01 level for differences) was found between the pilings and the bars; -.5376 was the computed correlation coefficient between the pilings and the dome (significant at the .01 level for differences); and a third correlation of .6316 compared the bars and the dome (also at the .01 level for difference). Since the correlations were low, but significant, the data seem to indicate that the bars use more directional moves than the pilings; the dome uses more directional moves than the pilings and that the bars use more directional moves than the dome. While there is a tendency toward the moves being made on one piece of equipment to be independent of each other, there is a
trend toward a lack of independence in the directional moves which a child will make on the pieces of equipment.

A non-parametric Wilcoxin Signed Rank for Matched Pairs Test was applied to determine whether or not children use different combinations of directional moves when playing on the three pieces of equipment. There were 51 different combinations exhibited of a possible 64. See Table 13 for frequencies of occurrence for combinations of directional moves made. Those pairs of directional moves which showed no differences in the frequencies of use between equipment were deleted before the statistic was computed. For example, if the pilings and the bars both elicited six occurrences of forward direction, these were subtracted from the total of 51 and the Wilcoxin Signed Rank for Matched Pairs was determined from the remaining 45 pairs. When a one-tail test was applied at the .05 level, a non-significant T of .3137 was found for different directional combinations used on the bars and the pilings (computed from 45 pairs remaining after deletion). When a one-tail test at the .05 level was applied to the 45 remaining pairs between the pilings and the dome, a non-significant T of .3932 was found. A one-tail test at the .05 level was applied to the 34 pairs between the dome and the bars, and a non-significant T of .2443 was indicated. Thus, it seems apparent from the inferential statistical treatment of the
data that the subjects did utilize different combinations of directional moves, but that the differences were too slight to be considered significant. By comparison, the descriptive analysis of the data supports the idea that there were indeed variations in the ways in which the subjects moved on the equipment relative to direction changes from quadrant to quadrant. The pilings elicited the highest variation in number of directional moves, while the bars and the dome elicited about the same combinations of moves relative to direction. If one were then to choose a piece of equipment on the basis of stimulating variety in changes of direction, the pilings would be the piece to consider first.

In order to determine the difference in the way the subjects made changes of level on the apparatus, a Chi Square was run which yielded the frequencies for the various patterns of changes of level: high to high, high to low, low to high, and low to low. Table 14 indicates the pattern of level changes which received the highest frequency of use as the high to high pattern followed by the low to low pattern, the high to low pattern, and the low to high pattern. If one were to compare the patterns of changes of level made on the pilings with those made on the bars, the data seem to show that the following patterns are made more frequently on the pilings than on the bars:
Table 14

Z Scores for Binomial Difference in Two Proportions Test for Each of Four Changes of Level on the Equipment

<table>
<thead>
<tr>
<th>Change of Level</th>
<th>FREQUENCY</th>
<th>FREQUENCY</th>
<th>Z Value**</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>for Piling</td>
<td>for Bar</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>.297*</td>
<td>.317</td>
<td>Not significant</td>
</tr>
<tr>
<td>High, Low</td>
<td>.228</td>
<td>.178</td>
<td>3.909, .01 level</td>
</tr>
<tr>
<td>Low, High</td>
<td>.227</td>
<td>.178</td>
<td>3.875, .01 level</td>
</tr>
<tr>
<td>Low</td>
<td>.247</td>
<td>.327</td>
<td>-5.585, .01 level</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>for Bar</th>
<th>for Dome</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>.317</td>
<td>.358</td>
</tr>
<tr>
<td>High, Low</td>
<td>.178</td>
<td>.160</td>
</tr>
<tr>
<td>Low, High</td>
<td>.178</td>
<td>.153</td>
</tr>
<tr>
<td>Low</td>
<td>.327</td>
<td>.329</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>for Dome</th>
<th>for Piling</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>.358</td>
<td>.297</td>
</tr>
<tr>
<td>High, Low</td>
<td>.160</td>
<td>.228</td>
</tr>
<tr>
<td>Low, High</td>
<td>.153</td>
<td>.227</td>
</tr>
<tr>
<td>Low</td>
<td>.329</td>
<td>.247</td>
</tr>
</tbody>
</table>

*% out of 1880 possible moves on the equipment

**.05 Table Z = ± 1.96 - 2-Tailed Test
.01 Table Z = ± 2.57 - 2-Tailed Test
high to low and low to high. In contrast, high to high and low to low were used more often on the bars.

When the level change patterns are compared between the bars and the dome, the data reveal that these patterns occurred more frequently on the dome: high to high and low to low. The high to low and low to high changes were more frequent on the bars.

The data suggest that, between the dome and the pilings, the high to high and low to high patterns were made more frequently on the pilings, and that the high to low and low to high changes occurred more often on the dome.

Patterns of changes in levels were compared on all three pieces of apparatus by means of a binomial difference in two proportions test (see Table 14). The high to high pattern showed a significant difference at the .05 level between the pilings and the bars, while all other level change patterns were significant at the .01 level between these two pieces of equipment. When level change patterns were compared for differences between the bars and the dome, the high to high and the low to high patterns reached significance at the .01 level, and the other two patterns were not even significant at the .05 level. All changes of level patterns were significantly different at the .01 level for comparisons between the dome and the pilings.
The non-parametric Kendall correlation procedure applied for the combinations of changes of levels used on the three pieces of equipment yielded the following correlations: 1.000 between the pilings and the dome (significant at the .05 level), .6667 between the pilings and the bars, and .6667 between the bars and the dome (neither significant at the .05 level). One may infer from the data that there are no differences in the patterns of level changes between the bars and the pilings and between the bars and the dome. In comparison, when changes occur on the pilings, they also tend to happen on the dome. Therefore, if one wished to emphasize the patterns noted in this study when one worked with children, a choice of either the pilings or the dome would seem suitable as a stimulus situation for children to experience those changes of level.

No significant differences were found at the .05 level when a non-parametric Wilcoxin Signed Rank for Matched Pairs test was applied to determine whether or not children used different combinations of changes in level while playing on each of the three pieces of equipment. Thus, the inferential statistical analyses revealed few differences in the individual patterns of level changes used on each piece of equipment except that patterns occurring on the dome are likely to occur on the pilings as well (see Table 15). However, the descriptive statistics again show a
slight tendency toward the likelihood of occurrence of
different patterns of level changes for different pieces
of equipment.

Table 15
Frequency of Occurrences of Changes of Level
Used by the Subjects on the Equipment

<table>
<thead>
<tr>
<th>Changes of Level</th>
<th>Frequency of Use on:</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pilings</td>
<td>Bars</td>
<td>Dome</td>
</tr>
<tr>
<td>High</td>
<td>589</td>
<td>627</td>
<td>709</td>
</tr>
<tr>
<td>High, Low</td>
<td>452</td>
<td>353</td>
<td>316</td>
</tr>
<tr>
<td>Low</td>
<td>450</td>
<td>352</td>
<td>303</td>
</tr>
<tr>
<td>Low, High</td>
<td>489</td>
<td>648</td>
<td>652</td>
</tr>
</tbody>
</table>

Results of the Analysis

Based on the data collected and analyzed, the following conclusions were reached.

1. There are no significant differences in kindergarten boys' use of gross movement while playing on the three selected pieces of equipment utilized in this study.

   This was rejected.

Variance was shown for the apparatus by an F of 5.0852 at the .05 level of significance. A significant F of 5.18 at the .01 level was found for differences among body parts. A significant F for interaction between equipment and body parts of 8.8369 was obtained at the .01 level. A Scheffe' test to ascertain where the significant differences were yielded the following results. For differences
among equipment (in total gross movement), the pilings and the dome showed significance at the .05 level, while differences among body parts appeared at the .01 level between the right foot and head, the left foot and left hand, and the right hand and left hand, and at the .05 level between the right hand and head, and between the right hand and midpoint.

2. There are no significant differences in kindergarten boys' use of the spatial dimension of range while moving on the three pieces of equipment.

This was rejected at the .01 level by a demonstrated significant F of 160.5955.

Differences in body parts relative to range were shown by an F of 243.6133, significant at the .01 level. A significant F of 24.9554 at the .01 level indicated a strong interaction effect between equipment and body parts. A Scheffe' test for location of differences among equipment showed the bars to differ from both the pilings and the dome at the .01 level. The same procedure applied for body parts found the differences to lie between the head and left foot, head and right foot, head and right hand, and right hand and left hand, all at the .01 level.

3. There are no significant differences in kindergarten boys' use of near and far range while moving on the three pieces of equipment.
This was rejected on the basis of significant differences found for the right and left hands when compared between the pilings and bars at the .05 level, and for the head, right foot, and left foot when compared between the pilings and bars at the .01 level.

All five body parts were significantly different in their uses of range when compared between the bars and dome at the .01 level, and all body parts showed significant differences when compared between the dome and pilings, with the exception of the left foot.

4. There are no significant differences in the bases of support used by kindergarten boys while moving on the three selected pieces of equipment.

This was rejected.

The supporting data revealed Kendall correlation coefficients of .2949 between the pilings and bars, .12367 between the pilings and dome, and .3108 between the bars and dome at the .01 level. These low correlation coefficients indicate that the bases of support utilized on each piece of equipment were independent of one another. However, the Wilcoxin Signed Rank for Matched Pairs Test did not indicate that these differences were significant ones when specific combinations of bases of support were matched, even though the descriptive analysis did show differences.
5. There are no significant differences in the use of the spatial dimension of direction by kindergarten boys while moving on the selected pieces of equipment. This hypothesis was rejected on the basis of significant differences shown by the data analysis.

These directional moves were significant at the .05 level when movement on the pilings and bars was compared: forward, diagonally forward, and backward. All other directional moves were significant at the .01 level, except for diagonally upward which did not reach significance at either level.

For the bars and dome, significance at the .05 level was reached by directional moves leftward, upward, diagonally upward, and along the true diagonals. Directional movement to the right and diagonally downward were significant at the .01 level.

Comparisons between the pilings and dome revealed no significant directional moves at the .05 level, and moves within the same quadrant (no directional change), leftward, rightward, backward, downward, and diagonally upward to be significant at the .01 level.

A Kendall correlation coefficient, significant at the .01 level, showed that as more directional moves were made on the bars, fewer occurred on the pilings; as more moves were performed on the dome, fewer were executed on
the pilings; and as moves in different directions increased on the dome there was a corresponding increase in directional moves on the bars.

Specific directional move comparisons did not reveal a significant Wilcoxin T at the .05 level for matched pairs, but in this case also the descriptive statistical analysis does show some differences.

6. There are no significant differences in the use of high and low levels among kindergarten boys while working on three selected pieces of equipment.

This hypothesis was rejected on the basis of differences shown in the analysis of data.

The patterns of changes in level were significant at the .01 level when comparing the pilings and the bars for high to low, low to high, and low to low; between the bars and the dome, significant at the .01 level appeared for the high to high and low to high patterns; and differences between the dome and the pilings were significant at the .01 level for all patterns of level changes.

A Kendall correlation coefficient, significant at the .05 level, showed that level change patterns which occurred on the pilings were also likely to be used on the dome. Specific patterns of level change comparisons did not reveal a significant Wilcoxin T at the .05 level for matched pairs, but as with the directional moves, the descriptive statistical analyses do indicate some differences.
CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The environment is a major concern which is currently receiving a significant amount of attention throughout society and consequently in education. Among other factors, it has been suggested that the environment has a significant effect on children and that education needs to explore the effects of various types of environments on children. Playgrounds are one part of the educational environment which should be explored. The roles of the teacher, of curriculum, and of research need to be considered together as modes of influence on the decisions needed to play outdoor learning centers and select equipment so that maximum educational benefit for children will be derived. A conceptual framework based on Laban's movement factors was suggested as a way to analyze children's movements, and movement education was mentioned as a viable means of integrating the teacher's role, curriculum, and the characteristics of children to provide a good learning environment for movement at the elementary level.
The purpose of this study was to explore the various ways boys moved on three pieces of equipment. The movement was analyzed by utilizing the element of space, and more specifically, its dimensions of range, level, and direction, along with the body factors of body parts and bases of support.

The literature published in the area of curriculum, space, and movement was reviewed with specific emphasis on the child's need for manipulation, as pointed out by Piaget. Characteristics of children were noted from the literature as were studies concerned with children's use of space on playgrounds and the resultant implications for playground planning.

This review of related research concluded that, in general, though a great deal of information is available about playgrounds, little research has been conducted to determine the actual results of children's interaction with various pieces of equipment.

Relative to the technological design of this study, some recent advances in photographic techniques made the current investigation possible.

The three pieces of equipment were selected for the study because they had non-moving parts. Boys were chosen as subjects due to their greater movement in a given situation than girls. The five-second interval for
time sampling by photography came from recommendations of previous research performed with children on equipment. Photographic slides provided an appropriate modality for collecting data, and the digitizer plotted the movements from the raw data images into an accurate two-dimensional Cartesian coordinate system.

A computer program was utilized to transform the data to three-dimensional coordinates, and various statistical procedures were designed and used to treat the data. These procedures included a three-factor repeated-measures analysis of variance, binomial proportions tests, and Scheffe's test for the gross movement aspect and for the dimension of range of movement. The Kendall correlation and the Wilcoxin T were used to analyze the body factor of bases of support. The dimensions of level and direction utilized the Chi Square, the Kendall correlation, and the Wilcoxin T for data analysis.

**Conclusions**

Based on the data collected and analyzed in this study, the following conclusions appear to be justified.

The greatest total amount of movement occurred on the pilings, with less movement on the bars, and the least on the dome. Thus, if one wished to provide equipment which would elicit the greatest total amount of movement from kindergarten boys, the pilings should be selected
instead of the bars or the dome. If a judgment had to be
made regarding the purchase of one piece of equipment and
if it was the teacher's best judgment that gross movement
was the experience the children needed more than any other
type of movement task, thus the best piece of equipment to
select would be the pilings, since they provided the most
amount of movement for each of the six body parts. The
right hand appeared to move significantly more than the
other parts. The other body parts moved less frequently.

In comparison to the pilings providing the greatest
amount of gross movement, the bars showed the greatest range
of movement. It seems, then, that the bars would be the
most appropriate piece of equipment to select for children
to work with in order to experience the spatial dimension
of range. If the curriculum were to stress movement of the
body parts near to the midpoint or far from the midpoint,
a teacher could expect that the bars would provide the best
stimulus for that kind of experience. Children might be
expected to use the right and left hands and head at a near
range and the feet at a far range from the midpoint. In
the current study, the right hand also tended to move
significantly more than the other body parts in reference
to range of movement, although the left foot used more
total distance of range from the midpoint. The boys
tended to use far range more than near on the bars.
When the total amount of movement occurring for each of the three minutes of filming was compared for gross movement and range, the results indicate that it would be more beneficial to film gross movement during the first minute and range during the second or third minutes of movement.

The data indicated that a large number of bases of support were utilized on all three pieces of equipment, but the descriptive statistical analyses showed that variations in the combinations were specific to each particular piece of equipment. In this case, selection of playground equipment suitable for children to interact with in regard to bases of support would depend on the types of bases of support one might wish to emphasize, the pilings being able to elicit certain ones, the dome others, and the bars a third set of combinations. Each of the pieces elicited approximately the same number of responses of different bases of support. Any one of the three might be an appropriate choice to utilize for children's movement experiences if bases of support were being stressed. For example, if a combination base of support using the right and left hands and right and left feet were being stressed, the bars or the dome would be expected to stimulate that response class most often whereas the pilings would produce more left and right foot combinations than the other two
pieces. On the other hand, the bars could be expected to produce more right and left hand and seat combinations than the other pieces.

Various directional moves were demonstrated on each piece of equipment. The bars and the dome tended to elicit similar patterns of directional moves, whereas the pilings stimulated different patterns. The choice of equipment in this instance would again depend on the kinds of directional patterns one might wish for children to experience in their movement. The needs of children and the curricular content would govern the choice of equipment. If it were important to stress moves to the right or left, the pilings would be an appropriate piece for boys to use. It would also be the best one of the three to use with up and down direction as a specified piece of curricular content. However, if movement within a single quadrant of the equipment were the most important aspect a teacher wished to stress rather than movement from one part of equipment to another, then the dome could be expected to promote that kind of movement. In comparison, the bars stimulated more diagonal changes of direction than the other two pieces.

Various patterns of level changes were noted for each piece of the equipment. The dome seems to elicit the same patterns as the pilings, whereas there tend to be no differences in the patterns performed on the bars and the
pilings, and on the bars and the dome. Again the choice of equipment would be dependent on the kind of patterns of level changes one might wish for children to experience in their movement. If boys needed to experience movement at a high level, the dome would be expected to produce more movement at a high level than the other pieces. It also produced more low to high changes in movement, although the bars stimulated nearly as much of that pattern. The pilings elicited more movement at a low level and more high to low changes in movement between levels.

A framework for analyzing movement utilizing Laban's spatial dimensions and the body factor of bases of support has been established and it may be inferred from the present data that it is appropriate for use as one criterion measure for the selection of equipment. One might also infer that if movement can indeed be analyzed from the ways boys use space, then time, force, and flow might also be used as other frameworks for analysis, as well as other body factors (body parts, relationships, and control). In this way, information used in curriculum development can also become the basis upon which to judge whether or not a piece of equipment is an appropriate addition to an outdoor learning center for movement.

Perhaps one of the most exciting conclusions that this study has revealed is a method by which movements of
children on various kinds of equipment can be evaluated empirically. The process of photographic techniques combined with the plotting of two-dimensional points on the digitizer and the computer-assisted transformation of these points into a three-dimensional pattern for measuring movement distances was most satisfactory. At long last, the values of equipment can be inferred by comparing movements made on individual pieces of equipment in comparison to movement patterns which a teacher wishes for children to experience. These same empirically-validated movement patterns can be related to criteria for the selection of equipment and can also serve as an objective basis for planning curriculum concepts and content for children's learning experiences in movement.

Recommendations

On the basis of this study, the following recommendations for further research might yield interesting information:

1. Compare the body relationships used on the three pieces of equipment: the range of distance between various body parts.

2. Compare the way the subjects use the equipment during the first minute with the second and third minutes in a time analysis.
3. Take one-second intervals of movement for one minute and then analyze these in terms of the sizes of intervals (number of seconds) needed to retain movement patterns close enough to reality to be accurate as children move on pieces of equipment.

4. Vary the subjects for similar studies, utilizing both sexes, several age groupings, mixed sex groupings, and mixed age groupings.

5. Design similar studies to analyze children playing on different types of equipment, e.g., equipment with moving parts, realistic equipment, etc.

6. Compare the use of four cameras at 90 degree angles with three cameras at 120 degree angles to gather data.

7. Compare the movement patterns of children who approach the equipment from four different sides at the beginning of the data collection period with those of children who begin the experimental period from a single entry point.
APPENDIX A

LETTER OF INVITATION
Dear Mr. and Mrs.

I would like to invite your son to be in a study. During the course of a Ph.D. program, a candidate must write a dissertation. Mine is concerned with studying the ways children use playground equipment. In order to do that, I would like to watch kindergarten boys play on three different pieces of equipment: (1) horizontal bars at three different levels, (2) a geodesic dome, and (3) a solid structure. In groups of four (selected at random) the boys will play freely for three minutes on each piece of equipment. While they are playing, they will be photographed. I will analyze the movements from the pictures which are taken. The purpose of the study is to determine the kinds of movements each piece elicits.

Before I ask for your permission, perhaps you'd like to know that:

1. The study will occur during April 15-19, 1974.

2. The places where photographing will take place are:
   a. Northtowne Elementary School (pieces 1 and 2) 4767 Northtowne
   b. Northam Park (piece 3) 2900 Tremont

3. Filming will occur in the morning and between kindergarten sessions so little or no time will be lost from school.

4. Filming schedule:
   MON. Familiarization with equipment on both playgrounds.
   TUE. Film at Northtowne
   WED. Reserve in case of rain
   THU. Film at Northam
   FRI. Reserve in case of rain

5. Children will need to be transported to the areas—perhaps in car pools.

6. Mr. Ron Hopper, principal of Worthington Hills Elementary School has approved the project.
A picture of each piece of equipment is available at the office at Worthington Hills. At Northtowne, probably only the horizontal bars will be used on the equipment shown.

Please do not discuss this with your son as being a special study; rather, suggest that we are interested in watching how kids play. It has been found that if people know they are in a study, they tend to act in unusual rather than normal ways.

I would appreciate your considering my requests. Hopefully, the results of the study will be beneficial to other children.

Please return the attached form to Worthington Hills by Wednesday, March 27, 1974. If you have any questions, please call me: 262-6226.

Thank you for considering my request.

Sincerely yours,

Donna Thompson
Graduate Student
Department of Physical Education

March 27, 1974

I will be happy for my son to participate in the study.

I can provide transportation for boys on:
MON____ TUE____ WED____ THU____ FRI____

I do not wish for my son to participate in the study.

I will need transportation on the following days:
MON____ TUE____ WED____ THU____ FRI____

When the participants have been determined and randomized, a list of transportation information will be sent to each participating family.

Parental Signature
APPENDIX B

LETTER OF INSTRUCTIONS
The Ohio State University  
Columbus, Ohio 43210  
March 27, 1974

Dear Mr. and Mrs. __________________________

Thank you for allowing your son, ____________________ to participate in my study. I am looking forward to working with your son and meeting you, if the opportunity occurs.

On Monday, April 15 we will meet at __________ at _________ and then go from there to __________________ at about _________. That should provide enough time to see the equipment at both play areas and become acquainted with filming conditions.

I will be providing a short or long sleeved shirt for your son to wear over or instead of his own shirt. I will be putting (removable) markings on the shirts for identification purposes. Hopefully the weather will be warmer. The shirts are my present to the boys when the study is concluded, but that's a secret now.

Below are directions to the filming sites and a list of those who can drive and those who need rides. I'll be happy to pay mileage if that will help you. I would appreciate your forming car pools. I assume you drivers have liability insurance. Attached are the names of those in the study and their phone numbers. I also have liability insurance for the study.

Please do not hesitate to call me if a problem develops: 262-6226.

Please be at the sites at the times indicated. Please consider school the pick-up point for transportation or make other arrangements with parents. Note the change of date/site from the original schedule. If it rains on any of those days, I'll call you to make arrangements for Thursday or Friday.

Thanks again for your help and cooperation.

Sincerely yours,

Donna Thompson
APPENDIX C

HUMAN SUBJECTS RESEARCH

AUTHORIZATION FORM
THE OHIO STATE UNIVERSITY

RESEARCH INVOLVING HUMAN SUBJECTS
AUTHORIZATION FOR A MINOR TO PARTICIPATE AS A SUBJECT IN RESEARCH

I authorize the participation of ____________________________
as a subject in the research investigation entitled: ____________________________

The nature and general purpose of the experimental procedure and the
known risks have been explained to me. I understand that ____________________________
was given an explanation of the research prior to initiation of the investigation and that he has agreed to participate. Further, I understand that he may terminate his participation in
this research at any time he so desires.

I understand the known risks are: ____________________________

I understand also that it is not possible to identify all potential
risks in an experimental procedure, and I believe that reasonable safe-
guards have been taken to minimize both the known and the potential but
unknown risks.

I understand that any additional questions related to this research
may be directed to the chairman of the Human Subjects Review Committee,

(college)

Witness ____________________________ Signed ____________________________
(Parent or guardian)

Date ____________________________

School of Health, Physical Education and Recreation 1760 Neil Avenue Columbus, Ohio 43210
APPENDIX D

SOURCES FOR CONSULTATION AND EQUIPMENT
1. **Play Timber (pilings)**  
P. O. Box 66  
Essex Street Station  
Boston, Massachusetts 02112

2. **Game Time, Inc. (geodesic dome and horizontal bars)**  
Litchfield, Michigan 49252

3. **David B. Selby, Associate Director (technical advice)**  
Division of Educational Services  
Teaching Aids Laboratory  
124 W. 17th Avenue  
Columbus, Ohio 43210

4. **Robert Wagner**  
William Longshore  
Donald Lokuta  
Department of Photography (technical assistance, camera loan)

5. **Ronald Farinelli**  
Richard Lipento  
Ehrenreich Photo-Optical Industries, Inc. (technical assistance)  
623 Stewart Avenue  
Garden City, New York 11530

6. **Al Mazzarella (technical assistance)**  
Photogenesis  
4930 N. High Street  
Columbus, Ohio 43214

7. **Helix Limited (rental of photographic equipment)**  
323 West Huron  
Chicago, Illinois 60610

8. **John Bruce (loan of swimming clocks)**  
Swimming Coach  
The Ohio State University

9. **Bill Burdette (technical assistant skilled in electrical wiring assemblies)**  
147 DeSantis Drive  
Columbus, Ohio 43214
APPENDIX E

INSTRUCTIONS TO THE CHILDREN

I am here to watch you play on the playground equipment. I am here to learn how you play. You can help me by getting on the jungle gym and moving on it as many different ways as possible when this lady [research assistant] asks you to begin. Please stay on the equipment as much as possible until I ask you to get off. While you are on the equipment, a camera will be set up to take pictures. Please continue to move on the equipment to show me as many different ways to use the equipment as you can think of.

Can you see where cameras one, two, three and four are?

Can you see the clocks?

When do you begin playing on the equipment?

How long do you play on it?

Do you have any questions?
APPENDIX F

INSURANCE
APPENDIX F

INSURANCE

It was necessary to take out liability insurance on the researcher since the study was run at school areas away from the one the children normally attended. Thus, no regular teacher would be responsible for the children's actions and the researcher would be providing stimuli for movement which might be unusual to the children.
APPENDIX G

ILLUSTRATION OF RANGE
APPENDIX G

ILLUSTRATION OF RANGE

Key:

Range: Distance from Midpoint
    : Midpoint
Far: Right Hand
Near: Left Hand
APPENDIX H

ILLUSTRATION OF LEVELS
APPENDIX H

ILLUSTRATION OF LEVELS

Key:

High Level: Above the midpoint
Low Level: Below the midpoint
* : Midpoint
APPENDIX I

ILLUSTRATION OF FORWARD, BACKWARD,
UPWARD, DOWNWARD DIRECTIONS
APPENDIX I

ILLUSTRATION OF FORWARD, BACKWARD, UPWARD, DOWNWARD DIRECTIONS

Key:

* : Midpoint
Forward : In front of midpoint
Backward: Behind midpoint
Up      : Above midpoint
Down    : Below midpoint
APPENDIX J

ILLUSTRATION OF SIDEWAYS DIRECTION
APPENDIX J

ILLUSTRATION OF SIDEWAYS DIRECTION

Key:

Sideways: On the frontal plane, to the side of the midpoint; for example, hands and feet.

• : Midpoint
APPENDIX K

ILLUSTRATION OF THE FLATBED

COORDINATE DIGITIZER
APPENDIX K
ILLUSTRATION OF THE FLATBED COORDINATE DIGITIZER
APPENDIX L

COST ANALYSIS
APPENDIX L

COST ANALYSIS

Photographer (donated his time) $100.00*
40 rolls film (at $2.52) + $4.04 tax 104.84
Develop 36 rolls of film - Photomat 104.46
1 - GAF Panavue Automatic Viewmaster 8.32

Rental Supplies from Helix Limited in Chicago
3 Nikon Motor Driven F36 Cameras at
$15.00/day 135.00
3 50 mm 1.4 Nikon Lenses with shades
at $3.00/day 18.00
1 American Graphics Time Trigger with
charger and Nikon Adapter at $5.00/day 15.00
1 Nikon Motor Driven F36 + Lens borrowed
from OSU - no charge

Delivery of Photo Equipment via Federal Express 57.20

Electrical Supplies
1 roll - 500' - #16 electrical cord 18.08
1 roll - 250' - #18 electrical cord 31.33
6 AC plugs 1.02
1 274-291 adapter .83

12 T shirts with numerals on them 29.87
2 Pks of iron-on tape 1.50
3 rolls tape for marking equipment 3.00
Phone calls 30.00

Digitizer expenses (donated by Battelle
Memorial Institute)

Computer Writing, Running, Interpreting - funds
from School of Health, Physical Education and
Recreation 400.00

Personal Liability Insurance 11.00

TOTAL $1,069.45**

*Honararium given to photographer
**The experimenter gratefully acknowledges an award for
dissertation research from the Delbert Oberteuffer Fund
which partially supported this project.
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