AN EXPERIMENTAL STUDY OF TEACHING SCIENCE AND MATHEMATICS CONCEPTS TO YOUNG THAI CHILDREN

Research Bulletin No. 20

The Behavioral Science Research Institute

with the

financial support of the United Nations Children's Fund

Behavioral Science Reserch Institute

(formerly the Bangkok Institute for Child Study)

Sri--Nakharinwirot University

Sukhumvit 23, Bangkok 11

Thailand

Acknowledgement

The project attempted by the Behavioral Science Research Institute (formerly known as the Bangkok Institute for Child Study), "An experimental study of teaching science and mathematics concepts to young Thai Children", was kindly funded by UNICEF through the educational channel of UNESCO. The Institute is deeply grateful to UNICEF for her financial support, and to UNESCO for the invaluable advices and suggestions. A few names should be mentioned here to express the Institute's gratitude and appreciation for their kind assistances: Mr. Diáz, UNICEF representative, Mr. Ratanaike and Mr. Drimmelan, UNESCO educational advisers, and Mr. Dera Sumitra, UNICEF program adviser. Last but not least, the study would not be possible without kind co-operation and understanding on the part of the school principals, teachers, parents, and children involved in our experimentation.

Prof. Chancha Suvannathat
Project Director

Behavioral Science Research Institute
Sri - Nakharinwirot University

June, 1976

Table of contents

List of tables

AN EXPERIMENTAL STUDY OF TEACHING SCIENCE AND MATHEMATICS CONCEPTS TO YOUNG THAI CHILDREN

Background and problem

The regional seminar, "The Development of Science and Mathematics Concepts in Children", jointly convened by UNESCO, UNICEF and CEDO, in Bangkok, (May–June 1972) recommended, among other things, that action research programs be undertaken in such areas as cognitive growth in children of the Asian Region, and the effects of different instructional procedures on cognitive growth. The recommendation was strongly based on the following justifications.*

1. During the past decade, curriculum development had tended to consider more carefully the findings of developmental psychology and the development of epistemology as these offered an insight into the function and structure of intellectual processes.

2. Among the developmental schools, the work of Piaget has received worldwide recognition as a useful framework for its relevance in the curriculum development.

3. It had been felt by the participants of the seminar that it was necessary to base curriculum development in Asia on a valid psychological theory of cognitive development. Learning would seem to be more effective when the logic of the child is considered rather than the logic of the subject matter alone.

4. Consequently, it was thought vital and practical to undertake a preliminary validation in Asia of some of the crucial insights of Piaget's theories. This validation, if carried out in many of the participating countries, would add substantially to the value of the findings, and consequently make possible crucial innovations in the field of curriculum development, thus permitting science and mathematics educators to achieve their objectives more efficiently and meaningfully.

*UNESCO, UNICEF, CEDO, *Report of a regional seminar on the development of science and mathematics concepts in children. Unesco regional office for education in Asia* : Bangkok Thailand 1973

5. A next important phase would ultimately be the development of models for the establishment of the link between research and curriculum development in Asia.

6. On the basis of the foregoings, the following actions were required:

I) a replication study in Asia for the validation of Piagetian theories,

II) action research in Asia for the development of models which will enable curriculum developers to integrate research findings into their work.

In Thailand, the findings from several previous studies as thoroughly reviewed (the detail of the review of past and current researches in the area of cognitive develop--ment of Thai children is given in appendix I) indicate that Thai children develop their mental stages (as defined by Piaget) a few years slower than Western children. Our main concern here is that Thai children in the sample rarely develop to the so-called formal operational stage at which it is expected that children would be able to solve problem effectively by logical reasoning. There may be many reasons for this finding, but an interesting one is that of the present practice of teaching–learning in Thai socializing agencies. Especially at school, teachers rarely teach children to think but focus their teaching on facts and rote memory. Children accordingly, seem to lack an insight into the problem and an ability to solve it by logical reasoning.

It is generally agreed that teaching children to learn concepts is an essential step for developing appropriate function of logical reasoning. Besides, it is anticipated that there would be a close relationship between scientific and mathematical concepts taught and the child's potential for meaningful learning in school. Then, it is interesting to investigate the effects of the teaching by developing concepts, and also to find if there is any relationship between the concepts to be taught and achievement in school. There--fore, on a step toward developing learning--teaching sequences that make best use of the child's capacities for learning and understanding, the present research is urgently needed.

As in any other part of the world, the city like Bangkok has a lot of slum children. These children are socially and environmentally deprived. Due to this fact, they have many handicaps to learn appropriate and useful concepts both at home and

school. To teach the slum boys and girls to develop and attain right concepts may be beneficial not only to themselves, but also to the society. While the slum children are facing their social and educational problems, another group of children in rural areas are also sharing a similar kind of deprivation. Based on previous research results, the rural children were found to be far behind the urban children both in physical and intellectual bases. Rural teachers especially in the remote areas are confronted by many obstacles in teaching their pupils. One main obstacle among several others is that both rural teachers and children lack environmental and psychological stimulations.

It is expected from the present investigation, which is the first "intervention" project of this kind in Asia, that the effects of teaching by developing concepts in children of different localities would help accelerate the intellectual progress. Also another expected outcome is to see the existence of the relationship between the concepts (to be developed by teaching) and school achievements. Besides, the investigation is hoped to provide data on teaching-learning processes for the improvement of teacher training and studies on learning. If the expected results turn out to be as described, the teaching by means of developing concepts in children should be strongly supported, and introduced in every primary school system in Asia as an alternative to the common practice of memorizing just mere facts. This kind of teaching could bridge the gap between the prescribed curriculum and what actually was experienced by educators in teaching and learning situations.

Objectives

The aim of the project is (a) to investigate the behavior of Thai children of different home backgrounds at a specific age group (7-8 year old) in response to teaching of certain science and mathematics concepts, (b) to determine the extent to which this form of cognitive ability is related to achievements in school (c) to determine the effect of concept teaching on children in different locations.

Hypotheses

(1) The children who are exposed to the teaching of science and mathematics concepts (treatment groups) attain higher scores on a battery of relevant Piagetian tests than the children who are not exposed to this treatment (control groups)

(2) For the attainment of concept scores in different groups, the effects of treatment in different locations are not the same.

(3) There is a linear relationship between the concept scores (as measured by Piagetian tasks) and the science and mathematics achievement scores.

Besides the three main hypotheses, several specific hypotheses are also set up in the section of the analysis of data.

Definitions of concepts and variables

I. Definition of concepts

Description :

The concept in science and mathematics refers to the ability to relate the previous facts or observations to the new ones : thus a person comes to have an insight into the problem and be able to solve it by logical reasoning. The concept in science and mathematics is measured by Piagetian tests.

II. Operational definitions of variables

Independent variables are defined as follows :

X_1 = locations (urban, slum, and rural)

X_2 = conditions (control and experiment)

Dependent variables are defined as the followings :

Y_1 is defined by scores of 1st set of Piagetian tests

Y_2 is defined by scores of 2nd set of Piagetian tests

Y_3 is defined by the science and mathematics achievement scores

Research procedures and methodology

I. Planning

In the early stage of research planning, the Institute submitted to UNICEF–UNESCO the research proposal of the experimental study of teaching science and mathe--matics concepts to young Thai children. When the Bangkok Institute was informed that the research project was approved and funded by UNICEF headquarter, the original research design had been reconsidered before its actual execution. Since the original research proposal was submitted to UNICEF almost one year before the official permission was granted to carry on the project, the research staff felt a necessity to reconsider all aspects of the project proposal. After several meetings, the Institute working group came up with some changes in details of the research plan. In addition to using Bangkok children in slum and nonslum areas, a sample of children from a rural area was included. Since our preliminary studies indicated the inconvenience and impracticality of using children in 3 different age levels, the present plan was to use only children fron one specific age level (7–8). The impracticality and inconvenience were due to matters concerning time arrangements with schools, complexity of writing lesson plans, and difficulty in getting children of some particular age level who did not have science and mathematics concept.

II. Preparation of the research instruments and materials

1. Selection of concepts for investigation

At the first stage of research execution, an agreement on concepts to be studied was made. Eight concepts in science and mathematics were selected to study by means of series of tasks. The research team agreed on the following criteria for selecting these concepts.

a. They constitute some of the fundamental concepts that underly many of the learning situation confronted by young children in schools, and are representative of the mental processes that are necessary for scientific and mathematical understandings. Two groups of concepts to be studied are mathematical concepts (number, set, spatial, and geometric concepts) and concepts of conservation of physical quantity (weight, volume, substance).

b. These selected concepts can also be drawn from the elementary school curriculum for Thai children which corresponds to Piaget's idea of mental stages of children.

c. These concepts have been studied in other parts of the world including Thailand yielding to a certain extent their universality.

d. The concepts can be tested by Piagetian techniques and materials which can be adjusted to the sample.

Then, the members of the research team studied thoroughly all the Piagetian tests dealing with science and mathematics. Final selection of experimental tests has been made on the basis of the criteria and careful considerations from previous research findings. The tests were: one to one correspondence, conservation of liquid, class inclusions (flowers), conservation of substance, conservation of length, mental imagery (static), class inclusion (animal), and conservation of weight. Careful translations of Piagetian techniques into Thai language were made in order that they conveyed the same meanings to the children in the sample. Both the language and materials used in the test administration were properly selected in terms of the cultural context and age of the children.

2. Construction of experimental lesson plans

The research team studied the Thai elementary curriculum on mathematics and science subjects with specific emphasis on behavioral objectives as stated in the curriculum. This was performed in conjunction with the preparation for writing the lesson plans in teaching for the development of mathematics and science concepts. Several drafts of lesson plans were attempted. The draft lesson plans were tried on children who were not in the sample with the main objectives for improving and modifying the lessons prior to the experiment. Each of the lesson plans followed the necessary steps of the scientific inquiry method emphasizing the behavioral objectives and the sequential stages of teaching which started consecutively from observation, explanation, prediction, and control stages.

Finally, the lessons to be used with the experimental groups were revised and ready for use in the experimental sessions. They consisted of 3 lessons for preparing the children's readiness in concepts learning, and the other 8 lessons designed for developing in children certain science and mathematics concepts. These lessons were as follows:

1. Preparational lesson I.
2. Preparational lesson II.
3. Preparational lesson III.
4. Lesson on conservation of numbers.
5. Lesson on conservation of length.
6. Lesson on seriation.
7. Lesson on mental imagery.
8. Lesson on conservation of continuous quantity.
9. Lesson on conservation of substance.
10. Lesson on conservation of weight.
11. Lesson on classification.

(See details of experimental lesson plans in appendices XII, XIII, XIV, XV, XVI, XVII, XVIII, XIX, XX)

3. Construction of lesson plans for the control group

Besides the experimental lesson plans, the other kind of lessons were developed for the children in the control group. The lesson plans for the control children consisted of 7 types of activities designed not to affect science and mathematics concepts. These activities were paper folding, singing and dancing, learning to pay respect to the Lord Buddha and Buddhist monks, listening to stories from story books, tracing and colouring pictures, shaping plasticene, and assembling jigsaw puzzles. The total 32 periods were used with the children in the control groups. Each period took about one hour and a half. (Details of the lesson plans for the control groups are in appendix XXI)

4. Construction of achievement tests

At the time when all lesson plans were still revised and preliminarily tried out with certain groups of children who were not in the sample, another attempt was made to develop two achievement tests, one in science, the other in mathematics. The two achievement tests were carefully constructed to measure the students' learning outcomes, which were in accordance with the instructional objectives. Subject matter contents in the two tests agree with those prescribed in the elementary school curriculum and also with those actually taught in the class. The tests were tried out before their actual use. The item analysis of the tests was done for the improvement of the final tests.

The two achievement tests were of multiple-choice type focusing on pictures rather than words. The mathematics achievement test consisted of 38 test items, and the science achievement test 44 items. Each test took about 45–50 minutes to administer. In order to put the children at ease when taking tests, there was a short interval (about 5–10 minutes break) during which the children were told a story or were shown some pictures. (Details of the two tests were in appendix X and appendix XI)

III. Sampling preparation and design

1. Selection of schools and communities.

In order to obtain children attending schools in different localities, the first attempt was made to make contacts with various schools in different communities. Certain criteria were set up for the selection of school. These were residential section and surroundings, socio-economic status of the majority of school children (as judged by stability of income and level of education on the part of their parents), social mobility, religion, accessibility and safety on the part of the researchers. Several visits were made to some communities with the guidance and co-operation of the Director and his staff of Prakhanong Health Centre, Ministry of Health. This particular health centre was chosen because it was located in one of the most squalid residential sections of Bangkok. This had to be done due to the fact that in certian residential sections especially the slum areas, the health centre plays its important role in improving thr health status of the people residing in the areas. Each health centre has long been launching its project and certainly establishes good relationships with the residents. By

means of contacting the inhabitants in slum residential sections through the health personels of the centre, the research team was assured of their co-operation and understanding of the research project.

Finally three schools of different localities were selected. The first one was the town or nonslum Bangkok school considered to be a typical school (which later in the report is called school No. 1). The second one was the slum Bangkok school (which later is named school No. 2). The third one was the village school located in the South-eastern part of the country (which later is called school No. 3). Children in all three selected schools were predominantly Buddhist.

At the first stage of the research project, approximately 400 children were randomly drawn from various schools which met the criteria as above mentioned. Contacts and arrangements with the schools were made before the long summer vacation in 1974. The research team members were divided into several groups to make informal contacts with the parents. With the co-operation of the principals, their personnels, and the parents, the children who were coming to be 1st grade pupils, were given individually the first set of Piagetian test as measure of concept. A careful analysis of the results was done on Piagetian tasks which required interview techniques. Elimination of some children was consequently made to discard the ones who already had acquired certain science and mathematics concepts. The rest of children who did not pass the criterion score (which was used to judge children as having or not having concepts), were maintained and used as sample.

2. Sampling design

Definition of population

The sample population were children aged from 7–8 years on the date of experiment, who did not have science and mathematics concept.

The sample concisted of 180 children who were randomly selected from 400 children at the first stage of sampling. From each of the 3 strata (urban, slum, village,) the children were randomly divided tnto two equal groups. There were 6 groups of 30 subjects of control and experimental conditions as shown in Table 1.

Table 1. Number of subjects in 2 experimental treatments and 3 control levels.

Subjects	Experiment (A_1)	Control (A_2)
Urban (L_1)	30	30
Slum (L_2)	30	30
Village (L_3)	30	30

This experimental design provided for an investigation on the interaction of the two variables viz, localities (3 levels), and experimental variable and, thus establishing a 2×3 (treatments $\times$ level) design.*

IV. Training of recorders

1. Selection of interviewers (experimenters and recorders).

Three main criteria in selecting the persons to do the job at the first stage were: (1) They were required to have some basic knowledge of research methodology, (2 They should have some experience in doing research with children, (3) They should indicate a positive attitude toward working with young children, and (4) They were required to attend the training workshop organized by the Institute to get them familiar with the work of Piaget. (The details of workshop were given in the next section).

There were 33 applicants who mainly were graduate students in the field of psychology and educational evaluation. After the workshop, only 15 persons were screened and finally selected. This was done on the basis of the evaluation of the applicants' performance during the workshop together with some necessary characteristics such as language fluency and sensitivity to the child's reactions.

2. Workshop for training interviewers.

* Lindquist, E.F. *Design and analysis of experiments in prychology and education.* Boston: Houghton Mifflin Co., 1956

The Institute organized a 3 day workshop for the interviewers or experimenters to be. On the first day, general training in methodology was emphasized. Basic knowledge of Piagetian theory was given to make them understand general objectives of the so-called "clinical method". On the second day, emphasis was given on making the interviewers familiar with the work of Piaget and the relevant techniques and materials which would be used in the Intitute's experimentation. The third day was organized so that the interviewers had to work with children in pairs with one person acting as experimenter and the other as recorder. They were trained in both roles so as to be able to alternate.

The workshop of the same nature was done twice, one prior to the time of pre-testing of concepts, and the other after the end of treatment (before post-testing). This was done so because the experimenters and recorders of both periods were not all the same ones.

V. Training of personnels to teach the experimental lessons

Specific training in this task was given to the selected personnels who were to take role of teachers in experimental groups. First, the teachers to-be in both experimental groups and control groups were given the the opportunity to visit various schools for young children and observe teaching methodology with young children. They were allowed to try out the experimental lesson plans with certain groups of children. It was expected, from the try out, that the lessons would be applicable to children of 7–8 years old. Besides, by trying out the lesson plans, the teacher-experimenters were made sure of both the applicability of the lessons and their own thorough understanding of specific purpose of each lesson. Success or failure of the whole experimentation would depend to a large extent to the well planned lessons and the preparation of the teacher-experimenters.

Record of the lesson trials and children's responses to the lessons taught were kept on a video tape. This was done to stimulate the discussions of the research team on the weak points of lesson plans for improvements.

Then, definite arrangements with sampled schools were made concerning the time table scheduled for teaching the sample population. However, the official permissions were obtained from the Municipal Provincial Organization, Ministry of Interior, and also from the Department of General Education, Ministry of Education.

During the time schedule mutually set, the two experimenter teachers were to teach the children in the experimental groups twice a week. Each period of teaching time took 1½ hours. The two other experimenter teachers were also selected to teach the children in the control groups at the same time as the first pair of experimenter-teachers. Accordingly, the children both in the experimental groups and control groups were met by their teachers twice a week. This arrangement was made to avoid the effect based on the criticism concerning the unequal opportunity in social contacts with the teachers on the part of children in the control groups and experimental groups.

During the four and a half month period of treatments, the major task of the experimenter – teachers was to keep records of pupils' reactions and progress in each lesson taught. The experimenter – teacher would make use of their records, based on their experiences and observations, as their own feedbacks for making the lessons valid and reliable. A careful and detailed recording in each activity of the lessons was kept to evaluate the outcome of the actual use of the experimental lessons. The evaluation was done by means of group discussions based on evidences from the research teams through the entire period of experiment.

VI. Evaluation

Through the entire research project, the research team and its working group met every two weeks or more. Detailed recordings of the procedures were kept. Film taking in some lessons taught was attempted. The evaluation on every aspect of the project was done consecutively as the research progressed. Details of all meetings to discuss the status and progress of the project, were kept and filed to be ready for use as references.

VII. Treatment of the data

1. The first hypothesis was tested by a t – test and HSD (Tukey)
2. The second hypothesis was tested by F – tests using analysis of variance.
3. The third hypothesis was assessed by a correlation technique.

Results

The analysis of data attempted to test the following hypotheses :

I. The children who were exposed to the teaching of science and mathematics concepts (treatment groups) attain higher scores, on a battery of relevant Piagetian tests, than the children who were not exposed to the treatment (control goups).

II. The children in urban environment (nonslum) would obtain higher scores on Piagetian tests than the children in slum and rural environments. When taking slum (urban) and rural environments into account, it was further hypothesized that the children in slum environment would obtain higher scores on Piagetian tasks than the rural children.

III. The children who were exposed to the teaching of science and mathematics concepts attain higher scores on the achievement tests in science and mathematics than the children who were not exposed to this treatment.

IV. The children who were in urban (nonslum) environment would attain higher scores on the achievement tests in science and mathematics than the children in slum and rural environments. When two different localities were taken into account, slum environment and rural environment, it was further hypothesized that the slum urban children would attain higher scores on these achievement tests than the rural children.

V. There was a linear relationship between the concept scores and the science and mathematics achievement scores.

Results as shown in Tables 1–17 were based on the attempts to test the main hypotheses I and II which are specifically stated as follows :

Hypothesis 1 : The children who were exposed to the treatment attain higher concept scores in the conservation of liquid than the children who were not exposed to the treatment.

Hypothesis 2 : The children who are in urban nonslum environment, in urban slum environment and in rural environment, attain different concept scores in the conservation of liquid.

Hypothesis 2.1 : The children who are in urban nonslum environment attain higher concept scores in the conservation of liquid than those in urban slum environment.

Hypothesis 2.2 : The children who are in urban nonslum environment attain higher concept scores in the conservation of liquid than those in rural environment.

Hypothesis 2.3 : The children who are in urban slum environment attain higher concept scores in the conservation of liquid than those in rural environment.

Table 2. Summary table of analysis of variance of the concept scores in the conservation of liquid.

Source	SS	df	MS	F
Treatments	785.407	1	785.407	71.923*
Environments	139.55	2	69.775	6.389*
Interaction	48.018	2	24.009	2.198
Error	1244.95	114	10.92	
Total	2217.925	119		

$F_{.05}$ (1,114) = 3.92, $F_{.05}$ (2,114) = 3.07

Table 2 indicates that the children exposed to the teaching of science and mathematics concepts attain higher concept scores in the conservation of liquid than the children not exposed to this treatment. The research hypothesis 1 is, therefore, accepted.

It also reveals that the children who are in urban nonslum, in urban slum, and in rural environments, attain different concept scores in the conservation of liquid.

In order to identify the pairs of environments leading to the differences in the conservation of liquid concept scores among children, the Newman–Keuls method* was employed by means of comparing the mean scores of the conservation concept in pairs.

*Kirk, R.E. *Experimental design : procedures for the behavioral sciences.* Belmont, California: Wadsworth Pub. Co. Inc., 1968

Table 3 Multiple comparisons of the mean scores in the conservation of liquid concept.

Types of Environment		(2)	(3)	(1)
	$\bar{X}$	2.7	2.725	5.0
Slum (2)	2.7	–	0.025	2.3*
Rural (3)	2.725		–	2.275*
Nonslum (1)	5.0			–

	r = 2	r = 3
$q_{.95}$ (r, 114)	2.8	3.36
$q_{.95}$ (r, 114)	1.462	1.755

From Table 3, the following results were obtained :

(1) The children in nonslum urban environment attain higher concept scores in the conservation of liquid than the children in slum urban environment The result is in accordance with the hypothesis 2.1

(2) The children in nonslum urban environment attain higher concept scores in the conservation of liquid than the children in rural environment. This also is in accordance with the hypothesis 2.2

(3) The children in slum urban environment attain the concept scores in the conservation of liquid not differently from the children in rural environment. This is not in accordance with the hypothesis 2.3

Hypothesis 3 : The children exposed to the treatment attain higher concept scores in the conservation of substance than those who were not exposed to the treatment.

Hypothesis 4 : The children who were in urban nonslum, in urban slum, and in rural environments, attain different concept scores in the conservation of substance.

Hypothesis 4.1 : The children in urban nonslum environment attain higher concept scores in the conservation of substance than the children in urban slum environment.

Hypothesis 4.2 : The children in urban nonslum environment attain higher concept scores in the conservation of substance than those in rural environment.

Hypothesis 4.3 : The children in urban slum environment attain higher scores in the conservation of substance than those in rural environment.

Table 4. Summary table of analysis of variance of the concept scores in the conservation of substance.

Source	SS	df	MS	F
Treatment	396.032	1	396.032	76.233*
Environment	63.2	2	31.6	6.082*
Interaction	1.268	2	0.634	0.122
Error	192.3	114	5.195	
Total	1052.8	119		

$F_{.05}$ (1,114) = 3.92

$F_{.05}$ (1,114) = 3.07

Table 4 reveals that the children exposed to the teaching of science and mathematics concepts, attain higher concept scores in the conservation of substance than those who were not exposed to the treatment. This is led to accept the research hypothesis 3.

The table also indicates that the children in urban nonslum, urban slum, and rural environments, obtain different concept scores in the conservation of substance.

In order to find the pairs of environments leading to the differences in the conservation of substance concept scores among children, the Newman–Keuls method* was used by means of comparing the mean scores of the substance conservation concept in pairs.

*Kirk, *ibid.*

Table 5. Multiple comparisons of the mean scores in the conservation of substance concept.

Types of Environment		(3)	(2)	(1)
	$\bar{X}$	2.2	2.6	3.9
Rural	2.2	–	0.4	1.7*
Slum	2.6		–	1.3*
Nonslum	3.9			–

	r = 2	r = 3
$q_{.95}$ (r, 114)	2.8	3.36
$q_{.95}$ (r, 114)	1.008	1.210

The results as shown in Table 5 are given as follows :

(1) The children in nonslum urban environment attain higher concept scores in the conservation of substance than those in slum environment. This finding is in agreement with the research hypothesis 4.1

(2) The children in nonslum urban environment attain higher concept scores in the conservation of substance than those in rural environment. This also agrees with the statement in the research hypothesis 4.2

(3) The children in slum and rural environments do not attain different concept scores in the conservation of substance. This is not in accordance with the research hypothesis 4.3

Hypothesis 5 : The children who were exposed to the teaching of science and mathematics concepts would attain higher concept scores in the conservation of weight than those who were not exposed to the treatment.

Hypothesis 6 : The children in nonslum urban, slum, and rural environments, would attain different concept scores in the conservation of weight.

Hypothesis 6.1 : The children in nonslum urban environment would attain higher concept scores in the conservation of weight than the children in slum environment.

Hypothesis 6.2 : The children in nonslum urban environment would attain higher concept scores in the conservation of weight than the children in rural environment.

Hypothesis 6.3 : The children in slum environment would attain higher concept scores in the conservation of weight than the children in rural environment.

Table 6. Summary table of analysis of variance of the concept scores in the conservation of weight.

Source	SS	df	MS	F
Treatment	806.008	1	806.008	74.013*
Environment	95.617	2	47.808	4.39*
Interaction	9.817	2	4.908	0.45
Error	1241.55	114	10.89	
Total	2152.992	119		

$$F_{.05}\ (1,114) = 3.92$$

$$F_{.05}\ (2,114) = 3.07$$

The above table shows that the children exposed to the teaching of science and mathematics concept get higher concept scores in the conservation of weight than those who were not exposed to the treatment. This result is in accordance with the research hypothesis 5.

The result from the above table also reveals that the children in nonslum urban, slum urban, and rural environments, get different concept scores in the conservation of weight.

With the objective to find further the pairs of environment leading to the differences in the conservation of weight, again the Newman–Keuls test* was employed by means of comparing the mean scores of the weight conservation concept in pairs.

Table 7. Multiple comarisons of the mean scores in the conservation of weight concept.

Types of Environment		(3)	(2)	(1)
	$\bar{X}$	3.625	3.8	5.6
Rural (3)	3.625	–	0.175	1.975*
Slum (2)	3.8			1.8*
Nonslum (1)	5.6			

	r = 2	r = 3
$q_{.95}$ (r, 114)	2.8	3.36
$q_{.95}$ (r, 114)	1.460	1.752

It is shown in the above table that : (1) The children in nonslum urban environment attain higher concept scores in the conservation of weight than those in nonslum environment. This is led to accept the research hypothesis 6.1, (2) The children in nonslum urban environment attain higher concept scores in the conservation of weight than those in rural environment. This is also led to accept the research hypothesis 6.2, (3) The children in nonslum urban, slum urban, and rural environments do not get different concept scores in the conservation of weight. This is led to reject the research hypothesis 6.3 .

Hypothesis 7 : The children exposed to the teaching of science and mathematics concepts attain higher concept scores in the conservation of length than the children not exposed to the treatment.

*Kirk, *ibid*

Hypothesis 8 : The children in nonslum urban, slum urban, and rural environments attain different concept scores in the conservation of length.

Hypothesis 8.1 : The children in nonslum urban environment would attain higher concept scores in the conservation of length than those in slum environment.

Hypothesis 8.2 : The children in nonslum urban environment would attain higher coucept scores in the conservation of length than those in rural environment.

Hypothesis 8.3 : The children in slum urban environment would attain higher concept scores in the conservation of length than those in rural environment.

Table 8. Summary table of analysis of variance of the concept scores in the conservation of length.

Source	SS	df	MS	F
Treatment	1062.075	1	1062.075	26.469*
Environment	102.05	2	51.025	1.271
Interaction	169.85	2	84.925	2.116
Error	4574.35	114	40.125	
Total	5908.325	119		

$F_{.05}\ (1,114) = 3.92$

$F_{.05}\ (2,114) = 3.07$

From Table 8, it reveals that :

1. The children exposed to the teaching of science and mathematics concept obtain higher concept scores in the conservation of length than the children not exposed to this treatment. The research hypothesis 7 is, therefore, accepted.

2. The children who were in nonslum, slum, and rural environments, do not attain different concept scores in the conservation of liquid. This is not in accordance with the research hypothesis 8.

Hypothesis 9 : The children exposed to the teaching of science and mathematics concept get higher concept scores in the class inclusion (flowers) than the children not exposed to this treatment.

Hypothesis 10 : The children in nonslum, slum, and rural environments obtain different concept scores in the class inclusion (flowers).

Hypothesis 10.1 : The children in nonslum environment obtain higher concept scores in the class inclusion (flowers) than those in slum environment.

Hypothesis 10.2 : The children in nonslum environment obtain higher concept scores in the class inclusion (flowers) than those in rural environment.

Hypothesis 10.3 : The children in slum environment obtain higher concept scores in the class inclusion (flowers) than those in rural environment.

Table 9. Summary table of analysis of variance of the concept scores in the class inclusion (flowers).

Source	SS	df	MS	F
Treatment	250.833	1	520.833	37.763*
Environment	0.267	2	0.133	0.009
Interaction	2.467	2	1.233	0.089
Error	1572.3	114	13.792	
Total	2095.867	119		

$F_{.05}\ (1,114) = 3.92$

$F_{.05}\ (2,114) = 3.07$

Table 9, demonstrates that :

1. The children exposed to the teaching of science and mathematics concept obtain higher concept scores in the class inclusion (flowers) than those not exposed to the treatment. The research hypothesis 9 is accordingly accepted.

2. The children in nonslum, slum, and rural environments, do not differ in the concept scores obtained in the class inclusion (flowers). This result does not accord the statement in the research hypothesis 10.

Hypothesis 11 : The children exposed to the teaching of science and mathematics concepts obtain higher concept scores in the class inclusion (animals).

Hypothesis 12 : The children in nonslum, slum, and rural environments, differ in the concept scores obtained in the class inclusions (animals).

Hypothesis 12.1 : The children in nonslum environment obtain higher concept scores in the class inclusion (animals) than those in slum environment.

Hypothesis 12.2 : The children in nonslum environment obtain higher concept scores in the class inclusion (animals) than those in rural environment.

Hypothesis 12.3 ; The children in slum environment obtain higher concept scores in the class inclusion (animals) than those in rural environment.

Table 10. Summary table of analysis of variance of the concept scores in the class inclusion (animals).

Source	SS	df	MS	F
Treatment	1642.80	1	1642.800	62.173*
Environment	194.45	2	97.225	3.679*
Interaction	92.15	2	46.075	1.743
Error	3012.30	114	26.423	
Total	4941.70	119		

$F_{.05}$ (1,114) = 3.92

$F_{.05}$ (2,114) = 3.07

Table 10, indicates that.

1. The children exposed to the teaching of science and mathematics concepts obtain higher concept scores in the class inclusion (animals) than those not exposed to the treatment. This is in accordance with the research hypothesis 11.

2. The children in different environments obtain different concept scores in the class inclusion (animals). This result is also in accordance with the statement in the research hypothesis 12.

In order to identify the pairs of environments leading to the difference in the class inclusion (animals) concept scores among children, the Newman–Keuls method* was used by means of comparing the mean scores of the class inclusion (animals) concept in pairs.

Table 11. Multiple comparisons of mean scores in the class inclusion (animals) concept.

Types of Environment		(2)	(3)	(1)
	$\bar{X}$	13.650	16.325	16.375
Slum (2)	13.650	–	2.675*	2.725*
Rural (3)	16.325		–	0.050
Nonslum (1)	16.375			–

	r = 2	r = 3
$q_{.95}$ (r, 114)	2.80	3.36
$q_{.95}$ (r, 114)	2.275	2.730

From Table 11, the following results were obtained: (1) The children in nonslum environment get higher concept scores in the class inclusion (animals) than those in rural environment. This result leads to the acceptance of the research hypothesis 12.2, (2) The children in slum environment get higher concept scores in the class inclusion (animals)

* Kirk, *ibid.*

than those in rural environment. This is also in accordance with the research hypothesis 12.3, (3) The children in nonslum and slum environments do not differ in the concept scores in the class inclusion (animals). This result is not in accordance with the research hypothesis 12.1.

Hypothesis 13 : The children exposed to the teaching of science and mathematics concepts get higher concept scores in the mental imagery (static) than those not exposed to the treatment.

Hypothesis 14 : The children in nonslum, slum, and rural environments differ in the concept scores obtained in the mental imagery (static).

Hypothesis 14.1 : The children in nonslum environment obtain higher concept scores in the mental imagery (static) than those in slum environment.

Hypothesis 14.2 : The children in nonslum environment obtain higher scores in the mental imagery (static) than those in rural environment.

Hypothesis 14.3 : The children in slum environment obtain higher concept scores in the mental imagery (static) than those in rural environment.

Table 12. Summary table of analysis of variance of the concept scores in the mental imagery (static).

Source	SS	df	MS	F
Treatment	35.208	1	35.208	9.575*
Environment	9.517	2	4.758	1.293
Interaction	12.817	114	6.408	1.742
Error	419.250	114	3.677	
Total	476.792	119		

$F_{.05}\ (1,114) = 3.92$

$F_{.05}\ (2,114) = 3.07$

From Table 12, the results indicate that : (1) The children exposed to the teaching of science and mathematics concepts obtain higher concept scores in the mental imagery (static) than those not exposed to the treatment. This result is in accordance with the statement in the research hypothesis 13, and (2) The children from different localities do not fiffer in the concept scores in the mental imagery (static). This result does not accord the statement in the research hypothesis 14.

Factor analysis of 7 Piagetian test results when used with Thai children

Since the Piagetian tests consist of 7 tasks to be performed, it is a necessity to investigate further that all these tasks measure some common factors. In case that the 7 tasks are found to measure the same common factors, all findings as shown in the above section should be grouped together for further analysis. But in case that each of the seven tasks measures its own unique factor, the treatment of data together with the preceding results are sufficient. Consequently, factor analysis* using centroid rotation, was then used to analyze the data to obtain the minimum dimensionality of the construct defined by the Piagetian tests. The results are shown in Tables 13, 14, & 15.

Table 13. Intercorrelations among 7 Piagetian tests.

Types of test (variables)	1	2	3	4	5	6	7
1. Conservation of liquid	–	.774*	.573*	.442*	.266*	.285*	.044
2. Conservation of substance		–	.690*	.483*	.204	.216	.108
3. Conservation of weight			–	.385*	.199	.156	.017
4. Conservation of length				–	.092	.206	.069
5. Class inclusion (flowers)					–	.580*	.050
6. Class inclusion (animals)						–	.078
7. Mental imagery (static)							–

$r_{.05} = .250$

*Harmon, H.H. *Modern factor analysis.* Chicago : University of Chicago Press, 1960

As shown in Table 13, the intercorrelation values among 7 tests even found positively and statistically significant at the 95% level, have a big range from .266 to .774. These are:

The test in the conservation of liquid correlates with the tests in the conservation of substance, in the conservation of weight, in the conservation of length, in the class inclusion (flowers) and in the class inclusion (animals).

The test in the conservation of substance correlates with the tests in the conservation of weight, and in the conservation of length.

The test in the class inclusion (flowers) correlates with the test in the class inclusion (animals).

It is noted also from the above table that the test in the mental imagery (static) is not found to correlate with any other 6 tests of Piaget.

Table 14. The weights of four factors for 7 variables before rotations.

Variables	Factors 1	2	3	4	h^2 (communality)
1. Conservation of liquid	.79	.26	.13	.17	.74
2. Conservation of substance	.81	.39	.09	.17	.85
3. Conservation of weight	.68	.34	.12	−.14	.61
4. Conservation of length	.54	.21	−.23	−.13	.41
5. Class inclusion (flowers)	.49	−.53	.27	−.08	.60
6. Class inclusion (animals)	.53	−.54	.05	−.10	.59
7. Mental imagery	.12	−.07	−.16	.15	.07

As found in Table 14 which reveals the weights of four factors before rotations, all the weights in Factor 1 are positive. But in other Factors, the weights of three factors have both positive and negative values. In the column of h^2 (communality) which results

from the combination of the weight in every factor squared, it is found that the variable on the conservation of substance has the highest value, and the consecutive values are found in the variables on the conservation of liquid, the conservation of weight, the class inclusion (flowers), the class inclusion (animals), the conservation of length, and the mental imagery (static). It is noticeable that the value of h^2 for the last variable (mental imagery) is very small.

Since Table 14 does not yield the complete interpretation for finding the characteristics of Piagetian tests on the aspect of science and mathematics, it is necessary to rotate the factors by means of matrix. The results after rotations are shown in the following table.

Table 15. The weights of four factors for 7 variables after rotations.

Variables	Factors				h^2
	1	2	3	4	
1. Conservation of liquid	–.07	.49	.69	.18	.75
2. Conservation of substance	–.05	.57	.75	.16	.90
3. Conservation of weight	.16	.33	.71	0	.63
4. Conservation of length	.27	.46	.35	–.06	.41
5. Class inclusion (flowers)	.23	0	.23	.71	.61
6. Class inclusion (animals)	.33	.16	.13	.66	.59
7. Mental imagery (static)	–.03	.23	–.07	.09	.07

Table 15 can explain the following results :

1. The variable on the conservation of liquid has the the highest weight in Factor 3 (.69).

2. The variable on the conservation of substance has the highest weight in Factor 3 (.75).

3. The variable on the conservation of weight has the highest weight in Factor 3 (.71).

4. The variable on the conservation of length has the highest weight in Factor 2 (.46).

5. The variable on the class inclusion (flowers) has the highest weight in Factor 4 (.71).

6. The variable on the class inclusion (animals) has the highest weight in Factor 4 (.66)

7. The variable on the mental imagery does not have any substantial weight on any Factor, except slight value of weight on Factor 2 (.23).

The results based on the factor analysis of the data from seven Piagetian tests, then indicate two common factors and two unique factors. The common factors are the conservation of substance and the classification of living things, while the mental imagery and the conservation of length are the two unique factors.

Accordingly, the seven Piagetian tasks are grouped again and can be classified as follows :

group 1 "The conservation of substance", which includes the conservation of substance, and the conservation of weight.

group 2 "The classification of living things", which includes the class inclusion (flowers), and the class inclusion (animals)

group 3 "The conservation of length"

group 4 "The mental imagery"

Based on the new grouping result of the type of Piagetian tests, another attempt was made to study the variations in 2 different set of test data namely, the set on the conservation of substance (group I), and the set on the classification of living things (group II). But for group III, and group IV, in which the factor analysis results indicate unique factors, no attempt was needed to study the variations of the test data in these two groups again. The results are still referred to Table 7 and 11 consecutively, The following Tables 16, 17, 18, then, are given to justify the attempt to study the variations in the two first different set of data.

Table 16. Summary table of analysis of variance of the concept scores tn the group "the conservation of substance.".

Source	SS	df	MS	F
Treatment	5824.133.	1	5824.133	98.357*
Environment	864.687	2	432.433	7.302*
Interaction	12.867	2	6.433	0.108
Error	6750.500	114	59.214	
Total	13452.367	119		

$F_{.05}$ (1,114) = 3.92
$F_{.05}$ (2,114) = 3.07

From Table 16, the analysis of data reveals that : (1) the children exposed to the teaching of science and mathematics concepts get higher concept scores in "the conservation of substance" than those not exposed to the treatment and (2) the children in nonslum, slum, and rural environments differ in the concept scores obtained in "the conservation of substance."

To furtherly identify the pairs of environments leading to the differences in "the conservation of substance" concept scores among children of different locations, the Newman–Keuls test* was again employed. The result of comparisons of mean scores was shown in the following table.

Table 17. Multiple comparisons of mean scores in "the conservation of substance" concept.

Types of Environment		(3)	(2)	(1)
	$\bar{X}$	8.55	9.1	14.5
Rural (3)	8.55	–	0.55	5.95*
Slum (2)	9.1		–	5.40*
Nonslum (1)	14.5			–
		r = 2	r = 3	
		$q_{.95}$ (r, 114) 2.8	3.36	
		$q_{.95}$ (r, 114) 3.406	4.088	

*Kirk, *ibid.*

If can be interpretated from Table 17 that : (1) the children in nonslum environment get higher concept scores in "the conservation of substance" than those in rural and nonslum environments, and (2) the children in slum environment do not differ from those in rural environment in obtaining the concept scores in "the conservation of substance."

Table 18. Summary table of analysis of variance of the concept scores in the group "the classification of living things."

Source	SS	df	MS	F
Treatment	4013.633	1	4013.633	68.697*
Environment	202.117	2	101.058	1.729
Interaction	121.717	2	60.858	1.041
Error	6660.5	114	58.425	
Total	10997.967	119		

$F_{.05}$ (1, 114) = 3.92

$F_{.05}$ (2, 114) = 3.07

Table 18 indicates that : (1) the children exposed to the teaching of science and mathematics concepts get higher concept scores in "the classification of living things" than those not exposed to the teaching, and (2) the children in nonslum, slum, and rural environments do not differ in the concept scores obtained in "the classification of living things."

It can be concluded in this section that it does not make any difference statistically if the 5 Piagetian tests were combined through factor analysis procedures or if they were treated individually.

In the next following section, Tables 19 to 24 are given. These tables reveal the results of testing the main research hypotheses III and IV as stated in the very beginning of this section of resutls. Also the research hypotheses III and IV are specifically stated as follows and will be given the consecutive number following the previous research statements.

Hypothesis 15 : The children exposed to the teaching of science and mathematics concepts obtain higher scores in the mathematics achievement test than those not exposed to the treatment.

Hypothesis 16 : The children in nonslum, slum, and rural environments obtain different scores in the mathematics achievement test.

Hypothesis 16.1 : The children in nonslum environment obtain higher scores in the mathematics achievement test than those in slum environment.

Hypothesis 16.2 : The children in nonslum environment obtain higher scores in the mathematics achievement test than those in rural environment.

Hypothesis 16.3 : The children in slum environment obtain higher scores in the mathematics achievement test than those in rural environment.

Table 19. Summary table of analysis of variance of the achievement scores in the mathematics test.

Source	SS	df	MS	F
Treatment	32.032	1	32.032	1.116
Environment	368.600	2	184.300	6.423*
Interaction	18.468	2	9.234	0.321
Error	3270.900	114	28.692	
Total	3690.000	119		

$F_{.05}$ (1, 114) = 3.92
$F_{.05}$ (2, 114) = 3.07

Table 19 indicates that the children exposed and not exposed to the teaching of science and mathematics concepts do not differ in the achievement test. This result is not in accordance with the research hypothesis 15. Also, the table indicates that the children in nonslum, slum, and rural environments differ in the scores obtained from the mathematics achievement test. The Newman – Keuls method* was then used to identify further the pairs of environments leading to the differences in the achievement scores among the children.

Table 20. Multiple comparisons of the mean scores in the mathematics achievement test.

Types of Environment		(3)	(2)	(1)
	$\bar{X}$	18.55	20.15	22.80
Rural (3)	18.55	–	1.60	4.25*
Slum (2)	20.15		–	2.65*
Nonslum (1)	22.80			–

	r = 2	r = 3
$q_{.95}$ (r, 114)	2.80	3.36
$q_{.95}$ (r, 114)	2.371	2.845

From Table 20, it can be interpreted that the children in nonslum environment get higher scores in the mathematics achievement test than those in both slum and rural environments. These results are agreeable to the statements in the research hypotheses 16.1 and 16.2 Besides, Table 19 indicates thet the children in slum environment do not differ from those in rural environment on the mathematics achievement scores. This is not agreeable to the hypothesis 16.3.

* Kirk, *ibid*

Hypothesis 17 : The children exposed to the teaching of science and mathematics concepts get higher scores in the science achievement test than those not exposed to the teaching.

Hypothesis 18 : The children in nonslum, slum, and rural environments obtain different scores in the science achievement test.

Hypothesis 18.1 : The children in nonslum environment get higher scores in the science achievement test than those in slum environment.

Hypothesis 18.2 : The children in nonslum environment get higher scores in the science achievement test than those in rural environment.

Hypothesis 18.3 : The children in slum environment get higher scores in the science achievement test than those in rural environment.

Table 21. Summary table of analysis of variance in the science achievement scores.

Source	SS	df	MS	F
Treatment	78.408	1	78.408	3.423
Environment	370.067	2	185.033	8.078*
Interaction	35.267	2	17.633	0.769
Error	2611.050	114	22.903	
Total	3094.792	119		

$F_{.05}\ (1, 114) = 3.92$

$F_{.05}\ (1, 114) = 3.07$

From Table 21, it can be interpreted that the children exposed and not exposed to the teaching of science and mathematics concepts do not differ in the science achievement scores obtained. This result is not in accordance with the hypothesis 17. Besides,

the result as shown in Table 21, indicates that the children in nonslum, slum, and rural environments differ in the science achievement scores obtained. The Newman – Keuls method* was used to investigate the pairs of environments leading to the achievement score difference.

Table 22. Multiple comparisons of the mean scores in the science achievement test.

Types of Environment		(3)	(1)	(2)
	$\bar{X}$	20.525	22.775	24.825
Rural (3)	20.525	–	2.25*	4.30*
Nonslum (1)	22.775		–	2.05
Slum (2)	24.825			–
		r = 2	r = 3	
	$q_{.95}$ (r, 114)	2.800	3.360	
	$q_{.95}$ (r, 114)	2.118	2.542	

From the above table, it is indicated that: (1) The children in slum environment get higher science achievement scores than those in rural environment. This agrees with the research hypothesis 18.3, (2) The children in nonslum environment get higher science achievement scores than those in rural environment. This also agrees with the research hypothesis 18.2, and (3) The children in slum environment do not differ form those in nonslum environment on the science achievement scores. This result does not agree to the research hypothesis 18.1.

When an attempt was made to combine the achievement scores on both science and mathematics tests, more specific hypotheses are stated as follows:

* Kirk, *ibid*

Hypothesis 19 : The children exposed to the teaching of science and mathematics concepts obtain higher scores in the science and mathematics achievement tests than those not exposed to the treatment.

Hypothesis 20 : The children in nonslum, slum, and rural environments get different scores in the science and mathematics achievement tests.

Hypothesis 20.1 : The children in nonslum environment obtain higher science and mathematics achievement scores than those in slum environment.

Hypothesis 20.2 : The children in nonslum environment obtain higher science and mathematics achievement scores than those in rural environment.

Hypothesis 20.3 : The children in slum environment obtain higher science and mathematics achievement scores than those in rural environment.

Table 23. Summary table of analysis of variance in the science and mathematics achievement scores.

Source	SS	df	MS	F
Treatment	210.674	1	210.674	2.626
Environment	1032.267	2	516.133	6.433*
Interaction	61.401	2	30.700	0.382
Error	9145.450	114	80.223	
Total	10449.792	119		

$F_{.05}\ (1, 114) = 3.92$

$F_{.05}\ (2, 114) = 3.07$

Table 23 reveals that : (1) The children exposed and not exposed to the teaching of science and mathematics concepts do not differ in science and mathematics achievement scores. This is nonagreeable to the hypothesis 19, and (2) The children in nonslum, slum, and rural environments differ in the science and mathematics achievement scores. In order to investigate the pairs of environment leading to the science and mathematics achievement scores among children, the Numan-Keuls method *was then used.

Table 24. Multiple comparisons of mean scores in the science and mathematics achievement tests

Types of Environment		(3)	(2)	(1)
	$\bar{X}$	39.075	44.975	45.575
Rural (3)	39.075	—	5.90*	6.50*
Slum (2)	44.975		—	0.60
Nonslum (1)	45.575			—
		r = 2	r = 3	
	$q_{.95}$ (r, 114)	2.80	3.36	
	$q_{.95}$ (r, 114)	3.965	4.758	

From Table 24, it can be interpreted that : (1) The children in nonslum envivoment obtain higher science and mathematics achievement scores than those in rural environment. This leads to the acceptance of the research hypothesis 20.2., (2) The children in slum environment obtain higher science and mathematics achievement scores than those in rural environment. This also leads to the acceptance of the research hypothesis 20.3. and (3) The children in nonslum environment and slum environment do not differ in the science and mathematics achievement scores obtained. This result does not agree to the research hypothesis 20.1.

*Kirk, *ibid*

The last part of this section is the attempt to test the main research hypothesis V stating that there will be a linear relationship between the concept scores as measured by 7 Piagetian tests and school achievement scores as measured by the science and mathematics achievement tests.

Hypothesis 21 : There is a linear relationship between science and mathematics concept scores and the school achievement scores in science and mathematics.

Table 25. Correlations between each science and mathematics concept and the school achievement.

Concept scores / School achievements	1 Conser. liquid	2 Conser. of substance	3 Conser. of weight	4 Conser. of length	5 Class inclusion (flowers)	6 Class inclusion (animals)	7 Mental imagery	Z
Science	.205	.133	.004	.063	.358*	.534*	.211	.348
Mathematics	.558*	.357*	.219	.348*	.333*	.357*	.122	.224

$r_{.05} = .250$

From the above table, it can be interpreted that : (1) There is a linear relationship between the concept scores in the class inclusions (flowers and animals) and the mathematics achievement score, and (2) there is a linear relationship between each concept score as measured by Piagetian tests (except the conservation of weight, and the mental imagery) and the science achievement score. When the scores on both science and mathematics achievement tests are combined, the result confirms the hypothesis 21.

It is interesting to see further if there is any statistical difference between the correlations of the concept scores to the science achievement and the mathematics achievement. The test is shown in Table 25.

Table 26. Test of the difference between the correlations of the concept scores to the science achievement and to the mathematics achievement.

Variables	r	Z
Science VS concept	.225	− 1.746
Mathematics VS concept	.348	

Table 26 indicates no difference between the two correlations tested.

In addition to all above presentations of result, the researchers are interested to see if there are some common factors among the two achievement tests and seven Piagetian tests. It is expected that the results based on the factor analysis of these tests will be beneficial for further investigations and applications of the research findings.

The centroid method of factoring* was then used to study the structure of the relation among the two achievement tests and seven Piagetian tests. The factor analysis results are shown in Tables 27, 28, and 29.

Table 27. Intercorrelations among seven Piagetian tests and the two achievement tests.

Variables	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9
1. Conservation of liquid	—	.774*	.573*	.442*	.266*	.285*	.044	.558*	.205
2. Conservation of substance		—	.690*	.483*	.204	.216	.108	.357*	.133
3. Conservation of weight			—	.385*	.199	.156	.017	.219	.004
4. Conservation of length				—	.092	.206	.069	.348*	.063
5. Class inclusion (flowers)					—	.580	.050	.333*	.358*
6. Class inclusion (animals)						—	.078	.357*	.534*
7. Mental imagery							—	.122	.211
8. Mathematics achievement								—	.493*
9. Science achievement									—

$r_{.05} = .250$

*Harmon, *ibid*

From Table 27, it is found that there is a wide range of significant intercorrelation values from .226 to .774. As indicated in the table, the test on the conservation of liquid correlates with the tests on the conservation of substance, the conservation of weight, the conservation of length, the class inclusion (flowers), the class inclusion (animals), and the mathematics achievement test. The test on the conservation of substance correlates with the tests on the conservation of weight, the class inclusion (flowers), and the mathematics achievement test. The test on the conservation of weight correlates only with the test on the conservation of length. The test on the class inclusion (flowers) correlates with the test on the class inclusion (animals), the mathematics achievement test, and the science achievement test. The test on the class inclusion (animals) correlates both with the mathematics achievement test and the science achievement test. As for the test on mental imagery, it does not correlate with any test. Finally, the mathematics achievement test correlates with the science achievement test.

Table 28. The weights of five factors for 9 variables before rotations.

Variables	Factors					h^2 (Communality)
	1	2	3	4	5	
1. Conservation of liquid	.78	−.35	−.13	.15	−.24	.83
2. Conservation of substance	.74	−.50	−.04	−.16	−.10	.83
3. Conservation of weight	.58	−.49	.22	−.16	−.10	.66
4. Conservation of length	.51	−.28	−.07	.11	.27	.43
5. Class inclusion (flowers)	.53	.36	.37	.10	−.12	.57
6. Class inclusion (animals)	.59	.43	.25	.08	.05	.60
7. Mental imagery	.18	.12	−.18	−.25	.12	.16
8. Mathematics	.66	.16	−.30	.24	−.13	.63
9. Science	.50	.56	−.21	−.12	−.09	.63

As indicated in Table 28, all the weights in Factor 1 are positive, but the weights of other four factors have both positive and negative values. The column of h^2 (communality) is the square of the combination of the weights in every factor. It is found that the variables on the conservation of liquid and the conservation of substance have the highest weight, and the next lower values are found in the variables on the conservation of weight, mathematics, science, class inclusion (animals), class inclusion (flowers), conservation of length, and mental imagery.

Since Table 27 does not yield the complete interpretation, it is required to rotate the reference axes to obtain a pattern of simple structure. The results after rotations are revealed in Table 28.

Table 29. The weights of five factors for 9 variables after rotations.

Variables	Factors					h^2 (Comunality)
	1	2	3	4	5	
1. Conservation of liquid	.39	.09	.73	−.10	.36	.83
2. Conservation of substance	.50	−.09	.55	.13	.50	.83
3. Conservation of weight	.39	−.19	.34	0	.60	.66
4. Conservation of length	−.01	−.01	.50	.25	.35	.43
5. Class inclusion (flowers)	.01	.51	.05	.03	.56	.57
6. Class inclusion (animals)	−.01	.62	.10	−.02	.46	.60
7. Mental imagery	.16	.19	0	.30	.01	.16
8. Mathematics	.16	.50	.59	−.02	.08	.63
9. Science	.22	.75	.10	.11	.03	.63

Table 29 explains the following results:

(1) The variable on the conservation of liquid has the highest weight in Factor 3 (.73)

(2) The variable on the conservation of substance has the highest weight in Factor 3 (.55)

(3) The variable on the conservation of weight has the highest weight in Factor 5 (.60)

(4) The variable on the conservation of length has the highest weight on Factor 3 (.50)

(5) The variable on the class inclusion (flowers) has the highest weight in Factor 5 (.56) and the next lower value (.51) in Factor 2.

(6) The variable on the class inclusion (animals) has the highest weight in Factor 2 (.62) and the next lower value (.46) in Factor 5.

(7) The variable on the mental imagery does not have any substantial weight in any factor except Factor 4 (.30).

(8) The variable on mathematics has the highest weight in Factor 3 (.59) and the next lower value (.50) in Factor 2.

(9) The variable on science has the highest weight in Factor 2 (.75).

The results, based on the factor analysis of the data from seven Piagetian tests and the two achievement tests then indicate three common factors, and two unique factors. While the tests on the conservation of liquid, the conservation of substance and the mathematics achievement share a common factor, the tests on the class inclusion (animals) and the science achievement share another common factor.

Discussion of results

The discussion will concentrate on some factors responsible for the above findings in order that some general conclusion can be drawn.

A brief comment on the research instruments should be made first. That concerns the Piagetian tests used in the investigation. It was found that the test on "mental imagery" has least relation to the others of the Piagetian test battery, and also to the achievement

tests. However, there are two kinds of "mental imagery" test : one is static, and the other is dynamic. And as found by Opper,* the Thai children did not perform well in the mental imagery test. For the present investigation only the static form of mental imagery was used. It is then suggested to use the dynamic form of "mental imagery" test in any further similar kind of investigation.

Concerning the experimental lessons used in this investigation, it was evaluated by the experimenter – teachers that most of the lessons were applicable for the present experimental purpose. That is they can be used to enable the children to understand certain concepts in science and mathematics. However, a useful application of the experimental lessons still depends a great deal on some important factors such as more time for teaching, convenience and enough room for class arrangements, and teachers' patience and understanding. If these experimental lessons would be attempted by any regular teacher in a regular classroom, it is felt that some improvements should be done first especially on the part of language and terms used in the lessons.

We have seen in the above sections that the overall effects of treatment (teaching of science and mathematics concepts) yield the differences between the experimental groups and the control groups in all seven Piagetian tasks and two achievement tests. This means the children exposed to the teaching of science and mathematics concepts have higher school achievement and higher aptitude to learn concepts than those not exposed to the teaching. This finding is satisfactory to the researchers, because it implies, to a certain extent, the practicality of the experimental lesson plans despite the fact that there are many difficulties in learning – teaching situations throughout the entire period of experimentation.

As for the differences of treatment effects upon children from different environments namely nonslum, slum, and rural, the result does not show that the effects of treatment are different. The children of different locations do not differ in the mathematics and science concepts as measured by Piagetian tasks, and also do not differ in the school achievement in science and mathematics subjects. In some certain tests such as the science achievement test, the sampled deprived children (slum) even did slightly better than the privileged ones (nonslum urban). Eventhough the effects of treatment are about the same to children of different localities, there is a trend indicating that the differences in

* See "opper" in *references*.

concept scores between the nonslum urban and the rural children are greater than those between the slum and the rural children, and also than those between the slum and the nonslum children. Another trend indicates that the slum children perform better in both Piagetian tasks and the achievement tests than those in rural environment. These findings are not surprising and support the results of Miss Opper who found urban – rural differences in the ages of acquisition of the various science and mathematics concepts.

We have seen that there is no significant simple treatment effects in the findings. Some reasons contributing to this finding may be raised for discussion. One is of a physical nature and location of the schools which might be affecting the child's performance at the tasks. Among the three sampled schools of nonslum, slum, and rural types, the experimenter – teachers found in the nonslum urban school the limited space and least physical facilities. On the contrary, they found in the rural school the ample space and convenience in class arrangement. The slum school is also found to be better than the nonslum school with regards to space and physical facilities. Besides, another factor has to be considered. That is the co-operativeness on the part of the parents which affect the child's regular attendance and attention to the experimental lessons. Among the three groups of children (nonslum, slum, and rural) the experimenter–teachers found the least co–operativeness on the part of nonslum urban parents. On the contrary, thay fonnd the best co-operativeness on the part of slum parents who seem eager to have their children take parts in both experimental and control groups. As for the rural parents, they lack initiative to see their children's progress rather than their own unwillingness to co-operate. During the experimentation sessions, another factor came unexpectedly. That was, in the latter part of experiment, the big flood in the central part of Bangkok and its vicinity. All schools were affected by the flood. Especially in the rural school, the children could not walk to the school. The damage from the flood caused indirectly the delay of treatment. Some adjustments had to be made, and the period of experimentation was extended. However, the extension did not help the situation due to the fact that they were approaching to the end of the school year and the schools are

pressed to keep the number of regular teaching hours for covering the prescribed curriculum set from the Ministry of Education. Both the children and their experimenter–teachers were somewhat exhausted. (See the detail of the experimenter–teachers' comments and reactions to the teaching–learning situations in the entire period of experimentation, in appendices XXII, XXIII, XXIV, XXV)

Based on the above discussions, it is anticipated that the effects of treatment upon different groups of children should be greater providing that there are improvements and eliminations of certain conditions as described above. Any replication of the present investigation can be attempted to compare its results.

Besides, the present samples are of very limited age range in this research. It might be wise to enlarge the age range to include the young children to whom we suspect that the treatment might be more effective than to the present samples.

As for the association between the science and mathematics concepts and school achievement, such a relationship is found to exist. However, a caution has to be made. That is when the co–efficient of determination was computed, the results reveal low predictive validity between the two variables. Again, this finding is not surprising. One main factor responsible for the result is due to the normal practice of teaching –learning in many of the Thai schools including the three schools in the sample. That is to say when the children were out of the experimental lessons, they had to come back to the normal class situations in which their teachers still emphasized on rote memory and facts learning. It can be expected that there would be some immediate effects of treatments upon the children's thought process, but such effects would not exist long. Soon after they are not exposed to that similar kind of teaching in their normal classroom learning, they are back to the same old pattern of receiving or passive rather than active thinking. However, since there is no evidence yet to say definitety about the length of time in which the children are able to retain the concepts taught, a suggested further research is to make a follow–up study of the children in the sample when they move up to the higher grades.

It is mentioned in the beginning of the report that one expected outcome is to see the close link between the concepts developed and school achievements. Eventhough the result of the investigation reveals such relationship, it is not satisfactory yet due to its low predictive validity. The close association between the two variables still depends on many factors such as educational and school policies. One essential necessity is to develop the seientific attitude on the part of learners, teachers and parents. They have to join co-operatively in making all learnings meaningful and beneficial.

This investigation is awaited for further studies and applications of its findings. The relation between the concepts taught and school achievement is hoped to be augmented with research implementations in proper time and place.

References

Anandhasit, Yupha. *The comparative study of the effects of active inquiry instruction in general science on inquiry, scholastic aptitude and sense of responsibility.* Master's thesis. College of Education, 1972.

Bergling, K. *The development of hypothetico–deductive thinking in children.* IEA. Monograph studies No. 3. Stockholm, Sweden: Almqvist and Wiksell International, 1974.

Boonyonk, Bumroong. *The study of the effectiveness of the combined inquiry instruction on inquiry, creativity and external–internal control.* Master's thesis. College of Education, 1971.

Boonsong, Supon. *The development of conservation of mass, weight, volume in Thai children.* Master's thesis. College of Education, in collaboration with the Bangkok Institute for Child Study, 1968.

Buasraung, Chavalit. *A study of patterns of error in adding two single integers by grade 1 children in Bangkok and Dhonburi.* Masters' thesis. College of Education, in collaboration with the Bangkok Institute for Child Study, 1964.

Buatong, Somporn. *A study of the primary school curriculum in Thailand* (Summary)·2nd Edition (Revised) Bangkok Institute for Child Study, March 1968.

Chandrapanya, Praopan. *Opinion of grade 4 teachers in the first educational region toward the Grade 4 mathematics curriculum.* Master's thesis, College of Education, in collaboration with the Bangkok Institute for Child Study, 1964.

Dhummasang, Paitoon. *Teacher opinions towards the grade 1 social studies curriculum as revised in 1960.* Master's thesis, College of Education, in collaboration with the Bangkok Institute for Child Study, 1964.

Dechpichai, Wan. *A study of geometry achievement of grade 4 children in some elementary schools of education region 1.* Master's thesis, College of Education, in collaboration with the Bangkok Institute for Child Study, 1964.

Furth, H.G., *Piaget for Teachers.* Englewood Cliffs, New Jersey: Prentice–Hall, Inc. 1970.

Furth, H.G., *Piaget and knowledge (Theoretical foundations).* Englewood Cliffs, New Jersey: Prentice–Hall Inc., 1969.

Harmon, H.H. *Modern factor analysis.* Chicago: University of Chicago Press, 1960.

Kirk, R. *Experimental Design: Procedures for Behavioral Sciences.* Belmont, California: Wadsworth Pub. Co. Inc., 1968.

Kongkitpisal, Piyaratana. *Applications of some principles in symbolic logic in the teaching of mathematics to Mathayom suksa 1 students.* Master's thesis. College of Education, 1968.

Kulpichitrā, Buree. *An evaluation of the arithmetic achievement of grade 4 children in the educational region 1 of Thailand.* Master's thesis College of Education, in collaboration with the Bangkok Institute for Child Study, 1964.

Kunawatanawuti, Tasanee. *The comparative study of the effects of inquiry and traditional methods of teaching on the student's inquiry, cognitive styles and curiosity.* Master's thesis. College of Education 1972.

Laovanich, Smai. *An experimental study on concept formation of topology and Euclidean geometry of children from three to ten.* Master's thesis. College of Education, 1972.

Latthi, Charlie. *A preliminary exploration of some values held by children who have completed grade 4.* Master's thesis. College of Education, in collaboration with the Bangkok Institute for Child Study, 1964.

Lindquist. E.F. *Design and analysis of experiment in psychology and education.* Boston: Houghton Mifflin Co., 1956.

Lovell, K. *The growth of basic mathematical and scientific concepts in children.* London: University of London Press Ltd., 1966.

Nikamanon, Patom. *The relationships among reading abilities, cognitive styles, concept formation, of fourth and seven graders.* Master's thesis. College of Education, in collaboration with the Bangkok Institute for Child Study, 1971.

Opper, P. Sylvia. *Intellectual development in Thai children* Ph.D.'s thesis. Cornell University, 1971.

Petchpud, Aree. *Construction of grade 1 arithmetic test and a study of arithmetic achievement of grade 1 children in eleven schools within education region 1 of Thailand.* College of Education, in collaboration with the Bangkok Institute for Child Study, 1964.

Ratanasuwan, Prakitcha. *Educational administrators' opinions toward the grade 4 curriculum in 1960.* Master's thesis. College of Education, in collaboration with the Bangkok Institute for Child Study, 1964.

Sangsa–ard, Chitra. *Opinions of grade 4 teachers in the first educational region toward the grade 4 basic science curriculum as revised in 1960.* Master's thesis. College of Education, in collaboration with the Bangkok Institute for Child Study, 1964.

Saitorn, Aree. *Teachers' opinions towards the entire curriculum of grade 1 as revised in 1960.* Master's thesis. College of Education, in collaboration with the Bangkok Institute for Child Study, 1964.

Satraphat, Duangduen. *A comparative study of the relationships between reading comprehension, visual perception and Piaget's logical thinking styles in ethnic Thai and Chinese first–fifth graders.* Master's thesis. College of Education, in collaboration with the Bangkok Institute for Child Study, 1972.

SEAMEO, *Science and mathematics concept learning of Southeast Asia Children.* Phase one report, No. 2. Glugor, Penang, Malaysia, 1974.

Siripanich, Ratana. *Listening comprehension in central Thai language and scholastic achievement of grade 2 central Thai–speaking children in Bangkok and of Malay–speaking children in Patanee.* Master's thesis. College of Education, in collaboration with the Bangkok Institute for Child Study, 1964.

Somnapan, R., *Isomorphic Structure of the Relation between Learning Environments and Cognitive Development of Thai Children.* New York: SEADAG Publication, 1973.

Sonthikhan, Sriprapa. *Report on the study of science and mathematics concepts of Thai Children.* A report submitted to the RECSAM International Committee for Research Coordination, Bangkok, 1975.

Spencer, T.D., and Kass, N. (editors). *Perspectives in Child Psychology (research and review).* New York: McGraw–Hill Book Comp., 1970.

Sricoon, Intra. *A study of listening comprehension, reading comprehension, spelling ability, and written expression of the Pratom 4 children in six elementary schools in Nakornrajsima.* Master's thesis. College of Education, in collaboration with the Bangkok Institute for Child Study, 1964.

Sritalanonta, Puangnoi. *The effect of visual differentiation training by using slides for reading readiness in kindergarten.* Master's thesis, College of Education, 1972,

Sthapitanonda, Somprasong. *The construction of a grade 1 spelling test and a study of the spelling achievement of children in eleven schools in educational region 1 of Thailand.* Master's thesis. College of Education, in collaboration with the the Bangkok Institute for Child Study, 1964.

Suvannathat, Chancha, et al., *Science achievement of Thai children in different grades.* Bangkok Institute for Child Study. Research Bulletin No. 16, 1974.

Suwannaratana, Chamlong. *Color–Form and Part–Whole discrimination development in Thai children.* Master's thesis. College of Education, in collaboration with the Bangkok Institute for Child Study, 1968.

Thyne, James M. *Patterns of Error in Addition Number Facts.* University of London, 1964.

Vichiarajote, Veerayudh. "*The Scientific Inquiry Development Project,*" Department of Educational Research, College of Education, 1970–1971.

UNESCO, UNICEF, CEDO, *Report of a regional seminar on the development of science and mathematics concepts in children,* Unesco regional office for education in Asia ; Bangkok, Thailand, 1972.

Watagawita, Khaisee. *Constructing a Reading Readiness Test and a study of reading readiness of grade 1 children in some schools in cducational region 1 in Thailand.* Master's thesis. College of Education, in collaboration with the Bangkok Institute for Child Study, 1964.

Whangkaw, Pensook, *Opinions of grade 4 teachers in the first educational region toward the grade 4 curriculum–as revised in 1960.* Master's thesis, College of Education, in collaboration with the Bangkok Institute for Child Study, 1964.

Wirasamrit, Samart. *A study of some mental abilities as related to pupils scholastic aptitude in learning science and mathematics.* Master's thesis. College of Education, 1969.

Wongswadiwat, Jirawat. *A study of science achievement of grade 4 children in some elementary schools in educational region 1.* Master's thesis, College of Education, in collaboration with the Bangkok Institute for Child Study, 1964.

Wutikhun, Montian, *A comparision of mathematics and science achievement of students in municipal, private, Elementary Education Department schools, and schools of the Administrative Committee of Metropolitan Bangkok.* Master's thesis. Sri—Nakharinwirote University, 1973.

Appendix I

Review of past and current researches in the area of concept development of Thai children

It is well accepted that a person will be able to derive some meaning from any concept when he consistently applies it to some objects or events. And to use a concept which embodies association as well as discrimination, one is required to recognize which objects possess the basic elements that define concept. With realization that concepts permit economy in communication and also enhance effective problem – solving, helping young children to learn concepts in various subjects is the key to facilitate the process of learning. Researches in educational – psychological fields reveal the close association between concept formation ability and scholastic achievement.

As far as researches in the learning process of science and mathematic concepts of young children (3 – 11/12 years) are concerned, it can be stated that in Thailand there are still quite a small number of researches done in this area, and even these few available seem to be scattered. However, there is an indication revealing that awareness of the significance of this type of research become larger.

Review of researches in the three areas more or less related to science and mathematic concepts will be given. The first group of researches were carried in the area of science and mathematic achievement as related to some factors; the second group of researches were in the area of cognitive development, and the last group were most related to the learning process in relation to science and mathematic concepts.

I. Researches in the area of science and mathematic achievement

With a great concern over the high incidence of grade repetition in the primary school, the Department of Elementary and Adult Education requested the Bangkok Institute for Child Study to collaborate in studying the effectiveness of primary school curriculum

in 1964 (Buatong, 1968). Due to the limitation of time and resources, the study was confined only to the curricula of grades 1 and 4. Sixteen graduate students (Chandrapanya, Dechpichai, Dhummasang, Kulpichitra, Latthi, Ratanasuwan, Petchpud, Saitorn, Sangsaard, Siripanich, Sricoon, Sthapitanonda, Watagawita, Whangkaw, Wongswadiwat, Buasraung, 1964) cooperated with this nationwide evaluative study. A probability sample of 144 schools containing some 25, 450 pupils were used. Also there were about 2260 teachers and 1060 educational administrators involved in the study. As for the research instruments used, twelve tests, eight questionnaires, and one scale were devised and constructed by the BICS staff and students. The construction of the achievement tests were based on an analysis of the prescribed curricula and the approved textbooks.

It was found that the absolute level of achievement of most children in all subjects and in all three grade levels (grade 1 new entrants, grade 2 and grade 5) was lower than the expectation of the educators who prescribed the course of study. The findings lead to the conclusion that either the curriculum or the instructional method in the elementary school or both must be improved. Analysis of the types of errors made by children on achievement tests revealed what aspects of subjects need different instr--uctional approaches or a change in emphasis. For example children in grade 5 achieved well on problems dealing with number facts (simple computation) in the arithmetic test but did poorly on problem solving with problems in story form. One may infer that teachers either have not spent sufficient time in instructing about how to solve story problems or the instruction given has been inadequate, focusing only on the fundamental operations. It is necessary to teach students to apply these operations as well.

The achievement tests on science and geography for children in grade 5 were designed to measure memory, understanding, reasoning and application. The children achieved highest on memory items and did poorly on the other aspects, which would seem to indicate that undue emphasis is being devoted to memorization of information and insufficient attention is given to other learning outcomes indicative of more substantial mastery of the subject areas.

Analysis of the achievement test performance of children in grade 2 in arithmetic reveals that they achieved poorly in counting by intervals, in problem on the use of Thai money, and on problem about time (hours and days), whereas they did rather well on simple counting operations.

Children in grade 1 most frequently errored on problems of simple additon by selecting one or both of the number given in the problem as the answer. This kind of error revealed that these children possesed no understanding of the addition operation Children's arithmetic errors also showed ignorance of the value of zero in the operation of addition, as well as confusion between Thai numeral ๑ (1) and Arabic number 9; a distinctive Thai or T-type error. Another distinctive error was called J–type (for juxtaposition) for it occurred when the answer to 6+4 (say) was given as 64 or 46. Otherwise, all the type of errors found in Thyne's study (Thyne, 1964) were revealed in these children's performance.

To conclude, most errors made by children on achievement tests involved application of information and understanding of concepts, which is to say that achievement was highest on memory task and simple routine operations and lowest where other more substantial kinds of learning results are required.

As for the opinions of teachers and administrators on the school curricula, it was found that the curriculum of grade 4 in general and the mathematic and natural science courses in particular were the focus of question put to teacher and school administrators. The grade 4 curriculum in general was considered to be inadequate as that of grade 1. Approximately 70% of the teachers from grade 4 indicated that they did not understand the content of the arithmetic and science course, which probably indicatse that the course material is unclear to the extent that students cannot reasonably be expected to understand well what is presented. In view of this, it is not surprising that about 40% of the teachers believed that the content of these courses was considered not suitable nor adapted to local needs and conditions. The teachers felt that the most useful part of the arithmetic instruction dealt with mental operations (problem–solving without the use of pencil and paper), but they considered relatively useless instruction about transactions with foreign currencies, the use of charts and figures, and standards

of measurements (metric and nonmetric). While it may be that the nonmetric standard of measurement and the use of charts and figures have limited applicability or usefulness for many children, at this grade level at least, the metric system is used throughout the country and should be a topic of interest and usefulness to most children of this age. The aspect of the science considered most useful concerned weather, while instruction about physical changes of substances was not considered useful. Teachers felt that the content of the syllabuses for the arithmetic and science courses are consonant with the prescribed curricular for these courses, and yet they indicated that both the content and the aims of three courses as presented in the syllabuses are unclear. It is not surprising that children achieve at a low level in these areas since teachers reported that they did not understand the content in the curricula or in the syllabuses.

Beside the above mentioned nationwide study on primary school curriculum, there is another research (Wirsamrit, 1969) attempting to investigate into some mental abilities related to pupils' scholastic aptitude in learning science and arithmetic. Samples were drawn from 7th grade pupils enrolled at five municipal schools. Ten types of tests namely arithmetic, Thai, memory, classification, analogy, spatial relations, three dimensions, visual perception, and science, mathematic scholastic aptitude tests were constructed and administered to 444 seventh grade pupils. One interesting finding was shown that there were some comon factors in both science test and mathematic test. These factors are language ability, computational accuracy and speed, spatial relations, and abstract reasoning. It was recommended that in teaching science and mathematic, teachers should be well aware of this fact and should provide children with activities and practical exercises related to these four factor areas.

Almost ten years after the nationwide study on the effectiveness of primary school curriculum was undertaken, the Bangkok Institute for Child Study joined in 1971 the International Association for the Evaluation of Educational Achievement in launching an international co-operative effort in studying science achievement in 19 countries. As a part of the international project, the Bangkok Institute served as a national centre in taking care of its part. The sample employed in the study of science achievement of Thai children (Suvannathat etal, 1974) was a probability sample using stratified cluster

sampling by areas and types of school. It involved approximately 7000 children who were in age 10–10.11, age 14–14.11, and grade 10 and grade 12. Again it was found that science achievement of Thai children seemed not to be satisfactory due to many factors deriving from both school variables and family background variables. On the whole, they did poorly on the area of comprehension and application, but well on factual information. Also on the attitude scales, their positive attitudes towards school seemed to be decreased as they approached higher grades. The science teachers of the children especially at the lower grades were not the ones who were specifically trained in science courses. Their attitudes toward science and science teaching were not quite positive. On the part of parents, unfortunately the parents of the children did not realize the significance of science and did not attempt or motivate the children to learn science better and more meaningfully. Eventhough there is no direct comparison between the science achievement of children in the developed countries and the developing ones, it could be stated here that the achievement scores of Thai children were below the international grand means in all areas of science.

At present, the Evaluation Unit under the Institute for the Promotion of Teaching Science and Technology, Ministry of Education, is beginning to launch another study to compare the science achievement of children who are under the old science curriculum and that of the ones who are under the experimental new science curriculum. In the study, the researchers will use the same set of science achievement tests and some attitude questionnaires which the Bangkok Institute used in the IEA international project. However, the results are still awaited to come.

The last of the first group of research concerning science and arithmetics achievement was the study of Wutikhun (Wutikhun, 1973) on a comparison of mathematics and science achievement of students in municipal, private, elementary education department school, and schools of the Administrative Committee of Metropolitan Bangkok. The purposes of the study were to compare mathematics and science achievement of students in four kinds of schools : municipal, private, Elementary Education Division schools (to be designated as EED schools), and school of the Administrative Committee of Metropolitan Bangkok (to be designated as ACMB schools). The Pratom 7 students, 1,734 in number, who were studying in the academic year of B.E. 2515 constituted the sample of the

study. The instruments employed in the study were a mathematics test battery and a science test. The mathematics battery comprised of three tests : problem, reasoning and skill.

The results of the study showed that for problem and reasoning tests, boys did better than girls but for skill test, girls did better. As for science tests, boys were superior to girls. When analyzed according to the kinds of schools and subject areas, the results can be summarized as follows. For problem and reasoning tests, students in EED schools and private schools achieved abont the same. EED schools children did better than the municipal's and the ACMB's and the municipal school children were superior to the ACMB's. With regard to the skill test, the achievement of students can be arranged from high to low as follows : private, EED. municipal, and ACMB schools. For the science test, students in EED schools did better than those in the other three schools. Private school students were better than those in the municipal and ACMB school. Students in the latter two schools did about the same in science test.

When compared the mathematics and science achievement of both boys and girls with the national norms, students of both sexes did better than the corresponding group of the norms. Also, students in each kind of the four schools did better than or at par to those of the national norms.

II. Researches in the area of cognitive development

Supon Boonsong's study (Boonsong, 1968) is worthy to be firstly mentioned, because it was the first investigation of this kind ever undertaken in Thailand. The results may not be generalized extensively due to the limitation of sample used. However, major findings showed a very interesting pattern of Thai children development concerning conservation of mass, weight and volume. Boonsong drew his sample from six primary schools in Bangkok area. From each of these schools, 3 boys and 3 girls in each age level, from 6 to 13 years old, were randomly selected. Total sample consisted of 288 students of which number of boys and girls were equally divided. All subjects were tested individually. Each subject was asked to respond to 3 questions on each type of conservation (mass, weight, and volume). The subject was asked first to predict, next to judge and then to explain his conservation or nonconservational responses. While the order of the questions were the same for all subjects, the presentation of the types of conservation was counterbalanced.

The development of Thai children concerning mass, weight and volume as found in this study followed Piaget's theory. The findings were also in harmony with those found by Lovell and Ogilvie and Lemos. The development of most children in lower age groups seemed to be in the first and second stage. There were very few whose scores fell into the third stage of development. Conversely, most children in higher age groups obtained scores which indicated that their concepts had reached the third stage. The Thai children in the sample had the concept of conservation concerning mass and weight at the age of 12. This was comparatively slower than Western children whose conservation concerning mass and weight, seemed to appear at 7 – 8 and 9 – 10 years old respectively. As for the conservation of volume, it could not be concluded from this study as to the age level at which children possessed. There was one more finding showing that the conservation of mass and weight seemed to develop simultaneously. This was different from the findings presented by Piaget, Lovell and Ogilvie and Elkind which were in agreement that children formed concept of mass before that of weight. Also the results of the study revealed no sex difference in conservation of mass, weight and volume in all age groups. The finding supported what Swat Pratoomraj and Johnson and Kovistra have found in Western children.

Along this area of research, Opper's study (Opper, 1971) was next to be presented. The investigator was interested to test in Thailand, a non Western culture with a non – Indo – European language, the claims of universality made by Piaget regarding certain aspects of intellectual development. These refer in particular to the developmental sequence and to the mental processes subsuming this development sequence for variety of concepts. Additional objectives were to see if the pace of intellectual development, as represented by the ages of acquisition of various concepts, was the same both within the culture and compared with other cultures. Finally, the present research sought to investigate if the stage of formal operations was also found in other cultures, or if it was specific to Western society.

To this end an urban and a rural sample were selected, the former from Bangkok, and the latter from a rural locality some 65 miles away from the capital.

Two series of tests were given to the samples. In the first place a battery of Piagetian tasks, seven operative and three figurative, covering the operations acquired by Swiss children during the period of concrete operations, was given to 50 urban and 54 rural children from 6 to 11 years. These tests were : class inclusion (flowers and animals); conservation of liquid; one to one correspondence; seriation; mental imagery (array of blocks; movement of squares; rotation of block in air). In addition, two tests covering the operations acquired by Swiss children during the period of formal operations were given to a second group of children from the two localities. The total number of children for these tests was 92 for the urban sample and 86 for the rural one, with the ages ranging from 6 to 16 years. The two formal operational tests were the conservation of volume and permutation.

Quantitative and qualitative analysis revealed that for the seven operative tasks the developmental sequence of stages was found to occur in both the urban and rural samples. Moreover, the same types of reasoning used by Swiss children were found in both Thai urban and rural children, often with identical wording. The above findings suggest the existence of cognitive "universals" in development, that is the presence of similar intellectual mechanisms at work in children in a variety of cultures.

The major difference between the samples was found to be the rate of development. The Thai urban children acquired the majority of the concepts at more or less the same speed as the Swiss children, with a slight lag in some cases. The Thai rural children, on the other hand, presented lag from two to three years in all instances. One finding was that the older the child the less the lag.

It was also found that the tasks presented a scaled order of difficulty in the following order with one – to – one correspondence being the first notion to be acquired by both samples : one – to one correspondance, seriation, conservation of liquid, conservation of length – two sticks, class inclusion – flowers, class inclusion – animals, conservation of length – several sticks. This order seems in general to be the same as that for Swiss children.

As far as the mental imgery tasks were concerned, it was found that, contrary to expectations, the static imagery task of the array of blocks proved to be no simpler than those of dynamic imagery, judging from the percentage of success and the ages of successful performance at the three tasks. The urban and rural samples did not differ in their patterns of development, and the rural lag in ages of successful performance was approximatly one year. Furthermore, the one task where Swiss norms were available, that is the movement of squares task, indicates a lag of approximatley three years for the Thai urban children and four years for the rural ones. This suggests that the performance at the figurative tasks does not replicate the Swiss performance, to the same extent as for the operative tasks, althouth the same type of errors were found in general as the Swiss group. More comparative information would be needed before this could be affirmed with certainty.

Finally, the present findings suggest that Thai children do reach the period of formal operations at approximately the same ages for the two groups. The same types of responses as the Swiss children are noted but there appears to be a lag of several years on the part of the Thai children for this period. Additional information would be necessary to state this with certainty.

Another interesting study was done by Chamlong Suwanaratana (Suwannaratana, 1968). His main objective was to study the development of Thai children in using color

form and part – whole as the criteria for object discrimination. The study comprised 300 children whose ages ranged from 4 to 9 years. These subjects were selected from 2 kindergarten schools and 3 primary schools in the province of Supanburi. There were 25 boys and 25 girls in each age level (4,5,6,7, and 8,9 age levels). The investigator constructed two sets of instruments. The first instrument was composed of eighteen 8.5" × 11" white paper cards. In each card. there were three geometrical figures : one on the central top part used as the standard figure, one on the left side of the standard, and the other on the right side of the standard. One of these two figures had the same form as the standard' s but different color, the other one had the same color as the standard' s but different form. The geometrical figures were arranged into three forms: pentagon, hexagon and heptagon. Three colors used were red, green and blue. As for the second set intrument, it consisted of 10 white paper cards having the same size as the first set cards' s. In each card there were small pictures which could be seen as a single new picture when they were grouped together. Each child was tested individually. Their responses when given two sets of instruments were collected, classified and analyzed.

It was found that Thai children in this limited sample followed the same pattern of the Western children in color – form discrimination. That was children in the very young age (1 – 3) discriminated things by form rather than by color, and as they moved to the young age (3 – 6) they tended ot discriminate things by color, and when they were above 6 years old up to the maturity, they again shifted back to discriminate things by form. The investigator found that Thai children 4 – 6 age levels discriminated things by color rather than by form, but children in 7 – 9 age levels tended to use form in discriminating objects. As regards to part–whole discrimination, children of all age levels used part criterion for discriminating objects. This finding was not in accordance with the one obtained elsewhere which pointed out children's ability to discriminate things by part and whole should increase with age.

The next investigation to be presented is a comparative study carried by Duangduen Satraphat (Satraphat, 1972). The researcher set her main objective in investigating the relationships among reading comprehension, visual perception and logical styles of thinking found in Piaget's conservation principal, and also studying these three kinds of abilities in terms of grade, sex and ethnic groups (Thai and Chinese). The total number of children was 300 from one Thai schhool and one Chinese school. Reading comprehension was measured by a cloze – procedure test. Visual perceptions were measured by five sub – tests (similarity, differentiation, incompleted picture, superimposed figure, and spatial relationship). Piaget's logical styles of thinking was measured by five experimentations (conservation of length, number, substance, liquid and volume). It was found that reading comprehension, visual perception and Piaget's logical thinking styles were interrelated with very high significance. Moreover, reading comprehension, visual perce-

ptions and logical thinking styles tended to increase with ages and grades with some exception. It also revealed that one thinking style, reversibility, was the highest among the other two (compensation and identity) to be associated with reading comprehension.

Patom Nikamanon's study (Nikamanon, 1971) was also worthy to be reviewed. He attempted to investigate the relationships between reading abilities and two cognitive variables namely concept formation and cognitive styles. A sample of 550 fourth and seven graders in Bangkok and Surin were given 5 tests: Reading Comprehension, and Reading Speed, "Picture" Cognitive Styles Test, "Verbal" Cognitive Styles Test, and Concept Formation Abilities Test. It was found that abilities in concept formation was highly related to reading abilities (comprehension and speed). Children of Bangkok were better in concept formation abilities than children of Surin province. Fourth graders who used "Categorical Style" were found to have higher reading abilities and concept formation abilities than the fourth graders who employed other cogintive styles (analytical and relational). The same was found with seventh graders. Childern in both grades used more categorial style and relational style than analytical style. Positive relatsonships between "Picture" and "Verbal" cognitive styles tests were found only in seventh graders.

Another interesting research was Smai Laovanich's study (Laovanich, 1972) on concept formation of topology and Euclidean geometry of children from 3 to 10 years of age, Children from 3 to 10 were chosen as a sample for individual experimention. The total number of children was 140, being divided into two equal groups of boy and girls. Some of its major findings were (1) the sample children could start distinguishing one of the topological forms from the others at the age of four, and Euclidian geometrical forms at the age of five; (2) the children could draw different types of topological forms at four, and Euclidean geometrical forms at nine; (3) the children could string the beads according to the given pattern when they were 6 years old, and they could do it in the reverse order when they were 7; (4) the children could tie a knot similar to the given pattern when they were 4 years old, and they could tie two knots at 6; (5) the children could arrange sticks in line with slight irregularities when they were 7.

The last research in this group was Sriprapa Sonthikhan's study on science and mathematics concepts of Thai children in a central province (Sonthikhan, 1975). The objective of the research was to test the applicability of Piagatian theory on intellctual development at the concrete operational stage when used with Thai children ranging in age from 7–12. Besides, it attempted to find the ages at which Thai children form the concept of the conservation of liquid, the conservation of solids, the conservation of length (two sticks, and several sticks), the conservation of weight, the conservation of volume, the coordination of perspectives, classification, and perception of embedded figures. Sessions of experiments were set after the well planned trial of the research instruments. Different experimental sessions were set for children of three different age groups (age 7–9, 10, and 11–12).

The study yielded some interesting results despite the fact that there were some limitations. Sonthikhan also found that Thai children in that central province were able to form the concepts of volume, solids, weight, and length at the later ages than European children as found by Piaget. However, the researcher said that most of the Thai children in the sample were found in the transitional stage of developing such concepts. She concluded that her research findings tended to agree with Piaget's statement that children form concepts in the cognitive area when they are between 7 to 12 years of age.

III. Researches in the area of the learning process in science and mathematic concepts

First among this area of researches to be presented is Puangnoi Sritalanonta's study (Sritalanonta, 1972). She set two main objectives for the investigation: (1) to study the effect of visual differentiation training by using slides on developing perceptual readiness for reading, and (2) to examine the relationships between visual differentiation ability and reading achievement. The subjects used in this experimental reserch were 120 second year kindergarteners whose age ranges between 5 to 6 years old. Visual differentiation test was used both as pre-test. and post-test. Two tests on word recall (the word analysis test and the word completion test) were also used as post tests. Two by two sixty color slides were used for the actual training for 8 weeks. These slides were divided into three sets ranging form simple to complex picture arrangements. The subjects were equally divided into an experiment group and a control group, and in each of the two groups the subjects were chosen on the basis of equating method. Each of the experimental group and control group was divided again into two groups: high ability experimental group, low ability exqerimental group, high ability control group and low ability control group. Each group consisted of 30 children. The pre-test scores of visual differentiation test were used as the criteria for equating the four groups. The two experimental groups were trained on visual differentiation by using slides. The training was given 16 times in 8 weeks. Each period was 20 minutes long. The other two control groups were left with some usual visual training by their teachers.

It was found that the experimental groups' ability in visual differentiation was higher than the control groups'. However, the control groups' visual differentiation ability was also increased. The relationships between visual differentiation and reading achievement for two word recall tests were found in the control group. But in the experimental group, visual differentiation ability was related only with word completion ability,

The second study along this line of research was done by Piyaratna Kongkitpisal (Kongkitpisal, 1968). Eventhough her study involved the subjects who were a little older than 12 years, interesting results ought to be introduced. Her two main objectives for

the study were: (1) to study if the students in Mathayom Suksa I (eight grade) can learn some concepts in symbolic logic, and (2) to study if the teaching of some selected concepts in symbolic logic will be effective as to improve the mathematic achievement of these students.

The subjects used in this study were 80 MS 1 students of one school in Bangkok. They were divided into the experimental group and the control group. Each group was taught five hours a week during the third term of the academic year B.E. 2512 by the same teachers (who were here the researchers). Both groups were taught the same mathematic contents. For the experimental group, some selected topics in symbolic logic were additionally taught.

One achievement test on logic and five achievement tests on mathematics were constructed and used as evaluative measures for both groups in the midterm and the final term examinations. A two–way analysis of variance was employed in analyzing the data.

Major findings were: (1) the experimental group performed well on logic achievement test, with the average score higher than 50 %; (2) the rate of improvement of the experimental groups was singnificantly greater than that of the control group in geometry, but not significantly in the mathematics problem–solving, and understanding of arithematic and algebra concepts; (3) the rate of improvement of the experimental group is significantly greater than that of the control group in all tests of mathematics.

It was then concluded that the MS 1 students could learn some topics in symbolic logic as early as at MS 1 level and that the teaching of such selected topics was effective as to improve the mathematic achievement of the students.

The last three research studies were parts of the Scientific Inquiry Development Project which was funded by the Asia Foundation during 1970–1971 (Vichiarajote, 1970–1971) First among these three was the study of Tasanee Kunawatanawuti (Kunawatanawuti, 1972). Her main purpose of the study was to compare the effects of two kinds of method in teaching science on cognitive styles and curiosity. It was found that the pupils who were taught by active inquiry method and the pupils who were taught by combined inquiry method performed in inquiry test and analytical cognitive test significantly higher than the traditionally taught students. No significant differences in curiosity scores and relational cognitive scores were found in every group of students. Analytical cognitive scores were found to be positively correlated with curiosity scores, but negatively correlated with relational cognitive scores. The inquiry scores tended to curvilinearly correlate with analytical cognitive scores and curiosity scores.

Second on the group was the study done by Yupha Anandhasit (Anandhasit. 1972). The main objective of her research was to study the effect of active inquiry instruction in the subject of general science on inquiry, scholastic aptitude and sense of responsibility, and also to ascertain any relationship among these variables. The experimental subjects consisted of 68 seventh graders in the academic year 1971 at one Primary Demonstration school, and also of 136 seventh graders in the same academic year at another governmental elementary school.

Interesting results indicated that after receiving active inquiry type of instruction, pupils' inquiry was found to be improved significantly. However, pupils' scholastic aptitude and their sense of responsiblity were found not to be significantly improved. It was also found that there were no significant relationships among inquiry, scholastic aptitude, and sense of responsibility in both linear and curvilinear forms.

Last was the study of the effects of the combined inquiry instruction on inquiry, creativity, and external–internal control, carried by Bumroong Boonyonk (Boonyonk, 1971). The purposes of the investigation were threefold: (1) to study the relationships between inquiry, creativity and internal–external control (2) to ascertain the construct validity of the inquiry test, and (3) to compare the seventh graders' inquiry gained scores, creativity gained scores, and internal–control gained scores in the experimental group and the control group. The subjects consisted of 32 girls and 46 boys. They were divided into the experimental group and the control group which were taught science by the combined inquiry instruction and traditional instruction respectively.

The creativity test composed of two sub–tests, similarities and line meaning tests. The inquiry test composed of two sub–tests, picture inquiry test and verbal inquiry test. The other test is internal–external control test.

The results were: (1) the relationships of internal control to inquiry and creativity were found to be positive but not significantly, (2) the construct validity of the inquiry test was significant at .001 level, and (3) inquiry responses, and internal control responses were obtained significantly higher from the experimental group than those from the control group. However there was no difference in creativity on originality responses in both groups.

Appendix II

Conservation of length – Two Sticks

Protocol of children having and not having the concept

Material and Procedure	Response of subject having concept (Male : 7,9 years)	Response of subject not having concept (Male : 8 years)
Material 2. Identical sticks 6 inches long: 2. Small dolls (1 boy, 1 girl) Procedure 1. E. places the sticks horizontally parallel on the table in front of the child, with the ends coinciding and separated by about one inch (.....A) (.....B). E. has the C. admit the equality of the length of the two sticks and asks him to show, by pointing, from when he can see that the sticks are equal. 2. a) E. makes sure that the C. is watching and then moves the upper stick about 2 inches to the right (.....A) (.....B). E : How are the sticks now? C : ..... If C. is not able to respond to the general question above, E. asks more specifically : "Are the two sticks still the same length, or is one longer, one shorter?"	2. a) E : ..... C : They are equal E : ..... C : They were moved at an equal distance.	2. a) E : ..... C : They are not equal

Material and Procedure	Response of subject having concept (Male : 7, 9 year)	Response of subject not having concept (Male : 8 year)
C : .....)		
E : Why ?		E : .....
C :		C : You make them unequal This (B) is shorter.
b). E. places the dolls at one end of each of the sticks and has them "walk" along the sticks.	b) E :	b) E : .....
E : How did the dolls walk ?		
If the C. cannot respond to the general question 2 b) above, E. asks more specifically : "Did they walk as much, or one more and one less ?"		
C :	C : They walked as much.	C : Not as much.
E : Why ? (In the case of nonequality, C. finds out which doll walked more)	E :	E : .....
	C : They both walked and walked, then stopped at the same time.	C : This doll (B) walked more than that doll (A)
C :		
3. E. returns the sticks to the original position of item 1 above.		
E : Are the two sticks of equal lenght, or one longer, one shorter ?	3. E :	3. E : .....

Material and Procedure	Response of subject having concept (Male : 7, 9 year)	Response of subject not having concept (Male : 8 year)
C : ..... E : Why ? C :	C : They are equal E : ..... C : At first it was one piece of wood, and you broke it into two equal sticks.	C : They are equal. E : ..... C : You make them equel.
4. a). E. makes sure that C. is watching and then moves the lower stick 2 inches to the right (.....A) (.....B) and asks the same questions as 2 a) above. C : ..... E : Why ? C :	4. a) E : ..... C : They are equal E : ..... C : You made them equal.	4. a) E : ..... C : They are not equal E : Why ? C : This (B) is longer
b). Item as for 2 b) above E : ..... C : ..... E : ..... C :	b) E : ..... C : They walked as much. E : ..... C : They walked together, and stopped at the same time.	b) E : ..... C : Not as much E : Why ? C : The boy (A) started to walk before the girl did.
5. Item as for 3 above E : ..... C : ..... E : ..... C :	5. E : ..... C : That are equal E : ..... C : You shaped them and cut them to make them equal.	5. E : ..... C : They are equal E : Why ? C : You make them equal.

Material and Procedure	Response of subject having concept (Male : 7, 9 year)	Response of subject not having concept (Male : 8 year)
6. a). E. maked sure that C. is watching and then moves the upper and lower sticks simultaneously 2 inches the right and left respectively (.....A) (.....B) and asks the same questions as 2 a) above. E : ..... C : ..... E : ..... C :	6. a) E : ..... C : They are equal. E : ..... C : They are equal at the first sight.	6. a) E : ..... C : They are not equal E : Why ? C : This (a) is longer.
b). Item as for 2 b) above E : ..... C : ..... E : ..... C :	b) E : ..... C : They walked as much. E : ..... C : They ran together and arrived at the stop at the same time.	b) E : ..... C : Not as much. E : Why ? C : The girl (B) walked a longer distance.

Appendix III

Conservation of Substance
Protocol of children having and not having the concept

Material and Procedure	Response of subject having concept. (Female : 7, 7 years)	Response of subject not having concept (Male : 7, 9 year)
Material 2 Identical cubes of clay approximately 1 $\frac{1}{2}$ Inches in dimensions (1 red, 1 green)		
Procedure E. gets C. to admit the identity of amount of clay in the two cubes A and B (C. adjust if he does not initially agree to the identity).		
1. E. rolls one of the clay cubes, (B), into a sausage-shaped form (C.) and asks: E: Is this one (A) equal to that one (C), or more somewhere or less somewhere? C: ..... E: Why? C:	1. E : ..... C : Yes they are equal E : ..... C : Because they were made equal	1. E : ..... C : There is more clay in the sausage. E : ..... C : Because it is long.
2. E: If I make the sausage (C) back into a cube (B), will the two cubes (A and B) be identical? C: ..... E: Why? C: ..... E: makes the sausage back into a cube (B)	2. E : ..... C : Yes. E : ..... C : I don't know why.	2. E : .... C : Yes, they will be E : ..... C : Because you made them.

Material and Procedure	Response of subject having concept (Female : 7, 7 years)	Response of subject not having concept (Male 7, 9 years)
3. E. makes the cube B into flat–pancake–shaped form (D)	3. E :	3. E : .....
E asks the same question as for 1 above E : ..... C : ..... E : Why ? C :	C : They are equal. E : ..... C : Because they were made equal	C : There are more clay in the pancake. E : ..... C : Because it is flat.
4. E: asks the same question and follows the same procedure as for 2) above.	4. E :	4. E : .....
E : ..... C : ..... E : ..... C : ..... E :	C : No, they are not. E : ..... C : I don't know why. E :	C : Yes, they are E : ..... C : After we shape them, they are. E : .....
5. E. divides cube B. into a series of smaller pieces (E) (about 8 or 9), then asks the same questions as for 1) above.	5. E :	5. E : .....
E : ..... C : ..... E : ..... C :	C : They are equal E : ..... C : I don't know why ?	C : There are more clay in the heap of small pieces. E : ..... C : Because they are small pieces.

Appendix IV

Conservation of Weight

Protocol of children having and not having the concept

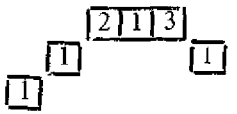
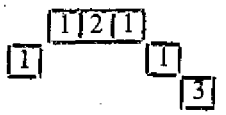
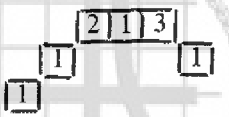
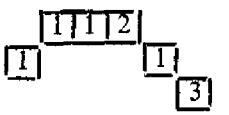
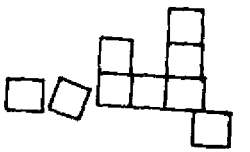
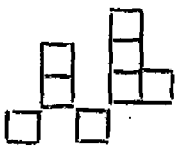
Material and Procedure	Response of subject having concept (Female : 7, 8 years)	Response of subject not having concept (Male 7, 9 years)
Material 2 Identical cubes of clay approximately 1 ½ inches in dimensions (1 red, 1 green) 1 balance		
Procedure E. gets C. to admit the identity of weight of clay in the two cubes (A, B) with the use of the balance. (C. adjust if he does not initially agree to the identity).		
1. E. rolls one of the clay cubes (B), into a sausage-shaped form (C), and asks : E : Is this one (cube A) equal to that one (sausage, C.) by weight, or more somewhere or less somewhere ? C : ..... E : Why ? C :	1. E : ..... C : They are. E : ..... C : They were already identical at the time we weighed them.	1. E : ..... C : They are not equal. The sausage weighs more. E : ..... C : Because this (sausage) is longer.
2. E : If I make the sausage (C) tack into a cube (B), will the two cubes (A + B) be identical in weight ? C : ..... E : Why ?	2. E : ..... C : Of course, they are. E :	2. E : ..... C : Yes, they are. E : .....

Material and Procedure	Response of subject having concept (Female : 7, 8 years)	Response of subject not having concept (Male 7, 9 years)
C : ..... E : makes the sausage (C) back into a cube (B).	C : They were already identical.	C : Because they are both in the ball–shaped form.
3. E. makes the cube B into a flat pancake–shaped from (D). E. asks the same question as for 1 above.	3. E :	3. E : .....
E : ..... C : ..... E : Why ? C :	C : They are. E : ..... C : They were already identical	C : No, they are not. The pancake weighs more.
4. E. asks the same question and follows the same procedures as for 2 above.	4. E :	4. E : .....
E : ..... C : ..... E : Why ? C : ..... E :	C : Yes, they are. E : ..... C : They were already identical	C : Yes, they are. E : ..... C : Because they are both in the ball–shaped form.
5. E. divides cube B. into a series of smaller pieces (E) (about 8 or 9), then asks the same questions as for 1 above.	5. E :	5. E : .....
E : ..... C : ..... E : ..... C :	C : They are. E : ..... C : They were identical from the beginning.	C : No, they are not, the heap of small pieces weighs more. E : ..... C : Because there are more pieces.

Appendix V

Mental Imagery—Static : Blocks

Protocol of children having and not having the concept

Material and Procedure	Response of Subject having concept (Male : 7, 9 year)	Response of Subject not having concept (Female : 7, 2 years)
Material Set of about 24 blocks (1 inch × 1 inch) Procedure 1. Copy Model  E. builds model 1. himself and then presents it to the C. asking him to copy it. When C. has copied successfully, E. remove both copy and model gives C. the pile of blocks and asks him to reconstruct the model. 2. Perception Model 	1.  2. 	1.  2. 

Material and Procedure	Response of Subject having concept (Male: 7,9 year)	Response of Subject not having concept (Female: 7,2 years)
E. Builds model 2 himself and then present it to the C. asking him to look at it carefully since he will be required to build one himself later on. E. leaves the model for approximately 20 minutes, then removes it and asks C. to reconstruct it. One group of children were given the copy technique first; the other group were given the perception technique first.		

Appendix VI

Class Inclusion—Flowers

Protocol of children having and not having the concept

Material and Procedure	Response of subject having concept (Female : 7, 9 years)	Response of subject not having concept (Male 7, 7 years)
Material 1 bunch of artifificial flowers consisting of 10 red roses and 2 white lotuses. Procedure The child is asked to name the flowers. (If he does not know the name of them, he can call them by their colour, i. e., "red flowers" in the case of rose and "white flowers" in the case of lotus. It is rare for a child not to recognize these two kinds of flowers nor be able to name them). The child is then asked : "What are all these called?" Are roses flowers? Are lotuses flowers? All these in this bunch are ....? After making sure that the subject knows the name of the flowers, and that all the objects in the bunch are flowers, the experimenter proceeds with the questions :	E : ..... C : Lotuses and Roses E : ..... C : Yes. E : ..... C : Yes. E : ..... C : Flowers.	

Material and Procedure	Response of subject having concept (Female : 7, 9 years)	Response of subject not having concept (Male 7, 7 years)
1. E : "In this bunch, are there more roses or more flowers ?"	1. E :	1. E : .....
C :	C : There are more flowers.	C : Roses.
a) If the child answers, "Flowers", the experimenter probes as to what exactly the child has in mind when giving this response.		
E : "Does 'flowers' mean all the flowers, or all the flowers that are not rose ?"	a) E : ..... C : Because roses are flowers, and so are lotuses.	
b) If C. answers, "Rose", E. probes as to why the roses are more than the flowers. What does "flowers" in this situation mean for the child ?		b) E : ..... C : Few lotuses, but many roses.
c) If C. answers somethingelse irrelevant to the question, indicating an incomhension of the question, E. repeats it and follows the same procedure as for a) and b)		
2. E : "Two children (boys if child is a boy, girls if child is a girl) want to make a bunch of flower. So I give the first child all the roses . He (she) makes his (her) bunch and then gives the roses back to me. I then give the second child all the flowers. He (she) makes his (her) bunch and then hands them back to me. Who has the biggest bunch, the first or the second child ?"	2. E : ..... C : The second child.	2. E : ..... C : The first child

Material and Procedure	Response of subject having concept (Female: 7, 9 years)	Response of subject not having concept (Male 7, 7 years)
C:		
E: "Why"	E :	E : .....
E. probes to find out exactly what flowers each child had. If the child has not understood the question, E. repeats it in two steps, i. e., stopping after the indications for the first child and asking "What did the first child get?" and then proceeding to the second child. Afterward, E. asks "What did the second child get?". E. then asks "Who got the bigger bunch?"	C : Because the second child has all the flowers. The first child has only roses.	C : He is a good boy, so he is given so many.
C:		
3. E: "If I give you all the roses, what will be left in the bunch?"	3. E :	3. E : .....
C:	C : Lotuses are left.	C : Nothing left.
E: "Why?"	E :	E : .....
C:	C : Because you do not give me the lotuses	C : You give him all of them.
E. "If I give you all the flowers, what will be left in the bunch?"	E ;	E : .....
C:	C : Nothing left	C : Nothing
E: "Why?"	E :	E : .....
C:	C : Because you give me all of them.	C : you give me all of them

Material and Procedure	Response of subject having concept (Female : 7, 9 yeara)	Response of subject not having concept (Male : 7, 7 years)
4. E. : "In the whole world, what do you think are there more roses or more flowers ?" C : ..... E : "Why ?" C : ..... At the end of the session, the E. may return to any of the previous questions that she feels were not initially understood by the child.	4. E : ..... C : More flowers. E : ..... C : Because "flower" includes every kind of flowers.	4. E : ..... C : More roses. E : ..... C : The rose–plants are beautiful.

APPENDIX VII

Class Inclusion — Animal

Protocol of children having and not having the concept

Material and Procedure	Response of subject having concept (Female : 7, 9 years)	Response of subject not having concept (Male : 7, 6 years)
Material 1 set of cards with pictures of the following : 5 parrots 5 brown ordinary looking birds 5 buffaloes 1 shell 1 rice plant Another set of 8 cards, 4 showing different four legged animals, 4 showing different birds including a chicken. 3 cards with the names of the classes : parrots, birds, animals. Procedure E. gets the C. to name the animals to make sure he knows the different names. E : Put together all those that should go together. Then C. must sort the pictures into correct piles. When the C. has sorted, E. removes the 2 extra irrelevant cards. Then E. gives the name cards to the C. and asks him to place them on their correct piles. E. reads the names if C. cannot yet do so.		

Material and Procedure	Response of subject having concept (Female : 7, 9 years)	Response of subject not having concept (Male : 7, 6 years)
1. E : Can we take these pictures (parrots) and put them in this pile (birds) and still keep the same label ? C : ,,,,,,,,,, E : Why ? C :	1. E : ..... C : Yes. E : ..... C : All are birds.	1. E : ..... C : No, we can't. E : ..... C : Because they are parrots.
2. Item for a picture of birds into animals E : ..... C : ..... E : ..... C :	2. E : ..... C : Yes. E : ..... C : All are animals.	2. E : ..... C : No, we can't. E : ..... C : Because they are birds.
3. Item for a picture of birds into parrots. E : ..... C : ..... E : ..... C :	3. E : ..... C : Yes. E : ..... C : They are all birds.	3. E : ..... C : No. E : ..... C : They are parrots. They cannot be together with birds.
4. Item for a picture of animals into birds. E : ..... C : ..... E : ..... C :	4. E : ..... C : No. E : ..... C : Because buffaloes are not birds.	4. E : ..... C : No. E : ..... C : Because they are animals.
5. E : If the hunters were to say they would kill all the parrots in the world, would there still be any birds left ?.	5. E :	5. E : .....

Material and Procedure	Response of subject having concept (Female : 7, 9 years)	Response of subject not having concept (Male : 7, 6 years)
C : ..... E : Why ? C :	C : Yes. E : ..... C : Ordinary birds would be left.	C : None left. E : ..... C : All are shot.
6. E : If the hunters were to say they would kill all the birds in the world, would there still be any parrots left ? C : ..... E : Why ? C :	6. E : ..... C : None. E : ..... C : Because parrots are also birds.	6. E : ..... C : None left. E : ..... C : Because all are killed.
7. E : If the hunters were to say they would kill all the animals in the world, would there still be any birds left ? C : ..... E : Why ? C :	7. E : ..... C : None left. E : ..... C : Because birds would be also killed. Not a bird would be left.	7. E : ..... C : None left. E : ..... C : All animals were shot.
8. E : In the world, are there more parrots or more birds ? C : ..... E : ..... Why ? C :	8. E : ..... C : More birds. E : ..... C : Because parrots are also birds.	8. E : ..... C : More parrots. E : ..... C : They are set free to fly for a pleasure.

Material and Procedure	Response of subject having concept (Female : 7, 9 years)	Response of subject not having concept (Male : 7, 6 years)
*9. E. Takes the 8 additional pictures and sets them randomly on the table. E : Are there more birds or more animals on the table ?. C : ..... E : Why ? (E. ascertains which pictures the child takes to be animals.) C : .... At the end of the session, the E. may return to any of the previous questions which she feels were not initially understood.	9. E : ..... C : More birds. E : ..... C : Because there are various kinds of birds.	9. E : ..... C : More birds. E : ..... C : Because there are few animals but a number of birds.

APPENDIX VIII

Conservation of Liquid

Protocol of children having and not having the concept

Material and Procedure	Response of subject having concept (Female : 8 years)	Response of subject not having concept (Female : 7, 9 years)
Material 2 identical tumblers (A and B) 1 taller and thinner glass (C) 1 shorter and fatter blass (D) 4 small glasses of identical size and shape (E,F, G, H) 2 bottles of different colored liquid		
Procedure		
1. E. presents one tumbler (A) three quarters full of liquid of one color and ask C. to pour the same amount of liquid of the other color into the other tumbler (B). When this is done:	1. E:	1. E: .....
E: Is there just as much water here (A) as here (B), or is there more somewhere, or less somewhere?		
C: ..... (If C. states that there is unequal quantity, he must adjust the quantities himself until they are equal,)		C: They are equal (C. points at the top level of the water)
2 E. asks the C. to anticipate the level of the water when poured from B into C.		

Material and Procedure	Response of subject having concept (Female : 8 years)	Response of subject not having concept (Female: 7, 9 years)
3. E. then pours the contents of B into the higher, thinner glass C. E: Is there just as much water here (A) as here (C), or is there more somewhere, or less somewhere?	3. E:	3. E: .....
C:	C: More water in C than in A.	C: There is more water in C. than in A.
E: Why? (E. probes into the C.'s reasons for both answers of equality and of inequality.).	E:	E: .....
C:	C: Because the glass C. is taller, so the water becomes more.	C: The level of water in C. higher than that in A.
E: If you were very thirsty and wanted to drink a lot of water, which glass would you choose?		
C: ..... E: Why? C:		
4. E: And if I pour the contents of glass (C) back into glass (B), will there be just as much water in both glasses (A and B), or more somewhere, or less somewhere?	4. E:	4. E: .....
C:	C: There will be the same amount of water.	C: There will be the same amount of water.
E: Why? C:	E: ..... C: Because the glasses A. + B. are of the same size.	E: ..... C: Because there was as much water in glass A as in B from the beginning.

Material and Procedure	Response of subject having concept (Female : 8 years)	Response of subject not having concept (Female : 7, 9 years)
5. E: asks the C. to anticipate the level of the water when poured from B. into D.		
6. E. then pours the contents of B. into the shorter, wider glass (D.) and ask the same questions as for 3 above. E: ..... C: ..... E: ..... C:	6. E: ..... C: It is of the same amount. E: ..... C: The glass D. is shorter.	6. E: ..... C: The water in glass A is more than in glass D. E: ..... C: When it is poured into D., it becomes less.
7. E. asks the same questions as for 4 above. E: then pours the contents of D. back into B. E: ..... C: ..... E: ..... C:	7. E: ..... C: It is of the same amount. E: ..... C: Because the glasses A and B are of the same size.	7. E: ..... C: It is of the same amount. E: ..... C: Because it was so before.
8. E. pours the contents of A. into 4 smaller glasses (E, F, G, H.) and asks the same questions as for 3 above. E: ..... C: ..... E: ..... C:	8. E: ..... C: The water is of the same amount. E: ..... C: Because when the water in those small glasses are all poured into one big glass, it will be as much as that in glass A.	8. E: ..... C: The water in glass A is more. E: ..... C: Because being in E, F, G, the water become less.

Material and Procedure	Response of subject having concept (Female : 8 years)	Response of subject not having concept (Female 7, 9 years)
9. Optional, depending upon whether the response of the C. indicate an uncertain notion of conservation, or if he appears to be in the transitional stage. E: A little boy (girl) was here before and said it was not the same amount of water, because here there was more (or less). (E. draws C's attention to the differences in the two levels of the water in the two glasses and sees whether the C. resists the counter – suggestion).		

Appendix IX

One-to-one correspondence*

Protocol of children having and not having the concept

Material and Procedure	Response of subject having concept (Male : 7, 9 years)	Response of subject not having concept (Female : 7, 2 years)
Material 10 small baskets 20 small pineapples		
Procedure		
1. E. places 7 baskets in a horizontal line, with about one inch space between them, in front of the C. and E. asks C. to place pineapples in front of the baskets in pairs (one-to-one correspondence.)	1. E :	1. E : .....
E : Are there as many (the same number of, an equal number of, etc) baskets as pineapples, or are there more baskets, or more pineapples ?	C : Equal	C : Equal
Why ?	Because there are six pineapples, and six baskets.	Because the teacher made them equal.
C : ..... (If C states that there is an unequal number of baskets and pineapples, he must adjust the numbers himself until he has agreed that there are as many baskets as pineapples.)		
2. E. bunches up the pineapples together, to form a shorter line than that of the baskets.	2. E :	2. E : .....

*This test was used to build up rapport between the experimenter and the child, and was not scored.

Material and Procedure	Response of subject having concept (Male : 7, 9 years)	Response of subject not having concept (Female : 7, 2 years)
E : Are there as many pineapples as baskets, or are there more baskets, or more pineapples ? C : ..... E : Why or "How do you know ?"	C : They are equal Because I can count them.	C : Not equal. There are more baskets than pineapples. Because they are not laid in opposite with the pineapples.
3. E. places the pineapples back to the original one-to-one correspondence and again asks if there are as many pineapples as baskets now, and why ?	3. E : ..... C : Equal Because they have the same number.	3. E : ..... C : There. are more pineapples than the baskets. Because they are not equal.
4. E. repeats the above procedure as 2 above, but bunches up the baskets this time. E. Are there as many pineapples as baskets, or are there more pineapples or more baskets ? Why ?	4. E : ..... C : Equal Because each has six.	4. E : ..... C : There are more baskets than pineapples. Because the baskets are not laid in opposite with the pineapples.
5. E. places the baskets back to the original one-to-one correspondence and again asks if there are many baskets as pineapples, and why ?.	5. E : ..... C : Equal. Because I can count when they are laid in pairs.	5. E : ..... E : Equal.
6. E. places the pineapples together in a form, and the baskets in another form. E. again asks if there are as many baskets as pineapples, and why ?.	6. E : ..... C : Equal Because at first they had the same number.	6. E : ..... C : Equal. Because they are grouped together.

Appendix X

Bangkok Institute for Child Study

Subject : Science

Level : Grade 1, Name..... School.....

Direction : From the following questions, there is only one correct answer for each item. Mark X on the letter A or B or C in front of the correct answer.

Example : How many legs does a cat have ?

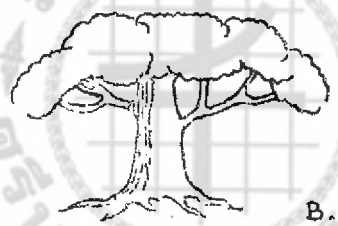
A. Two legs.

B. Three legs.

C. Four legs.

1. What is not a living thing ?

A.



B.

C.

2. What is not an animal ?

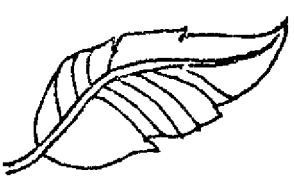
A.

B.

C.

3. By what way do trees breathe ?

A.



B.

C.

4, Which is a plant ?

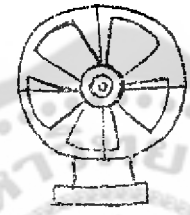
A.

B.

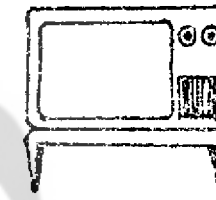
C.

5. Which is a living thing ?

A.



B.



C.

6. Why do trees bend their branches to the sunlight ?

A. The sunlight is necessary for trees.

B. Trees like sunlight.

C. Trees are warm in the sunlight.

6. Which animal is useless to a man ?

A. Bird.

B. Bee.

C. House fly.

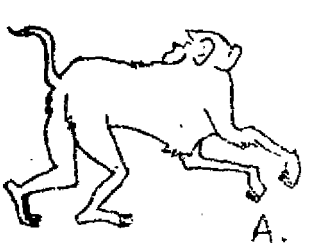
8. Which part of a man works like the roots of a tree ?

A.

B.

C.

9. Which animal lays eggs ?


A.


B.


C.

10. Which trees give fruit all year round ?

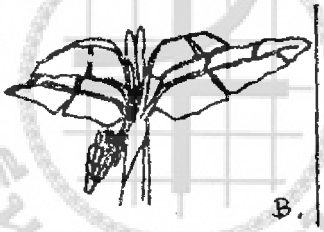
A. Longhan.

B. Papaya.

C. Rambutan.

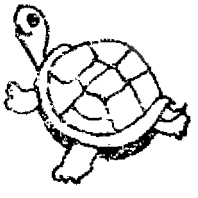
11. Which plant reproduces by seeds ?


A.


B.


C.

12. Which is called "reptile" ?


A.


B.


C.

13. Which is an insect ?


A.


B.


C.

14. Where does the sun rise ?

A. In the east.

B. In the south.

C. In the north.

15. Where does the sunlight come from ?

A. The earth.

B. The sun.

C. The star.

16. Where is the sun in the afternoon ?

A. In the east.

B. In the west.

C. In the south.

17. If the sun disappeared, how would we be ?

A. Very cold.

B. Fairly cool.

C. Dead.

18. How does the "North Wind" make us feel ?

A. Cold.

B. Warm.

C. Cool.

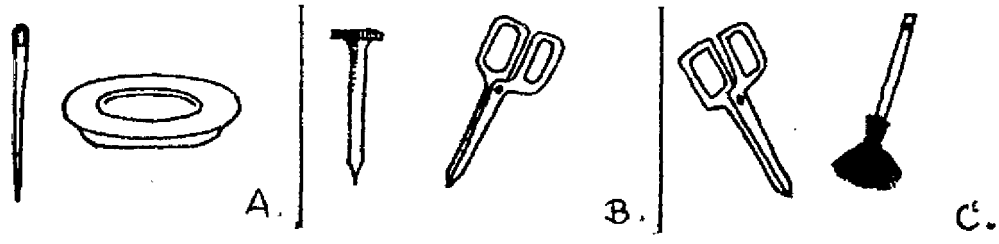
19. Mrs. somnuk turns her face to the west and stretches her hands. Which direction will her right hand point to ?

A. The east.

B. The north.

C. The south.

20. Which pair of these objects can be attracted by magnets ?

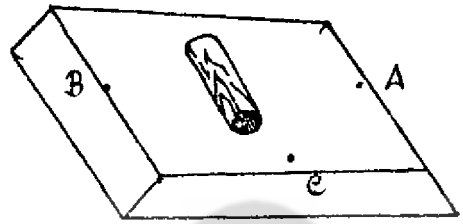


21. You want the log to move from A to B. From what side are you going to push ?

A. Side A.

B. Side B.

C. Side C.



22. If one wing of the glider is torn, what will happen to it ?

A. It will fly for a long way as usual.

B. It will fly for a short way and then fall.

C. It will suddenly fall.

23. Why can kites fly high ?

A. Because of wind.

B. Because of air.

C. Because of light weight.

24. In what way are a lion, a deer and a porcupine alike ?

A. They are fierce.

B. They are big.

C. They are in the forest.

25. Which way are a snake, a crocodile and a duck alike ?

A. They are domestic animals.

B. They lay eggs

C. They have legs.

26. From these pictures, what can you conclude?

A. Living things need water.

B. Man and animal need water.

C. Plants need water.

27. Which pair of animals are both domestic?

28. What are home–grown vegetables most useful for?

A. Food.

B. Shade.

C. Decoration.

29. In what season are trees completely dry?

A. Rainy season.

B. Cold season.

C. Hot season.

30. How will the rose be, if you plant it and never water it?

A. It will be fresh as usual.

B. It will tither and then die.

C. It will not grow anymore.

31. Which is not necessary for plants?

A. The moon.

B. The water.

C. The sunlight.

32. How can you know that a tree is a living thing?

A. It can move.

B. It can chew food.

C. It can grow.

33. Which pair of these animals is the most necessary to farmers?

A. Elephant – cow.

B. Cow – buffalo.

C. Elephant – buffalo.

34. Which car can run the fastest?

35. In what condition will you feel least tired?

A. Swim against the water current.

B. Swim along the water current.

C. Swim in the still water.

36. Which doesn't help the clothes to dry?

A. The wind.

B. The sunlight.

C. The moonlight.

37. If you want to dry your clothes quickly, where should you hang them?

A. Under the roof's edge,

B. In the open space beneath the main floor of the house. (called in Thai "Taitoon")

C. In the open air.

38. When do we use electric light or lamp?

A. When it is dark,

B. When it is hot.

C. When it is cool.

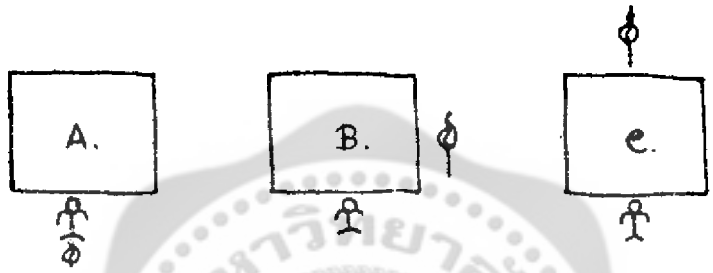
39. What is the heat of the sun comparable to?

A. The heat from a gas stove.

B. The heat from a lamp.

C. Nothing can be compared.

40. Where would you place the light in order to cast the shadow on the screen?

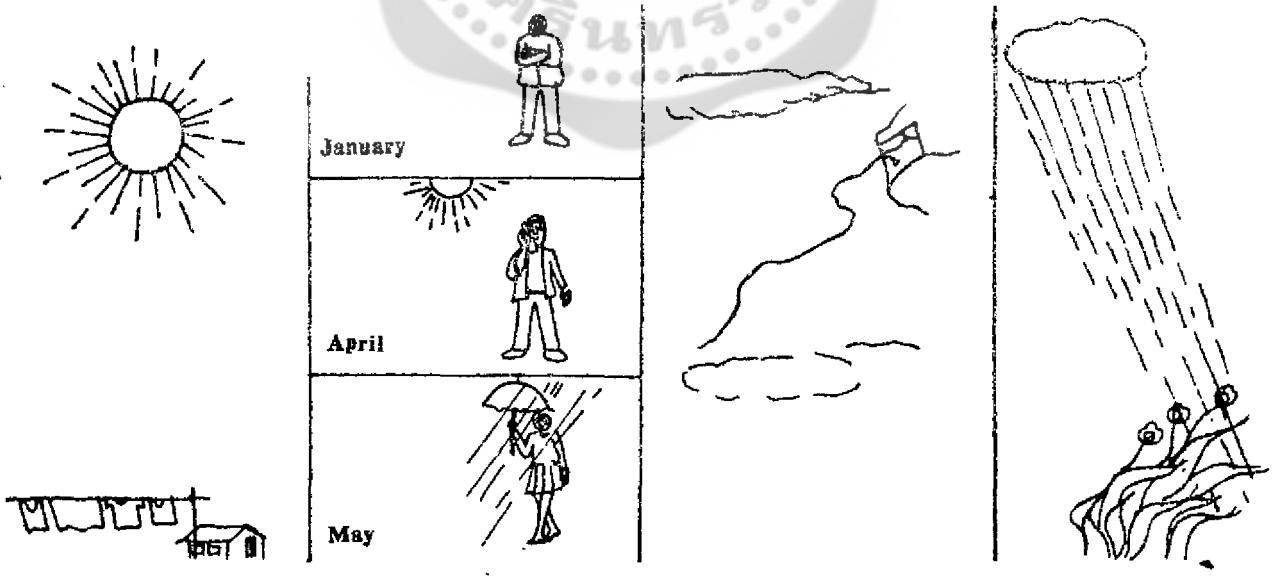


A. Picture A.

B. Picture B.

C. Picture C.

Direction : Use the pictures below to answer questions 41 – 44.



A. B. C. D.

41. In picture A, how is the weather?

A. It's going to rain.

B. It's very hot.

C. It's rather hot.

42. In which picture should you use an umbrella?

A. Picture A.

B. Picture C.

C. Picture D.

43. What is shown in picture B?

A. There are many seasons in a year.

B. We must use an umbrella.

C. We use different kinds of clothes.

44. From picture B, what can you say about the weather?

A. The weather is hot.

B. The weather is cold.

C. The weather is changable.

Appendix XI

Bangkok Institute for Child Study

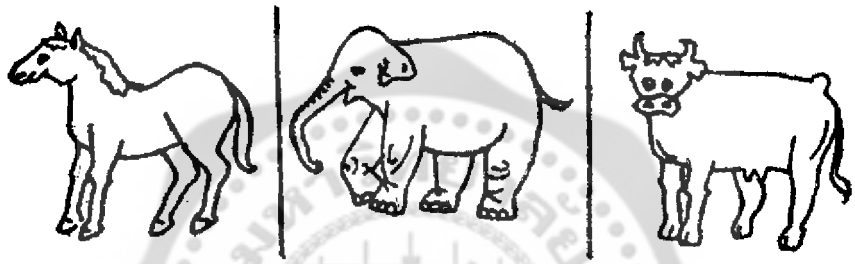
Subject : Mathematics

Level : Grade I

Name : ..... **School**.....

Direction : Choose the correct answer for each item. Mark × on the letter A, or B, or C in front of the answer.

Example : 1. Which animal is the biggest ?



A B C

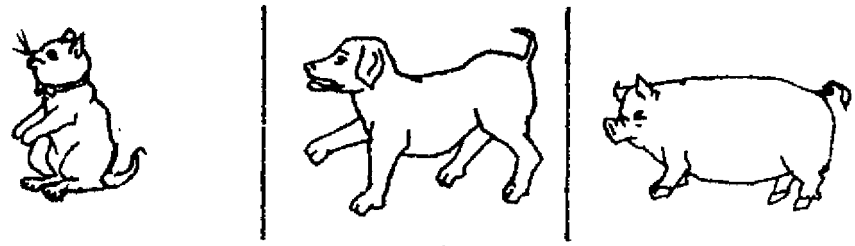
2. How many days are there in February this year ?

A. 28 days B. 29 days C. 30 days

1. Which is the biggest ?

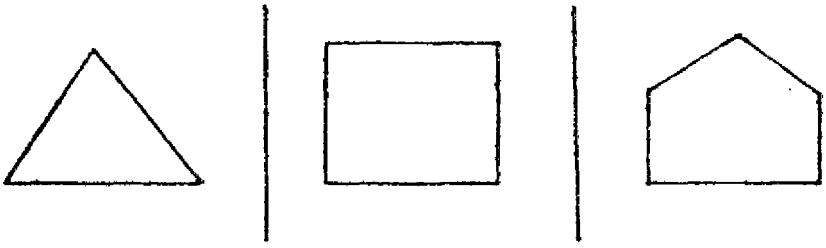
A. B. C.

2. Which is the smallest ?



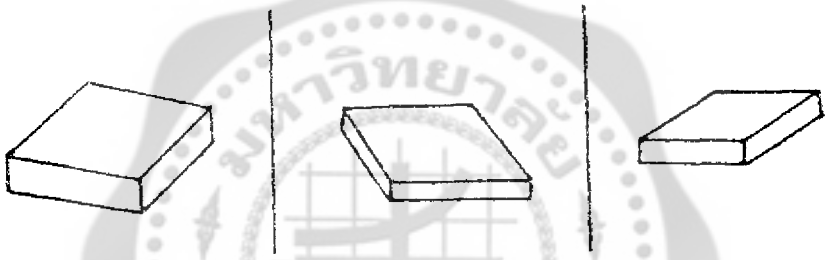
A B C

3. Which picture has four sides?



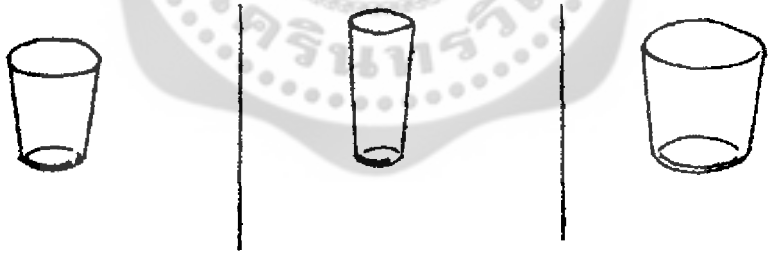
A. B. C.

4. Which eraser lasts longest?



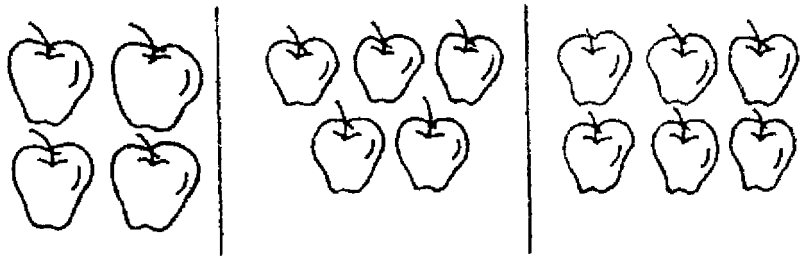
A. B. C.

5. If you want to fill up a big bucket quickly, which glass will you use?



A. B. C.

6. Which is the "odd" number of apples?



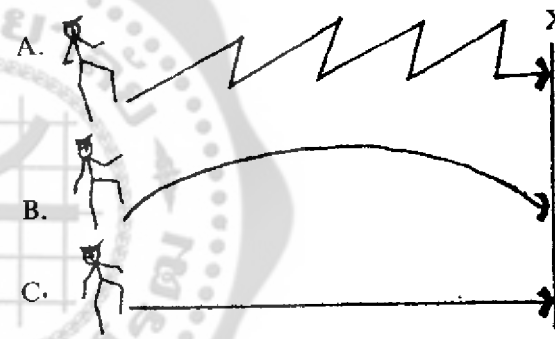
A. B. C.

7. Which is ranked from small to large?
   A. 4, 1, 6,
   B. 1, 6, 4.
   C. 1, 4, 6.

8. Which number is "fifty - eight ?
   A. 58
   B. 508
   C. 518

9 Which amount of money can you buy a lot of cake?
   A. 01 baht.
   B. 10 baht.
   C. 001 baht.

10. Mana, Preecha and Udom walk along these roads at the same speed. Who will be the first to reach the line X?
   A. Mana.
   B. Preecha.
   C. Udom.

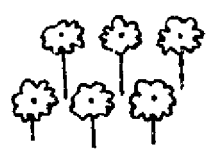


11. What number comes between 14 and 16?
   A. 14
   B. 15
   C. 16

12. Dang has "81" birds. Dee has "eighteen" birds. Who has more birds?
   A. Dang has more birds.
   B. Dee has more birds.
   C. They have equal number of birds.

13. If you add up number, what will be the result?
   A. More.
   B. Less.
   C. Same.

14. How many legs do two cocks and one pig have?
   A. 6
   B. 8
   C. 10

15. I've  and pick up 

How many flowers do I have altogether?

A. 10

B. 11

C. 12

16. Nai Son had eight eggs. He broke three of them. Then he bought two more. How many eggs did he have?

A. 7

B. 10

C. 13

17. $15 + 17 = ?$

A. 31

B. 32

C. 33

18. I bought a pen for 10 baht and a pencil for 5 baht. I had 12 baht left. How much money did I have before I bought them?

A. 3

B. 17

C. 27

19. If you want to decrease any number, what method will you use?

A. Add.

B. Subtract.

C. Add and subtract.

20. $8 + ? = 17$

A. 7

B. 8

C. 9

21. My sister is 11 years old. My mother is 28 years older than my sister. How old is my mother?

A. 17 years.

B. 39 years.

C. 40 years.

22. The price of a shirt is 27 baht. Somchai has 21 baht. How much price will the merchant have to reduce so that Somchai can buy the shirt?
    A. 6 baht.
    B. 7 baht.
    C. 8 baht.

23. How much is $4+4$ more than 5?
    A. 3
    B. 4
    C. 5

24. Mother gave me 3 pieces of cake. Auntie gave me 4. Mother gave my sister 2 pieces and Auntie gave her 6. Did my sister and I have equal number of cake?
    A. We had equal.
    B. I had more.
    C. Sister had more.

25. It is 2 0'clock now. What time will it be in the next 3 hours?
    A. 5 0'clock.
    B. 6 0'clock.
    C. 7 0'clock.

26. How much is the difference between 30 and 13?
    A. 43
    B. 27
    C. 17

27. The mango  cost 3 baht. I gave the merchant a 5 baht coin. He gave me one baht as a change. How much more should I get from him?
    A. 1 baht.
    B. 2 baht.
    C. 3 baht.

28. $15+13-21=?$
    A. 6
    B. 7
    C. 8

29. There are 30 students, 24 of them passed the exam, 3 were absent. How many students failed?
    A. 3
    B. 4
    C. 5

30. How many pairs of socks are there altogether?
    A. 5 pairs.
    B. 10 pairs.
    C. 15 pairs.

31. You had twelve dolls and gave them to three friends equally. How many dolls did each friend get?
    A. 3 dolls.
    B. 4 dolls.
    C. 5 dolls.

32. Samarn got one half of a cake. His brother got another half. How much did they get?
    A. Samarn got less than his brother.
    B. Samarn got more than his brother.
    C. Samarn got as much as his brother.

33. A row of numbers is:
    10 20 30 40..... 60
    What is the missing number?
    A. 40
    B. 50
    C. 60

34. You have one pile of 30 oranges and want to break them into as many piles as possible. How many oranges should be in a pile.
    A. Three oranges a pile.
    B. Five oranges a pile.
    C. Ten oranges a pile.

35. You have 3 one – baht coins. How many twenty – five satang coins for those 3 coins?

A. 4 coins.

B. 8 coins.

C. 12 coins.

36. The book is 2 bahts 25 satangs. You give the shopkeeper 3 bahts. How much change will you get back?

A. 25 satangs.

B. 50 satangs,

C. 75 satangs.

37. How many days are there in June and December?

A. 60 days.

B. 61 days.

C. 62 days.

38. The first of the month is Friday. What will the fifth be?

A. Monday.

B. Tuesday.

C. Wednesday.

Appendix XII

Lesson preparing children to learn concepts of classification

Section 1

Classification – Animals

Time : 1 hour.

Specific Objectives : Get the children to

a) Know animals from toys and pictures of various animals.

b) Understand how to classify animals into sub – classes by way of analytical, relational or categorical style.

c) Be able to respond to their own psychological needs, thus, they will be more interested in the classification of animals.

Materials :

1. Picture of animals.
2. Toy animals (miniature forms and comic forms).

Sequences of teaching :

1. The children are presented with various comic toy animals. After touching and looking closely at each toy animal, the child must tell its name and about its eminent character and mimic that animal he names, for instance, an elephant's walking style, a horse's neighing, etc. Finally, the teacher tells all children other animals' names which they do not know.
2. The children are presented with two pictures. At first, they are asked to tell what they have seen in each picture, then to compare between things in the two pictures and to point out which are the same or different.
3. The class are divided into four groups. Three groups are required to have some activities that do not concern classificatory learning, such as colouring pictures of animals, folding the paper animals and listening to the tales.

The children of another group are required to classify the toy animals into groups. The classification depend on their own understanding and decision. They are asked to tell about the criteria in their classification. Then, the teacher rearranges all toy animals into classes and explains her criteria to the children as the following stages.

The first stage :

The teacher shows the children three comic toy animals : A giraffe and a couple of gold fish. From these three animals the teacher lets each child choose two which he thinks it should be together. Then, the teacher shows her arranging to the children by pointing at the golden area of the skin of the giraffe and the female golden fish. She puts them together and tells the children that she groups the two animals because their parts of bodies are of the same appearance. The teacher points at the blue area of the male fish skin, then asks the children to choose another animal to go with the male fish. They choose the giraffe, because its eyes, forehead and belly are blue. When all children understand how to classify animal in such analytical mode, they learn to classify in relational mode, for example, a male and a female fishes are grouped together because they may be husband and wife or lovers. The children are trained until they are able to classify animals in relational mode, then they learn to classify in another mode.

In categorical classification, the children learn to group animals into sub–classes by judging from its natural lives, for instance, a fish, a lobster and a shell were put into one sub–class because all of them are aquatic animals. The children are trained until they can classify the animals in categorical style. They repeat to classify in every mode again till they understand that classification may be done in three modes.

The second stage :

All toy animals are presented to the children.

a) Let each child arrange all toy animals in groups by using categorical mode.
b) Let the child group the toy animals by using analytical mode and explain to his teacher and classmates about the reasons for the classification, such as why he groups them together and which parts of the animals in the group are alike.
c) The teacher guides the child to use relational mode in his grouping of toy animals as for the question, "Which ones ought to live together?"

The third stage :

The teacher lets the children learn that classification is flexible and can be done more than by one mode, depending upon how they look at things by analytical, categorical, or relational sight. Then, the teacher gives all toy animals to each child and asks him to classify them in any style he likes. The result is that ninety per cent of the children use categorical mode in their classifications.

That is, they arrange animals into aquatic group, wild group, and group of birds. Few children use relational or analytical mode in their classification, for instance, the giraffe and the rabbit are grouped together because they eat grass, or, the bear is grouped with the elephant because parts of their bodies are pink.

When the teacher finishes her teaching the third group of children, the other groups take turns to learn, classifying animals. The lesson to learn, classifying animals, is the lesson which the third group of children have learned previously.

Evaluation :

The teacher observes and records each child's ability in classifying animals in terms of how much he succeeds, and what is the reason in his arranging. The teacher should record carefully to follow – up each child's progress.

Section 2

Classification – Plants

Time : 1 hour.

Specific Objectives : To get the children to

a) Know plants (vegetables, fruits, flowers) from pictures, have experiences and reasonable consideration, till they are able to understand the similar parts of plants and classify them into groups.

b) Understand the criteria to classify plants in analytical, relational, and categorical modes, and be able to apply those criteria.

c) Be able to respond to their own psychological needs, and be more interested and enjoy the activities in item b.

Materials :

1. Fresh plants which are easily to buy from the market. There are :

vegetables – lettuces, turnips, momordicas, gingers, eggplants, cauliflowers, cucumbers.

fruits – oranges, grapes, langsats, longans, rambutans, jujubes.

flowers — ixoras, water lilies, red sages, amaranth, roses, cockscombs, marigolds, allamandas.

2. Pictures of vegetables, fruits and flowers.

Sequences of teaching :

1. The children are presented with the pictures of vegetables, fruits and flowers. The teacher shows them one picture at a time. Every time he asks them to tell whether it is the picture of vegetable, fruit, flower plant, or animal.

2. The children are divided into four groups, each at each corner of the class room. There is a pile of various vegetables, fruits, and flowers in every corner.

The children take turns to be sellers and buyers. Each buyer takes turns to buy only vegetables, fruits, or flowers, but he must tell the seller the name of which he wants to buy. The seller will bring him what he wants.

The teacher observes the children whether their classification of plants into vegetables, fruits and flowers are correct. The children will be trained in this stage until they are able to classify the plants into the three groups.

After the children understand what are vegetables, fruits, or flowers, the teacher groups all kinds of plants into one pile and asks them whether it should be added together, and why they think so. The children who understand clearly from the beginning will answer that it can be grouped together because all vegetables, fruits and flowers are plants. The child who does not understand must go back to the first stage of training again.

3. In motivating the children to be interested in their lesson and enjoying the training, the teacher let them make flowery dance and sing Thai folk songs in which the words were about flowers, fruits or vegetables.

4. After the children have some fun, they are divided into groups for perception training. The perception training in this stage is the same to the training in the third stage of the section I, but plants instead of animals were used.

Evaluation

The teacher observes each child's ability in classifying, whether he can arrange plants into groups with suitable reasoning. The child who cannot classify the plants must be trained again. The teacher records every child's progress in training.

Section 3

Classification – Form

Time : 2 hours.

Specific Objectives. To get the children to

a) Know colors : sky–blue, pink, green, marine, yellow.

b) Know forms : triangle, square, rectangle, parallelogram, illipse and circle.

c) Know sizes : large, medium, small.

d) Notice forms, set up things which are similar in form together and arrange in order of size.

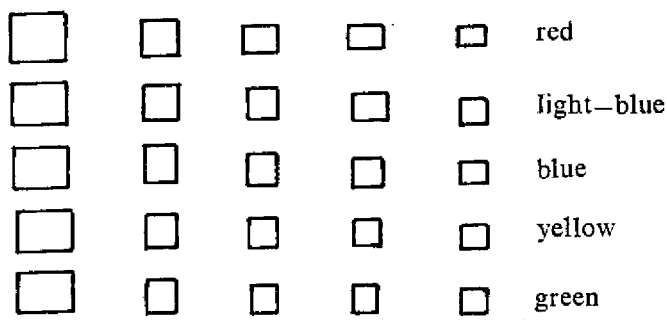
e) Be trained in observing. When a picture in the set is missing, the child who understands about forms and colors will notice that the set is not complete.

Materials :

1. Plates of wood, cardboards, rubber, plastic, sand – papers, foam rubber and cork. These are cut in geometric forms : triangle, squares, parallel quadrilaterals, rectangle, circles and elliptical forms.

2. Color cardboards : light blue, pink, green, blue, and yellow, are cut into triangles, squares, parallelograms, rectangles, circles and ellipses.

3. Five groups of square papers which are different in color, and sizes, viz :



There are also groups of triangles, parallelograms, rectangles, circles and ellipses, isomorphic to the group of squares.

4. A piece of paper : size 4" x 2 $\frac{1}{2}$"
5. Ribbons of different colors.
6. Blocks of different shapes.
7. Geometric form blocks.
8. A pound of plasticene.

Sequence of teaching:

1. The teacher introduces the names of the geometric forms to the children such as triangle, square, parallelogram, rectangle, circle, and ellipse.
2. The children are divided into four groups, each for a corner of the class room. The corners are arranged with the following teaching materials.

   The first corner materials are geometric form blocks.

   The second corner materials are geometric form plates.

   The third corner materials are blocks of different shapes.

   The forth corner materials are color cardboards in geometric forms.

   The children take turns to touch and play with all materials in every corner. If the children seem to be bored, they are allowed to shape pieces of plasticene into geometric forms.

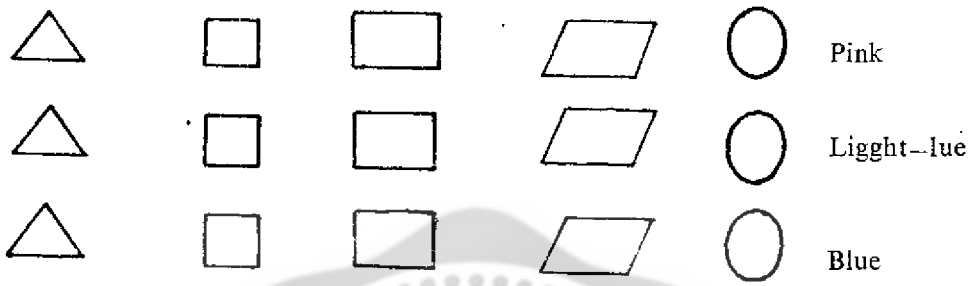
The children in the first two corners, are assigned to arrange all materials in the corners into groups of similar shape but different colors, or groups of same color but different shapes.

The children in the third corner are divded into two subgroups. They own the same shapes of blocks, but the first group blocks are shaped in opposite direction to those of the second group. Any child in the first group is allowed to pick up a block, such as C (left half–circle) then, one in another group must get such shape of block which is opposite in direction as ↄ (righ half–circle) to join with two ends of the first one such that the two pieces of blocks will close into a full circle as O. Children of both groups are allowed to take turns to pick up a different half of any shape or to complete it with the second half. In training, the children learn to describe the similartiies or differences of things. They are required to explain why they can complete the two pieces of blocks together and why they can not.

The children in the fourth corner are trained to classify things both in shapes ahd colors (they should pass first the training at three corners). The teaching method is described as follows.

1. To fix the geometric form papers on the board, viz.

trinangles squares rectangles parallelograms circles



The children are trained to notice that all form papers on the board are set into two dimensions: form in columns, and color in rows. The teacher should line a ribbon covering the first column or all triangles, and asks the children what the ribbon covers (either the form or the same color). If the children understand clearly, the answer must be "form". Then, they will be able to describe about the form of paper in the column. If the children can not not answer, the teacher must describe to them the similarities of the form papers in the first column, and points out that all papers in third column are of the same triangular form. Then, the teacher continues her teaching by covering the ribbon on the second column which is the column of square papers, and asking the same question. From the second column, he goes on the next columns in similar manners till the last column.

The teacher moves the ribbon from 'columns' to cover the first row of form papers which are the same color, and asks the children with the similar questions using in columns. The right answer will be "the same color" instead of "the same form". The teacher then continues to the next row until he has finished the last row.

2. The children are presented with the sets of triangles, squares, rectangles, parallelograms and circles of form papers. There are two sets in each form: green and yellow sets. The teacher asks the children to arrange the two sets of papers on the board in the same manner as shown. In order not to confuse with colors, they should be presented with one set at a time.

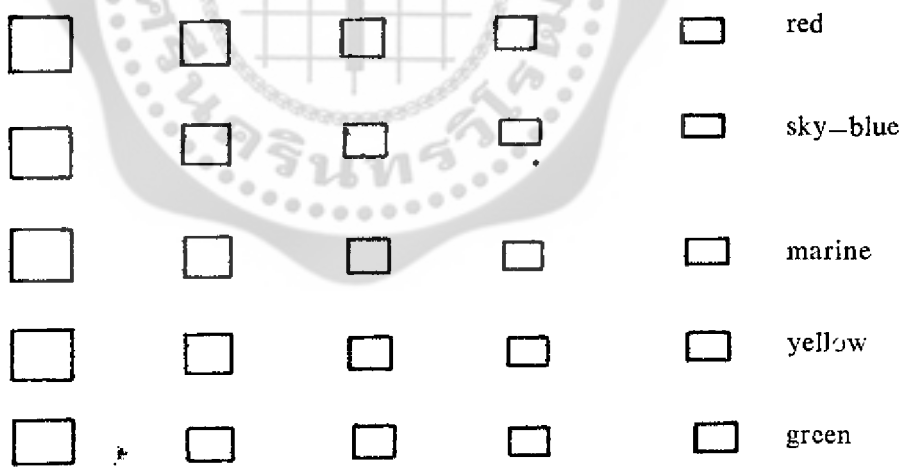
3. The children are presented with the elliptical form papers. They are pink, light blue, blue, green and yellow. The teacher asks them to arrange these ellipses on the board, continuing from those they have arranged.

4. After telling the children to close their eyes, the teacher takes one of form papers from the board. She tells them to open their eyes and look for the missing paper by looking at crossing points of the ribbons. The children who can find it must decribe about form and color of the missing paper.

The children are trained in such method until they are able to notice things in two dimensions or in forms and colors. Then they are trained in this method again, but there are more than one piece of missing paper at a time.

5. All form papers on the board are piled together. A child is required to select some papers of any form or color he likes from the pile, and arrange the first row on the board with his selected papers.. The teacher asks the other children in the group to select the rest of the papers and arrange the next rows and columns on the board until all rows and columns are complete.

6. The teacher shows the children five sets of square papers. There are red, light blue, blue, yellow and green sets, and there are five sizes from the largest to the smallest squares in each set. The teacher asks the children to bring her the largest squares of each set. She then fixes these largest squares on the board. The children are asked to bring to the teacher the square papers which are next largest in order from the remaining pile. The teacher then fixes all second selected square papers on the board, continuing from the first ones in order of size and in the rows of color. Both teacher and children cooperate until the smallest squares are all fixed on the board. Five sets of squares are arranged on the board as shown in the following figure.



After finishing the sets of squares, the teacher gives the sets of triangular, rectangular, parallelogram and elliptical papers to the children. The child who has recieved the papers must arrange his paper sets on the board in the same style as square sets.

Evaluation :

The teacher evaluates the children's concepts of forms from all their training activities. Their arrangment of papers are either right or wrong. The teacher may take off one piece of form papers which are fixed on the board, and ask the children to find out what is missing.

Appendix XIII

LESSON 1

The Concept of Conservation of Numbers

Part I

Time: One hour.

Specific Objectives: To prepare children to understand the number concepts.

Behavioral Objectives: When the teacher shows objects or numerals, the children should be able to count and know what numbers they represent (from 1 to 9).

Materials:

1. Five schoolboys and five schoolgirls.
2. Books, pieces of wood, pencils, rulers, five of each item.
3. Cards, marked 1 to 9.
4. A piece of card board cut into playing cards, marked 1 to 9. Each numeral is on 25 cards. These cards were grouped into 5 sets of 5 cards each for each numeral.

Teaching stages: (These lessons, prepared for children's readiness prior to teaching the concepts of conservation of numbers, are adapted from "Triad : Teacher's Manual, Part 1.")

1. The teacher calls one boy to stand in front of the class and asks the class the number of boys they see. The teacher does the same using a girl. Then she lets the boy and the girl stand on each side in front of the class, and asks, "Is one boy the same number as one girl?" When the students give the right answer, the teacher increases the numbers to 2, 3, 4, and 5.

2. The teacher does the same as in the teaching stage number 1, but using other materials like books together with wood, pencils together with rulers, and so on.

3. The teacher calls two boys and picks up one pencil, then asks, "Are there enough pencils for the two boys?" The teacher increases the number of boys and pencils, one at a time and asks the same question every time the number is increased. If the students answer there is (are) not enough,

then the teacher asks how to do so that there will be enough. (Let the students themselves think carefully.) The answer will be either : "Increase one more pencil.", or "Let one boy go back to his seat." There answers will show that the students understand what the teacher wants. The teacher can use this as a means of evaluation at the same time.

Then the teacher calls three girls to come in front of the class and picks up three rulers and asks whether there are enough rulers for the girls. (This is done in order to check the comprehension of the class).

4. The teacher calls five students to stand in front of the class. One student holds card "number 1" (with # 1 printed on the card). Another student holds card "number 2". The teacher follows this step until the last student holds card "number 5." She says, "In the group of the student who holds card number 1 means there is one student. In the group of the student who holds card number 2 there must be two students." The teacher calls one more student to stand in group 2, and then asks the class about the right numbers of students in the other three groups accordingly.

5. The teacher has nine students standing in line front of the class. Each holds a card. Each card is marked with the number 1, 2 or 3 up to 9. When the teacher calls "Number 1", the student who holds card number 1 steps forward for one step and counts "one". When the teacher calls "Number 2"; the student who holds card number 2 steps forward for two steps and then counts "one, two", The teacher follows this example until the student who holds card number nine has been called. When the class understands the direction, the teacher calls from number 1 to number 9. When the students step forward, they must count each step. The other students in class repeat the countings. (The teacher does not have to call them in any order). When all the students have been called, they will stand at different points, and the teacher will tell the students to get back to their original standing points. For example, when the teacher calls number 5, the student who holds card number 5 will make five steps backward. At the same time he must count down from from five to one. The class repeats. The activity will be the same until all return to their places and the teacher switches to other groups of students in class, so that everyone has an opportunity to perform the task.

6. The teacher arranges the students into four groups: five in each group and distributes cards (materials number 4) to each group. Each person in each group will receive nine cards with the faces down. The first person turns his first card over. The others in the group do the same and leave the cards in the middle. When the card numbers are duplicated with the preceding one, the student who call out first will get all the cards in the pile. The game is continued until one runs out of cards, the one who has more cards than the others wins the game.

Part II

Time: 1 hour

Specific Objectives: To prepare students to observe and understand that numbers and length, and numbers and area are not the same. (In this case students may give wrong answer because they can not discriminate numbers from area.)

Behavioral Objectives:

1. When two ribbons of differnt length are placed on a metal board and two objects are then attached to the ribbons and different things are used at different teaching steps, children should be able to distinguish numbers from length accurately.

2. When two different sizes of triangular shaped paper are placed on a metal board and the same number of objects are placed on each of the paper, and are changed at different teaching steps, children should be able to distinguish numbers from area accordingly.

3. When two different sizes of rectangular shaped paper are placed on a metal board and the same numbers of objects are placed on each piece of paper, and different numbers are changed according to different teaching steps, children should be able to distinguish numbers from area.

Teaching Materials:

1. One red ribbon and one blue ribbon, with different length and another colour long ribbon.
2. Magnets shaped the form of hand, foot, mushroom, and heart. Four of each.

3. Metal board.
4. Two pieces of papers cut into triangular shapes of different sizes.
5. Two pieces of papers cut into rectangular shapes of different sizes.
6. Number cards, each marked from 1 to 4.

Methods of Teaching :

A. In the situation of distinguishing numbers from length.

1. The teacher places one magnet on card marked "1" and two magnets on card marked "2". He does the same until he has got five magnets on card marked "5", then asks, "How many magnets are there on card marked 1?" (The right answer is "one".) If the students cannot give right answer, the teacher lets them count the number of magnets, then asks, "What is the following number (2) and how many magnets are there (2)?" This same question is used until five is reached.

2. In the testing situation,

   2.1 The teacher places the hand shaped magnet on red ribbon which is on the metal board like this :

hand	hand	hand	hand

and places the foot shaped magnet on blue ribbon like this :

foot	foot	foot	foot

The numbers of magnets-both "hands" and "feet" can be increased or decreased. After the teacher has followed the above example and he wants to check the understanding of the class, he may use different numbers.

Teacher : "Are there more feet than hands or are there equal?"

Students : "There are more feet than hands."

Teahcer : "Let's count."

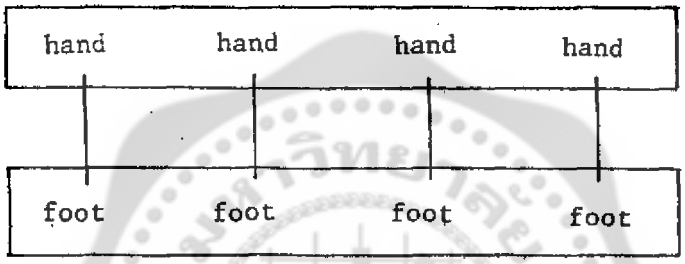
Students : "There are four feet and four hands."

Teacher : "Are there more feet than hands or are there equal?"

Students : "There are more feet than hands." (This means that students still can not distinguish numbers from length.)

3. Using different situations to describe.

3.1 The teacher cuts one long ribbon into four pieces and places between the pairs of hand and foot shaped magnets like this :



Teacher : "Are there more feet than hands or equal?"

Students : "There are equal."

Teacher : "Right, there are equal."

The teacher takes out ribbons which are placed between feet and hand and then asks the following question.

Teacher : "Are there more feet than hands or equal?"

Students : "Equal"

Teacher : "How about a man? How many hands does a man have?"

Students : Two hands.

Teacher : "How many feet does a man have?"

Students : "Two feet."

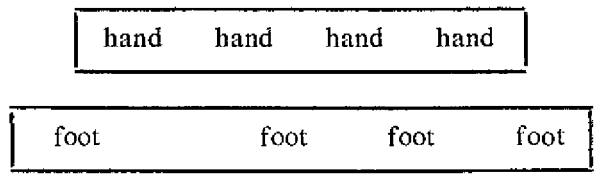
Teacher : "Does a man have more feet than hands"

Students : "No he doesn't."

Teacher : "Yes, a man has equal number of feet and hands.
Are there more feet than hands on this board?"

Students : No, there aren't. There are equal."

3.1 Teacher : "Now look ! I will move these hands to the new positions like this." (See the picture below)



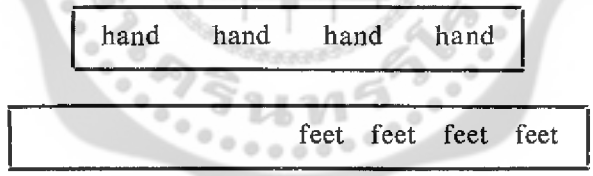
"Are there more feet than hands or are there equal?"

Students : "Equal."

Teacher : "Very good. There are equal."

3.3 The teacher moves the foot shaped magnets to one side of the board and leaves the hand shaped ones separately as before.

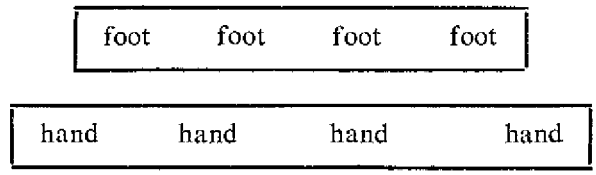
Teacher : "How about this? Are there more feet than hands or are the there equal?"



Students : "There are equal."

Teacher : Yes, it's right. There are equal."

3.4 The teacher places foot shaped magnets on the short ribbon and hand magnets on the long ribbon like this :



And then he follows the preceding teaching steps.

B. In the situation of distinguishing numbers from areas.

1. Discriminating numbers from area – triangle △

2. Discriminating numbers from area – rectangle □

From the two situations above, the teacher follows ths steps of discriminating numbers from length. He may change the teaching materials to mushroom shaped or heart shaped magnets in order to avoid repetition.

Part III

Time : 1 hour

Specific Objectives : To inform students that different lengths do not change the numbers of paired objects.

Behavioral Objectives : When pairs of things such as soap boxes are placed parallelly to or orthogonally with their lids, students should know that the numbers of boxes are equal to the numbers of the lids.

Materials : Soap boxes and their lids, five of each.

Sequences of Teaching

Observation Stage :

Step 1. In the situation the boxes and the lids are paralleley and horizontally placed together in comparison with when they are placed orthogonally.

Teacher : Places the lids parallel to the boxes;

"Are the boxes and the lids equal in numbers ?"

Students : "Yes, they are."

Teacher : Places the lids orthogonally to the boxes, "Are the boxes and the lids equal in number ?"

Students : Yes, they are. (right answer)

No, they aren't. (wrong answer)

Teacher : Asks those who give wrong answers,

"Are there more lids or more boxes?"

Students : There are more boxes.

In case that most of students give wrong answers, the teacher should let them put the lids on the boxes and asks,

Teacher : "Are there more boxes than lids or are there equal?"

The teacher may alternately place them vertically and horizontally and asks again and again to see whether the students understand it or not,

Part IV

Specific Objectives : When objects are matched directly, students should know that the number of them are equal. And when something is added to or taken out of the group, the numbers are not equal.

Behavioral Objectives : When students are matched together in pairs and though each pair does not stand face–to–face, children should know that the numbers of students in each row are the same.

When the numbers of students in any rows are increased or decreased, children should know that inequality is resulted because of increased or decreased numbers of students.

Teaching Materials : Students in class.

Sequences of Teaching :

I. Observation Stage

Twenty students are divided into acting group and observing group, with 12 students in acting group and 8 students in observing group. The observing group is divided into two subgroups with 4 in each subgroup. These are discussing groups. The teacher manipulates the acting group while she asks the observing group and lets the acting group support or reject the answers.

There are 5 pairs of boys and girls and one pair of boys in the acting group. Each pair of boys and girls holds each end of the ribbon. The arrangement is the same in every situation.

Step 1. Test situations by Piaget are used (not including the pair of two boys). The numbers of boys and girls are equal.

a. The girls stand in a row longer than that of boys.

Teacher : "The row of the girls is longer than the row of the boys, isn't it?"

Students : "Yes, it is."

Teacher ; "There are more boys than girls, aren't there?"

Students ; "Yes, there are." (wrong answer)

Teacher : "Now, let's count. How many girls are there more than boys?"

Students : "There are equal."

b. The boys form a row longer than the girls.

Teacher : "The boys row is longer than the girls row, isn't it?"

Students : "Yes, it is."

Teacher : "There are more girls than boys, aren't there?"

Students : "Yes" (wrong answer)

Teacher : "Now, let's count. How many boys are there more than girls?"

Students : "There are equal."

Step 2. Increasing the number of students.

a. The girls form their row longer than the boy's by putting the two other boys in the girls' row.

Teacher ; "Is the girls' row longer than the boys' row?"

Students : "Yes, it is."

Teacher : "There are more girls than boys, aren't there?"

Students : "Yes, there are." (wrong answer).

Teacher : "Now let's count. How many girls are there more than boys?"

Students : "There are two boys more than girls. They have just come in the row."

b. The boys form the row longer than the girls by adding two boys in the boys' row.

Teacher : "The boys' row is longer than the girls' row, isn't it?"

Students : "Yes, it is."

Teacher : "There are more boys than girls, aren't there?"

Students : "Yes, there are,"

Teacher : "How many more?"

Students : "There are two boys more than girls."

Teacher : "Now the boys' row is long. Are there more or fewer boys than girls?"

Students : "There are more boys."

Teacher : "The boys' row was short before. Were there more or fewer boys than girls recently?"

Students : "There are more boys."

Teacher : "There are more boys whether the row is long or short, isn't it?"

Students : "Yes."

Step 3. The numbers of students are decreased.

a. The girls form the row longer than the boys' row, using only three boys.

Teacher : "The girls' row is longer than the boys' row, isn't it?"

Students : "Yes, it is"

Teacher : "There are more girls than boys, aren't there?"

Students : "Yes, there are." (right answer)

Teacher : "Count them"

Students : "There are five girls and three boys. So there are two girls more than boys."

b. The girls form the row shorter than the boys' row, using only 3 boys as in (a)

Teacher : "The girls'row is shorter than the boys' row, isn't it?"

Students : "Yes, it is."

Teacher : "There are more girls than boys, aren't there?"

Students : "No, there aren't." (wrong answer)

Teacher : "Why don't you count.?"

Students : "There are five girls and three boys, so there are more girls than boys."

Teacher : "Was your answer right or wrong?"

Students : "Wrong."

Teacher : "Although the girls'row is shorter, are there more or fewer girls than boys.?"

Students : "There are more girls than boys."

Teacher : "There are more girls, whether their row is short or long. Is that right?"

Students : "Yes, that's right."

Remarks : Do not forget to let the students in the acting group answer. If they do not seem to see themselves, replace them with those in the observing group.

II. Explanation Stage :

a. Follow the situation in Step 3 by asking only the numbers not length and ask the reason why the numbers of boys and girls are not equal. The students must be able to explain that it is because the teacher takes two boys out of the group.

b. Follow the situation in Step 2 by asking only the numbers not length. Ask why the numbers of boys and girls are not equal. The students must be able to explain that it is because the teacher adds two boys to the group.

c. Follow the situation in Step 1 by asking only the numbers not length. Ask why the numbers of girls and boys are equal. Students must be able to explain that it is because the teacher does not increase or decrease the numbers of boys in the group, and the two extra boys are taken away.

III. Control Stage :

a. When the number of girls is increased and when they form the row shorter than the boys' row, children should be able to answer that there are more girls than boys.

b. The teacher lets the children count the numbers of students in class and realize that there are twenty of them, and lets them run into the field until it looks like the field is full of them. The teacher asks each child to look

at his friends and asks whether or not there are more children in the field than in the classroom. Children should be able to answer that there are the same, meaning twenty.

c. The teacher lets some students go to the restroom, some play in the field and some go into the classroom and asks whether the twenty children are still in the school or there are only those in their sight. They should be able to answer that all are still in school.

IV. Prediction Stage :

The teacher puts the ribbon together into a pile, not let the children hold them.

a. Follow the situation in Step 3. "How can you make the numbers of boys and girls equal?"

– Students should learn to predict that when placing two boys in the boys' row, the numbers of boys and girls will be equal.

– Students should learn to prove by placing two extra boys in the boys' row, the boys hold one end and the girls hold the other end of each ribbon. The teacher should emphasize, "How you can make me believe that the numbers of boys and girls are equal?"

b. Follow the situation in Step 2 and asks, "How can you make the numbers of boys and girls equal?"

– Children should learn to predict that when we take out the two extra boys from the row, the numbers of boys and girls are equal.

– Children should learn to prove by having the girls hold one end and the boys hold the other end of the ribbon and let the rest of the children go.

c. Follow the situation 3 and ask "How can we make the numbers of boys and girls unequal?"

– Students should learn to predict that we can bring other boys into the group or take them out.

– Students should learn to prove by increasing or decreasing the numbers as mentioned or matching pairs of them.

Appendix XIV

LESSON 2

The Conservation of Length

Part 1

Time for teaching : 1 hour

Specific Objectives : 1. To let the children know how to measure.

2. To let the children know the terms namely long, short, longer, shorter, longest and shortest.

Behavioral Objectives :

1. When the teacher arranges a situation for the children, that is, telling the children to judge which sticks in their hands are as long as the pieces of paper in the circle. The children will compare the sticks in their hands with the pieces of paper, then they can choose the right circle.

2. When the teacher arranges a situation for the children, that is, asking the children which one of the five different color sticks in different circles is longer or shorter than the rest or which ones are equal, which is the longest or the shortest, they will compare those sticks and if they understand the terms longer, shorter, the longest and the shortest, they will be able to give the right answer to the teacher.

Materials :

1. Sticks of different colors : orange, dark brown, dark green, yellow and pink, 4 of each, are cut into different length, i.e, the pink one—the shortest, then the yellow, the dark green, the dark brown and the orange one will be the longest. There are also 10 white short sticks and 10 red short ones. The red ones are a little longer than the white ones

2. Pieces of cardboard are cut to have the same length as the color sticks.

3. Adhesive — tape.

Sequences of teaching

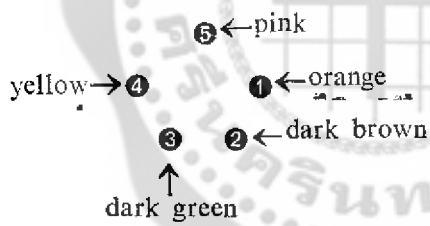
Preparational stage :

Step 1 : To observe the length and to compare or measure.

Assistant teacher : Draw 5 circles on the floor. Put a piece of paper in each circle on the floor. Stick them with adhesive-tape. The paper is cut into several pieces with the following sizes :

1. size equal to the orange stick.
2. size equal to the dark brown stick.
3. size equal to the dark green stick.
4. size equal to the yellow stick.
5. size equal to the pink stick.

The teacher draws the five circles in the following manner :



Teacher : Put together those color sticks, 4 of each, on the teacher's table. Then ask the children to come in line to pick one piece each as he likes.

Students : The assistant teacher requests the students to stand in 5 different groups.

Teacher : "Let us see which one in your hand is equal to that in the circle, then please go and sit in that circle."

Students : 1. If the students go in group, it shows that they know they have to sit in the same circle (because they have equal sticks), but if they separate from the organized group, it shows that they are more concerned with comparing their own stick to the pieces of paper. This indicates that they lack the ability to generalize.

2. If the children notice the length and make a close estimation or right judgement concerning which circle they should sit inside, it shows that they have made some observations.

3. If the children compare the stick with the piece of paper, it shows that they know how to measure.

4. If the children sit in the wrong places, it shows that they know nothing of the 3 criteria mentioned above. The teacher should let them compare their sticks with those of their friends and with the pieces of paper, then ask them to move to the other place. While doing so, the teacher observe whether the children make any observation.

Step 2 : Let the students observe whether things are equal in length, longer, shorter, the shortest, the longest. Then, ask the students to compare once again that their sticks are equally long within the same circle.

Let the children compare their sticks once again with those in other circles in order to see the differences in length. Have all the children in the circle 1 (orange) compare their sticks with those of the circle 2 (brown). Ask all of them to say that the orange one is longer than the brown one, and the brown one is shorter than the orange one. When it comes to the circles 5 and 1, let the children say that the orange one is longer than the pink one and the pink one is shorter than the orange one. Let all the children sum up that the orange one is the longest and pink one is the shortest.

Step 3 : Have the children learn how to observe in order that they can add the right length. Place the white sticks and the red ones in the centre of the whole circles so that all the children can reach. Let them begin from the circles 1 to 2 (orange to brown). Let the children in the circle 2 find out whether they should add the white or the red one to their stick in order to make it equal to the orange one. Ask the children who are in the circles 1, 3, 4, 5 to tell whether they are right or wrong. Ask the children in circles 1 and 2 to say that the orange one is the same length as the brown one which is added to the red one. Do it this way until the whole circle is completed.

Part 2

Time for teaching : 1 hour

Specific Objective : To help the children gain the concept of conservation of length.

Behavioral Objective : When the teacher places 2 pieces of linoleum of equal length in any manner, the children should be able to tell that the two pieces of linoleum are of equal length.

Materials : 5 pieces of linoleum of which 4 red ones are of equal length, the rest in brown is shorter.

Sequences of teaching

Section 1 :

I. Observation stage :

Step 1 : To compare 2 pieces of linoleum of equal length.

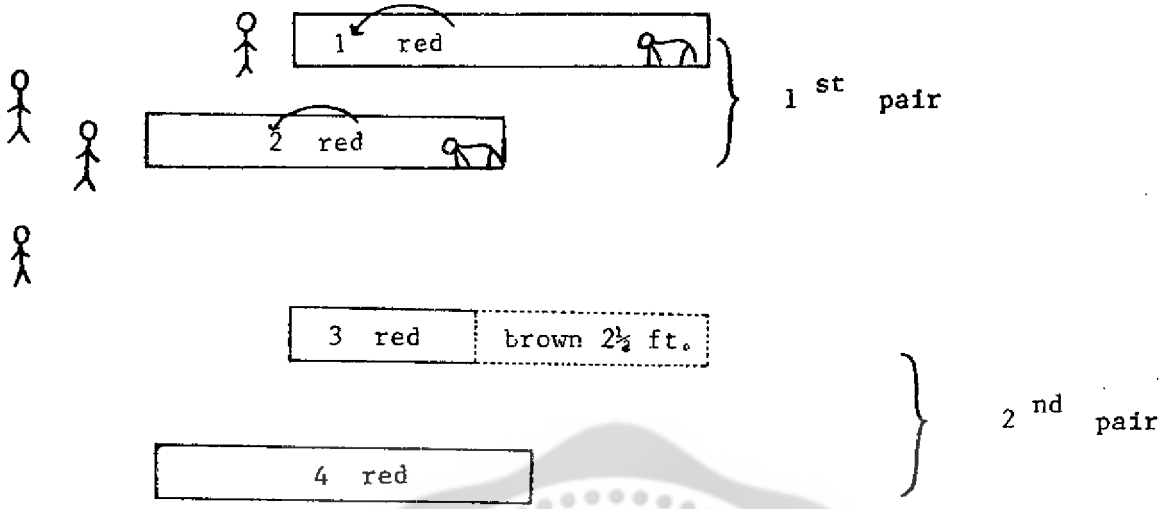
Teacher : a) put two pieces of linoleum in the same line, then ask whether they are equal. Let two children compete each other by means of crawling. Ask them to say that they both have gained equal distance in crawling although one can do it faster than the other (in case that both children do not reach the destination at the same time).

b) Let the same child crawl on both pieces of linoleum. Then ask whether the child has made the same distance in crawling through those two pieces of linoleum.

c) Move the two pieces of linoleum out of the line. Then, ask the students whether these two pieces are of the same length. This is intended to test whether the children have gained or have not gained any concept of the length.

d) In case that they have not gained the concept, let them repeat their crawling on both pieces of linoleum. Ask them again whether they have made the same distance in crawling through these two pieces.

Step 2 : To compare both pieces of linoleum, one is equal to the standard one used in step 1, the other is longer about $2\frac{1}{2}$ feet. (Use the brown one and the red one and stick these two together). Place the 4 pieces of linoleum in the following manner :



Teacher : "Is there any similarity or difference between the first pair and the second pair of the linoleum?"

Student s: We should see that all the 3 pieces are equal in length, and the rest consists of 2 color pieces attached together.

Teacher : Choose the children who made the same speed in crawling. Pick the pair who are used to involve in the first step and let them make another competition. Let other children reinforce the game by cheering their friends. The competitors are at the left side of the first red pair of linoleum (as shown in the picture). A question is asked which one will be the first to reach the other end of the first red pair of linoleum.

Students : May answer that the one on the piece no. 2 will reach later, because he has to crawl a longer distance than the one on the piece no. 1. (This is a wrong answer, because they do not have the concept.)

Teacher : Start the competition. In case that the teacher can pick the children with equal speed of crawling, they will reach at the same time (the children will know that they have made the wrong answer). Then, the teacher moves the same competing couple to the second pair of linoleum. Ask the cheering ones to point out which one will reach later, because he has to go a longer distance.

Students : Point at the piece of linoleum no. 4. (The reason is that because they look at the case in the same manner as they have pointed at the piece of linoleum no. 2 in the first pair. That is, they look only at the left side. But in the actual outcome, the child on the piece of linoleum no. 3 will reach later because that piece is longer.)

Teacher : Let each child crawl on the pieces of linoleum no. 3 and 4. Then, ask them which one has covered more distance.

II. Explanation stage :

Teacher : "Why in the last time, your friends reach the end of linoleum at the same time, but why this time they reach at different time?"

Student s: (Should have noticed the extended pieces of linoleum and can point this as the reason) "It is because the piece of linoleum no. 3 is actually longer."

Teacher : "How about the last time? You guessed that the one on the piece of linoleum no. 2 would reach later because the piece of linoleum was longer, but why your two friends reached at the same time?"

III. Prediction stage :

Teacher : "How can we know whether the first or the second pair are equal in length?"

Students : "Put these two pieces in the same line." This can be proved by moving and comparing both pairs of the pieces of linoleum.

Teacher : "Now if we have those of equal crawling speed to compete one another on the first pair and the second pair, which pair will have one reaching earlier and the other later? Who is the one to reach later?"

Students : The ones on the first pair will reach at the same time. The ones on the second pair will reach at different time. The one to reach later is that on the brown piece which is stuck to the red piece.

IV. Control stage :

Teacher : Move both pairs of the linoleum in the testing situation. That is, to have the pieces of linoleum overlap one another. Then, the teacher points at the overlapping sides and ask, "If we have the ones who crawl at the same speed to compete on the first pair and the second pair of the linoleum, in which pair they will reach at the same time and in which pair one will reach earlier, the other later. ?"

Students : "The first pair will reach at the same time, but not the second pair. The one on the piece of linoleum no. 3 will be the last one to reach.

Section 2 :

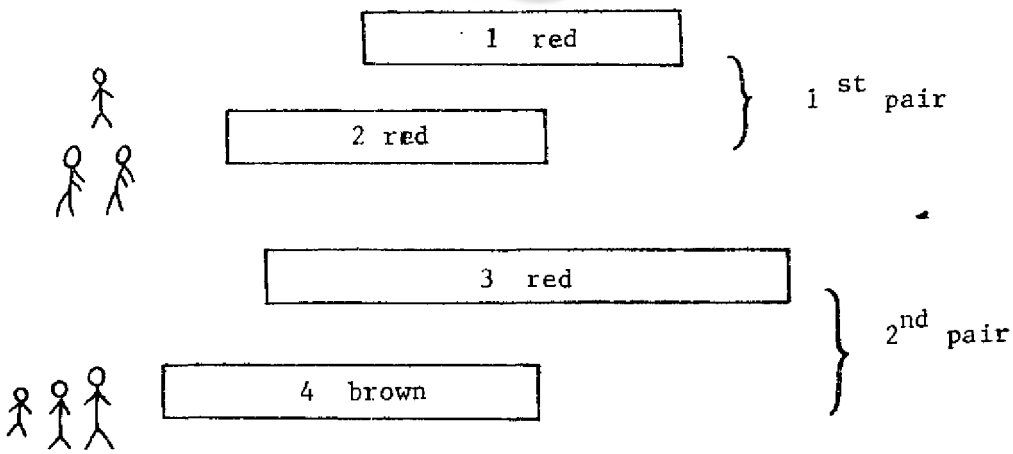
The teaching in the second section is to evaluate the outcome of the teaching in the first section.

Step 1 : To compare two pieces of linoleum of equal size.

a) Place them in the same line. Let the children compete their crawling again, then ask the other pair with the same speed of crawling to prepare themselves.

b) Use a testing situation in order to test whether the children have gained any concept of length.

Step 2 : Make comparisons according to the following pictures.



Teacher : Ask the couple of children who have equal speed in crawling in stage 1 to make another competition. Ask the rest of the group to cheer. The competitors are at the left end of the linoleum (as shown in the picture). The teacher then asks the group which one will reach the end of the linoleum first.

Students : Should answer that the one on the piece of linoleum no. 2 will take more time to reach as he has to go through a longer distance than the one on the piece of linoleum no. 1 (this is a wrong answer because it indicates that they do not have the concept).

Teacher : Let the children start the competition. In case that the children crawl at the same speed, they will reach at the same time (the children will then realize they have made a wrong guessing). The teacher asks the same couple to compete on the second pair of linoleum. Ask the cheering group to point out who will reach later, because he or she will have to go for more distance.

Students : The one on the piece of linoleum no. 4 (should be so, because they perceive the situation in the same way as they did when they pointed at the second one in the first pair. That is, to look only at the left side). In the competing situation, the children on the piece of linoleum no. 4 will reach the end so fast (contrary to the observational stage in the section 1).

Teacher : "Why did they arrive at the same time, and now why does this one (on the piece no. 4) crawl faster than the other (the one on the piece no. 3)?"

Students : (Should be able to notice that the piece no. 4 is elusively longer than the piece no. 3 just for the part extended at the left side. Actually the piece no. 4 is much shorter than the piece no. 3.) "It is because the piece no. 4 is much shorter than the piece no. 3"

Appendix XV

Lesson 3

The Concept of Seriation

Part 1

Time : 1 hour.

General Objectives :

(1) To teach pupils the concept of "high", "low", "higher", "lower" as well as "highest" and "lowest".

(2) To enable the pupils to stand in line in order of their height.

Behavioral Objectives :

(1) Observing a game called "Ngoo kin hang."*

(2) Analysing, i.e. discriminating properly "low" from "high" and "lower" from "higher".

(3) Arranging a row of their peers in proper order of different height.

---

*A game, "Ngoo kin hang", (litterally an eating–up–a snake's–tail, which in fact means a snake's young) is generally known and played among Thai children of school age. To play the game, a number of children of relatively different height stand in a row of proper order, one behind the next higher, keeping their hands on the hips of the one in front to make a chain of the snake family. The tallest child at one end of the row is supposed to play the snake mother's role. The shortest child at the other end takes the part of the youngest snake. Another child, more often a boy, is supposed to be a male snake roaming for food. When he comes to see the mother snake with a chain of her youngs, he tries by someway or other to get the little young snake for his victim. The mother snake, with all her attempt keeps all her youngs behind her and protects them from the enemy's reach. At the same time all the youngs also make an attempt to keep themselves far away from the touch of the enemy. As soon as any one of the youngs becomes his victims, the game ends.

Materials : Pupils in the classroom.

Sequences of teaching

I. Observation Stage :

Teacher : "Who knows or has ever played a game called Ngoo kin hang"?

"For those who have ever played it, please come up and stand overthere (at the left hand side of the classroom). For those who do not know it, come and stand here (at the right hand side). Come on."

(The group that has ever played the game is then divided into two subgroups.)

"Now, you, this group (one of the two subgroups) show your friends how to play the game. All the rest look at them. Go ahead, please."

Students : (The assigned group first arrange a row among themselves and play the game. The other two groups observe)

Teacher : (Asks the second subgroup who knows the game.) "Are your friends playing the game properly?"

Students : "Yes" (If the row their friends make is in an orderly graded type; the tallest stands at one end and the shortest at the other end).

"No" (If otherwise).

Teacher : (In case the first subgroup has not done properly, the teacher asks the second subgroup to play the game. They may be helped if they are awkward.

In case the first group has done properly, the second subgroup will be asked to show the unproper performance. They might question themselves how it could be done. However the teacher may help put somebody in a wrong place, (e.g. the tallest and the shortest are placed in the middle of the row) and asks the group who do not know the game.

"Do you notice whether the correct performers and the incorrect performers are different? How?

Students : For the correct group, they arrange the row in a proper order. They put the tallest at one end of the row. The second is shorter, and the shortest among all stands as the last at the other end. But, for the incorrect group, the row is disorderly arranged."

II Explanation Stage :

Teacher : "Why do you think that those who play the game properly must set the row of themselves in the form that the tallest takes the first place at one end, the second, third, fourth and so on are shorter and shorter towards the other end of the row, and the last one is the shortest among all?"

Let one who knows the game answer the question. It will help those who have never known the game previously understand the reason more clearly.

Students : "The tallest one suits the mother position. The next will be the eldest young. The others will be the second, third, fourth and so on childen of the family. The last one is the youngest."

Teacher : "Why can't the tallest take the second position and the shortest become the fourth?"

Students : "No. It cannot be like that. It is incorrect."

Teacher : "Is the youngest brother (or sister) the tallest or the shortest?"

Students : "The shortest."

Teacher : "Is the youngest brother (or sister) the first or the last of the row?"

Students : He (or she) must be the last.

III. Prediction Stage :

Teacher : "Now you all know that the enemy snake are trying to eat up a snake young, and the mother protects her youngs with all her attempt. Which of the youngs will easily become the victim? Why?"

Students : "The youngest one, because it is the last behind."

(The correct answer is, "the smallest one, because he (or she) will not be able to run away from the enemy's reach as fast as the other siblings can do.)

Teacher : "Well, if the youngest one come to stand next behind the mother and the eldest takes the last position, would it be easily for him (or her) to be caught ?"

Students : "It makes no difference, for the last one must be caught first."

(This answer indicates the wrong prediction)

Teacher : "Well, let's try and see."

(Arranging two different row of children.* For one type of row. the very tall child stands next to the mother, thereafter shorter and shorter. The last one is the shortest. For the other type of row, the smallest child stands next to the mother, followed by taller and taller children towards the end. The tallest is the last of all. Then let them play the game. The result should come out this way. The smallest at the end of the row is arrested sooner than the tallest, when he (or she) stands at the same place.)

"What happens ? Who is caught sooner ? Why ?"

Students : The smallest is, because of his (or her) short legs. With her (or his) longer legs, the eldest can manage to run away."

(In case the smallest is unusually quick, it is necessary to find the tall one of equal ability. The teacher may ask the children to run a race and choose two of the same ability among them.)

(For the correct answer which means correct prediction) :

Students : "It is more difficult for the tallest to be caught, because he (or she) has longer legs and runs faster."

Teacher : "Well, let's see."

(It needs proofs. So try out with the same process as above.)

"Very good. You can predict it well."

---

*It may be done with one group of children, who will be asked to play the game once in one type of row, and the other time in another type of row.

IV. Control Stage :

Teacher : "If you play this game with somebody else who does not know our secret today, and you yourself are the mother snake, how will you arrange the row to make it difficult for the enemy to seize your young, from the tall to the short one or from the short to the tall one.?"

Students : "From short to tall."

Teacher : "In case you are the enemy snake, will you like the row to he arranged in the same order? Why?"

Students : "No. I shall set it from tall to short, so that it is easy for me to get my victim."

Part 2

Time : 2 hours.

Objectives : (1) To enable the pupils to see the difference between two types of arrangement of some instruments. One type is an orderly arrangement with a regular rate of increase in size, and the other type with an irregular rate of increase. The pupils should also be able to give reasons.

(2) To enable the pupils to predict the equal rate of increase in the regular type, and the unequal rate in the irregular type.

(3) To enable the pupils to arrange any objects in both types of order.

Materials :

(1) Two wooden rods of different colours and different lengths.

(2) A set or well size – graded wooden rods of different colours.

(3) A set of wooden rods of different colours and of various lengths.

(4) Three toy – staricases of regular steps.

(5) A toy – staircases of irregular steps.

(6) A number of wooden blocks.

(7) A piece of thread.

Sequences of teaching

I. Preparational stage :

Teacher : "Now, all of you look at these two pieces of wood. (The two pieces of wood are different in length. The blue one is longer than the red one). Which one is longer?"

(The teacher holds the two wooden rods, blue and red, together with keeping one end of the rods on the same level.)

Students : "The blue one is."

Teacher : (Gives the rods to the pupils and asks);

"How do you know which is longer?"

Students : (Keep the rods close together and level one end of them)

Teacher : "Now, measure the back of your chair with your hand. How long is it?"

(While the pupils are doing as assigned, the teacher also does herself, and lets the pupils notice the difference of the results that come out from the different measuring tools. The teacher then, gives one of the rods to the pupils and asks them to measure the chair with it. With the same rod, the teacher also measures the same chair herself).

Students : (Draws a conclusion) "The rod works better than our hands."

II. Observation Stage :

Teacher : (Calls up 2 children. One pupil is given a set of coloured rods of various lengths. To the other pupil, a set of coloured arithmetic stairs, well size – graded wooden rods, is given.)

"Now, listen to me. Each of you, try yourself putting what are given to you on my table and arrange them in the way that you will play the Ngoo – kin – hang game with them. The class. watch them, please."

(Eventually, the two children bring about two patterns of arrangement. The child who has the set of "arithmetic stairs" with him carries out a pattern of regular rises. The other child carries out a pattern of irregular rises, since he has in his hand the set of rods that are of various length.)

"Well do the two patterns of arrangement produced by your two friends look alike? If alike, how? If not alike, how?"

Students : "No, they are not. This (the "arithmetic stairs") looks like stairs, but that has irregular rises, though there is rise from short rods to tall ones."

For wrong answer :

Students : "They are alike, because they rise from short rods to the tall ones."

Teacher : "What does this (the "arithmetic stairs") look like at your house? You climb up and down every day."

Students : "Stairs"

Teacher : "Does that (the one of irregular rises) look like stairs?"

Students : "No, it does not. It has steps but it is not stairs."

III. Explanation Stage :

Teacher : "Why doesn't one of those pattern look like the other one?

(Correct answer) :

Students : "All steps are of the same length for this toy staircase, and for that one they are of various length."

(Wrong answer) :

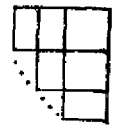
Students : "The rods are of different length."

(This answer is categorized as wrong, probably because the child does not use proper terms in his description, although he already has the concept. Let's move to the stage of prediction).

IV. Prediction Stage :

Teacher : "If you close your eyes and climb up the two staircases, which one will you stumble and fall?"

(This question is meant to see whether the pupil can imagine the dotted line in the picture)



(Correct answer) :

Students : "When climbing up the one that does not look like stairs."

(Wrong answer) :

Students : "I can climb both without any trouble. I feel it. I feel every step."

Or : "I fall down both, because you tell me to close my eyes."

(For wrong answer) :

Teacher : "If you climb the stairs at your house, do you need looking at them or feeling them?

Students : "No"

Teacher : "Why not"

Students : "Because I climb up and down every day"

(This answer indicates that the pupil understands the point, but he cannot conclude.)

Teacher : "If you climb this staircase (the 'arithmetic set'), why do you think you will fall when you close your eyes?"

Students : "Because I am not used to it."

Teacher : "Are the stairs at your house and this (the 'arithmetic set') alike or are the stairs at home smaller?"

Students : "They are about the same size"

Or : "They are smaller"

Or : "They are larger."

Teacher : (Making other two staircases with a number of the wooden blocks so that the steps of one set are smaller and those of the other are larger than the steps of the 'arithmetic set'.)

"Now, we have at the moment 3 sets of stairs, one of small steps, one of medium and the third one of larger steps. Which one is the easiest to climb up?"

Students : "That with small steps."

Teacher : "Why?"

Students : "Because my legs are short."

Teacher : "If your legs were as long as mine, would those staircases be equally easy for you?"

Students : "Yes, they would"

Teacher : "If you close your eyes and climb these sets of stairs, are they equally easy or equally difficult?"

Students : "That of small steps is the best"

(This indicates that the children still connot imagine the dotted line. They think of other variable—'height' instead of 'equality'.)

Teacher : "What do you do when you want to know whether things are equal."

Students : "Measuring them."

Teacher : Well, now try to think cerefully. If we measure the length between these two points (a and b in the picture) with a piece of thread I bring with me, and between these two points (b and c, are they equally long? If they are, why?

Correct answer should be:

Students : "Yes, they are, because they look equally long."

Wrong answer:

Students : "No, they are not"

Teacher (To both who give correct and wrong answers)

"Well, measure them by yourself."

Students : "Ah! They are equal."

Teacher : "Now, measure the other two sets of stairs, please, and see whether the steps rise equally."

Students : (After they have actually measure the rises.)

"They are equal."

Teacher : "Now, I shall blindfold you with a piece of cloth. (The pupils may be asked to close their eyes instead. The teacher brings the 4 toy-staircases up and lay them down in front of the pupils. The rises of the 3 staircases are of three different sizes. Each one has its own size, short, medium and long. For the fourth one, it holds various sizes of steps alternatively.)

"Well, suppose you have 4 sets of stairs in front of you. Try to climb up on them, but please use your fingers. Don't peep at them either."

Students : (The first thing that the pupils can do should be feeling the staircases with their hands until they are quite certain how the stairs are. For the one of short rises, they do not raise their finger high when they move it from one step to the other. For the one of long rises, they raise their finger reasonably high to move from the first on to the second step. But, for the one of various sizes of steps, they have to feel at every step. Every one in the class will have an opportunity to experience these things and also sees how his peers do).

Teacher : "Well, now try again to answer my question. Which of the four staircases is the most difficult one for you to climb while you close your eyes? Why?"

Students : "The one with different sizes of steps is, because we cannot know beforehand which pair of steps are close together or far apart."

Teacher : "Do you remember what you answered me last time?"

Students : "Well, we fell on all staircases, or we had to feel all of them."

Teacher : "Then what do you think about these staircases? When the one of several sized steps is put aside, there will be only three staircases left here. Just now you told me that the one of small steps was the easiest when you climbed up with your eyes closed. By now you have tried it by yourself. Will you answer me once again which is the easiest for you? Why?"

Students : "They are all easy, because whatever type of stairs they are of, all steps within one set are of equal size. We then can predict the size of the next step."

V. Control Stage :

Teacher : (Giving the children the wooden blocks), "Well, now please build a staircase with these blocks."

Students : (The pupils should be able to carry it out, because the blocks are all of the same size. It is an easy thing to do. If they cannot do individually, they can work in groups, or can be helped by the teacher.)

Teacher : "Now, let's work together. Firstly, how many blocks do you want?"

(The teacher lays down one block first.)

Students : "One"

Teacher : "How many do we want for the second step?"

(Two blocks are laid down, one upon the other.)

Students : "Two"

Teacher : "Now you go on with the third step. How many blocks do you want?"

etc etc.

"Well, measure the distance between these points with this piece of thread and see whether they are of the same length."

Students : (Measuring) "They are."

Teacher : (Giving a number of pencils or candles of various lengths to the pupils.)

"Children, now please put the pencils (or the candles) in a proper alignment. It does not matter whether you start it with the shortest piece or the longest piece."

Pupils : (Getting the assignment done.)

Teacher : "Now, again we shall build a staircase with these pencils (or candles). How will you do?"

Pupils : (The pupils shold be able to carry it out by taking away the piece of unproper length, and leaving the pieces that give proper rises to form a proper staircase).

Teacher : (In case the pupils show some awkwardness, the teacher may suggest,) "Which piece should be taken out? Try."

Appendix XVI

LESSON 4

The Conservation of Substance

Time for first stage teaching : 8 hours.

Specific Objectives : The children are to understand that when an object is changed in shape the amount of substance is not changed.

Behavioral Objectives : After experience, the children are able to respond correctly that, when an object is changed in shape, the substance is still the same.

Materials : Plasticene blocks of the same volume in different colors.

Sequences of teaching

I. Observation step

First step :

Materials : 1. Green and yellow 1.5 x 2.5 cm. plasticene blocks of the same thickness.

2. 1 x 2 in. rectangular cardboard.

Teacher arranges lumps of plasticene into two rows, four piles in each row, two lumps in each pile.

First row  Green plasticene

Second row  Yellow plasticene

Teacher : "Is every pile of plasticene in the first row equal? Why?"

Students : "Equal." "Because there are the same two lumps."

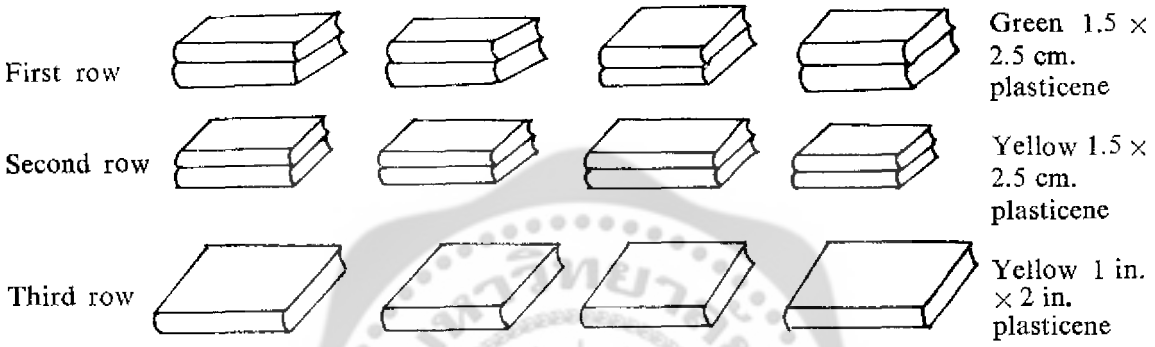
Teacher : "Is every pile of plasticene in the second row equal? Why?"

Students : "Equal." "Because there are the same two lumps."

Teacher points at the first pile of plasticene in the first row and the first pile of plasticene in the second row and asks if the piles of plasticene are equal. Do the same to the other three pairs.

Students : "Equal."

Teacher picks up four piles of plasticene from the second row and gives one pile each to four students. Then all students make the piles of plasticene into the size as the 1 in. × 2 in. rectangular cardboard. When all piles of plasticene are completely made, put them in the place of the previous second row. See the following picture :



Teacher : "Are all piles of plasticene from the third row equal?"

Students : "Equal." "Because they are the same size."

Teacher points at the first pile of plasticene in the first row and the first pile of plasticene in the third row and asks if the plasticene are equal. Do the same to the other three pairs.

Students : "Not equal." (wrong answer)

Teacher : "Why aren't they equal?"

Students : "Because this one is small but that one is big."

Teacher : "How many original lumps of plasticene are there of this (1 in. × 2 in.) block of plasticene?"

Students : "Two lumps."

Teacher : "Is this (1 × 2 in.) block of plasticene the same two original lumps of plasticene as the others from the first row?"

Students : "It's the same two original lumps of plasticene."

Teacher : "Do you throw some plasticene away when you make this 1 in. × 2 in. block?"

Students : "We don't throw any plasticene away."

Teacher : "Well, is this one (from the first row) the same mass as that one (from the third row)?"

Students : "Equal."

Teacher : "Why?"

Students : "Because they are the same original two lumps of plasticene. When we make them into 1 in. × 2 in. block, we don't throw any plasticene away."

Teacher points at the three next pairs of plasticene and asks if the quantities of plasticene are equal. The students should be able to answer and give the correct reasons.

Teacher points at the alternative pairs of plasticene from the first and third rows and asks if the lumps of plasticene are equal. The students should be able to answer and give the correct reasons.

Second step :

Materials : 1. Light blue and pink 1.5 cm. × 2.5 cm. plasticene blocks of the same thickness.

2. 1 in. × 2 in. rectangular cardboard.

Teacher puts the 1.5 cm. × 2.5 cm. blocks of plasticene in two rows, four piles of plasticene to each row. The piles of plasticene stacked in the first and second rows range from five, four, three to two piles of plasticene, respectively.

First row  Light blue 1.5 cm. × 2.5 cm. blocks.

Second row  Pink 1.5 cm. × 2.5 cm. blocks.

Teacher : "Is every pile of plasticene in the first row equal? Why?"

Students : "Not equal" "Because there are not the same number of lumps to each pile. There are five, four, three and two lumps of plasticene respectively. (The children may point to help their explanations.)"

Teacher : "Is every pile of plasticene in the second row equal? Why?"

Students : "Not equal, because there are not the same number of lumps to each pile. There are five, four, three and two lumps of plasticene, respectively. "(The children may point to help their explanations.)"

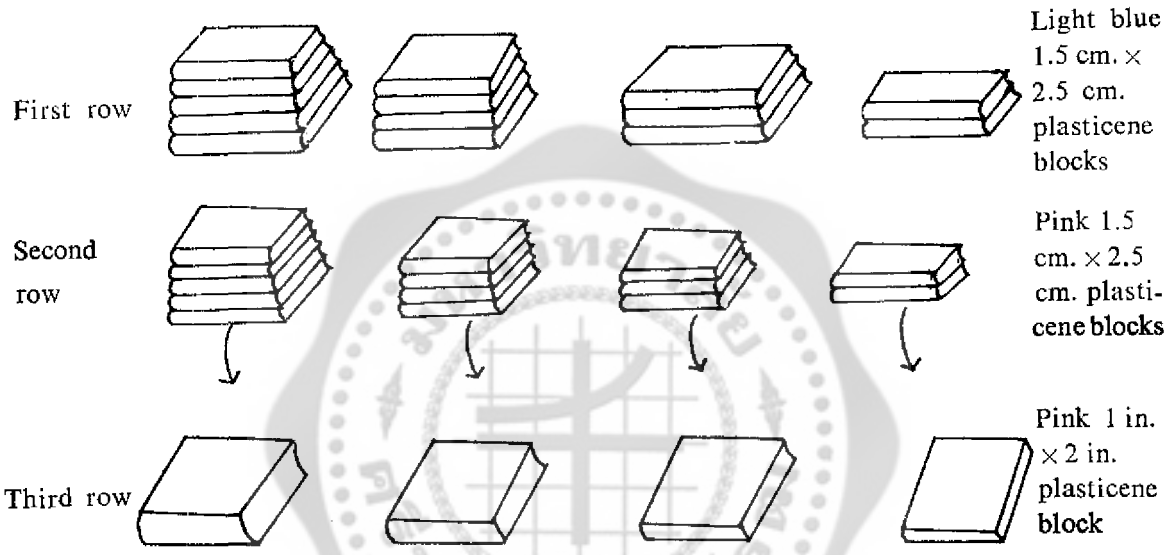
Teacher points at the first pile of plasticene in the first row and the first pile of plasticene in the second row and asks if they are equal. Do the same to the other three pairs.

Students : "Equal."

Teacher points at the alternative pairs of plasticene piles in the first and second rows and asks if they are equal.

Students : "Not equal."

Teacher picks up four piles of plasticene from the second row and gives one pile to each of the four students, then tells all students to make the pile of plasticene into the size of the 1 in. × 2 in. rectangular cardboard. When all piles of plasticene are made, put them in place of the previous second row. See the following picture:



(The same in length and width, but not in thickness.)

Teacher : "Is every lump of plasticene in the third row equal? Why?"

Student : "Not equal" "Because the first lump in the third row is the highest and the others gradually decrease in thickness, so the forth lump is the thinnest." (The children may not say the same words as in this sentence but in words of similar meaning.)

Teacher points at the first pair of plasticene blocks from the first and third rows and asks if the lumps of plasticene are equal. Do the same to the other three pairs.

The students should be able to correctly answer based on an understanding of the first stage.

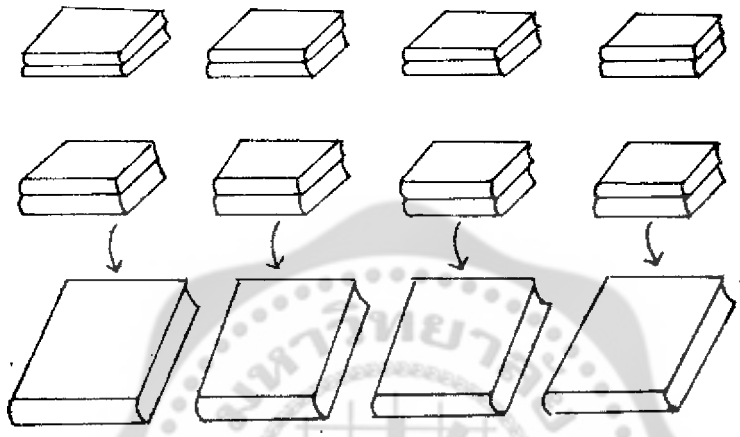
Teacher points at the alternative pairs of plasticene blocks and asks if they are equal.

Students : "Not equal." (right answer)

II. Explanation stage

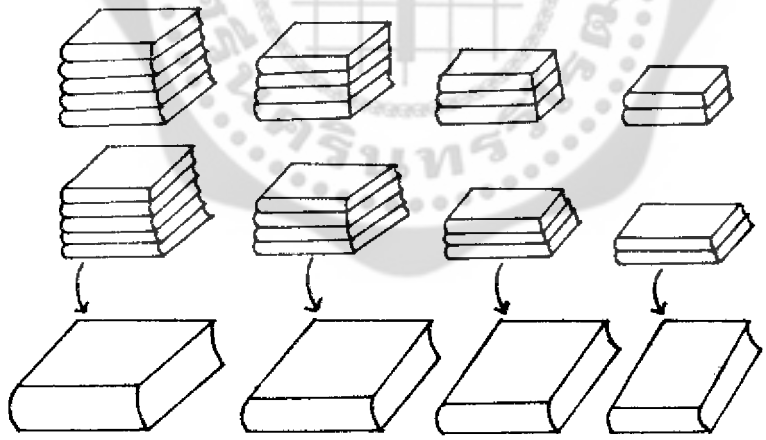
Materials in the first and second observation stages are still in place. See the following picture.

Materials in the first stage



The lumps of plasticene in the third row are of the same three dimensions.

Materials in the second stage



The lumps of plasticene in the third row are the same in length and width, but not in thickness.

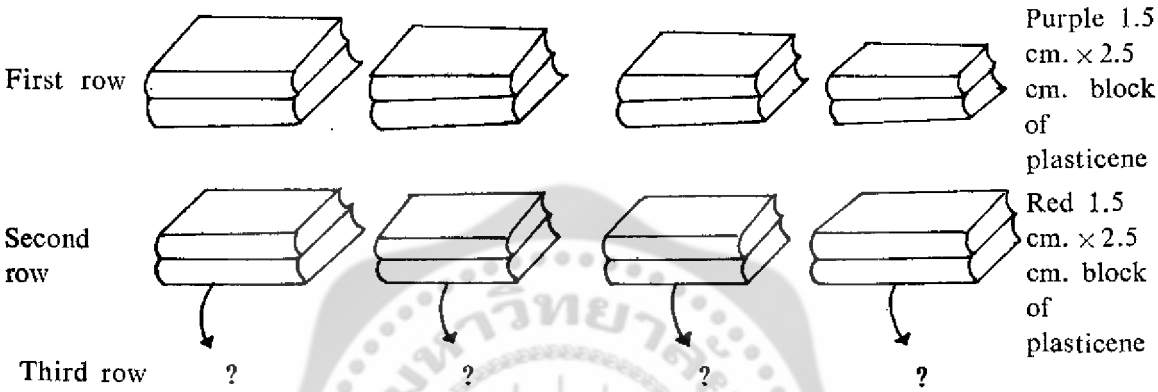
Teacher : "Why is this row (points at the third row in the first stage) the same in thickness but not the same as this row (points at the third row in the second stage) which gradually decreases in thickness ?"

Students : "Because the lumps of plasticene in this row (point at the third row in the first stage) are the same amount of plasticene when made into blocks which have the same length and width, so they have the same height too, but this

row (points at the third row in the second stage) are not of the same amount of plasticene, there are five, four, three and two lumps of plasticene in each pile, respectively, when made into blocks which are the same in length and width, they cannot have the same height."

III. Prediction stage

The materials are arranged according to the following picture



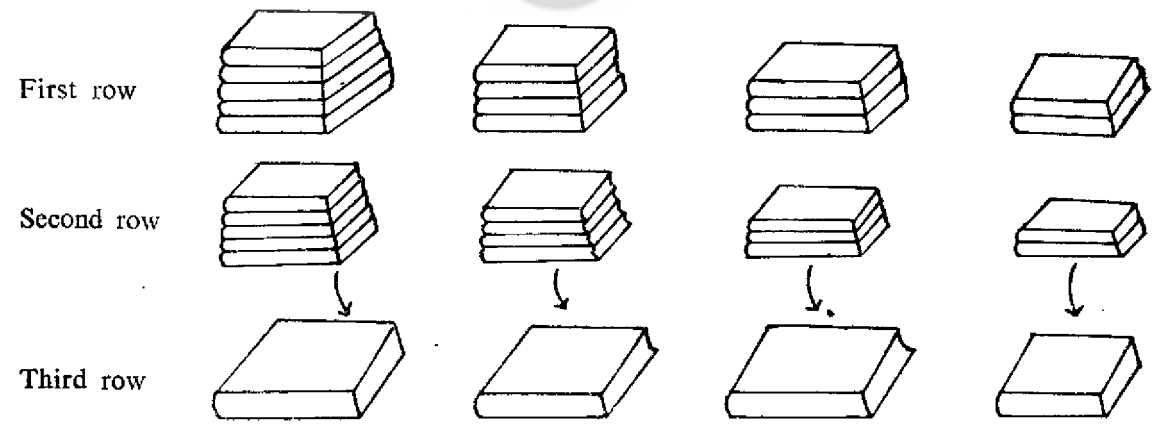
Teacher : "If the lumps of plasticene are shaped into blocks decreaseng in size, what happens to their thickness?"

Students : "Their thickness will be gradually increased." or "The lumps of plasticene range from the thinnest to the thickest."

Teacher tells the students to prove it empirically. After the proof, the students should be able to correctly answer that lumps of plasticene from the third row are equal, and can answer that the lumps of plasticene from the first and third rows (which are made from the second row) are also equal."

IV. Control stage

The materials are arranged according to the following picture.



The lumps of plasticene from the third row are the same in length and width, but not in thickness.

Teacher alternates the lumps of plasticene from the first row, as follows :

5, 3, 2, 4
or 3, 2, 4, 5
or 2, 5, 4, 3
.....etc.....

The students should be able to correctly match them from the first and third rows which have the same quantities of plasticene.

Time for second stage teaching : 4 hours

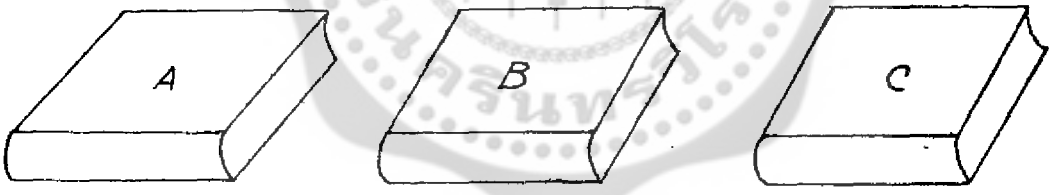
Specific Objectives : The children understand that when some the plasticene is changed in shape its quantity stays the same. (The objective of this stage is to have the children understood the principles of compensation and reversibility. In compensation, the children should understand that the small but thick lump of plasticene is equal to the big but thin lump of plasticene. For reversibility, the children should understand that if the lump of plasticene is returned to its original shape and size, its quantity is unchanged.

Materials : 1. Three lumps of 2.5 cm. × 3.5 cm. × 2.5 cm. plasticene.

2. Three sizes of cardboard : 2.5 cm. × 3.5 cm., 1.5 cm. × 2.5 cm. and 1.5 in. × 2.5 in.

I. Observation stage

Three identical lumps of plasticene as the following picture.

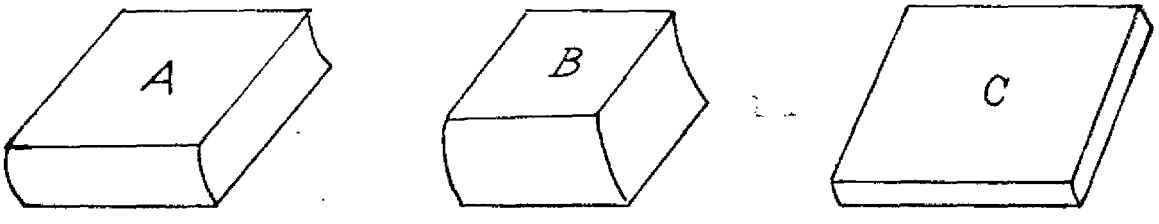


2.5 cm × 3.5 cm × 2.5 cm plasticene.

Teacher : "Are lump A, lump B. and lump C. equal ?"

Students : "Equal."

Teacher tells the students to make lump B the same size as the 1.5 cm. × 2.5 cm. cardboard and make lump C the same size as the 1.5 in × 2.5 in. cardboard.



Teacher : "Are lump B and lump C equal ?"

Students : "Equal"

II. Explanation stage

Teacher : "Why are they equal ?"

Students : "Because, at first, the plasticene in lump B and lump C were equal and, even if they were changed into another shape, they are still equal."

Teacher : "Do you have another reason ?"

Students : "No."

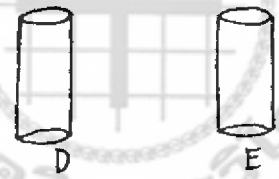
Teacher : "Look at lump B and lump C."
"How are they different ?"

Students : "Lump B is smaller but thicker than lump C, and lump C is bigger but thinner than lump B."

Teacher : Are lump B and lump C equal ?"

Students : "Equal."

Teacher : "Lump B is smaller, but lump C is larger. How are they equal ?"
The students can't give the reason, but still persist that they are equal. Teacher gives two identical lumps of plasticene called D and E. Lump D is pressed down but lump E is squeezed on the sides.



Teacher : "Are they different from before now ?"
"How are they different ?"

Students : "They're changed. Lump D is short but fat, but lump E is thin but tall."

Teacher : "Why are they like that ?"

Students : "Because when you pressed lump D down, the plasticene spreaded out which make it fat and short. On the contrary, with lump E, when you squeeze on the sides, the plasticene rose up which made it thin and tall."

Teacher : "Are they equal now ?"

Students : "Equal"

Teacher : "How do you know that they are equal ?"

Students : "Because, at first, they were equal. Lump D is short but fat, lump E is thin but tall, so they are equal."

Teacher : "Now, look at lump B and lump C again."
"Can you tell me why they are equal although they are not the same size ?"

Students : "They are still equal ; lump B is small, but very thick and lump C is tall, but very thin."

Teacher : "Can you prove that they are really equal ?"

The students can not prove it.

Teacher tells the students to make lump B and lump C into the same size as the 2.5 cm. x 3.5 cm. rectangular cardboard and then tells them to compare these three lumps.

Teacher : "How are these three lumps when compared ?"

Students : "All are equal."

Teacher : Why are they all equal ?"

Students : Because, at first, lumps A, B and C are equal. Then lump B and C are changed in shape and then are made the same as lump A. All are still equal."

Teacher : "If someone wants you to prove that the two lumps of plasticene are equal, how can you do it ?"

Students : "Make them back into the original shape and size."

Teacher returns to the original situation and asks if lump B and lump C are equal.

The children should be able to give reasons representing all the three categories of thought patterns if they understand this lesson. The three categories are :

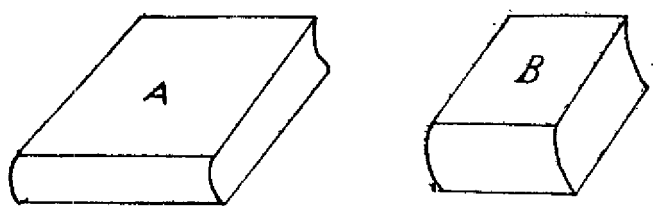
(A) Identity category : "Lump B is equal to lump C, because, at first, they were equal. Though they are changed into different shapes and sizes, they are still equal."

(B) Compensation reason : "Lump B is equal to lump C, because lump B is small but thick, lump C is large but thin."

(C) Reversibility reason : "Luump B is equal to lump C, because if we make lump B and C back into their original shape and size, they will be equal."

III. Prediction stage

Teacher lays out two identical lumps of clay as the following picture.



Teacher : "If I make lump A larger, what happens to its thickness ?"

Students ; "The thickness decreases. The lump of plasticene is flatter."

Teacher : "If I make lump larger, is lump A or lump B thicker ?"

Students : "Lump B."

Teacher : "If I make lump B smaller, what happens to its thickness ?"

Students : "The thickness increases. The lump of plasticene is taller."

Teacher : "If I make lump A larger and lump B smaller, which one is thicker ?"

Students : "Lump B."

The students should be able to answer that lump A and B, which are changed in shape and size, are still equal and be able to prove it.

IV. Control stage

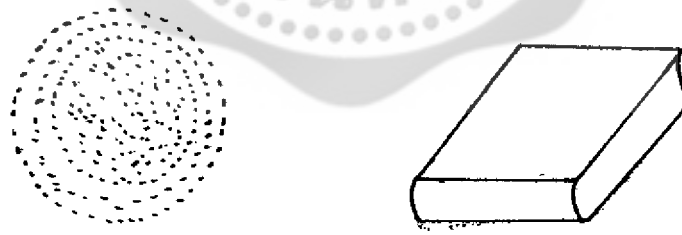
Teacher lays out two identical lumps of sugar as in the following picture.

First lump. Second lump.

Teacher : "Are these two lumps of sugar equal ?"

Students : "Equal."

Teacher crushes the first lump of sugar and asks if it is equal to the second lump of sugar.



First lump. Second lump.

Students : "Equal" (right answer)

"Not equal" (wrong answer)

Appendix XVII

LESSON 5

The Conservation of Continuous Quantity (liquid)

Part 1

Time for teaching in the preparational stage : 30 minutes

Specific Objective : To have the children see the dissimilarity of the containers' shapes (shallow but wide, long and wide, long but narrow, and shallow and narrow.)

Behavioral Objective : The children should be able to correctly identify the differently shaped containers when asked by the teacher.

Materials :

1. Two large bowls, one of water and one of sand.
2. Two buckets with handles (for teachers).
3. Four little buckets with different colours (for children).
4. Objects for teaching.
   a) Four sets of cylindrical plastic boxes. In each set there are six different sizes, ranging in size from big to small.
   b) Four cylindrical plastic boxes. All are medium sizes.
   c) Twenty coloured plastic glasses.
   d) Some long glasses.
5. One soap box.
6. Containers in different sizes.
7. One big flower print cooky mold and one small flower print cooky mold, and rabbit cooky mold.

Sequences of Teaching :

First stage :

Put the objects from items 4, 5 and 6 in the middle of the room or the group.

Divide the children into four groups : bright, average 1, average 2, and dull. Have them pick up the containers. Each group picks up one kind of containers (shallow and narrow, long but narrow, long and wide, and shallow but wide) and picks up one piece at a time.

The teachers check the containers. If the students picked the containers with the wrong shape for their group, have them decide which group they should give those containers to. Train them to say the words that characterize the shapes of the containers.

Second stage :

Have the high intelligence group and the low intelligence group choose the containers that they will use with sand from item 7 (the 'khanom' molds) The teachers observe how they mold the sand in the molds. If they do not know how to mold the sand, the teachers teach them and then let them do it by themselves.

Have the two groups of average children take the containers to two corners where there are two large bowls containing water. There are also containers of the same size in each corner. The teachers follow the children to the corners. The children in the above average group compete with each other in dipping up water from the bowl to put into their buckets. The teacher points out that they lost the game because they used small containers, and the other side won the game because they used big containers. The teacher in the below average group lets the children play freely but always asks them whether the water dipped up by big containers is more or less than the water dipped up by small containers.

The teachers alternate the children and make sure that the three groups have involved in the activities in all three corners. There is one exception for the bright group which can be taught directly without being in the water corner where there is no competition. (After the lesson, they can play in that corner if they want to.)

Part 2

Time for the first stage teaching : 8 hours

Specific Objective : To have the children understand, be able to explain, and be able to generalize the idea that if the same amount of water are poured into similarly shaped containers, the water will reach the same level. But if the amounts of water are not equal, the levels in the containers will not be the same.

Behavioral Objectives :

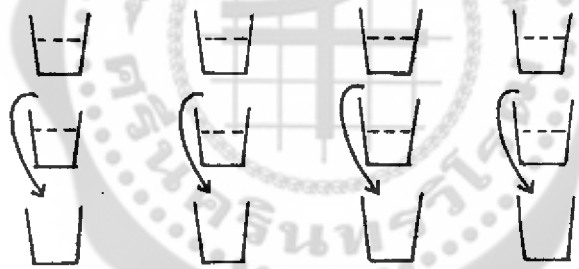
1. When the same amounts of water are poured from one container into other container which is similar in shape and size, the children should be able to tell that the level of the water will not be different.

2. When the same amounts of water are poured from a container into other container which is different in shape but equal in size, the children should be able to tell that the level of the water will not be different.
3. When the differing amounts of water from a container are poured to other container which is similar in shape and size the children should be able to tell that the level of the water will be different.
4. When the differing amounts of water from a container are poured into other container which is dissimilar in shape but is equal in size, the children should be able to tell that the levels of water will be different.
5. If differing amounts of water are poured into containers which are shaped differently from the containers in the learning situation, the children should be able to predict the difference in the levels of the water.

Materials :

Twelve glasses equal in size and shape. There are equal amounts of water in the first eight glasses. The teacher puts these glasses in two rows, four glasses to each row. The third row has four empty glasses.

(See the following picture.)



Sequences of teaching :

I. Observation stage :

First step :

A situation is created in the way by which the amounts of water and sizes and shapes of the containers are kept invariable.

Teacher : "Is the water in all the glasses from the first row equal ?"
"Is the water in all the glasses from the second row equal ?"
Point at the first glass of the first row and the first glass of the second row and ask if the water is equal. Do the same to the other three pairs.
The students should answer that it is equal.

Teacher : Pour the water from the glasses in the second row into the glasses in the third row, one by one.

"Is the water in all the glasses from the third row equal ?"

Point at the first glasses of the first row and the third row and ask if the water is equal. Do the same to the other three pairs.

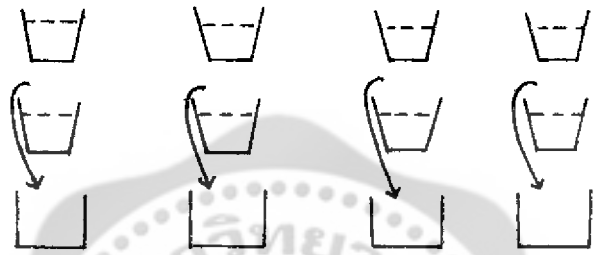
Children : "Equal."

Materials :

Eight glasses equal in size and shape containing the same amounts of water and four shallow but wide plastic boxes.

Put the glasses of water in two rows (four glasses to each row). The third row are the four empty plastic boxes.

(See the picture below.)



Second step :

A situation is created in the way by which the amounts of water and the sizes of the containers are kept invariable, but the shapes of the containers are changeable.

The teacher pours the water from the glasses in the second row into the boxes in the third row (one by one).

Teacher : "Is the water in this box equal to the water in this glass (the first glass in the first row) ?"

Children : "Not equal." (wrong answer)

The teacher points to the next pair of glasses and boxes.

Teacher : "Is the water in this glass equal to the water in this shallow but wide box ?" Ask the same to other two pairs.

Children : "Not equal." (Wrong answer)

Teacher : "Is the water in all shallow but wide boxes equal ?" Always stress on the word "but".

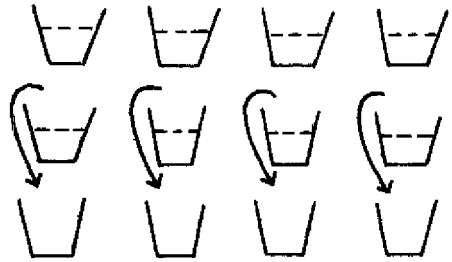
Children : "Equal."

Materials :

The same as the first step.

Put the glasses in three rows (four glasses to each row). All glasses in the first and the second row contain water ranging from large amount to small amount and each pair has the same amount of water. The third row lies empty glasses.

(See the picture below.)



Third step :

A situation is created in the way by which the amounts of water are variable but the sizes and shapes of containers are invariable.

The teacher pours the water from the glasses in the second row into the glasses in the third row, one by one.

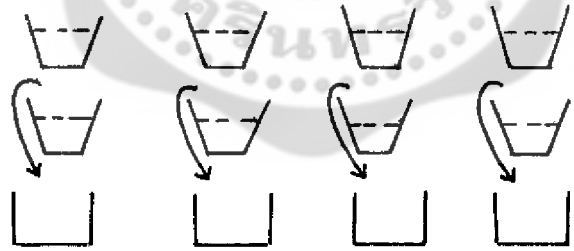
Teacher : "This pair." Point at the first pair of glasses in the first and the third row. "Is the water equal ?" Do the same to the rest by comparing them in pairs.

Children : "Equal."

Materials :

Two rows of four glasses containing water ranging from large amount to small amount, and one row of shallow but wide plastic boxes, all are equal.

(See the picture.)



Fourth step :

Create a situation in which the amounts of water and the sizes of the containers are variable but the shapes of containers are invariable.

The teacher pours the water from the first glass in the second row into the first box in the third row.

Teacher : "Is the water in this shallow but wide box equal to the water in this glass?"

Children : "Not equal." (wrong answer)

The teacher does the same to another three pairs.

Children : "Not equal." (wrong answer)

Teacher : "Is the water in all shallow but wide boxes in this row equal ?"

Children : "Not equal." (right answer)

Teacher : "How do you know that it's not equal. ?"

Children : "It ranges from small amount to large amount."

Materials :

The containers in all four stages are set out in the same manner as they were in the previous stages.

Teacher : "How is the water in these shallow but wide boxes in this row ? (Point at the third row in the second step.) Is it the same or different from the water in these shallow but wide boxes in this row ? (Point at the third row in the fourth step.)"

Children : "Different. The water in these shallow but wide boxes in this row (point at the row in the fourth step) ranges from large amount to small amount, but the water in these shallow but wide boxes in this row (point at the row in the second step) is equal."

Fifth step :

Compare the second step situation with the fourth step situation.

II. Explanation stage :

Teacher : "Why is it like this ? Why is it that in this row the water is equal but in this row the water ranges from small amount to large amount ?"

Children : "The water in the shallow but wide boxes in this row (the row in the second step) was poured from glasses (point at the empty glasses in the second step) that had contained water which was equal (in level). But the water in the shallow but wide boxes in this row (the row in the fourth step) was poured from the glasses in this row (point at the empty glasses in the fourth step) and the glasses had previously contained water which was not equal (in level.)"

Notice :

This explanation refers only to levels of water, equal or not equal, that the children can see. But it does not mean to the children that the amounts of water are exactly equal. Take a careful note on the children's language and record what they have said. This will help the instructors be able to determine later on the time when the students have the concept of the conservation of continuous quantities.

III. Prediction stage

Materials :

Use the containers from the third step but alternate the glasses by putting them in order ranging from small to large amounts of water and exchange the shallow but wide boxes with the new empty ones.

The children should be able to predict how high the water level in each shallow but wide box will come up. They can prove this by pouring the water into each box.

Sixth step :

Teacher : "If we set the glasses containing water ranging from small amount to large amount, how will the level of the water in each box be ?"

IV. Control stage

Seventh step :

Teacher : "If we don't have this new set of shallow but wide boxes (take the boxes away and point at the containers in the fourth step which contain water ranging from large amount to small amount), how can you prove that the levels of water in these boxes will range from low to high ?" The teacher arranges the glasses in the fourth step so that the levels of water in the glasses range from low to high.

The children : 1) should be able to think of it in reverse by switching the shallow but wide boxes containing water in different order from small amount to large amount as they had already observed what the teacher did before.

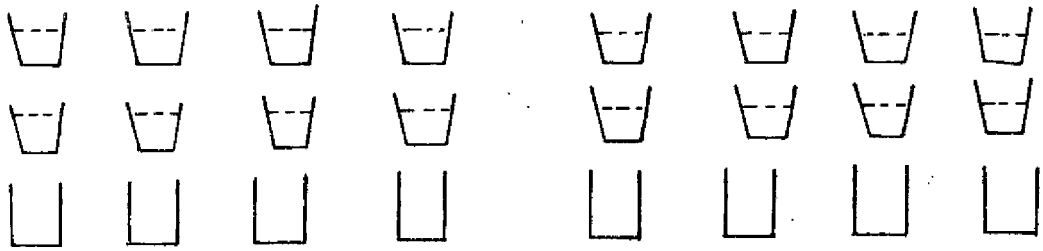
2) may pour the water from the shallow but wide boxes back to the empty glasses in the second row in order to prove that the levels of water are equal. (Let the children guess before pouring.)

Notice : These two items are probably hard for many children. The teacher can help them by arranging the glasses in different forms many times for the questions in the control stage. Do item 1 slowly and when the children can arrange the shallow but wide boxes correctly help them to prove item 2. The teacher can ask the students to predict how the level of water will be if the water is poured back from the shallow but wide boxes, which contain the least amount of water, to the first empty glass in the second row, (the expected answer is : "The level of water will be the lowest.")

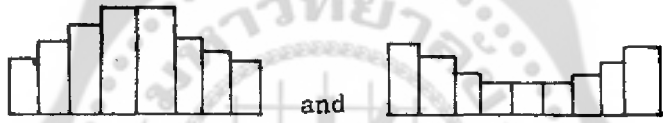
Eighth step :

Set up a situation like the second and the fourth steps by changing the glasses in the third row to long glasses.

Material : See the following picture :—



Teacher : "If we pour the water from the shallow glasses into these eight long but narrow glasses, how can we arrange the glasses so that the levels of the water in these glasses will be in the forms as follows :



(Draw the picture on the blackboard)

The children should be able to arrange the empty glasses into both forms by writing the numbers of the glasses in the correct order. If they cannot do it, let them pour the water and experiment for themselves.

Part 3

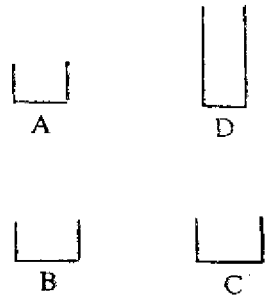
Time for teaching in the second pariod : 4 hours.

Specific Objective :

When equal amounts of water are poured into dissimilarly shaped containers, the amounts of water are still equal. The aim of this teaching is to have the children understand the principles of compensation. That is to know that the water in a wide glass will spread out over a wider area and that the level drops to a lower level, and that the water in a long, narrow glass will rise to a higher level. That is, the volume of the water which is spread out is equal to the volume of the water which is high and narrow. If, on the contrary, the water is poured back into the original, equal glasses, the levels will be equal.

Materials :

Four glasses as in the picture.



Sequences of teaching :

Observation stage :

Teacher : "Is the water in glass A equal to the water in glass B ?"

Children : "Not equal."

Teacher :

"If I pour the water from glass A into glass C and from glass B into glass D, will the water in glass C and in glass D be equal ?"

Student : "No."

Explanation stage :

Teacher : "Why isn't it equal ?"

children : "Because in the first place the water in glass A and in glass B was not equal."

Teacher : "That's right. If in the first place the water in glass A and in glass B was not equal, then no matter in what glasses you pour the water into it will stay equal."

"If I pour the water to glass A and make it equal to the water in glass B , then pour the water from glass A to glass C from glass B to glass D, then will the water in glass C and in glass D be equal or not ?"

Children : "Equal."

Teacher : "How do you know that the water in these two glasses is equal ?"

Children : "It is equal because the water in glass A and in glass B was previously equal."

Teacher : "Do you have another reason ?"

Children : "No"

Teacher : "Look at the water in this glass (point at the water in glass ()
How is the glass ?"

Children : "It's wide."

Teacher : "That's it. Because the glass is wide, so that the water will spread out over a wider area and the level will drop to a lower level. but how is this glass ?

(point at glass D )"

Children : "Narrow."

Teacher : "Right. This glass is narrow. When we pour the water into it, the water will rise to a higher level. The situation is the same as when you take two identical dolls made of plasticene. When one is pressed down, he will get shorter and fatter. When the other doll is squeezed on the sides, how will he be ?"

Children : "He'll be taller."

Teacher : "That's it. Are two persons previously equal ?"

Children : "Yes, they are."

Teacher : "How are they now ?"

Children : "One is fat, but the other is thin."

Teacher : "Is the fat one short or tall ?"

Children : "Short."

Teacher : "How about the thin one, short or tall ?"

Children : "Tall."

Teacher : "Now one of them is fat and short, the other is thin and tall.
How were they before ?"

Children : "Equal."

Teacher : "How are they now, are they equal ?"

Children : "No."

Teacher : "Why ?"

Children : "One is fat but the other one is thin."

Teacher : "One is fat but short, and the other one is thin but tall, right ?"

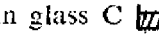
Children : "Yes."

Teacher : "The fat part has spread out, the thin part has risen up, are both parts equal ?"

Children : "Yes."

Teacher : "So is the short but fat person equal to the thin but tall one ?"

Children : "Yes."

Teacher : "Now let us see the water in glass C  and the water in glass D 

Is the water in these two glasses equal ?"

Children : "Yes."

Teacher : "Why ?"

Children : "Because glass C is wide and shallow, but glass D is narrow and long."

Teacher : "Very good. Glass C is wide and shallow, but glass D is narrow aad long. If there is a person who doesn't believe that the water in these two glasses is equal because it seems that the water in this glass (C) is only here (the teacher points at the level of the water)  but the water in this glass (D) is up here (point at the level of the water)  , it's not equal at all. How can we prove to him that the water is equal ?"

Children : (Silent.)

Teacher : "Watch carefully. I'll prove it for you." The teacher pours the water from glass C and glass D back into glass A and glass B, one by one. "Do you think that the water in this glass (A) and this glass (B) is equal or not ?"

Children : "Equal."

Teacher : "Now, if someone wants us to prove to him that the water in glass C  is equal to the water in glass D  how will you do ?"

Children : "Pour the water from glass C  and glass D 

to glass A  and glass B  one by one."

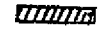
Teacher : "Very good. If we pour the water back to the original glasses, then will the water be equal ?"

Coildren : "Yes."

Teacher : "Is the water in glass C  and the water in glass D  equal ?"

Chileren : "Yes."

Teacher : "Why ? I don't believe that it's equal."

Children : "Because if we pour the water from glass C  to glass A  and the water from glass D  to glass B  the water will be equal."

Teacher : "Now, how should we explain that the water in glass C  and glass D is equal ?"

The children should be able to give reasons representing all the three categories of thinking patterns if they understand this lesson. The three categories are :–

a. *Identity category* "The water in glass C is equal to glass D because the water in glass A and glass B is previously equal, so when we pour it to glass C and glass D it must be equal."

b. *Compensation category* "The water in glass C is equal to the water in glass D because glass C is wide and shallow but glass D is long and norrow.

c. *Reversibility category* "The water in glass C is equal to the water in glass D because if we pour the water in glass C and glass D back into glass A and B then it will be equal."

Teacher : "Any body likes to give me the reasons ?"

The children will be requested one by one to give the teacher the reasons.

Prediction stage :

The teacher takes a big glass and a small glass, then pour the water into them at the same level as indicated in the picture.

E F

Teacher : "Do you think the water in glass E is equal to the water in glass F ?"

Wrong answer :

Children : "Equal."

Teacher : "How do you know that the it is equal ?"

Children : "Because it is equal."

(If the children answer like this, it means that they still don't get the concept, and the teacher has to go back to teach them the explanation stage again.)

Right answer : .

Children : "Not equal."

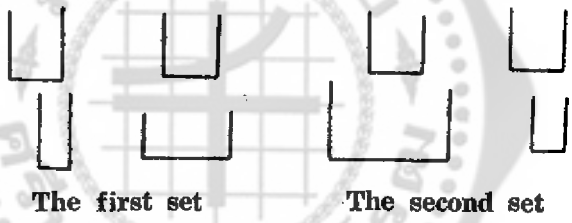
Teacher : "How do you know ?"

The children pick up two equal glasses from the teacher's table and pour the water from glass E and glass F into them one by one. They will find out that the water is not equal.

Control stage :

Use 8 glasses which are :-

- a test tube (narrow but long)
- the biggest plastic box (wide and long)
- a cylindrical plastic box (narrow but shallow)
- a cylindrical plastic box (narrow and shallow)



Teacher : "How much do we put the water into the glasses from the first row (both sets but ask one set at a time) in order to make it equal when we pour it into the containers in the second row."

(Have the children bring the water.) The children should be able to give a good estimate.

Appendix XVIII

LESSON 6

The Conservation of Weight

General Objective :

To have students form a concept of conservation of weight. This is to prepare the children's readiness and basic experience to develop the concept of conservation of weight.

Time for teaching : 1 hour.

Specific Objectives :

1. To have students know their weights by comparing theirs with the others.
2. To have students understand the concept of equilibrium.
3. To enable students to estimate an equilibrium of the objects which weigh the same.
4. To enable students to estimate an equilibrium of the objects which have the same quantity.

Behavioral Objectives :

1. When a student weighs himself and sees his friend's weight, he should be able to tell that his friend's weight is heavier or lighter than his.

2. When students play a boat-shaped "rocking chair" (invented playing equipment), they should be able to tell which side of the "rocking chair" will tilt to (the fatter student's side or the skinner student's side). And in order to balance the "rocking chair", they will know that they have to put another skinny one to the heavier side aud another fat one to the lighter side. Have them use the word "balance".

3. When two objects are made known to weigh the same, students should be able to predict that the scale will be balanced when each of these objects is put on each side of the measuring scale.

4. When oriented to know objects which are of the same quantity but of different weight, the students should be able to predict that there will be no balance.

Sequences of teaching :

Stage 1 :

Material : A spring balance, or a scale

Method of teaching :

1. To have one student on a scale and let the others observe their friend's weight and shape.
2. To have the second student guess his own weight. If he is on the scale, will he be heavier or lighter than the first one ?

   And what is the reason ?

Stage 2 :

Material : A boat–shaped "rocking chair"

Method of teaching :

1. Have one student sit on the side of the "rocking chair" and let the others observe his weight and his shape.
2. The teachers select other children and let the other children choose the one among them to sit on the other side in order to balance the "rocking chair".
3. Teach the students to understand the measuring of "balance" and learn to use this word properly.
4. Have two students sit on the one side of the "rocking chair", and try to get it balanced by choosing two other students whose weights are about to the former ones' weight on the other side.

Stage 3 : Vary quantity but control weight.

Materials :

a) A spring balance, a boat–shaped "rocking chair", and a "haap" (two wooden baskets with a long stick to carry, making the weight suspended from both ends).

b) Kapok, lotus–seed and sand (each of them is one kilogram).

Method of teaching :

1. Have students weigh all the materials.
2. Have students guess : If one kilogram of lotus–seed is put on one side of the spring balance and one kilogram of sand is put on the other side, which side will it tilt to ? Let the students carry the "haap". Put the two kinds of materials on the balance as well as on the "rocking chair" too. This is to make students understand isomorphism of the measuring scale, the "haap" and the boat–shaped "rocking chair".
3. Verify.

(To have students take turn to carry the "haap" if they are interested.)

Stage 4 : Vary weight but control quantity.

Materials : Kapok, lotus–seed and sand : all of them are of the same quantity.

Method of teaching :

1. To have students guess that if they put these materials (kapok, lotus–seed and sand) in different combinations on the "haap", (each pair of kapok, lotus–seed and sand) which side of the "haap" it will tilt to.
2. To verify.

Time for teaching : 2 hrs.

Specific Objectives :

1. To have students change their incorrect concept that weight depends on size. The students learn to realize the fact that although there are some objects which are small and light, big and light, big and heavy, there are still some other objects which are small but heavy, big but light.
2. To have students perceive the idea that the objects which are of equal size and quantity, will be equal in weight when they are of the same kind of materials.
3. To have students know that the same kind of objects, which are equal in quantity but variable in shape, will still be equal in weight. This kind of understanding means that the students learn to have a concept of conservation of weight.
4. To have students relate this concept to mathematics and science subjects.

Behavioral Objectives :

1. When the teachers give students different kinds of the objects which are small and light, big and heavy, they should be able to have correct guessing on the weight of these materials. But, when these objects are small but heavy, big but light, they would make incorrect guessing on the weight of the objects. They should learn that the weight does not depend on size but rather depends on the kind of materials.
2. When the students are given the same kind of objects which are of equal quantity contained in the same shape and the same size vessels, they should be able to make a correct guessing on the weight of the objects. But if the students are given different kinds of objects contained in the same shape and the same size vessels, they would make incorrect guessing on the weight of the objects. Finally, the students should be able to form a concept that weight does not depend on size but depends on the kind of materials.

3. When the teachers give students the same kind of objects of different quantities in the same shape but different size containers the students should be able to make correct guessings both on the weight and the material of the objects. But, when the students are given the same kind of the objects of equal quantities in the same shape but different size vessels, they would make incorrect guessing on the weight of the objects (in case that they do not have the concept of the conservation of weight). They should learn that the weight of the same material of objects does not depend on shape but depends on quantity.

4. When the teachers give students a new situation in mathematics and science, they should be able to use explanatory words, rules or the concept of conservation of weight, to describe various new situations.

Sequences of teaching

Observation stage :

Step 1 : Let the students observe different objects which are small and light, big and heavy.

Materials : Kapok contained in the smallest box.
Sand contained in the biggest box.

Method of teaching :

1. To have students guess which one is heavier, the kapok box ()

   or the sand box. ()

2. to have students balance and observe and carry things on the "haap".
3. To have students guess which object is heavier, and which one is lighter.
4. To verify
5. To have students hold the kapok box and say that it is small and light, and to have them hold the sand box and say that it is big and heavy.

Step 2 : Small *but* heavy
Big *but* light

Materials : The biggest kapok box. () kapok The smallest sand box. ( )

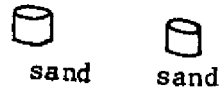
Method of teaching :

1. To have students guess which one is heavier, the kapok box () or the sand box. ()
2. To have students balance and observe and carry the "haap".
3. To have students guess what object is heavier, and what object is lighter.

4. To verify.
5. To have students hold the kapok box and say that it is big but light, and to have them hold the sand box and say that it is small but heavy.

Step 3 : Same material of objects which are of equal size and weight.

Material : Two sand boxes which are of equal size.



Method of teaching :

1. To have students guess which one is heavier than the other one or they are equal.
2. To have students carry the "haap" balance and observe.
3. To have students guess what object is in the box.
4. To verify.
5. To have students say that the same kind of sand when put in the same size boxes, they are equal in weight.

Step 4 : Objects which are equal in size, but different in kind and weight.

Materials : Kapok and sand are in two boxes that are equal in size and shape.

Method of teaching :

1. To have students guess which one is heavier than the other one or they are equal.
2. To have students carry the "haap" balance and observe.
3. To have students guess which kind of objects is in the box.
4. To verify.
5. To have students say that when the two equal boxes are filled up with different kinds of materials, the weights of these two boxes will differ.

Step 5 : Vary the quantity of sand.

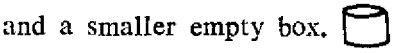
Materials : Sand contained in the middle size box and in the smaller box.

Method of teaching : The sequential steps are the same as in the fourth step (item 1–4.)

5. To have students say that although the material of objects is sand, the weights of the objects are different when the material varies in quantity.

Step 6 : Vary the size of vessels, but keep the quantity of sand constant.

Materials :

1. Two equal boxes (used in the third step) containing the same amount of sand.
2. A big empty box and a smaller empty box. 

Method of teaching :

1. Pour sand into two empty boxes.
2. To have students observe the levels which are different
3. To have students guess which one of the boxes is heavier than the other one.
4. If they guess that the boxes are equal in weight, they are right. Since it is clear that just merely the big box is heavier than the other box, so the teacher does not have to put these boxes on the scale for verification.
5. If their answer is wrong, the teachers will turn back to the fifth step. This is done so in order that the students will be able to explain that when the quantities of sand differ, the weights will not be equal. Then, the students are asked to compare the results with those in the sixth step.

II. Explanation stage :

Teacher : "Why is the sand of different levels equal in weight ?"

Student : "It is equal in weight, because it is shown in the beginning that it is equal. We do not add anything to it. (An answer of this type is considered to be identity reasoning.)

"It is equal in weight, because this sand box is high but narrow while the other sand box is short but bigger." (An answer of this type is considered to be compensation reasoning.)

"It is equal in weight, because if we pour the sand back, it will be equal in quantity." (An answer of this type is considered reversibility reasoning.)

III. Prediction stage :

To have students prove the sixth step by using plastic sac instead of boxes. In case that the scale cannot be used, let the students try to carry the materials and tell the teacher about their feeling towards the weight which are supposed to be equal at one end in the front and at the other end in the back.

Request the students to think in the above mentioned three patterns of thinking. If there is no response like "The teacher does not add anything, so it is still equal", the teachers should delay this stage until the teaching comes to the first step of the control stage.

IV. Control stage

Step 1 :

Materials : Three pairs of sponges which are of the same size.

Method of teaching :

1. To have students feel the weight of two sponges which are of the same size. Then, have them tell that they are equal.
2. Teachers dip a sponge in the water, and squeezes it moderately so that it will not be too wet. Then she asks the students if they are equal in weight or they are not.
3. To have students answer and prove it by holding the sponge which was dipped in the water, and the other one which was not dipped. This is to make them feel the differences of the weights of sponges. (The teachers can use a scale to prove it, although it does not yield definite accuracy.)

Step 2 :

Materials : The wooden plate consisting of many circular forms which are divided in fraction by fixed quantity.

Method of teaching :

1. Ask students that the circular wood plate in each ring will be equal or unequal in weight. (If students have the concept of weight, they will answer all divided plates are equal in weight. The teachers should demonstrate clearly to the students that each divided plate weighs the same.
2. Have students tell that all divided plates are equal in weight.
3. Verify.

Appendix XIV

Lesson 7

Class Inclusion (Animal)

Part 1

Teaching time : 2 hours.

Objectives and purposes of the lesson :

1. Pupils should get to know the set of reptiles and the set of aquatic animals, by judging from their related characteristics.
   Moreover, they should be able to discriminate between the animals in reptile set and the animals in aquatic set.
2. Pupils should be able to understand set and subset. In the other word, they should understand that the reptile and aquatic animal are subsets of all animals.

Materials :

1. 3 dimension and 2 dimension pictures of various kinds of animals, for example :
   - Set of reptiles : snake, crocodile, lizard, turtle, frog, chameleon, skink, snapping turtle, etc.
   - Set of aquatic animals : fish, crab, lobster, shell, etc.
   - Set of animals : pig, buffalo, dog, cat, etc.

Teaching stages

I. Observation stage :

Put animals (picture and 3 dimension things) on the table. Divide the children into 2 groups.

Stage 1 : In order to get the concept of snake, the teacher add various characteristics of snaks until pupils can answer the question correctly.

Teacher : "What creature eats small toads as his food ?"

Pupils : (Some of them answer immediately and some still keep silent.) The teacher should stimulate them to talk together.

Teacher : "The creature we mentioned above, has long body without tail."
"It is harmful, some kinds of them may bite us to death."

Pupils : "Snake."

Teacher : "That's correct." The teacher then gave score to the group.

The teacher should see whether this answer came from all pupils in group, or from only one pupil in group. If not by all pupils in group, the teacher should ask further question like, "Do you agree with the answer just now?" and let them talk together till all of them agree to the answer.

Stage 2 : This stage aims to make pupils know more about various kinds of snakes (by using De Cecco's method) step by step, for instance:

1. Demonstrate the picture of snakes, showing structure with other details, for example, snake's skin, etc.
2. Give the illustration of snakes.
3. Give the illustration of toy or simulate snake, for example, an ell.

Stage 3 :

This stage aims to stress the related characteristics of reptiles.

Teacher : "What creature moves his body by creeping ? what is creeping ?"

Pupils : Show the way to creep by their hands.

Teacher : "This kind of animal is harmful and it bites people to death. What is it ? Does it have legs ? Can you guess ?"

Pupils : "Snake has no legs."

Teacher : "Correct, very good."

"Then, can you guess another one ? We have it in here. It has long body. It moves by crawling. How do we crawl ?"

Pupils : demonstrate how to crawl.

Teacher : "Correct, what is it ? Does it have legs ? Can you guess ?"

Pupils : Keep silent.

Teacher : "Do you know skink ? Skink looks like snake but it has four legs."

Pupils : "I have never seen it."

Teacher : "Can we call skink and snake 'snake' ?"

Pupils : "No, we can't."

Teacher : "What do we call these two altogether ?"

Pupils : "We call them reptiles."

Teacher : "Can we say that centipede is a reptile ?"

Pupils : "Yes, we can."

Teacher : "What creature lives both in water and on earth. When it is in water, it swims. Do you know how to swim ?"

Pupils : Demonstrate how to swim.

Teacher : "That's correct. When it is on earth, it slowly crawls with four legs. Can you guess what it is ?"

Pupils : "Turtle."

Teacher : "Can we call turtle a reptile ?"

Pupils : "Yes."

Teacher : "That's correct. Can we say that turtle is an aquatic animal ?"

Pupils : "Yes."

Teacher : "That's correct. Can we call centipede an aquatic animal ?"

Pupils : "No, we can't."

Teacher : "Is snake an aquatic animal ?"

Pupils : "No, it isn't."

Teacher : "Are centipede, snake and skink, altogether, called reptiles ?"

The teacher puts the pictures of centipede, snake and skink together.

Pupils : "Yes, they are."

Teacher : "Within these 3 kinds of animals, which one can swim ?"

Pupils : "Snake and turtle."

Teacher : "Can snake and turtle dive ?"

Pupils : "Yes, they can."

Teacher : "Are they still alive in water and also on earth ?"

Pupils : "Yes, they are."

Stage 4 :

This stage aims to stress the related characteristics of aquatic animals.

Teacher : "What creature lives in the water ? It can swim and can be edible."

Pupils : "An eel."

Teacher : "Does the eel die if we let it stay on the ground ?"

Pupils : "The eel can stay on the ground but not so long, because it can't stand dryness."

Teacher : "Does the eel crawl when it moves ?"

Pupils : "Yes, it does, but in water."

Teacher : "Do we call the eel reptile ?"

Pupils : "Yes, we do." (incorrect answer)

Teacher : "Is the eel able to live both in water and on the dry like snake ?"

Pupils : "No, it can't."

Teacher : "Is the eel a reptile or not ?"

Pupils : "Eel is an aquatic animal,"

Teacher : "What creature has long body and lives in the water? It also has clamps on the part of the head and also the claws."

Pupils : "A lobster."

Teacher : "Does the lobster crawl along the water floor or swimm or does both of the two things?"

Pupils : "It does both of two things."

Teacher : "Is lobster a reptile?"

Pupils : "Yes, it is." (Incorrect answer)

Teacher : "Does the lobster die, if it stays on the dry land?"

Pupils : "It dies."

Teacher : "Then, is the lobster a reptile or an aquatic animal?"

Pupils : "It is an aquatic animal."

The teacher, in case pupils cannot answer the questions, tries to mention the names of aquatic animals, name by name.

Pupils : cannot answer the quastions.

Teacher : "Can the eel crawl?"

Pupils : "It may crawl along the floor of the canal, but it may swim."

Teacher : "Then; is the eel an aquatic animal or reptile?"

Pupils : "It is an aquatic animal."

Teacher : "How about lobster, does it crawl?"

Pupils : "Yes, it does."

Teacher : "Can we call lobster a reptile? Why?"

Pupils : "No, we can't. Because the lobster crawl and it lives only in the water. It'll die it stay on land."

Teacher : "Then, what shall we call lobster?"

Pupils : "We call it an aquatic animal."

Teacher : "If we put the animals together in one pile like this, we can not say that it is a pile of aquatic animals or a pile of reptiles. Then, what shall we call it?"

Pupils : "We can call it a pile of animals." (In case the pupils can answer correctly, put them to prediction stage immediately.)

In case pupils can't answer correctly, the teacher may ask, "Is a snake an animal? Is an eel an animal? etc. The teacher may also ask, "If we call every animal an animal, can all of these animals be called "animals"?

Pupils : "Yes, they can."

Teacher : "Why ?"

Pupils keep silent.

Teacher : "When we call them animals. do we say that they are reptiles or aquatic animals ?"

Pupils : "No, we don't."

Teacher : "If we don't. Then, it means that reptile is an animal and also the aquatic animal. Is that correct ?"

Pupils : "That's correct."

Teacher : "For this reason, all creatures we pile together are called animals. That's because we didn't mention their related characteristics for example, the way they crawl or the way they stay in the water. Is that correct ?"

Pupils : "That's correct."

II. Explanation stage :

Stage 1 :

Teacher : "Why do we call a snake, a centipede and a turtle, reptiles ?"

Pupils keep silent.

Teacher : "Among snake, centipede and turtle, which one moves by crawling and which one moves by creeping ?"

The teacher asks pupils to demonstrate how centipede, snake and turtle move.

Teacher : "Why do we call snakes, centipedes and turtles reptiles ?"

Pupils (talk together) : "Because snakes, centipedes and turtles crawl."

Stage 2 :

Teacher : "Why do we call eels and lobsters aquatic animals ?"

Pupils : "Because snakes can swim but they do not live in water. Many snakes live out of water."

Stage 3 :

Teacher : "When we put snakes, centipedes, turtles, eels and lobsters together in one pile, can we call this a pile of aquatic animals ?"

Pupils : "No, we can't. That's because centipede is not an aquatic animal. Snake is not an aquatic animal, because it can live out of water. Some snakes live on land and do not live in water."

(In case pupils do not understand the words related basic characteristics, the teacher should use, "They have something similar," instead.)

Stage 4 :

Teacher : "Among animals which live in water, what do they have in common ?"

Pupils : "They live in water."

Teacher : "What else ?"

Pupils : "They'll die if they live out of water. They can swim and breathe in water. They won't be drawned."

Teacher : "Excepts eels and lobsters, what else are aquatic animals ?"

Pupils : "Shells, crabs and other kinds of fish."

Teacher : "Can crabs stay very long out of water ? Can they live out of water forever ?"

Pupils : "No, they can't."

Stage 5 :

Teacher : "What do reptiles have in common ?"

Pupils : "They can creep, or crawl. Some of them can stay both in water and out of water. Some of them can stay only out of water."

Teacher : "Apart from snakes, turtles, centipedes, what else can creep or crawl ?"

Pupils : "Skinks, chameleons, crocodiles,monitor lizards and edible ground lozands."

III. Prediction stage

Stage 1 : (Put pictures of some other animals together with the picture of aquatic animals.)

Teacher : "If we pile up the pictures of aquatic animals, then put the pictures of some other animals into it, can we call this a pile of aquatic animals ?"

Pupils : "No, we can't."

Teacher : "For what reason ?"

Pupils : "That's because centipede lives on earth. It can't live in water. It will be drowned."

Stage 2 : (Put the pictures of other animals together with the pictures of animals.)

Teacher : "If we mention only animal without considering about their similarities, can we put any kinds of animal into this pile ?"

(Keeps the picture of centipede with the pictures of aquatic animals.)

Pupils : "Yes, we can."

Teacher : "Why ?"

Pupils : "Because we didn't mention aquatic animals. And because they are all animals."

The teacher points at the pile of aquatic animals in which there is a picture of centipede.

Teacher : "Shall we call all of these, animals or aquatic animals ?"

Pupils : "Animals."

Stage 3 : To compare between a pile of reptiles and a pile of aquatic animals.

Teacher seperate reptiles and aquatic animals into 2 piles.

Teacher : "Now we have a pile of aquatic animals and a pile of reptils. Let's compare. Which one has more animals ?"

Pupils : "The pile of reptiles has more because in it there are snakes, centipedes, and turtles (there are 3 kinds of animals). But the pile of aquatic animal has only eels and lobsters (There are only 2 kinds of animals).

Stage 4 : To compare "Animals" to "Reptiles" by using two piles of pictures.

Teacher : "If I say animals, can we mix these two piles together ?"

Pupils : "Yes."

Teacher : "Then, do it."

The pupils did as the teacher said.

Teacher : "In case we intend to compare between the reptiles only, which pile of animals can be compared to this pile of animals ?" (The teacher prepares one more pile of reptiles, for example, snakes, centipedes, turtles and crocodiles mixed with some other animals.)

Pupils should seperate the reptiles and put them together in a pile. In case they don't do this, the teacher should suggest that they do.

Teacher : "If we have two piles like this, which one has more, animals or reptiles ?"

Pupils : "Reptiles."

Teacher : "See, what do we have in common in both of the two piles ?"

Pupils : "We have turtles and reptiles."

Stage 5 : To compare "animal" to the reptiles in the same pile

Teacher : "If we take the same animals out of the pile, and then put the rest of them into one pile, what shall we call this new pile ?"

Pupils : "We may call it a pile of animals."

Teacher : "Are there any reptiles in the pile of animals ?"

Pupils : "Yes, there are."

Teacher : "Which do we have more in this pile, animals or reptiles ?"

Pupils : 1. "Animals, because there are 6 animals and 4 reptiles."
(Must be correct answer, go to control stage.)

2. "Reptiles are more because there are 2 animals and 4 reptiles." (Must be incorrect answer.)

Teacher : "What do you call these (Showing the pictures of an eel and a lobster), animals or aquatic animals ?"

Pupils : "We may call animals or aquatic animals."

Teacher : "How about 4 kinds of reptiles ? Can we call them animals ?"

Pupils : "Yes, we can."

Teacher : "When we say "animals", how many of them are there ?"

Pupils : "There are 6."

Teacher : "In case we compare the number of animals to reptiles, which are more ?"

Pupils : "Animals are more." (correct answer)

Stage 6 : In case the pupils give the incorrect answers, the teacher should start this stage by repeating the lesson in stage 3. In doing so the teacher should see that the number of reptiles and the number of aquatic animals are equal, then divide the animals into 2 piles.

Teacher : "Which pile is smaller (Teacher points at the pile in which reptiles and aquatic animals are mixed.)

Pupils point at the pile of reptiles.

Teacher : "What do you call the smaller pile ?"

Pupils : "We call it a pile of reptiles."

Teacher : "What do we call the bigger pile ? Can we call it a pile of reptiles ?"

Pupils : "No, we can't. Because there are also aquatic animals in it."

Teacher : "Then, what should we call ?"

Pupils : "A pile of animals."

Teacher : "Which are more, reptiles or animals ?"

Pupils : "Animals."

Teacher : "How many kinds of animals are there ?"

Pupils : "Six kinds."

Teacher : "How many kinds are the same as those in the other pile ?"

Pupils : "3 kinds."

Teacher takes the same kinds of animals off the pile and puts the rest of animals into that pile.

Teacher : "Which are more in this pile, animals or reptiles ?"

Pupils : "Animals, because there are 6 kinds of them but there are only 3 kinds of reptiles. (correct answer)

"Reptiles are more because there are 3 kinds of them but there are only 3 kinds of aquatic animals. (Incorrect answer). The teacher should repeat this process until the pupils give the correct answers. Stop the process when seeing that they haven't yet had the concept of inclusion.

The purpose of this process is to prepare the experience for pupils in arraning the picture of various kinds of animals and pile them correctly. Also, pupils should have ability to see the distinction and relation between animals in small group and the whole group.

Stage 7 :

Teacher : "If the eel dies, are any other animals still alive ?"

Pupils : "Yes, they are."

Teacher : "For example ?"

Pupils : "For example, fish, lobsters, shells and crabs, etc."

Teacher : "In case all aquatic animals die by the pollution of water, are there any animals left ?"

Pupils : "Yes, there are still land animals, birds and reptiles left ?"

Teacher : "In case all animals die, what should be left ?"

Pupils : "Non any left."

(In case they can't answer correctly, repeat the process of animal inclusion again.)

IV. Control stage

Stage 1 : The teacher uses wild animals, for example, lion, giraffe, elephant and biting animals such as lion, snake, centipede, etc.

Teacher : "In this pile of animals, which are more, animal, or biting animals ?"

Pupils : "There are more animals." Teacher uses butterflies, pictures of birds and some quadruped.

Teacher : "Which are more, birds or animals ?"

Pupils : "The animals are more."

Part 2

Teaching time : 2 hours.

General Objective : The pupils should be able to form the concept of combining subsets to the whole set.

Specific Objectives :

1. The pupils form concept by De Cecco's stages.

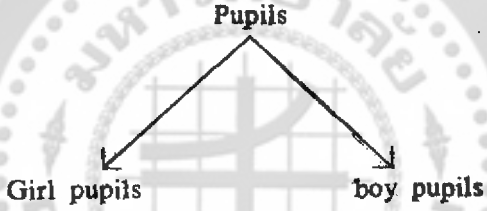
2. The pupils should be able to classify and compare a subset to another.
3. The pupils should be able to classify and compare the subset to the whole set.

Behavioral goals :

1. Within the situation in which 2 subsets of things are included, pupils should be able to discriminate these 2 subsets. Then they should be able to name them by subset or by whole set.
2. When pupils are given the situation in which 2 subsets are included, they should be able to tell and compare the sizes of the two subsets.
3. Within the situation in which the whole set is included, pupils should be able to compare it with the subset without seeing the subset.

Teaching stages :

Stage 1 : Teaching of the structure of concept.



I. Observation stage

Teacher divides the pupils into 2 groups. One group is named "Observing group" (the able) and "Observed group" (the unable). There are the same number of pupils in the two groups. The teacher asked the "Observing group".

Teacher : "We are going to divide the other group into two groups. What shall we do ?"

Pupils : "Divide them by sex."

II. Explanation Stage :

Teacher : "Why ?"

Pupils : "Because some of them are girls and some are boys"

III. Prediction stage

Teacher : "If I am with this group (girl group) can we call female group ?"

Pupils : "Yes, we can."

Teacher : "If I am with this group (girl group) can we call girl students' group ?"

Pupils : "No, we can't. That's because you are not a student."

Teacher : "If we mix the girl group with the boy group, can we call girl students' group ?"

Pupils : "No, we can't."

Teacher : "What should we call, then ?"

Pupils : "We should call students' group."

IV. Control stage :

The teacher asked the observed group the same questions.

Part 2 . a. To compare girl group and boy group by comparing between subsets.

b. To compare girl group and boy group by comparing between subset and set.

I. Observation stage :

Teacher asking the able group : "Between the girl group and boy group, which one is bigger ?"

Pupils answer correctly.

Teacher askes the girl group and the boy group to mix together.

Teacher : To the able group : "This group is bigger than the girl group just now. Is this correct ?"

Pupils : "That's correct." (correct answer)

Teacher : "Which is more, the students or the girl students ?"

If pupils answer correctly, go to the explanation stage immediately. If the answer is incorrect, suggest them to see which group is called "girl students". The teacher should ask the girls to go in and out of group until all the pupils can compare between the mixed group and the girl group.

The teacher, in case the pupils give incorrect answer, divides them by counting the number of girls and the number of boys and girls mixed together.

Teacher : "This group (boys and girls mixed together) is bigger than that group (girls' group). Is this correct ?"

The teacher repeats until pupils are able to compare a subset to the whole set.

II. Explanation stage :

Teacher : "There are more students than girl students. Is that correct ?"

Pupils : "Yes, that's right"

Teacher : "Why ?"

Pupils : "Because in the students' group, there are both girl and boy students. But in girl students' group, there are only girl students". Or "Because boy students are students and girl students are students."

III. Prediction Stage :

Teacher : "If we take girls from the group of children (the teacher takes one or two girls off), are there still more students than girl students ?"

Pupils : "Yes, there are more."

The teacher adds some more girl students by putting some of the girl students from 'the observing group' into 'the observed group'.

Teacher : "Now, which group is bigger and why ?"

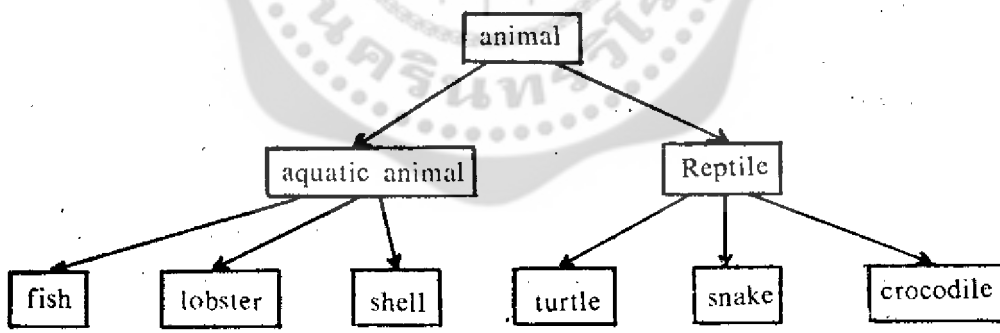
Pupils : "Student group is still bigger, because there are both boy and girl students."

Teacher : "In this room there are more students than girl students or boy students. Is that correct ?"

(In case the pupils give incorrect answer, repeat again.)

IV. Control stage :

Use oral practice as the condition in learning which aims to teach the structure of the following concept.



Teacher

1. Prepares a set of aquatic animals, 2 sets of reptiles (turtle, snake, crocodile).
2. Tell the pupils to arrange animals into sets. Then ask them whether there are more animals than reptiles or fewer than reptiles comparing to the pile of reptiles only.
3. (If the pupils answer correctly,) takes off a set of reptiles and then asks the same question. In case the pupils give incorrect answer, it means that pupils can not compare in vertical direction.

4. The teacher should try to stress the differences of the comparisons in horizontal and vertical directions between animals and reptiles. That is to say, to compare the pile of aquatic animals to the pile of reptiles and then compare a pile of animals to a pile of reptiles.

It might be neccesary to have the same things, that is to say, comparing the pile of aquatic animals to the pile of reptiles and then leave them as they were. Then the teacher groups another set of objects and pictures into a pile of animals. The teacher compares them to the pile of reptiles. The pupils will see that there are more in the pile of animals than in the pile of aquatic animals. The teacher then takes all things off except the pile of animals and asks the pupils which are more, animals or reptiles. If the pupils can not answer correctly, the teacher should use the oral practice method which helps the pupils to get the concept step by step.

Lesson 7

Part 2

(Class Inclusion : Flower)

Teaching time : 2 hours.

Objectives and purpose of the lesson :

1. The pupils should understand the set of edible plants (vegetables and fruits etc.) and also the set of living things (for example vegetables, fruits and flowers, etc.)
2. The pupils should understand "set" and "subset", including the understanding of edible plants as a subset of plant and plants as subset of living things.

Materials :

1. Several kinds of fruits, for example, orange, banana, angul, rose apple, langsats, etc.
2. Several kinds of vegetables, for example, kantonese vegetable, lettuce, egg-plant, chili, etc.
3. Several kinds of flowers, for example Pagoda flower, Cosmos, Cockscomb flower and Everlasting, etc.
4. Animal toys, for example snake, shell and lobster, etc.

Teaching stages

I. Observation stage

Stage 1 :

The teacher after introducing all the equipments, asks the children to divide the plants into groups, that is to say, a group of vegetables, a group of fruits, and a group of flowers.

Teacher : "What is this called ?" (pointing at the group mentioned above, one by one.)

Pupils : "It is called a group of vegetables, a group of fruits and a group of flowers."

The teacher told the pupils to mix vegetables and fruits together and then asked "Now, when we mixed these two things together, what do we call them ?"

Pupils keep silent.

Teacher : "What is this group composed of ?"

Pupils : "It is composed of vegetables and fruits."

Teacher : "Is vegetable edible ?"

Pupils : "Yes, it is."

Teacher : "How about fruits ?"

Pupils : "There are also edible."

Teacher : "Then, after we had combined a group of vegetables and a group of fruits together what should we call it, why ?"

Pupils : "We should call it a group of edible plants." The teacher told the pupils to put the group of flowers into the group of edible plants, and then asked, "What do we call these things ?"

Pupils keep silent.

Teacher : "Can we call them edible plants ? Why ?"

Pupils : "No, we can't, because we can't eat flowers."

Teacher : "Then, what shall we call this group ?"

Pupils still keep silent.

Teacher : "What is this group composed of ?"

Pupils : "It's composed of vegetables, fruits, and flowers."

Teacher : "What are vegetables, fruits, and flowers ?"

Pupils : "They are plants."

Teacher : "Then, what should we call this group ?"

Pupils : "It should be called a group of plants."

The teacher told pupils to put various kinds of animal toys (for example, snakes, lobsters and shells into the plant group.)

Teacher : "What do we call this group, now ?"

Pupils : "We don't know."

Teacher : "Do we call it plant ? Why ?"

Pupils : "No, we don't. Animals are not plants."

Teacher : "Are animals and plants living things ?"

pupils : "Yes, they are."

Teacher : "If I put animals into the plant group, what shall we call it ?" Can anybody answer me ?"

Pupils : "We many call it a group of living things."

Stage 2 :

The teacher told the pupils to seperate vegetables and flowers and put them into two group. The teacher, after pointing at each group, asked pupil, "Which is bigger, this one or that one ?" (fruits, vegetables)

The pupils, counting the number of vegetables and flowers, should be able to answer.

The teacher told the pupils to seperate the edible plants from vegetables and put them into two heaps.

Teacher : "Which is bigger, this one or that one and why ?"

Pupils : "The heap of edible plants is bigger because it includes fruits and vegetable. Or they may answer, "The heap of edible plants is bigger because vegetable is also edible."

The teacher asked pupils to arrange a pile of plants (Vegetable + fruit + flower) and also a pile of edible plant (vegetable + fruit).

Teacher : "Which is bigger, this one or that one ? And why ?"

Pupils : "The heap of plants is bigger because it includes vegetable fruits and also flowers but the heap of edible plants included only vegetables and fruits." Or they may answer, "The heap of plant is bigger because plant is also edible."

The teacher, again, told the pupils to arrange a pile of living things, (vegetable + fruit + flower + animal) and a pile of plant (vegetable + fruit + flower).

Teacher : "Which is bigger, this one (a pile of living things) or that one (a pile of plants), and why ?"

Pupils : "The pile of living things is bigger because it includes vegetables, flowers, fruits and animals but the pile of plants includes only vegetables, fruits, and flowers."

II. Explanation stage.

Stage 1 :

The teacher mixed vegetables and fruits together.

Teacher : "Why can't we call this a pile of vegetables ?"

Pupils : "Because fruits are included in this pile, and fruits are not vegetables."
Teacher : "And why do we call this a heap of edible things ?"
Pupils : "Because they are all edible plants."
Teacher : "Which is bigger, a pile of edible plants or a pile of fruits ? Why ?"
Pupils : "A pile of edible plants is bigger, because it includes both fruits and vegetables."

Stage 2 :

The teacher mixed vegetables, fruits and flowers together.

Teacher : "Why can't we call this a heap of flower ?"
Pupils : "No we can't, because vegetables and fruits are not flowers."
Teacher : "Why should we call all of these, plants ?"
Pupils : "Because vegetables are plants and also are fruits and flowers."
Teacher : "If we mix all plants together into a group, is it more than vegetables and fruits ? Why ?"
Pupils : "Yes, it is, because vegetables and fruits are also plants."

Stage 3 :

Teacher consolidates animals, vegetables and flowers.

Teacher : "Why can't we call this a pile of plants ?"
Pupils : "Because of the animals; animals are not plants."
Teacher : "Why do we call them living things ?"
Pupils : "Because both animals and plants are living things."
Teacher : "If we put all the living things together, would they be larger than vegetables, fruits and flowers ?"
Pupils : "The living things would be larger because both vegetables and animals would be included."

III. Prediction Stage :

Teacher : "If we take animals out of the pile of living things, what will remain ?"
Pupils : "Plants will remain"
Teacher : "Then, in case we take flowers out of the pile of plants, what will remain ?"
Pupils : "The edible plants will remain."
Pupils : "If we have a pile of edible plants and we want the vegetables to be left over, what should be taken off ?"
Pupils : "The heap of fruits should be taken off ?"

IV. Control stage :

Set of various kinds of things (which were not mentioned in the above lesson) should be compared. Pupils should have capacity to answer the questions correctly. Sets of various kinds of things are, for example :

set of children, set of girl children.
set of animals, set of wild animals.
set of vehicles, set of bicycles.

Appendix XX

Lesson 8

The Mental Imagery (Static)

Time for readiness – preparation stage : 1 hour.

General Objectives : To get students to be familiar with blocks and learn how to arrange them into different forms.

Specific Objective : The students should know to put blocks in horizontal, vertical and diagonal line, using different numbers of blocks, arranging them into different (symmetrical and asymmetrical) forms.

Teaching materials :

1. Ten wooden boards with slots into which to insert the blocks.
2. Cubic wooden blocks,
3. Several forms of wooden blocks.

Teaching methods :

Form the students into four groups and place each group in each corner of the room.

In the first corner : The boards number one to five and blocks are used.
In the second corner : The boards number six to ten and blocks are used.
In the third and fourth corners : the followings are placed in each corner :

- Ten long red blocks.
- 26 cubic blocks.
- Six round yellow blocks.
- Six short round purple blocks.
- Two triangle yellow blocks.
- Five long green blocks } With two in one corner and three in the
- Five short green blocks } other.
- Two concave orange blocks.
- Two semi – circle green blocks.

In the first and second corners, the teacher lets five children consecutively put cubic blocks in the holes of each board. The teacher may start the students in the first corner and then move them to the second corner and vice versa. Time should not be spent for more than fifteen minutes. When they understand the direction, they are allowed to do it themselves.

In the third and fourth corners, the teacher and her assistant, one in each corner, watch the students perform the task step by step. When the students are able to do the job, they are allowed to arrange the blocks into different forms.

Preparation for readiness : Step 1

1. Introductory free play.

The students are allowed to play and put different colour blocks in any forms as they like. Their task is examined by the group.

2. Intermediate.

The teacher uses four different things or four sticks of different shapes. She tells one student to hide one piece of stick and asks the group what is missing. The group are asked about the shape or colour of the missing one.

3. Advanced.

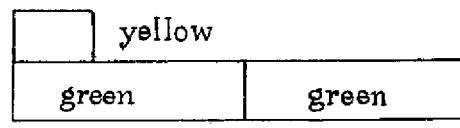
The teacher places three or more sticks in any form then covers them with a box. The students are supposed to follow without seeing the example. When they have finished, the teacher lifts off the box and lets them see the original form.

Preparation for readiness : Step 2.

1. The teacher joins the two long blocks on the floor and puts the other two short blocks on both ends in the manner like the following.

The teaher asks how the long and short blocks are joined. She may suggest the children to use the words on, below, beside, on the left side, on the right side, and so on.

2. The teacher repeats step one but this time she may arrange them asymmetrically, using the other sets of blocks VIZ.



The students are asked to identify both the colour and the size of the block.

3. The teacher forms other patterns, using more than three blocks.

The reasons are because the arrangements depends on size and length.

The students in the third and fourth corners take turns and repeat the lessons prepared for those in the first and second corners.

These two stages for preparing readiness are introduced because of the two problems :

1. Students usually make mistakes by using wrong numbers of blocks unintentionally. According to Sylvia Opper, this is not correct because the students try to keep the pattern balance following Gestalt's "The Law of the Whole".

2. Children cannot join the blocks in diagonal lines. Rural students are less effective than the urban ones in doing so. Miss Opper assumed that this was because, in their perception, the two diagonals were a skew. So they jump to the conclusion that it is the characteristic of each block itself.

What the students are supposed to learn is that diagonal line of blocks can be achieved by putting blocks next to each other at the upper right hand corner. It is not necessary to slant each block to form a diagonal line.

Part 1

Time for teaching : 2 hours.

Specific Objectives :

1. Students can join the blocks horizontally.
2. Students can join the blocks vertically.
3. Students can join the block diagonally.
4. Students can learn to join the blocks in every direction mentioned above.
5. Students can join the blocks in form of a circle.

Behavioral Objectives :

1. Showing the first board, the teacher asks how to form a straight line horizontally outside the board, the students should know they must join from the sides in both upper and lower lines.
2. Showing the second board the teacher asks how they will horizontally join a straight line inside the board. Students should be able to answer that they have to join blocks on top of the former ones.
3. Showing the third board, the teacher asks how they will join either horizontally or vertically next to the board. The students should know they have to join next to the right side and on top of the former ones.

4. Showing the fourth board, the teacher asks how to join a diagonal line. The students should know that they must put the blocks corner to corner, and they must be able to verify it.

5. The teacher, using the fourth and the fifth boards, asks if they want to transfer the line as in the board number four to the board number five. The students should point out a diagonal line in the fifth board and they can really perform the task.

6. Showing the sixth board, the teacher asks how to form a diagonal across the former one. The students should reply that they have to put two more blocks across and they could show how.

7. Showing the seventh board, the teacher asks how to join a diagonal to the right and how to join in a vertical direction. The students indicate the way to join and they must be able to do it.

8. Showing the eight board, the teacher asks how to join blocks in diagonal direction. She can demonstrate and puts other blocks parallel to the first one, if the students do not know the word "parallel". The students could do it correctly.

9. Showing the ninth board, the teacher asks how many diagonal lines there were and how many new ones they can join. The students should know that there were two and they can join four more lines : one in the middle, one on the top right hand corner and two at the bottom left hand corner.

Teaching materials :

1. Ten wooden boards for inserting blocks in.
2. Cubic blocks.
3. Different shapes of sticks or blocks.
4. Sponges.
5. 1×2 in. mirror.

Teaching stages

I. Observation stage :

The teacher calls out five students at a time.

She joins the cubic blocks in one row, and joins blocks of different sizes and colours (red, green, yellow, orange) in the other row and asks how the two rows are different.

The students should reply that the line of cubic blocks is more even than the other.

II. Explanation stage :

Teacher : "Why are they different ?"

Students : "Because every side of a cubic block is equal, but the blocks in the other row are not the same, both in sizes and shapes."

III. Prediction stage :

The blocks are mixed together.

Teacher : 1. "If we join a red block to a light blue one, is it smooth ?"

2. "If we join a yellow block to a purple, is it smooth ?"

3. "If we join a small green block to a big green one, will it be smooth ?"

Students : "They are smooth." They demonstrate it by joining the blocks.

IV. Control stage :

The teacher may allow students to use other things like sponges and soap–boxes of different sizes, which they can join them together evenly.

Part 2

I. Observation stage :

First step :

The teacher lets the students see the third board with blocks in every hole.

Teacher : "Now, look at every row of blocks on this board and notice the similarity and differences."

Students : "It is similar because it is a straight row ; every block has equal sides. The difference is that they are in different directions."

Second step :

The teacher lets the students look at the third and the fourth boards of which every hole is filled with a block.

Teacher : "What is the difference between the rows of blocks in the fourth board as compared with those in the third board ?"

Students : "The sides of the blocks in the third board are smooth because they are formed in straight lines but in the fourth board, the corners of the blocks come out in different directions. In the third board there are two directions and in the fourth board there is one direction."

Teacher : Right now you should learn three words correctly.

1. Horizontal : This is flat as you lie down on the floor.
2. Vertical : It is like when you stand up or we pile up something high.
3. Diagonal : It is neither lyingdown nor standing up but it inclines. Who can stand diagonally ?"

The teacher tells students to form a small circle with one student stands at the center and leans towards the ones in the circle who will successively push the centered one around the circle. It is a game allegedly for amusement and a lesson of the diagonal.

Third step :

1. The teacher lets the children observe the fourth board which is put next to the third one. The students will see that a corner is divided into 45° angle by a diagonal.
2. The teacher takes the fourth board from the third one and lets the students put blocks in a diagonal direction on the third board.

If the students are right, pass them to the item with an asterisk **below.**

If they are still wrong; that is, they cannot put the blocks diagonally, the teacher lets the students use the fifth board.

Teacher : 1. "Now you put blocks like those in the third board. (They are vertical, and horizontal.)"

2. "Now you imitate those in the fourth board. (They are vertical, horizontal and diagonal.)"

The students should be able to do because they may follow the example with the fifth board as their prototype.

*The teacher shows the fifth board which is already done. In the middle of a corner, a diagonal line divides the corner equally and forms two 45° angles. She then compares the fifth board with the third one which is filled unorderly with blocks by students.

Teacher : "Are they alike ?"

Students : No, they are not"

II. Explanation stage :

Teacher : "Why are they different ?"

Students : "On the third board, the diagonal is not upright. But it is like that on the fifth one."

Teacher : "Why is the diagonal line on the fifth board straight, but that on the third one is not straight ?"

Students : "Because we put blocks on the fifth board perpendicular to those two axis vertical and horizontal and the blocks themselves are cubical (students may use their own words to describe even sign languages.) The blocks on the third board are not cubic.

If the students cannot answer, the teacher uses the tenth board to explain. She may let the students watch and put blocks in an inside circle and an outside circle which are punched to form holes. The students will see for themselves that the blocks may form circles instead of straight lines.

III. Prediction stage :

The teacher begins from the first board to the ninth one as described in the behavioral objectives. The teacher lets the students predict how they will put blocks before they really place them. They are allowed to verify by doing.

IV. Control stage.

First step.

The teacher puts blocks in three directions, vertically, horizontally and diagonally without any board. It is not necessary to do like the testing situation. The example is concealed in a box. The students follow the example without seeing it.

Second step.

The teacher may use the former example which is now uncovered. Then she places a mirror in front of the blocks and turns its face down. The students are to join the blocks as the image in the mirror. (This is to reversely drill, to correct the wrong direction the students may make.)

The teacher forms the blocks in a shape of an arrow. Therefore, some blocks must be diagonally placed.

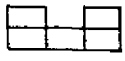
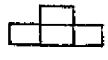
Part 3

Teaching time : one hour.

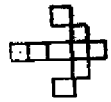
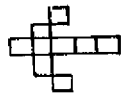
Specific Objectives :

1. The students know the word symmetry, asymmetry and learn that asymmetrical form is more difficult to form.
2. The students can join the blocks in symmetrical and asymmetrical forms and must follow the original form in both form and number of blocks.
3. Students understand the inverse form.

Behavioral Objectives :

1. Students can join the blocks symmetrically when the teacher leaves half of it unfinished. (The teacher forms  . Students can do either  or  and they can even tell where the center of the complete form is.)
2. When the teacher places the blocks in asymmetrical form, students should remember and could do the same. They should learn to know that different directions and number are important factors for their observation and memory.

3. After the students observed the pattern of joining blocks from the mirror, they can emulate.
4. After looking at the example, they can join blocks inversely. As

from  to 

Teaching materials :

1. Cubic blocks.
2. A mirror.
3. A piece of card board used as a blind for teacher's example.

Sequences of teaching.

I. Observation stage.

The teacher gets two forms of block, one symmetrical, the other asymmetrical, and asks, "Are they alike or different ?"

The students should be able to explain how they are different.

II. Explanation stage.

Teacher : "How are they different ?"

Students : "They are different in both the numbers of blocks and direction."

The students can use their own words that give the meaning of direction and number. The former ones are similar in direction and number, but the latters are different.

III. Prediction stage.

Teacher : "If these two forms are covered, which one can you make more correctly ?"

She then covers both of them.

Students should predict that the symmetrical is more simple.

The teacher allows the students to verify by doing.

IV. Control stage.

When the teacher places blocks in asymmetrical form for their duplication, the students should know that they can not do unless they remember the directions and number of blocks in the example.

Part 4

Teaching time : 1 hour.

General purpose : To drill inversion by moving the places of materials.

Behavioral Objective : When the teacher puts different colours of blocks in a cylindrical box, which is not seen through, and turns it in any direction, students could tell the order of the blocks. That is to say which colour will come out first or which will be the last.

Materials.

1. A cylindrical plastic box lined with cardboard paper to prevent seeing from outside.
2. Blocks or marbles.

Sequences of teaching

I. Observation stage.

The teacher puts blocks or marbles in the box and turns it 180°. The order of the blocks will be inverted. Another turn 360°, the order of the blocks will come to be the same as the original.

Students observe and explain.

II. Explanation stage.

Teacher : "Why the order of them are different when we turn the cylinder once and twice ?"

Students should be able to explain. If they still could not, the teacher should repeat again and again and asks how they will be after one turn and two turns.

Some students can explain at this stage.

III. Prediction stage.

The teacher lets students predict and try to guess at the order of things in the box.

The students should be able to do it.

Teacher : "How can you show that your guess is right ?"

Students : "Pulling off the cardboard, so you can see."

IV. Control stage.

First step.

1. The teacher makes three turns and lets students predict.
2. The teacher makes four turns and lets students predict.

Second step :

The teacher adds more blocks marbles of differen colours.

Appendix XXI

Lesson Plan for the Control Group

Types and purposes activities

Seven main types of activities with each of their purposes are grouped as follows:

1. Paper folding

The purpose is to give the students a pleasant way to use their free time by making themselves some playthings from cheap materials. "Paper fold" will train them to be economical, to help develop eye–hand co–ordination, to practice cutting and folding paper, and to organize themselves.

2. Singing and dancing

The purpose is to train the students to enjoy singing and dancing. Singing and dancing will teach them grace and rythm, as well as helping them to appreciate music and dancing, and the relaxation it affords.

3. Paying respect to the Lord Buddha and Buddhist monks

The purpose is to accustom the students, as they are Buddhists, to the neccesary way and rituals of Buddhism. This kind of teaching will help cultivate the student's mind, expand their trust and respect to people and things that are worthy of their respect.

4. Listening to stories from story books

The purpose of this activity is to help the students create imagination and to get enjoyment. Each story will give them some good ideas and models for socially acceptable behaviours.

5. Tracing and colouring pictures

The purpose is to improve the students' concentration, and to develop eye–hand co-ordination. This activity will orientate them to the art of drawing, and give them the opportunity to practice the exercises intended to familiarize and to discriminate colours.

6. Shaping plasticene

The purpose is to help them learn by doing, and sharing with their friends' new ideas. The students are expected to use their creativity in doing the activity.

7. Assembling jigsaw puzzles

The purpose is to train the students how to think, observe and organize their ideas. They will enjoy their share in the part of finding needed pieces of the lacking ones of jigsaw puzzles. Social skill is indirectly expected to develop as the students have to do an assigned jop on a co-operative basis.

1 period = 1 ½ hr.	Content
1st period	To teach the students how to cut a piece of square paper from a large one and fold it into a woven bamboo basket form.
2nd period	To teach the students how to fold a piece of square paper into a pig's head form.
3rd period	1) To teach the students how to pay respect to the Buddha Images, monks and their parents. 2) To tell them the story about the existence of the Five Buddhas and the original purpose of "Loy Kratong"
4th period	1) To repeat the story of the Five Buddhas by asking each pupil to tell it. 2) To teach them how to "Gkrarb Benjangkabhradit."
5th period	After drilling the students to 'gkrarb' in the form of Benjangkabhradit, the teacher changes the activity into folding a piece of square paper and turn it to a rabbit form.
6th period	1) The teacher drills the students to pay obeisance to the Buddha Image in the form of Benjangkabharadit. 2) To teach them how to fold a piece of square paper and turn it into a "Tagror" form.
7th period	The teacher drills the students to pay a respect to the Buddha Image in the form of Benjangkabhradit. To teach them how to fold a piece of square paper and turn it into a lotus form.
8th period	To teach the students what they should chant while they are worshiping the Buddha Image with flowers. After that the students are asked to 'gkrarb' in the form of Benjankabhradit. Then the teacher lets each of them repeat the chant.
9th period	The teacher drills the students to chant while offering flowers to the Buddha Image and to 'gkrarb' in the form of Benjangkabhradit, then, teaches them how to fold a piece of rectangular paper and turn it into a crew hat form.

1 period = 1½ hr.	Content
10th period	The teacher lets the students repeat the activity of offering flowers to the Buddha Image and 'gkrarb' in the form of Benjankabhradit, then teaches them a song called "An Elephant". The theme of the song describes the appearance of an elephant. The teacher demonstrates to them how to act while they are singing, too.
11th period	The teacher lets the students repeat the activity of offering flowers to the Buddha Image and 'gkrarb' in the form of Benjangkabhradit, and teaches them how to fold a piece of square paper and turn it into a bird form.
12th period	The students are requested to repeat the flowers offering activity to the Buddha Image and 'gkrarb' in the form of Benjangkabhradit, then teaches them a new song called "The Little Frogs".
13th period	The students repeat the paper folding activities from the beginning lesson to the last lesson. Each of them would do seven forms of paper folding. The teacher gives the rewards to the one who finishes first, and to the other who does best.
14th period	The teacher allows the students to repeat the flowers offering activity to the Buddha Image. After that the teacher teaches them to worship the Virtue of the Three Yems which signify the Buddha, his teaching and his monks. The worship consists of two forms of doing : 1) Recall verbally the moral principles taught by the Lord Buddha, and 2) Praising the merits of the three gems. These prayings are performed before their sleeping time. Students repeat singing the song named "An Elephant" and "The Little Frogs". Then the teacher teaches them a new song called "The Ducks".
15th period	The students repeat the worship activities number I & II. After that, the teacher teaches them how to worship No. III That is to tie oneself to the worthiness of the three gems. The teacher teaches the students about the Five Precepts. The pupils repeat singing those three songs named "An Elephant", "The Little Frogs", and "The Ducks", and teaches them a new song called "A Horse".

1 period = $1\frac{1}{2}$ hr.	Content
16th period	The students repeat the worship activities number I, II & III, flowers offering activity to the Buddha Image, 'gkrarb' in the way of Benjangkabhradit. The teacher teaches them how to fold two pieces of square paper into a golden fish form and a whale form.
17th period	The students repeat the worship activities number I, II & III, flowers offering activity to the Buddha Image, 'gkrarb' in the way of Benjangkabhradit. Then the teacher lets them listen to stories cited from the story books.
18th period	The students are drilled to worship activities number I, II & III. then the teacher lets them listen to other stories from the story books.
19th period	The students repeat the flowers offering activity to the Buddha Image, 'gkrarb' in the way of Benjangkabhradit. After that, they are let to listen to stories from the story books.
20th period	The students repeat the worship activities number I, II & III, 'gkrarb' in the way of Benjangkabhradit. Then the teacher lets them listen to one story from a story book, and teaches them to dance in the Thai dancing style.
21th period	The students repeat the worship activities number I, II & III, 'gkrarb' in the way of Benjangkabhradit. Then the teacher lets them trace pictures on the given sheets, and colour them with the coloured pencils.
22th period	The students repeat the activity of offering flowers to the Buddha Image, 'gkrarb' in the way of Benjangkabhradit. Then, the teacher lets them trace pictures on the given sheets, and colour them with coloured pencils.
23th period	The students repeat the worship activities number I, II & III, 'gkrarb' in the way of Benjangkabhradit. Then the teacher lets them trace pictures on the given sheets, and colour them with coloured pencils.

1 period = 1½ hr.	Content
24th period	The students repeat the activity of offering flowers to the Buddha Image, 'gkrarb' in the way of Benjangkabhradit. Then, the teacher lets them trace pictures on the given sheets, and colour them with coloured pencils.
25th period	The students repeat the worship activities I, II & III, 'gkrarb' in the way of Benjangkabhradit. Then the teacher lets them shape the plasticene in various forms which they like.
26th period	The students repeat the worship activities number I, II & III, 'gkrarb' in the way of Banjangkabhradit. Then the teacher lets them shape the plasticene in various forms that they like.
27th period	The students repeat the activity of offering flowers to the Buddha Image, 'gkrarb' in the way of Benjangkabhradit. Then she lets them, shape the plasticene in various forms which they like.
28th period	The students repeat the activities worship number I, II & III, 'gkrarb' in the way of Benjangkabhradit, then assemble pieces of jigsaw puzzles.
29th period	The students repeat the activity of offering flowers to the Buddha Image, 'gkrarb' in the way of Bentangkabhrapit and after that assemble pieces of jigsaw puzzles.
30th period	The students repeat the worship activities number I, II & III, 'gkrarb' in the way of Benjangkabhradit and assemble pieces of jigsaw puzzles.
31th period	The students repeat the activity of offering flowers to the Buddha Image, 'gkrarb' in the way of Benjangkabhradit and finally assemble pieces of jigsaw puzzles.

Appendix XXII

Experimenter--teachers' reactions toward the experimental lessons taught

---

1. Lesson on class inclusion (animals and plants)

This lesson was viewed by the experimenter - teachers too difficult for the sample children, especially for the rural ones. The village children could not understand the concept of subset and set. This was due to the children's confusion in number and set. For example, when the teacher divided animal pictures into two piles. The first pile consisted of the pictures of fish, shrimp and mollusk (so this pile had three pictures). The other pile consisted of other five kinds of fish picture (so there were five pictures). Then, the teachers asked the children which ones outnumbered the others, aquatic animals or fishes. The children's answer was the fish, because they counted the number of the fishes which was here five. This revealed that the children did not understand the concept of subset (= fish) and the concept of set (= aquatic animals). Another example was when the teachers let all children stand in front of the class and asked them if in their group there were more male children than children or vice versa. The children were not interested in "children", but they would only compare male children and female children. The majority of children in the school No. 1 could understand this lesson, while half of the children in the school No. 2 could understand it, and all of the children in the school No. 3 could not understand the lesson. However, there was an exception in the village group for only two able children.

2. Lesson on class inclusion (The kind of forms)

1. The children could not perceive objects with two attributes (especially the rural children found the lesson very difficult).

2. In the experimental teaching, the experimenter - teachers divided the children into four groups. The experimenter - teachers found that the children who used to receive at a preparational stages training to know color, shape and class inclusion, were the ones who could comprehened the lesson well. That was when they were taught in arranging positions of forms by focusing on two attributes, they could understand more of the idea than the group of children who did not receive the training. Accordingly, the experimenter - teachers had to spend much more time for the latter group of children.

3. In this lesson the children enjoyed with rolling action. This helped their observation on things which were of two attributes. That was they began to consider both color and shape.

4. In this lesson, the children in the school No. 3 were more inforior than the children in the school No. 1 and the school No. 2. Those in school No. 1 and 2 were able to classify various forms of geometric shape despite the fact that the teachers did not teach them. For example, they could classify things according to color, shape, size. .....etc.

3. Lesson on the conservation of number

In this lesson, it was viewed by the experimenter - teachers that it was too easy for the children. This might be because the children have already learned counting. So the children in three schools could do well in this lesson.

4. Lesson on the conservation of length

1. There was a problem occurring when the teachers let the children crawl on a piece of linoleum. That was they would pay more attention to speed than to length. If it was possible, the teacher should use other kind of equipment which could move automatically by itself on the linoleum. This method would eliminate an extraneous variable. That was speed. If this could be arranged, the children would concentrate only on length.

2. This lesson was shorter than other lessons. So, the teachers could use a shorter time in teaching the children to learn the concept. This lesson did not require the repetition in teaching concept like the lesson on conservation of quantity. The content in this lesson could be carried out smoothly from the beginning to the end. By the end of the lesson, the children could be able to catch this concept. One weakness in teaching this lesson was the teachers' misunderstanding that the children got the concept when they could give the right answer. Due to this misunderstanding, the teachers did not train them again. It then yielded the result not so good as the teacher expected. The experimenter - teachers realized later that the majority of children's answers was just the imitation of their friend's answers. Consequently, the result of the posttest scores was not so good on the task of conservation of length.

5. Lesson on seriation

In this lesson the children in the schools No. 1 and 2 were very enjoying except the children in the school No. 3. Most of the children in the rural school were shy for cooperating in the activity. Accordingly, it made the lesson uninteresting to them. In this lesson "Ngukinhang" activity, pleased the children in the schools No. 1 and 2 but it could not please those in the rural school. To conclude, the lesson's content was all right, but there was a problem on the part of some learners whom the experimenter - teachers could not motivate.

6. Lesson on the mental imagery

In this lesson, the children could not put the block in the right angle yet. However, when they were trained for a period of time, more than half of these children could do it. There were few children who could not control their hands well. As for the rural children, there were five to six children who could not control their hands well.

7. Lesson on the conservation of quantity

This lesson was very detailed and very long. It required eight periods for training. The experimenter - teachers divided their class into groups. Each group had five children. When these five children were together in a group, there was a problem. That was the children often answered the same why when they were asked the question individually. The experimenter - teachers thought that each child should be taught individually. This method would solve the problem, because the teachers would know when the children could answer by themselves and with their own reasons, not by following their friends' answers and reasons. However, this method would raise another problem about time, because it aleady required eight periods when it was taught in groups. If it was taught individually, the lesson would take much longer time. Some children in the school No. 1 were very keen. They felt annoyed with this lesson, because they were questioned the same pattern and had to repeat their responses again and again. Sometimes the experimenter - teachers felt miserable too. Due to the children's annoyance, they did not pay attention to the lesson and often answered the questions without thinking. Furthermore, the experimenter - teachers felt that there were too many materials accompanying the lesson. If the lesson was actually taught tin a regular classroom, it would make the room very untidy and dirty.

8. Lesson on the conservation of weight

The children learned this lesson with great enjoyment. It was enjoyable even to the village children who had problems in learning other lessons. The concent was considered appropriate, and not too long and not too short. The teaching materials were interesting. The children enjoyed the rocking chair very much. Besides, they also like to carry the "haap". Some children even played the role of monger. There were four to five children in the school No. 3 who had the difficulty to understand the word "weight", because this word was an abstract term. But the experimenter - teachers could help them by let them weigh themselves again or let them be on the rocking chair. This mothod would help them observe their own weight. Yet, when the children were on the rocking chair, they enjoyed playing together more than thinking about the concept of weight. This was a weak point of this method.

To conclude, three weak points of the lessons taught should be given as follows :

1. Most of the children often imitate the answers of their friend.

2. The experimenter - teachers lead the children rather than assist them to help themselves. The teachers should help children to learn by themselves but they could not succeed in that approach. The children could not satisfy the teachers' question and the atmosphere of the classroom was quiet and the lesson was blocked. Then the experimenter - teachers felt the time was much wasted so the teachers felt it was necessary to lead them again. In fact this approach should not be used. But if the experimenter - teachers let children go by their own pace without being led, they could not finish their teachings within the treatment periods.

3. There was no table on which the experimenter - teachers could place their materials and equipments when did their teaching. This was due to the limited space in the room. For example, in the school No. 1, the experimenter - teachers could not use the regular classroom at all. They had to move to the nursing room where there was no chair to sit on. Both the children and the teachers had to sit on the floor. This made a lot of problem in class arrangements.

On the whole, most of the experimental lessons were applicable and could be taught to enable the children to understand certain concepts on science and mathemtics. However, the application of the experimental lessons still depended a great lot on some important factors such as more time for teaching and learning, convenience and enongh room for class arrangement, school policy, together with patience and understanding on the part of teachers who have to develop faith in their children's capacity to learn.

Appendix XXIII

Experimenter-teachers' evaluation of teaching-learning processes in the experimental sessions

---

School No. 1

I. Student Characteristics

A). Learning : Most of the students in the experimental groups (except two or three) were active. They were very interested in learning activities, though their attention shifted frequently. Thus, the teachers were required to organize entirely new activities or change previous activities in various details in order to meet the students' need.

B). Manners : Most of the students showed poor manners and behaved in a disorderly fashion. Quarreling and fighting continued throughout each teaching period. All of them, however were cooperative and often helped the teachers in the assigned duties.

C). Personality : The students were not afraid to ask and answer questions. They were also fairly mischievous.

II. School Environment

A). Location of school : The school ground was too restricted when compared with the number of students. Furthermore, the principal allowed food vendors to sell their products inside the school ground, causing disorder and disturbances.

B). The rooms were small, with insufficient ventilation and light.

C). The experimental group classroom was so near to the control group classroom that the teachers must close the doors to prevent the control students from observing the experimental group's activities. This resulted in added stuffiness and tensions.

D). The materials in the experimental room, such as tables and chairs, were so close together that it was nearly impossible to divide the students into many groups for different activities. Class arrangements could not be done as it was expected.

III. School Administrators

School administrators (principals and vice-principals) were very cooperative. They assisted in many areas, such as providing necessary services and ensuring student attendance.

IV. Homeroom Teachers

Homeroom teachers could exert a great deal of influence on student learning. Most of them, however, did not understand the importance of science and mathmatics concepts and gave little cooperation to the researchers.

V. Experimental Teachers

The experimental teachers were tired and tense, as results of the followings :

1. Travel : The traffic was very heavy during the trip to school.

2. Classes were taught in the afternoon when the weather was stuffy.

3. The students were very naughty. Quarreling and fighting were usual and much of the teacher's time was taken up by disciplinary measures.

4. Since the class was divided into 4–5 groups, each under taking different activities, the demands on teacher time and alertness were great. This was aggravated by the students short attention spans.

VI. Parents

Some parents did not realize the importance of teaching concepts. The time for teaching concepts was set after students had finished their own regular school work. Yet, some parents did not allow their children to continue their learning in the experimental lessons because they thought that it was a waste of time. Accordingly, the children's attendance was not so steady. Some of them were absent for a long time. Eventhough the school teachers helped the researchers by sending letters to the parents requesting their children to attend class, they were not willing to cooperate.

VII. Miscellaneous :

Instruction in the school No. 1 was divided into two shifts : morning - classes and afternoon - classes. The subjects in this study were morning shift students and teaching was conducted in the afternoon from 12.30 p.m. to 2.00 p.m. This period was not good, for the following reasons :

1. When the instruction began, most students had just finished their lunch. Some were still eating, and the rest still had not eaten anything. In the letter case, the teachers did not always know. Had they known, they would have had these students eat first.

2. Both teachers and students were easily tired, owing to hot and stuffy weather.

3. Since the students studied during the entire morning, they were too tired to continue studying in the afternoon. This might be one cause that affected the outcomes of teaching - learnings.

School No. 2

I. Student Characteristics

A) Learning : In general the students were interested in all lessons. They also showed an interest in the special activities which the teacher organized. During class, there were nine students who paid particular attention to the lessons (all of them were on the same level as those in the first school). Four students preferred sneaking out to play, while the rest paid moderate attention to the lessons.

B) Manners : All of the girls displayed good manners. All but two or three of the boys were well disciplined. However, both boys and girls were cooperative and liked to help the teachers as much as possible.

C) Personality : Most of the students were properly behaved. However, they lacked self-confidence and were afraid to ask or answer questions because of shyness. However, some students were rather mischievous and liked to talk with teachers.

II. School Environment

A) Location : The school grounds were large and clean. There were rows of trees and everything appeared quite orderly.

B) The classroom : The classroom was well ventilated and well lighted, and had enough space for the number of students.

C) Although the experimental group room was so near to the control group room that the teacher must close the doors while teaching, the weather was not so hot and stuffy compared to the first school, for the following reasons :

- the room was fairly large.
- the room had many windows producing good lighting and ventilation.
- the morning weather was fresh.
- an electric fan provided good air circulation.

D) Materials in the experimental room, such as tables and chairs, were not placed close together. Therefore, students could be conveniently divided into many groups, and the teachers could walk through easily to assist all of the groups.

III. School Administrators

The principal and vice principal were very cooperative and offered a great deal of help in all situations.

IV. Homeroom Teachers.

The homeroom teachers were very helpful in ensuring that the experimental students attended all classes.

V. Parents

It could not be determined whether or not the parents supported the concept teaching, because all instruction was conducted during the regular morning school hours. Yet the parents' cooperation could be seen from the pre-testing and post-testing of concepts.

VI. Experimental Teachers.

The experimental teachers were not as tired as when they taught in the first school, for the following reasons :

1. Travel : Although the traffic was very heavy, the experimental session was in the morning and the teachers felt not much tired.

2. The classroom : The classroom was fairly large with good ventilation and lighting.

3. Although the class was divided into 4 or 5 groups, with each group performing different activities, the teachers were not tird easily, because the students were quite interested in all activities. The experimenter-teachers were more motivated to teach this group of children.

4. Since most of the students were well behaved, the teachers' task was not so laborious.

5. The teachers could induce the students to learn because of conducive atmosphere.

School No. 3

I. Student Characteristics

A. Learning : There were only five bright students, the rest were below average. Most of the students were passive. Even when they were interested in learning, they did not like to cooperate in activities. Attendance of the two or three students was not steady. One particular boy was very dull. He could not speak complete sentences and showed high tension, and often cried when teachers spoke with him. The other boy was very mischievous and unruly. In the latter case, the classroom was disorderly and disturbed.

B Manners : Although most of the students showed good manners, their manners were more inferior when compared with those in the second school. However, they liked to help the teachers. Only one boy was too mischievous to be handled.

C. Personality : The students were introvert. That was they were very shy, and noncooperative in activities. Particularly, during the first three or four hours of the beginning of teaching, all of the students were shy and afraid to ask and answer questions.

II. School Environment

A. Location : The school was located near the farmers' field and was separated from villagers' houses providing good fresh air. Besides, the school grounds were large and looked tidily with vast field for students to play conveniently.

B. The classroom : The classroom was well ventilated and well lighted, clean, and large enough for the number of students.

C. The experimental room was so near to the control room that the teacher must close the doors while teaching to prevent the control students from observing the experimental group's activities. The weather was not, however, so hot and stuffy, for the following reasons :

- the room was large.
- the room had many windows providing good lighting.
- the morning weather was fresh.
- the room was besides the canal and fields providing good air circulation.

To sum up, the classroom condition in the school No. 3 was slightly better than that of the school No. 2.

D. Materials in the experimental room were the same set of those in the second school.

III. School Administrators

The principal and vice principal were very cooperative in all situations.

IV. Homeroom Teachers

The homeroom teachers were also very cooperative in many areas. They had trust in the fruitfulness of the research project. Their human relationsnips were good.

V. Experimental Teachers

In general the experimental teachers did not enjoy teaching in the third school for the following reasons :

1. Travel : Although the morning weather was fresh and the traffic was not heavy, the researchers were still very exhaustive (because of the long trip from Bangkok to the rural school.)

2. The students were not active and noncooperative in activities. It seemed that the teachers performed activities alone. Eventhough the lessons were required for the students to think and to give reasons, some students were not willing to speak and they are afraid to question. These factors hindered the progress of teaching and made the teachers bored in teaching.

To be brief, although the atmosphere inside the classroom was very good, the teaching did not succeed due to those problems above mentioned.

VII Miscellaneous

This school was located so close to the temple grounds that teaching was affected by some religious rites or villagers' activities. Students were interested and craved to join these activities. Accordingly, the teachers were forced indirectly to allow them out, because they felt that it was not good to confine absent - minded students to concentrate on the lessons.

Appendix XXIV

Experimenter-teachers' reactions to the control lessons taught

---

Lesson on paper foldings

School No. 1

Some students had previously experienced to do some forms of paper foldings, but the forms they had to learn were different from the ones they knew.

The students were interested in this activity only at the beginning of the activity.

School No. 2

The students had before experienced to do some forms of paper foldings, but they still were interested in this activity.

School No. 3

The students had never experienced in doing some forms of paper foldings. They could not do even some simple forms of paper foldings as they had boasted to their friends and teachers.

Lesson on singing and dancing

School No. 1

Most of the students have sung several songs and could accord their actions while singing, because they had previously learned them.

They were able to remember new songs and were interested in this activity.

School No. 2

The students were more interested in singing song when compared with those in the third school.

School No. 3

The students had previously sung a song called "The Elephant", but they could not accord their actions while singing. The students were also interested in the other songs that they had not sung before, but they could not do it well.

Lesson on paying respect to the Lord Buddha and Buddhists

School No. 1

In this activity, the students were fussy and disorderly and could not do it well. However, they could remember the tales. They could recite some teaching lines of the Lord Buddha.

School No. 2

The students were interested in this activity. They tried to do well, and they could remember what the teacher taught.

School No. 3

They knew somewhat how to pay respect to the Lord Buddha and Budhists but they were not interested in this activity. This might be because the activity was so dry.

Lesson on listening to stories from story - books

The students of the three schools were particularly interested in this activity. They felt relaxed and less bored in this lesson.

Lesson on tracing and coloring pictures

The students of the three schools were also interested in this activity. They could express themselves well in this activity.

Lesson on shaping plasticene

School No. 1

The students liked to play with plasticene. They enjoyed making the shapes of simple forms such as simulated snake and the like.

School No. 3

They made in the shapes of various forms perfectly.

School No. 3

They liked to make plasticene in shapes of cooking utencils.

Lesson on assembling jigsaw puzzles

The students of the three schools were eager to join in this activity.

General observations on the students' behavior when taking the lessons.

School No. 1

a. Most of the students were bright but sometimes were restless. They often quarreled with one another.

b. They could remember what the teacher taught but they got poor manners.

c. They could classify, compare and conclude things.

d. They were restless.

e. The materials, such as tables and chairs were so close together and in disorder, that it was nearly impossible to provide some activities conveniently. Things outside the classroom were disorderly and disturbing.

f. They attended classes more regularly at the beginning. But at the latter part of the treatment, a lot of them were absent.

School No. 2

a. The students could understand lessons quickly and could perform the task themselves.

b. They could remember what the teacher taught and could repeat it.

c. They could classify, compare and conclude things.

d. They showed good manners.

e. The classroom was clean and well ventilated. This helped the children and teachers alert to the activities.

f. The majority of children came to classes regularly, except the ones who were poor achievers.

School No. 3

a. Although the students could unterstand lessons slowly and had to depend upon the teachers, they were interested in the activities.

b. They fairly remembered what the teacher taught.

c. They could not classify, compare and conclude things.

d. They moderately behaved.

e. The classrooms were clean, well ventilated and well lighted. This helped learners and teachers to enjoy the activities.

f. They always attended all classes, except some cases who were ill.

Appendix XXV

Experimenter–teachers' evaluation of teaching learning processes in the control sessions

---

General evaluation

Teaching in the three control groups encountered similar problems. This part consolidated the problems met by the experimenter-teachers in the three schools. Where the problems of individual schools differed, they would be discussed seperately.

The problems encountered were :

1. Problems related to students: The students of the three schools were overactive and naughty. They preferred dynamic activities and were characterizd by soort attention span. As a result, the teacher were required to organize numerous student activities. In the first school, most of the students resided in the business area. Both their manners and language showed evidence of their surroundings.

2. Problems related to teaching : The students of the control groups were not taught academic lessons. They were taught with other kind of activities such as paper folding, singing and dancing, paying respect to the Lord Auddha and Buddhist, listening to stories from story - books etc. The teachers thought the planned activities were not enough, because the students were not interested in repeating activities.

3. Problems related to meterials : There were too few materials such as four students to one jigsaw puzzle, or there was one copy of each story book and some materials were not attractive.

4. Problems related to teaching period : One hour and a half for teaching was too much for the first grade students because of their short attention span. So, by the end of teaching period, some children were not interested in the lesson at all.

5. Problems related to the classroom : All the control group classrooms were so near to the experimental group classrooms that the control group students could see what was going on in the experimental group. And they preferred to be in the latter group. Besides, the surroundings of the first school classroom were disorderly and had a lot of disturbances. In the first and the second schools, the materials such as tables and chairs were so close together that it was nearly impossible to provide some activities conveniently.

6. Problems related to the location of school : The location of three schools were markedly different. Although the second school was selected on the basis of being in an inferior environment (slum), the school ground was large and orderly. The third school was the same as the second school. On the contrary, the school ground of the first school was restricted and resided in the business area with the small field in the middle. Around the field was the place for selling food. This resulted in added fussiness and distractions.

7. Problems related to the teachers : The experimenter-teachers were tired and tensed as a result of travel. The traffic was very heavy during the trip to schools.

8. Problems related to school administrators : School administrators were very cooperative but the homeroom teachers did not realize the importance of teaching and gave little cooperation. Especially in the first school, the homeroom teachers allowed the students go home when the regular school hour was over.

9. Problems related to the parents : Some parents of the first school students did not realize the importance of teaching activities and did not allow the children to continue their learning because they thought that it was a waste of time. This yielded some absentees during the control lessons.

ANNEX I

List of personnels involved in the research project and their main functions.

Project director Supervisor of the project Writer of the report	Prof. Chancha Suvannathat

Research planning and design	:	Asst. Prof. Ravipan Somnapan Asst. Prof. Tahwon Koedkietpongse Asst. Prof. Duangduen Bhanthumnavin Asst. Prof. Nuanpen Wichierachote Asst. Prof. Preeja Dhunma Asst. Prof. Somnuk Kumurai Miss Duangduen Satrapat Miss Penkhae Prajonpatchanuk
Writer of the experimental lesson plans	:	Asst. Prof. Nuanpen Wichierachote
Writer of the control lesson plans	:	Asst. Prof. Boonkorb Wisamitananta
Experimenter - teachers in the experimental groups	:	Miss Duangduen Satrapat Miss Pranote Leksawad.
Experimenter - teachers in the control groups	:	Asst. Prof. Boonkorb Wisamitananta Miss Nuanlaor Jiemsuwan
Test translator	:	Miss Duangduen Satrapat
Achievement test constructors	:	Asst. Prof. Somnuk Kumurai Mrs. Prapaisree Utawee
Interviewers and test recorders	:	Asst. Prof. Patra Sukhontasarp Asst. Prof. Tahwon Koedkietpongse Asst. Prof. Wanpen Bhisalpongse

Miss Penkhae Prajonpachanuk

Mr. Ong - art Jiyajan

Mrs. Prapaisree Utawee

Mrs. Nongnuan Pongapaiboon

Miss Karuna Kitkhayan

Dr. Sawana Pornputkul

Miss Duangduen Satrapat

Miss Nuanlaor Jiemsuwan

Miss Pranote Leksawas

together with

Graduate students in the social psychology major and educational evaluation major during the year 1974–75.

School contacts officers : Asst. Prof. Somnuk Kumurai

Mr. Ong - art Jiyajan

Data processor : Miss Duangduen Satrapat

Statistics and computer adviser : Asst. Prof. Ravipan Somnapan

Photagraphers : Mr. Ong - art Jiyajan

Mr. Pairote Baujai

Proof readers : Prof. Chancha Suvannathat

Mrs. Prapaisree Utawee

Miss Pranote Leksawas

Editor : Prof. Chancha Suvannathat

Assistant editor : Asst. Prof. Ravipan Somnapan

Secretary : Mrs. Prapaisree Utawee

Assistant secetarry : Miss Karuna Kitkhayan

Accountants : Asst. Prof. Wanpen Bhisalpongse

Asst. Prof. Somnuk Kumurai

Typists : Mr. Prasit Khunprom

Mr. Niyom Subcharoen

ANNEX II

Plan of action

Stage I (3 mos)

a. Development and refinement of necessary tools and techniques for teaching science and mathematics concepts.
b. Translations of Piagetian tests and procedures into Thai language,
c. Construction of tests to assess children's scholastic achievement in science and mathematics.
d. Community and school contacts for selecting locations and subjects.

Stage II (3 mos)

a. Workshop for training the recorders and interviewers.
b. Pre-testing approximately 400 children (by means of Piagetian tasks).
c. Modifications of the lesson plans to use in the experimental groups and control groups. The final drafts of the lessons are expected to finish.

Stage III (6 mos)

a. Treatment (actual developing science and mathematics concepts through teaching the experimental subjects twice a week for 24 successive-weeks).
b. Evaluation of teaching-learnings processes in the experimental groups and the control groups.

Stage IV (3 mos)

a. Workshop for training the other set of recorders and interviewers.
b. Post-testing children (by means of Piagetian tasks, and achievement tests).

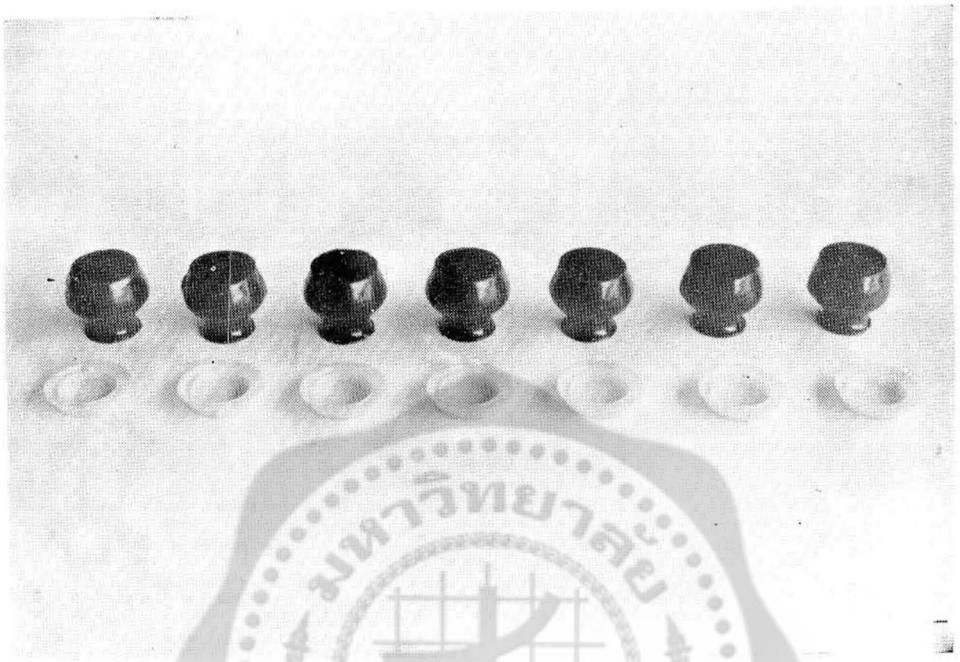
Stage V (3 mos)

Treatment and analysis of data

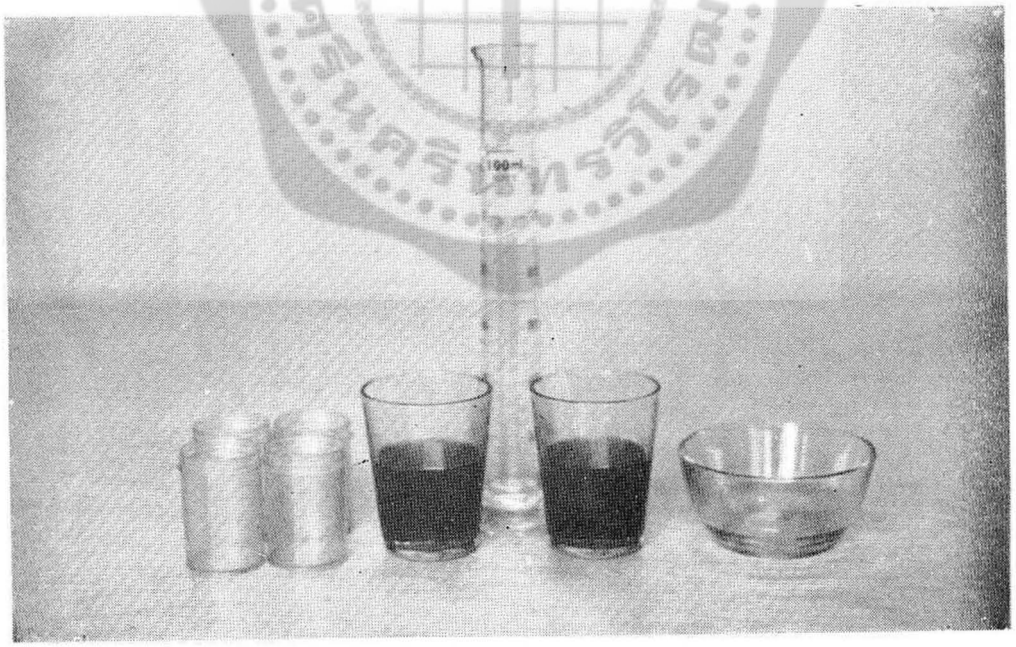
Stage VI (3-6 mos)

Writing report (both English version and Thai version).

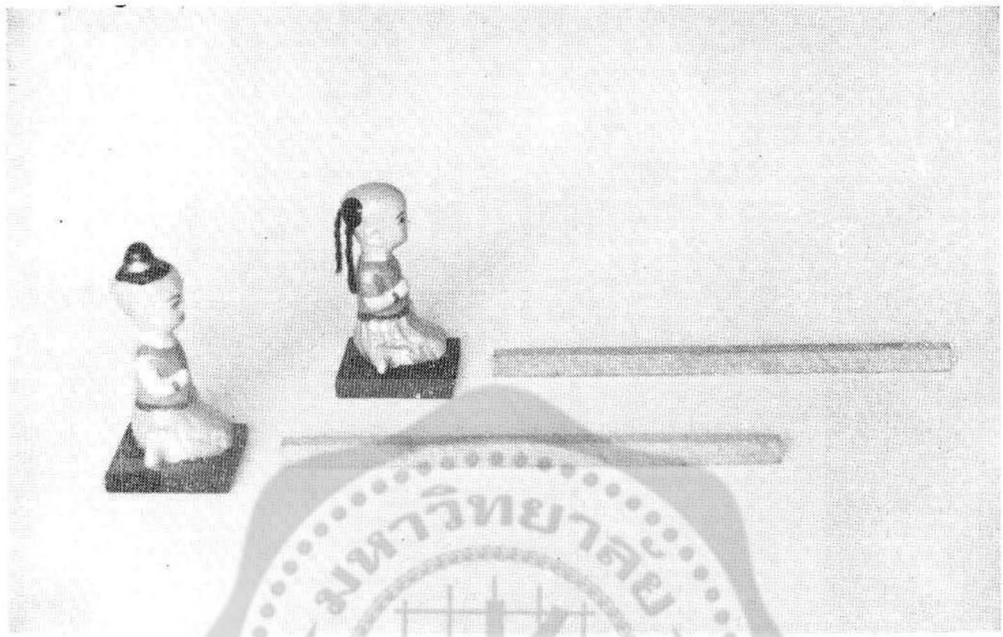
Tests and materials



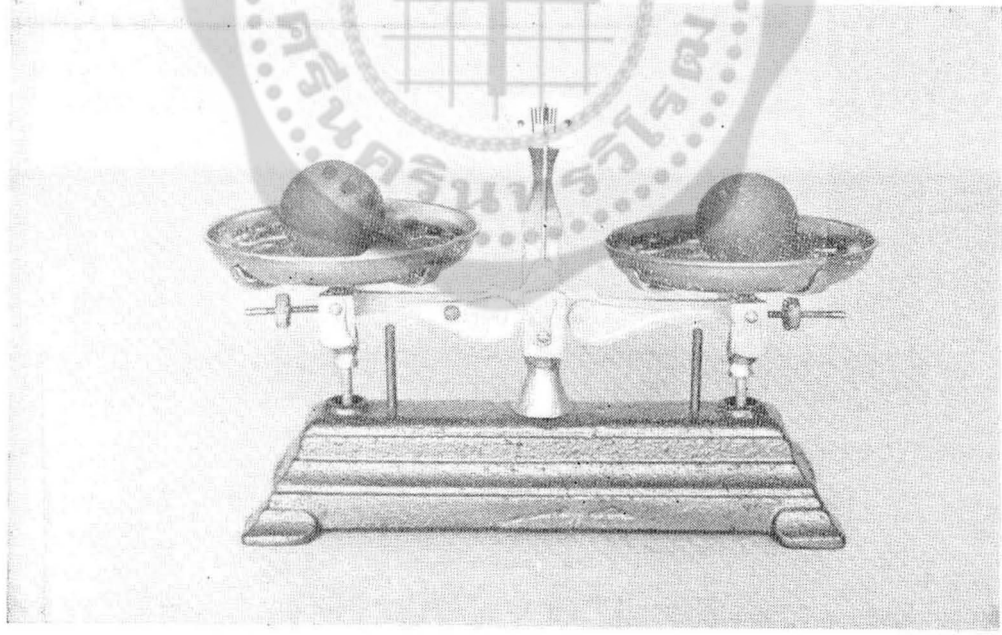
1. One–to–one correspondence test



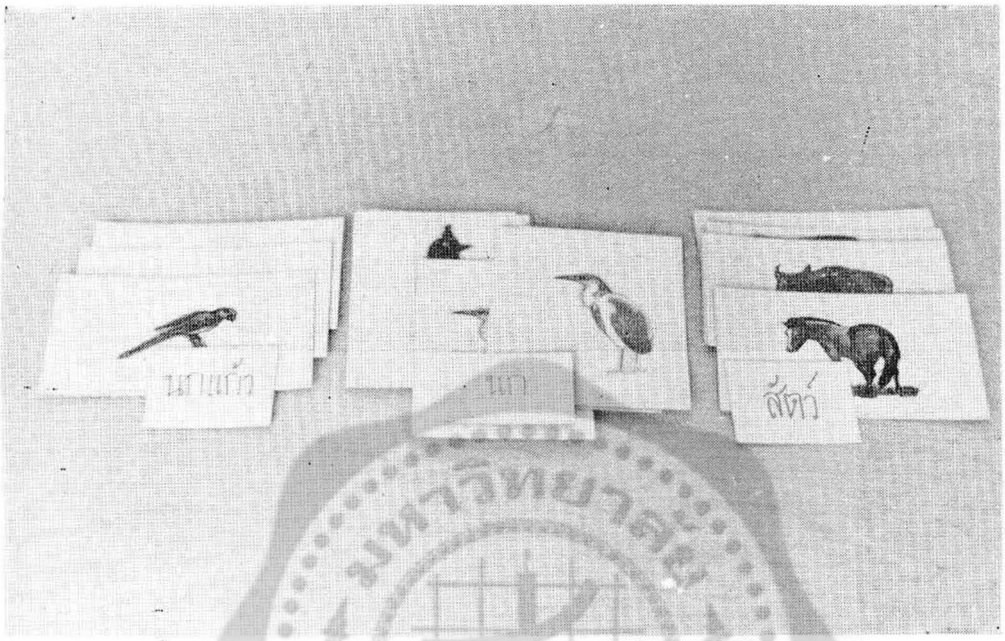
2. Conservation of liquid test



3. Conservation of length test

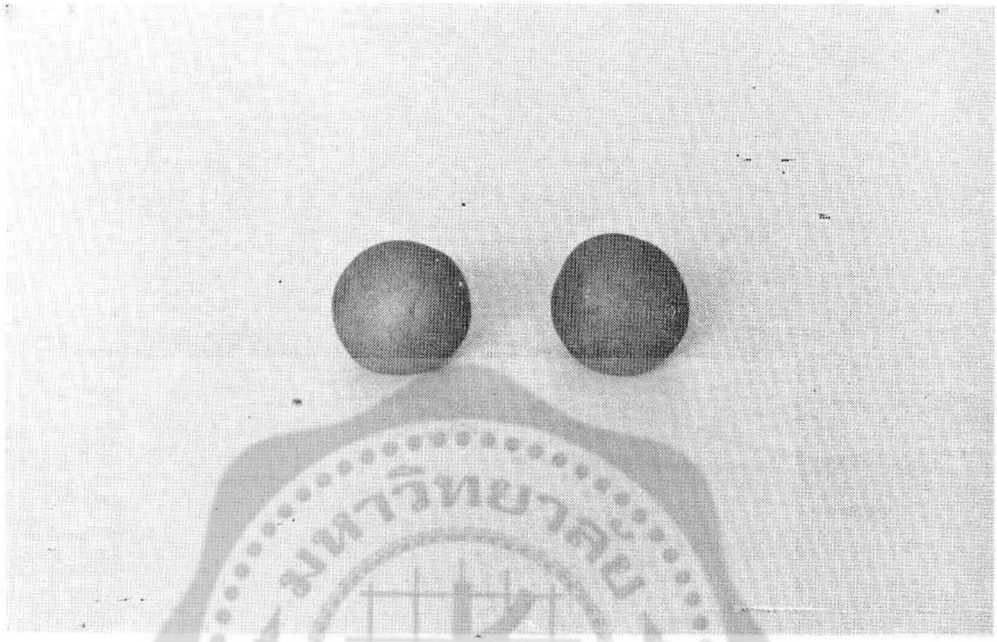


4. Conservation of weight test

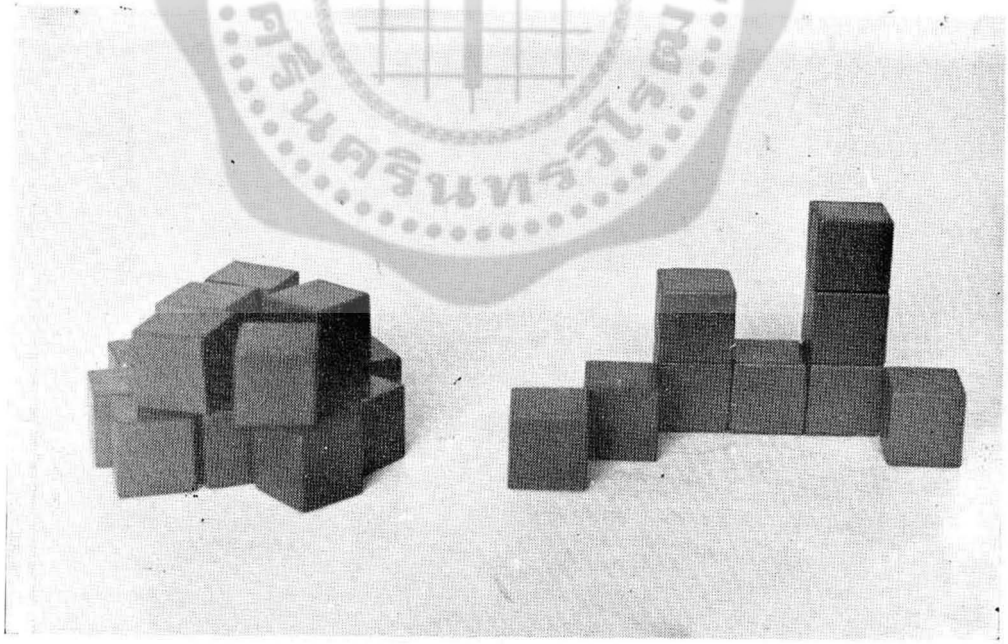


5. Class inclusion (animals) test

6. Class inclusion (flowers) test

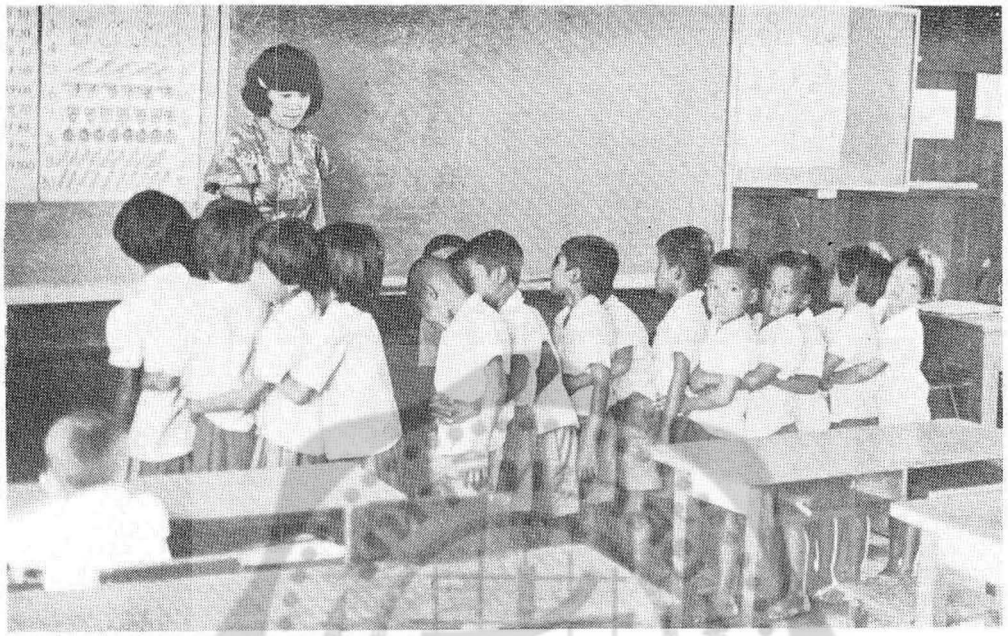


7. Conservation of substance



8. Mental imagery (static) test

Teaching in the experimental groups



Teaching in the co[illegible] roups