Departemen Pendidikan dan Kebudayaan

The British Council

Contract No: CNTR97 2735A

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Curriculum Capacity Project (CCP)

The Maths Curriculum '94 for Primary School: An Evaluation

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June 1999

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Introduction

After I finished the evaluation of the primary School Curriculum 94 from a whole-school perspective, I continued with the evaluation of the math programme. I was asked to:

- Evaluate the Indonesian Maths Curriculum '94 for SD in relation to that of The Netherlands;
- To observe curriculum implementation through visits to 2 schools outside Jakarta, to strengthen findings and evaluation;
- Share evaluation skills with Puskur staff.

For evaluation and comparison of the Indonesian maths curriculum I examined the next available documents:

Curriculum '94 documents of Indonesia
Case studies of mathematics in several provinces, by Puskur Staff
Need analysis in Cianjur, by Puskur Staff
Review of primary School Science Curriculum, by Lloyd Blazely
Curriculum analysis, by Ibu Diah, head Puskur Staff SD
Act of Law plenary Education of The Netherlands
Individual school curricula of several schools in The Netherlands
Yearly schedule of activities of several schools in The Netherlands
The course outline of a Dutch educational maths package, "Pluspunt"

In order to observe curriculum implementation I intended to visit several schools in and outside Jakarta, together with members of Puskur staff who are responsible for the Maths programme. But the time was not available to make effective school visits. Instead I used my experiences with curriculum implementation during my work as PEQIP consultant in the provinces Yogyakarta, Padang, Aceh, Bali, Manado and Kupang and as consultant mathematics for the BC workshop "Active learning" in Cipanas.

I discussed my findings with the Puskur staff members Mathematics and with the former and present project manager, Mr. Faisal and Mrs. Ella. At request of the project managers I made a detailed report and tried to give much information about what children could be taught at which age/development level based on my professional experiences.

1. Curriculum Documents

Curriculum '94 Indonesia	Curriculum The Netherlands
1. Book on the Foundations, Program and Development of Basic Education 2. Books on Basic course outline of SD and of SLTP (GBPP) 3. Books on the Guidance for the implementation of SD and of SLTP	1. The Primary Education Act, especially section 8 and 9 2. Individual school curriculum, made by each school in conformity with the Primary Education Act 3. Yearly schedule of activities, filled in and completed by each school in conformity with the Primary Education Act
Additional documents	
• Educational course materials (Buku Paket), from Pusbuk • Books on the guidance, from Directorate and Kanwil	Educational course materials from publishing firms

In Indonesia the whole basic education is central regulated by the curriculum 94. Not only the general and specific aims, the content and the allocation of time are prescribed, also the course outline per subject is given as well as the guidance for implementation. This as contrasted with the situation in The Netherlands, where the freedom of curriculum design is included in the Primary Education Act.

The content of document 1, Foundations, Program and Development, can be compared with the content of section 8 and 9 of the Primary Education Act and the form "schedule of activities" in The Netherlands. The content of the books 2 and 3, the GBPP and the Guidance is not central regulated in the Netherlands. Non-governmental educational publishers publish educational courseware for each subject and/or subject matter area, in which course outlines and methodological guidance are described. Each school chooses educational courseware that fits in their own school policy, laid down in their own school policy document (individual school curriculum). Each school is held accountable to the government for its curriculum, therefore she will not easily buy educational courseware which is not in conformity with the Primary Education Act.

1.1 The function of the curriculum

A curriculum is a prescription of the education of a country. How far a curriculum has to go, from prescribing general aims and principles via a general description of the course outline to prescribing the course outline from day-to-day, is a decision of the government.

I don't plead for one or another, but the documents have to be in conformity with the Government's intention. Indonesia chooses for a central prescriptive and detailed curriculum, including a day-to-day course outline. In that case the documents have to be complete and clear for the users. In my evaluation of the maths curriculum I started from this principle.

1.2 Book on the Foundations, Programme and Development of Basic Education

This document describes the objectives of basic education (Primary and Junior Secondary school) and their relation with the objectives of national education, teaching programs including the allocation of time, implementation, assessment and further development of the curriculum.

For Mathematics: "The function of maths as a subject matter is to develop the ability to communicate using numbers and symbols and sharpen logical thinking which can help clarifying and overcoming every day problems. At the level of SD the emphasis is on the introduction, understanding and ability to use numbers in relation with daily life practice."

1.3 Books on Basic Course Outline of SD, and of SLTP (GBPP)

Puskur made course outlines per subject, from grade I to VI. This time I examined the course outline for Mathematics. On one hand the course outline is very detailed. Year objectives, trimester objectives as well as lesson objectives are prescribed and also the amount of lesson hours which have to be spent on maths for each subject matter. On the other hand the prescriptions are not complete. As contrasted with the described function of mathematics in document 1, the GBPP prescribes mainly knowledge aims and technical skills. The clarifying and overcoming of every day problems are underexposed.

Another shortcoming is the lack of methodological guidance. Especially the methodological guidance provides the teacher with the proper help how to teach a specific subject matter to the children of a specific age and development stage. It is not practical when this guidance is given in a third document.

Consequence: very much information for the teacher, a shortage of attention for experience/exploration activities by the pupils and therefore the danger of maintaining the teaching method of lecturing and showing, the learning method of memorising and copying.

Besides curriculum 94, Pusbuk provides the schools with course outlines and guidance per subject, laid down in the so-called "Buku Paket". Although both departments are governmental, the educational courseware for Mathematics from Pusbuk is not always in conformity with the curriculum. Buku Paket often offers more and goes deeper than prescribed in the curriculum.

1.4 Books on the Guidance for the Implementation of SD, and of SLTP

Although planned and mentioned in Book 1, these books are not yet developed/published complete. They are not available in Puskur and only in one school I saw the Guidance for grade III and VI (published 1997). Therefore I could not evaluate the content and quality of the third document. I must conclude that, since guidance books are not yet developed properly, document 2 decreases in value and usability.

2. Objectives

2.1 The function of teaching mathematics

The curriculum is clear in it. In book 1 the function is described as follows:
The function of maths as a subject matter is to develop the ability to communicate using numbers and symbols and sharpen logical thinking which can help clarifying and overcoming every day problems. At the level of SD the emphasis is on the introduction, understanding and ability to use numbers in relation with daily life practice. This vision is in accordance with the general accepted starting point that arithmetic appears in daily life, which is full of arithmetic situations. Arithmetic are a generalisation and an abstraction of operating in arithmetic situations. (Borghouts van Erp)

2.2 General objective versus year-trimester-lesson objectives

A lot of the impact of the general objective has gone lost in the prescribed objectives in the course outline (Book 2). The trimester/lesson objectives are emphasised on technical use of numbers and formulas and hardly show the relationship between formulas and arithmetic situations in daily life.

As an example the program for Grade III.

General objective mathematics:
The function of maths as a subject matter is to develop the ability to communicate using numbers and symbols and sharpen logical thinking which can help clarifying and overcoming every day problems.
At the level of SD the emphasis is on the introduction, understanding and ability to use numbers in relation with daily life practice.

Year objectives grade III

- Pupils have counted ability (addition and deduction) using integers numbers 5.000 to 10.000 and specific fraction numbers, and to be able to use it in daily life for counting money
- Pupils have counted basic ability (multiplication and division) using integers numbers up to 9 (multiplying result up to 81)
- Pupils have ability to solve narrative arithmetic
- Pupils have ability to measure the length (m, dm and cm), and to define time (hour, day, week and month) and weight (kg, ons)
- Pupils have an understanding of space through visual display of concrete thing

Pupils like to learn mathematics

Termly objectives mathematics grade III/I

- Able to do addition and subtraction round numbers 1.001 up to 5.000, and multiplication and division (multiplying result up to 81)
- Able to use lines of numeral to define numbers system
- Able to compare 2 numbers
- Able to conduct addition and subtraction using fraction numbers of one third and one sixth
- Able to define time and linear measure

Lesson objectives mathematics grade III/I. no. 1

Able to add and subtract whole numbers 1,001 up to 5,000 and multiply and divide (multiplying result up to 81)

- To know numbers 1,001 – 5,000: to read the symbol, to write the symbol and the name of the numbers
- The value of the place
- Addition with result up to 5,000: addition without storing technique, with one storing technique, with two time storing technique
- Subtracting (subtract figures up to 5,000): to subtract with one credit technique, with two times credit technique, to subtract a number in a row from two to more, to define unknown numbers in subtracting sentence, to define unknown digits at deducting case, to define himself numbers to be subtracted and subtraction one and then to solve it (can be set out in a game)
- To add and subtract 3 numbers or more, to solve narrative arithmetic
- Multiplication: to remember multiplication as a repetitive addition, to multiply 2 numbers of one digit of 6x6 up to 9x9, to remember the exchanged characteristics of multiplication, to know multiplication characteristics with figure 1, to multiply with zero and know the characteristics, to know multiplication table up to 9x9, to multiply 3 numbers of 1 digit, to solve narrative arithmetic
- Division: to remember division as a repetitive subtraction to be zero as the opposite of multiplication, to divide a number with others without remainder, to divide in a row 3 numbers, to solve narrative arithmetic
- Multiplication and division: to know the relation between multiplication and division, to solve narrative arithmetic
- Mixed arithmetic process: to solve the problems that contain at least 4 added, subtracted, multiplied and divided arithmetic parts appropriate with sequence of conducted arithmetic process, to solve narrative arithmetic that contain mixed arithmetic process.

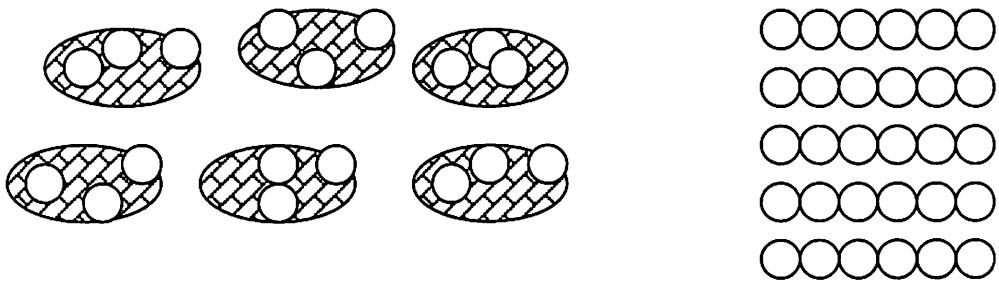
Only in narrative arithmetic the relation with daily life is visible. But narrative arithmetic is provided as a specific kind of sums: a story (arithmetic situation in daily life) has to be translated and abstracted into a formula. It should be better when the opposite also was visualised: a formula is an abstraction of an arithmetic situation. E.g. 48 : 6 = ... 48 apples have to be divided over 6 baskets.

There is in principle no difference between narrative and "common" arithmetic.
But when I worked with children and even when I discussed with teachers it seemed as if the opposite doesn't exist. For the majority making sums/ working with formulas is a technical operation, which has nothing to do with arithmetical situations in daily life. Arithmetic is reduced to doing tricks with numbers conform certain rules and teaching arithmetic means: teaching the rules.

This meaning has some consequences: narrative arithmetic is experienced as extremely difficult by a lot of children, especially those with language problems; "common" arithmetic is experienced as difficult by the weaker children, because they don't understand what they are doing.

Back to the example: 48 : 6 =
Children learned the rule and solve the problem as follows: 1 x 6 = 6, 2 x 6 =,
3 x , 4 x, ... **8 x 6 = 48** ⟶ 48 : 6 = **8**
Some know the multiplication table and find the answer straight away. Others make mistakes, like **7 x 6 = 48** ⟶ 48 : 6 = **7** (miscalculating)
Or **6 x 8 = 48** ⟶ 48 : 6 = **48** (no understanding of the rule and formula)

Dividing 48 apples over 6 baskets however, can be visualised by the children. First in a drawing and later on in their mind.



1x 6 = then is not only a part of the multiplication table, but has a meaning: I put one time in each basket an apple, 2 x 6 = I put 2 times in each basket an apple. And with 48 apples I can 8 times put an apple in each basket.
Miscalculating can still occur, but a child is able to check the answer. Failures by misunderstanding will reduce.

Starting in Grade I-II, where formulas should always be related to arithmetical situations in children's life, it should be better when also in Grade III-VI introductions of new/next steps always be provided in relation with arithmetic situations. The curriculum should prescribe this approach.

3. Teaching programme

3.1 Addition and subtraction, multiplication and division, counting money

3.1.1 Content and the time of provision

Gr	Indonesia	The Netherlands
Addition and subtraction, multiplication and division		
I	+/- up to 100	+/- up to 10 in formal notation, exploration up to 30
II	+/- up to 1000 x/: up to 45 (5x9)	+/- up to 20 automated, exploration up to 100 multiplication table of 1, 2, 5 and 10 automated able to calculate multiplication from 1, 2, 3, 4, 5 and 10
III	+/- up to 10.000 x/: up to 81 (9x9), calculate up to 990	+/- up to 100 in sums and context multiplication tables of 1 to 6 and 10 automated apply multiplication strategies: exchange-, double-, halve- and one time more/less strategy able to multiply and divide in contexts
IV	+/- up to 100.000 x/: up to 100.000	+/- up to 100.000 exploration multiplication with tens and hundreds division tables
V	up to 1.000.000	+/- up to 100.000 able to estimate and to chose handy strategies
VI	> 1.000.000	
Money		
I	+/- up to 100	
II	+/- round numbers up to 1000	Sums with coins and notes, from 5 cents coin to F 100 note (=10.000 cents)
III	+/- round numbers up to 10.000	Able to compose amounts with coins and notes and add in a handy way
IV		+/- with amounts; able to read price list
V		Playing with as little as possible coins/notes; change money; division through 10 and 100
VI		

3.1.2 Amplification and comments

1 Exploration phase and automated phase

In the Netherlands a difference is made between the exploration phase and the automated phase. In the exploration phase children examine a field (counting, jumping in the counting row, playing with numbers, trying to solve problems). They are allowed to use concrete materials, drawings and schemes. In the exploration phase, children are allowed to make mistakes and to try out not handy strategies, since they are learning from "trial and error".

In the automated phase, children have to master the numbers and formulas, being able to solve problems without additional materials. The field for exploration is always wider than the field that has to be automated. For instance in grade II children explore numbers up to 100, but have to master calculations up to 20.

2 Addition and subtraction in grade I up to 100

In Indonesia addition and subtraction in grade I is already taught up to 100, as contrasted with most other countries. The given reason for that is the money counting. The smallest amount nowadays children use is 50 or 100 Rupiah. This reason is not strong enough to start earlier than children can understand with the provision of sums up to 100. For a successful development of maths ability it is very important that the basic understanding of numbers and their relation with arithmetic situation is developed well. Children of that age can cope with numbers and amounts they can handle: see, count and grip. They can do that with the amounts of things up to 20. Only after the achievement of this basic understanding and the basic skills to work with the numbers, they are able to explore bigger amounts.

In The Netherlands, money counting starts in grade II, with playing with coins and notes (play money). There is no need yet they have a complete understanding of the amounts of 1000 or 10.000 cents, since they are working with concrete materials, like a F 1,- coin and a F 10,- note.

3 Multiplication and division

It is unclear why multiplication in grade II is provided up to 45 (up to 5x), while addition and subtraction goes already up to 1000. There is no big difference between the provision level in Indonesia and in The Netherlands. But in Holland you see more emphasis on different strategies and understanding.

4. Mental arithmetic, strategies and estimating

The Indonesian course outline, prescribed in the curriculum, starts already at the end of grade I with calculating arithmetic. There is too little attention for mental arithmetic. In mental arithmetic much attention can be paid on different strategies and problem solving learning.

Example of mental arithmetic, using different strategies:
Children are provided with a problem, they have to solve. E.g. 22 + 13 =
They use different strategies.

22 + 13 = (2 + 10) + (2 + 3) = 30 + 5 = 35
Or: 22 + 10 + 3 = 32 + 3 = 35
Or: 22 + 3 + 10 = 25 + 10 = 35

Afterwards their strategies will be compared. At the end children will use the strategy they find the best, the most handy, the fast or the one they understand the best. So, not all children use the same strategy. Children learn to think creatively.

In Indonesia children learn one strategy: 22 + 13 = 22 = 20 + 2
13 = 10 + 3
= 30 + 5 = 35

Another example of the use of different strategies in mental arithmetic:
9 x 8 = one time less than 10 x 8, so: 80 – 8 = 72
Or: 5 x 8 + 4 x 8 = 40 + 32 = 72

6 x 8 = one time more than 5 x 8, so: 40 + 8 = 48
or: two times 3 x 8, so: 2 x 24 = 48
or: three times 2 x 8, so: 3 x 16 = 48

In Indonesia other strategies are also provided, but one by one. Children have to copy the strategy that is provided by the teacher. In that way there is no talk of creative thinking.

Also a shortage of attention is paid on estimating in the Indonesian course outline.

Example of estimating:
22 + 13 will be some more than 30 (20 + 10)
240 : 8 will be some more than 24 (240 : 10)

With estimating children not only learn to think creatively, but they are also provided with an instrument to check their own found solutions.

5 Final level

At the end Indonesia and the Netherlands both provide sums up to 1.000.000 and more. So there is no difference in the final level, but there is in the moment of provision and the way of provision, the learning process.

3.2 Fractions

3.2.1 Content and the moment of provision

Gr	Indonesia	The Netherlands
I	-	-
II	Adding and deducting ½ and 1/4	-
III	Adding and subtracting ½, 1/3, ¼, 1/5, 1/6, 1/8 and 1/10	-
IV	Able to add fractions Change fractions in decimal fractions Order, adding/deducting fractions with different denominator	Recognise and appoint simple fractions in visible context Recognise and determine arithmetic situations with combined numbers (like 2½)
V	Able to change common fractions into forms of decimal fractions and to sequence these fractions Able to do the adding, subtracting, multiplication and division of fractions The same, using decimal fractions and percents	Able to determine relation part-whole in fractions To place fractions in counting row and circle chart To determine the difference between fractions with different denominator Adding/deducting fractions with different denominator Multiplication of a fraction with a whole number Relation between fractions and decimal fractions To find percentages on the basis of ratio
VI	Able to use fractions and ratios	

3.2.2 Amplification and comments

1. **Start in grade II**
   Indonesia starts too early with fractions, which is on a moment (grade II) children yet can understand fully the meaning of fractions. Especially when you consider that the basic understanding of whole numbers did not get the right attention (see 3.1). With fractions can be started after the basic understanding of division is reached. Normally that is end Grade III/beginning Grade IV.

2. **Relation with arithmetical situations**
   The relation with arithmetical situations is not clear enough. Fraction drawings (circles, bars) are advised for explanation, but that is not the same as starting with a concrete situation, which can be translated in written symbols and a formula. Fraction drawings are already an abstraction of an arithmetic situation.

   Better is to start with concrete materials and drawings of concrete things to divide, like a melon, a pie, a tahu block, a kue lapis/talam, a wood block. The situation

could be the preparation for a Selamatan. When the concept of fractions is clear, you can continue with geometric structures. But each time a child lost the concept, the teacher should return to a concrete situation with understandable things to divide.

3. **Descriptions of the objectives**
In the description of the objectives the Dutch curriculum is more emphasised on the understanding, while the Indonesian curriculum more stress on the ability of making sums, the technique.

3.3 Measuring and geometry

3.3.1 Content and the moment of provision

Gr	Indonesia	The Netherlands
	Time	
I	Days of the week	
II	Months Whole hours, related to daily activities	Reading whole hours (with small hand) Reading whole, half hours and quarters on a clock with 2 hands
III	Able to definite time, also after or before a given time To read and write hours (not round)	Able to compute time from analogue times To read analogue and digital times To match digital and analogue times
IV	Able to measure time	Able to compute time from analogue and digital times
V	Able to determine the time: hours, minutes and seconds The relation of days, weeks, months, years, cycle of 8 years, centuries	Reading of time tables (train) Time calculations up to hundredths of seconds Determine time periods with and without calendar
VI		Able to read off clocks with digital and analogue time notation To convert digital time notation in analogue time notation and reverse To convert time units To calculate time intervals and estimate time on grounds of experiences and the combination of data
Length, width, circumference, surface area, weight and content		
I	Use not standard measures for measuring length	

	Able to know the width of objects and to compare them intuitively	
II	Able to measure length with m, cm To use non-standard measurement units to count width and know the necessity of standard measurement units	Measure cm with ruler Place measures in context: cm, m, kg, l
III	Able to definite linear measure: m, dm, cm To measure the width To measure the weight in kg, ons and gram	Able to measure in m, cm, mm The concept litre, kg and gram Place linear measures (km, m, cm) in contexts Able to convert meters in centimetres and reverse, cm in mm and reverse Able to convert distances on a map in real distances, using ratio by fitting and measuring with a ruler To use ratio by fitting and measuring for determination of length and surface area of shapes and objects
IV	Able to measure length Able to measure the circumference on flat structures Able to measure and estimate weight with kg, hg, dg, gram, tons Able to measure volume	Able to convert km in m, dm and cm and reverse, also with simple decimal numbers To use the concepts surface area and circumference To put surface area in m^2 or in cm^2 To determine content of piles on the basis of length, width and height To measure with l, dl, and cl
V	Able to determine the width, circumference and weight To determine the surface area and circumference of flat structures in km^2, m^2, mm^2, ha = hm^2, are = dam^2, ca = m^2 Able to determine the volume of cubes and bars using standard units	Able to weight in kg To read off tables of distances To determine content in l, dm^3 and m^3 To determine circumference and surface area of even shapes To estimate surface area of free shapes
VI	Able to determine the volume of spatial structures Stabilisation, deepening and enlargement	Stabilisation, deepening and enlargement

Diagrams and tables		
I	-	-
II	-	-
III	-	Able to make and read bar diagrams
IV	-	Able to read and interpret simple bar-, line-, picture- and sector diagrams Able to determine the comparative quantities in simple ratio contexts and to place them in a ratio table
V	Able to make and read bar diagrams and pie diagrams	Able to mark percentages in bar diagram and pie diagram To read and interpret double bar- and line diagrams To relate together covered distance and needed time, petrol consumption and mileage
VI	More able to present data in the form of bar- and pie diagrams	Stabilisation, deepening and enlargement
Ground plans, maps		
I		
II		Build with blocks and read/draw ground plan
III		Able to determine the amount of blocks in block structures and to draw the ground plan To describe and draw places and routes on a map with the help of co-ordinates
IV		To describe routes on the basis of a ground plan To estimate what is visible/not visible from a fixed position To find places on a map with the help of co-ordinates
V	Able to determine point locations on a co-ordinate level	Able to determine point locations on a co-ordinate level To handle scale To calculate distances between co-ordinates with the help of values
VI	Stabilisation, deepening and enlargement	Stabilisation, deepening and enlargement

Geometrical structures		
I	Able to know and to differentiate geometry structures: circles, squares, globe and cylinder	
II	Identify quadrangles, cubes and bars	
III	Able to differ complementary angles from not-complementary angles Able to know squares and rectangles Able to know upright prism	
IV	Able to identify folded symmetries/reflections Identify trapeziums and parallelograms, various angles and triangles and able to know hypotenuse, sides, angle points on spatial structures Able to measure the angle degree and width	Recognise turned and reflected figures
V	Able to use folding symmetries and able to manipulate flat structures Able to know trapeziums and able to use folding symmetries and rotating symmetries Able to read, draw and measure angles in °	
VI	Stabilisation, deepening and enlargement	

3.3.2 Amplification and comments

1 **Time, length, width, circumference, surface area, weight and content**
Differences in the content between the two curricula are not so big. The Dutch program only provides more applications.

2 **Diagrams and tables**
As contrasted with the other program components the Indonesian curriculum starts very late with the provision of diagrams and hardly any attention is paid to the use of tables. In The Netherlands it is found important to teach children the use of

tables and diagrams for being able to process and read data, related with daily life in a handy way.

3 **Ground plans and maps**
Also with spatial orientation the Indonesian curriculum starts not until grade V. In the Netherlands the provision normally starts in grade III, also for supporting Social Studies, which starts with the use of the atlas in grade III.

4 **geometrical structures**
The provision of this component starts already in grade I. It seems hardly any attention is paid to this component in The Netherlands, but that is not so. Geometrical structures are taught in relation with measuring, that while in Indonesia the academic approach is chosen.

In my opinion the Indonesian curriculum is going too far for primary school children. Without the relation with the surrounding and daily life, these structures stay abstract and non-functional for children.

4. Learning Theories

The course outline is not enough written in accordance with general accepted theories of cognitive development and the function of mathematics.

4.1 Several points of view

Piaget: Children from about age 7 to about age 11 are in the period of concrete operations. Children are able to conserve quantity and number, to form concepts of space and time, and to classify or group objects if the objects are present. However, they are still tied to the concrete operations of the immediate world.

Although Piaget's theory has been criticised, it kept his basic importance in the course of developmental psychology.

Bryant and Trabasso: The deficits of the concrete operational child do not lie in being tied to the physical presence of stimuli, but in memory capacity.

Glick & Wapner: Although memory capacity is an important factor in age differences in logical inference, it has been found that children between the age of 8 and 18 solve problems of inference presented with concrete examples more easily than those with verbal presentations.

Cross-cultural studies: The sequence of intellectual growth may be modified by cultural and experimental factors, as well as by training in problem-solving strategies.

J. Borghouts-van Erp: Arithmetic is doing, operating; it is a generalisation, an abstraction of operating in arithmetic situations.

Dr. H. Djaali: The present program mathematics SD in Indonesia is very abstract and complicated for SD children, not in accordance with the concept and not with the allocated time (see enclosure 1: Kompas of 6 May 1999).

4.2 The learning process

Arithmetic is operating. There are 4 levels of operating:
1. Operate with hands (concrete level)
2. Operate with the eyes (visual level)
3. Operate with words (verbal level)
4. Mental operation (automated level)

Level 4 can only be mastered with real understanding via mastering level 1 to 3.

Many pupils in higher grades are able to make sums perfectly, but a lot of them are doing that without real understanding. They are conditioned instead of developed the ability of logical thinking, logical inference.

When you examine pupils in higher grades who have problems with mathematics, you will find their problems are caused by not mastering a lower level. Level 1, 2 and 3 are hardly provided in the course outline of the Indonesian curriculum.

Level 1: Concrete materials are being advised and used, but mainly for showing in front of the classroom. Only the teacher and some of the children are operating with hands. Besides, the function of the operation by these children is not to learn by doing, but to show the other children.

Level 2: Although all pupils watch the activities of the teacher/fellow pupils in front of the classroom, operating with hands or using the blackboard, that is not the same as operating with eyes. Operating with eyes is an active operation, done by each pupil in order to solve a problem. Watching the teacher is more passive form. Pupils are receiving information, an example of how to solve a problem (to make a sum), that they can use later for solving the same kind of problems/sums by themselves.

Level 3: In the mainly classical system only a few children have the opportunity to operate with words. Those are the ones who are allowed to answer the teacher. Level 3 can be reached when children have regular discussions with each other about strategies and solutions.

Combining several actual learning theories, the learning process can be divided in phases:
1. The orientation phase
2. The learning moment of insight moment (Aha-Erlebnis)
3. The trying out and training phase (exploration)
4. The automated phase
5. The application phase

Although one lesson can contain all phases, normally each phase takes a period, with the exclusion of phase 2.

In the Indonesian course outline as well as in the daily lesson practice in the schools there is too little attention for phase 3 and 5, and the teacher's role dominates. This is not in accordance with the theory about active learning and problem solving activities, nowadays quite accepted in Indonesia (projects like PEQIP and Basic Education). Everything that children (and adults!) try out, find out, discover, compare, explore, solve and inference by them selves will be better consolidated. For that reason phase 3 and 5 are very important in a learning process.

5. Allocation of Time

5.1 Hours spent

	Grade	Hours per week	% school time per week
Indonesia	I	5	30.5%
The Netherlands	I	4:15	18%
Indonesia	V-VI	5:20	17%
The Netherlands	V-VI	5	20%

See enclosure 2

5.2 Comparison

Indonesia spends more hours per week for maths than Holland. In hours, the difference is not so big, but in percentages it is.

1. **Lower grades**
   In Indonesia mathematics appears to be found more important than in The Netherlands. Over 30% are prescribed for mathematics. In the Netherlands most time is prescribed for language (39%). The program for grade I-II in Indonesia is heavier than in the Netherlands. Arithmetic is provided up to 100 in grade I and up to 1000 in grade II, as contrasted with most other countries: up to 20 and 100. Besides the level of abstraction is high. In Holland arithmetic is much longer related to arithmetical situations in children's life, and therefore easier to achieve basic understanding.

2. **Higher grades**
   While Indonesia decreases the allocation of time to 17%, The Netherlands increase the time up to 20%. This is, because the program becomes more complicated and more applications are provided in the higher grades, often supporting other subjects or integrated in other subjects. Think of measuring in IPA and Technique, spatial orientation and scale for map reading (IPS), the use of tables and diagrams for being able to process and read data, related with daily life in a handy way (IPS, IPA, Language).

3. **General**
   In The Netherlands people start form the principle that in elementary mathematics the basic understanding has to be consolidated. For that, the amount of time is not determining, but the way of teaching and the basic programme is. Once the basic understanding is consolidated, children are able to cope with a more heavy and complicated programme. They learn faster when the basic understanding is consolidated. Therefore there is in lower grade time distributed, enough for achievement of basic understanding and more time in higher grades, when children can cope with more complicated problems.

   In Indonesia, people start from the principle that children has to learn as much as possible in the first years of primary education, in order to be able to cope with the

more complicated programme of Grade II-VI. Therefore, much time is distributed in the lower grades, almost the same amount as in higher grades.

Logically seen and conform my experience to learning children I have more trust in the Dutch principle. When there is basic understanding, you don't have to teach each step intensive. Children are able to make the relation between the complicated problem and the basic operations they learned and understand. It doesn't make sense to provide complicated problems to children who did not yet achieved the basic understanding. You know in advance already they will not succeed.

6. Implementation

6.1 Problems, experienced by teachers, head teachers and supervisors

1. **Components of the program are difficult to teach**
   Often I am asked to give examples how to teach complicated sums. The teachers cannot find arithmetical situations in daily life for explanation. Sometimes due to own shortage of basic knowledge, but often because of the high abstraction level and the complexity of the formulas.

2. **Many children don't like mathematics**
   First of all children are not often given attractive mathematical problems to solve. Often the lesson is boring. Most of the time they have to listen to the teacher and to follow examples on the blackboard. For the weaker pupils the program is too difficult and they lose motivation. The strong ones lose interest because they have to follow instruction and examples, while they already understand the concept.

3. **Allocation of time is not in accordance with the program**
   Some teachers ask for more time, others for reduction of the program. This experienced problem is not only caused by the discrepancy between time and program, but also by the way of teaching. The very classical approach causes that many teachers spend more time than needed on instruction, explanation and checking the results of individual children during the lesson process.

4. **Teachers have lack of professional knowledge**
   This problem is often mentioned by head masters and supervisors, but also by teachers. Indeed, I myself met teachers who even missed the basic understanding and ability of mathematics. Supplementary training for these teachers is needed. But when components of the program are already too difficult to understand for primary school teachers in general, what about the children? In that case it is better to examine whether these components are really needed in primary education or not.

5. **The curriculum is very prescriptive and detailed**
   The head masters and supervisor control the carry out of the curriculum by the teacher. Some of them emphasise on their supporting role, but others are strict controllers. Many teachers are used to follow the curriculum exactly, since they are afraid to make failures when they deviate from the prescription. And other teachers don't possess enough professional knowledge to use the curriculum creatively.

7. Recommendations

7.1 The function of teaching mathematics

It should be better when the course outline reflect the function of teaching mathematics that is described in book 1 of the curriculum. That means that objectives have to withdrawn or rewritten and other objectives have to be added.

One criterion for objectives that reflect the function of teaching mathematics in a primary school could be: taught arithmetical operations (formulas) have to be related/able to relate to arithmetical situations in children's daily life. When a arithmetical operation is too abstract or too complicated to make this relation, it is better to teach it in secondary school.

E.g. division by a fraction (grade V) is for many children magic. They learn how to do it, but don't understand what they do. The teacher explains the operation by comparison: 100 : 50 = 2
100 : 5 = 20
100 : 0,5 = 200,
but is not able to relate the operation with an arithmetical situation. You could consider reserving this operation for the bright children only (enlargement) and not yet including it in the minimal program for primary education.

7.2 In accordance with general accepted learning theories

More attention should be paid to all levels of operating, especially in grade I-II. Children are learning by doing, not yet by listening to the teacher or observing and copying the teacher's example.

More attention should be paid to all phases of the learning process, especially to exploration and application.

Exploration: when children are allowed to try out things, free to use different strategies and find their own solutions to solve a problem, they understand better what they learn. To be clear: in the exploration phase children are allowed to make mistakes. These mistakes and the discussion about it (with the teacher and among children!) are part of the learning process, learning from mistakes.

Application: through application children understand better why they learn something. In application, where the instrument (mathematics) is being used, the teacher can really examine the pupil's process in arithmetical abilities.

I recommend indicating in the objectives which phase is mentioned and/or which level of operating. Whether the children are expected to try out and explore, or to operate automated, for instance.

7.3 The description of objectives

Many objectives meant to be taught in relation with arithmetical situations. But when only the technical aspect is described, it is difficult for the teacher to understand that underlying intention. And when he/she does understand, it cost a lot of extra time and additional books to design a lesson. Besides, the curriculum is very prescriptive and detailed, and the head master/supervisor control the carry out by the teacher. Many teachers are used to follow the curriculum exactly, since they are afraid to make failures when they deviate from the prescription. And other teachers don't possess enough professional knowledge to use the curriculum creatively. It would be better to rewrite these objectives and include arithmetical situations and practical applications, which have to be carried out by the pupils them selves.

7.4 Program: content and moment of provision

- Arithmetic in Grade I: up to 20.

Exploration is possible up to 100. Children of that age can cope with numbers they can handle: see, count and grip. They can do that with amounts of things up to 20. Only after the achievement of this basic understanding and the basic skills to work with the numbers, they are able to explore bigger amounts.

- Money counting can start in Grade I, but only in a play situation in the exploring phase. Create a shop of market in the corner of the classroom.

- Calculating arithmetic better starts not until Grade III. At the end of grade II this form can be introduced as one of the strategies.

- Arithmetic should more emphasis on mental arithmetic and estimating with the use of different strategies, also in higher grades

- The provision of fractions better starts not until the understanding of the concept is solid.

- Measuring can start in grade I, as long as it is provided on concrete level of operating (that means: all children handle measure instruments). Also in higher grades it is recommendable to let the children measure with instruments, instead of only making sums.

- More attention to working with (reading and making) diagrams and tables, with ground plans and maps is recommended. These are the ideal components for applications of measuring and ratio. For children these applications are much more attractive and clear than sums only. In simple form they can be provided from grade III.

- I recommend providing only simple geometrical structures related to arithmetical/geometrical situations in daily life.

7.5 Allocation of time

I recommend a reduction of time in lower grades, combined with a program that is more emphasised on the basic understanding of numbers and their relationship with arithmetical situations, and on the lower levels of operation. When children are more learning by doing (handling) instead of listening and copying in a maths lesson, time can be used more effectively.

Maths is important for children's development, but so are language, social studies, science, arts and crafts and physical education. In primary education, basic education all components are important. Besides, components are supporting each other. For maths for instance, are language and arts & crafts very important (reading/writing, spatial orientation and imagination, drawings). Too much emphasis on one component is at the expense of the other and thus of the complete development. We have to make choices, but they have to be on behalf of the basic development of children. From that point of view language is a more important component in Grade I-II, especially in Indonesia where for the majority of the children the Indonesian language is not the mother tongue, and where social studies and science are integrated in this component.

The distribution of time for Grade I-II in Indonesia could be:

Subject	**Lesson**	**Time/ week**	**%**
Language, including social studies and science	13	6:30	43.3
Mathematics	8	4:00	26,7
Physical education	3	1:30	10
Arts and craft	2	1:00	6,7
PPKN and religion	2	1:00	6,7
Local subjects	2	1:00	6,6
Total	**30**	**15:00**	**100 %**

But on behalf of good mathematical development, I repeat:
a reduction of time is of no harm, only in combination with reduction of the programme (more in harmony with the development stage of 6-7 year olds), and
a more effective use of time: children learning by doing.

Materi Pelajaran Matematika SD Terlalu Abstrak dan Rumit

Jakarta, Kompas

Materi pelajaran matematika untuk murid Sekolah Dasar (SD) perlu dikurangi dan disempurnakan, terutama pada materi-materi yang terlampau abstrak dan rumit. Selain itu, struktur penyajian matematika dan alokasi waktu juga harus dikaji ulang agar lebih sesuai dengan penjenjangan konsep matematika dan waktu riil yang tersedia.

Ahli pendidikan matematika Dr H Djaali mengungkapkan hal ini saat dikukuhkan sebagai guru besar tetap pada Fakultas Pendidikan Ilmu Pengetahuan Sosial (FPIPS) IKIP Jakarta, Rabu (5/5). Dalam orasinya berjudul "Pembelajaran Matematika di SD Ditinjau dari Kesiapan Intelektual Anak", Djaali menyoroti berbagai masalah dalam pembelajaran matematika di SD dalam kaitannya dengan usia anak yang masih terlalu dini.

"Pembelajaran matematika di SD harus disesuaikan dengan perkembangan kesiapan intelektual anak. Juga perlu kesesuaian antara banyaknya materi yang ada dalam kurikulum dengan alokasi waktu yang tersedia," kata Djaali seraya menambahkan bahwa dalam kaitan dengan kesiapan intelektual anak tercakup dua hal, yaitu perkembangan intelektual atau struktur kognitif dan pengalaman belajar yang telah diperoleh anak.

Terlalu berat

Menurut lelaki kelahiran Buton ini, tindakan yang bijaksana dalam pengajaran (matematika) adalah menghindari penerapan operasi-operasi atau konsep-konsep yang terlalu dini. Dalam kaitan ini, baik materi maupun strategi pembelajaran yang dipakai harus sesuai dengan perkembangan intelektual atau struktur kognitif anak. Tindakan memaksa anak untuk terlalu cepat pindah dari satu stadium (tingkat-tingkat perkembangan intelektual) ke stadium berikutnya merupakan langkah yang tidak bijaksana.

"Perlu disadari bahwa anak bukanlah orang dewasa. Mereka mempunyai kemampuan intelektual yang sangat berbeda dengan orang dewasa," tutur Djaali mengutip teori perkembangan intelektual yang dikemukakan Jean Pieget.

Tentang hal ini Djaali mencontohkan materi pembagian dalam mata pelajaran matematika yang terlalu berat bagi anak usia SD. "Jika 15 kelereng untuk tiga orang, untuk berapa orangkah jika tersedia 35 kelereng? Anak usia 10-11 tahun akan menjawab tidak tahu. Sedangkan anak usia 13-14 tahun akan menjawab untuk tujuh orang karena setiap orang menerima lima kelereng," katanya.

Ditambahkan, anak usia 10-11 tahun akan dapat menjawab pertanyaan tersebut apabila kepadanya disajikan benda-benda konkret berupa 35 kelereng, lalu dibimbing memanipulasi kelereng-kelereng itu untuk memahami persoalan dengan baik. Dengan cara ini materi yang disajikan dapat benar-benar bermakna bagi murid SD yang masih berada pada apa yang disebut "stadium operasional konkret".

Di sini jelas, walaupun pada "stadium operasional konkret" anak sudah mengerti relasi, akan tetapi ia tidak dapat menyelesaikan jenis operasi yang lebih sulit, apalagi dengan menghubungkan relasi-relasi ke dalam hukum-hukum.

Hasil penelitian Djaali tahun lalu terhadap siswa kelas lima dan enam SD di DKI Jakarta menunjukkan, siswa kelas lima SD baru 15,24 persen yang memasuki kategori "stadium operasional formal" dan untuk siswa SD kelas enam baru 24,52 persen yang sudah memasuki "stadium opersional formal". Padahal siswa yang diteliti sudah berumur sekitar 10-13 tahun.

Tak sesuai konsep

Pada bagian lain Djaali mengingatkan, penyajian konsep-konsep matematika di SD—terutama konsep-konsep abstrak yang menggunakan proposisi logika-formal—sedapat mungkin dilakukan dengan pendekatan melalui benda-benda konkret. Tanpa pendekatan ini, katanya, materi-materi abstrak yang ada dalam Kurikulum Matematika SD tidak akan bermakna bagi siswa. Dampak ikutannya anak akan kesulitan menyerap materi-materi berikutnya.

Menurut hasil kajian Djaali, struktur penyajian matematika dalam Kurikulum Matematika SD tahun 1994 ternyata sebagian materinya tidak sesuai dengan penjenjangan konsep matematika. Misalnya, konsep pengukuran diperkenalkan mendahului konsep perkalian, yaitu disajikan pada kelas satu caturwulan pertama, sedangkan perkalian baru disajikan pada kelas dua caturwulan ketiga.

"Padahal, konsep pengukuran didasarkan pada konsep perkalian atau konsep rasio," ujarnya.

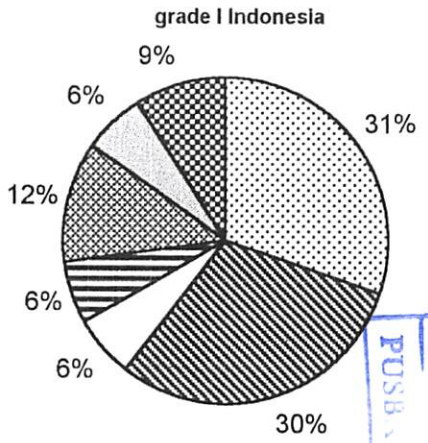
Sementara itu, Rektor IKIP Jakarta Dr Sutjipto yang memimpin upacara pengukuhan mengemukakan, materi pelajaran matematika seperti yang disinyalir Djaali memang tidak sepenuhnya disusun sesuai perkembangan anak. Selain itu, banyak guru yang mengejar target kurikulum, sehingga guru tidak mengajarkan bagaimana belajar matematika, tetapi hanya memberi materi-materi yang menyeramkan bagi anak. "Yang mesti dilakukan adalah mendorong minat anak untuk belajar matematika melalui permainan, hal-hal yang menarik atau sikap guru yang terbuka," kata Sutjipto. **(lok)**

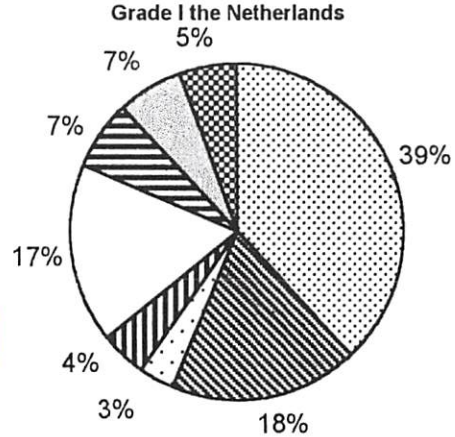
allocation of time

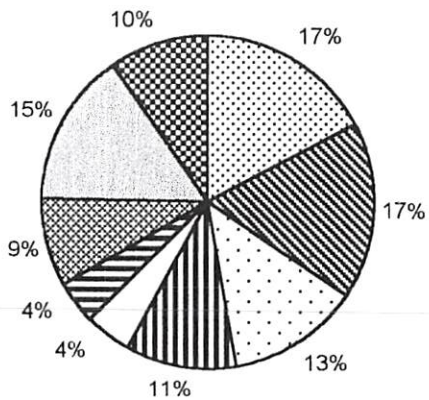
Grade I	Language	Mathematics	science	social studies	Art & Craft	phys.educatio	PPKN+Agama	local subjects	play time	total
Cur 94	10	10			2	2	4	2		**30**
	5:00	5:00			1:00	1:00	2:00	1:00	1:30	**16:30**
Cur the Neth	8:45	4:15	0:45	1:00	4:00	1:30		1:30	1:15	**23:00**

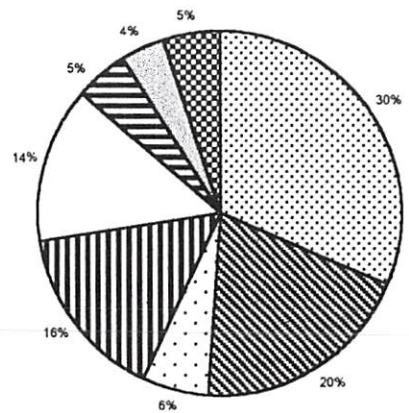
Grade IV	Language	Mathematics	science	social studies	Art & Craft	phys.educatio	PPKN+Agama	local subjects	play time	total
Cur 94	8	8	6	5	2	2	4	5		**40**
	5:20	5:20	4:00	3:20	1:20	1:20	2:40	3:20	3:00	**29:40**
Cur the Neth	7:45	5:00	1:15	4:00	3:45	1:30		1:00	1:15	**25:30**

Grade VI	Language	Mathematics	science	social studies	Art & Craft	phys.educatio	PPKN+Agama	local subjects	play time	total
Cur 94	8	8	6	5	2	2	4	7		**42**
	5:20	5:20	4:00	3:20	1:20	1:20	2:40	4:40	3:00	**31:00**
Cur the Neth	8:00	5:00	1:30	4:00	3:30	1:15		1:00	1:15	**25:30**









Enclosure 2