2.6 Zambia

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2.6.1 History of Mathematics Education

- **Introduction**

This paper provides a brief overview of the changes in mathematics education in Zambia from right before political independence till date. The major focus is on mathematics at the primary/basic school stage, where the initiatives have mostly been local.

- **Mathematics Education in the Colonial Era**

Zambia gained its political independence from Great Britain in 1964. The general aims of the Primary School Course in the colonial era were stated as follows:

"To develop

a) the highest possible standards of individual conduct and social behavior;

b) permanent literacy in one vernacular language and in English;

c) sufficient skill in arithmetic to meet everyday requirements with speed and accuracy;

d) an understanding of the immediate environment and how other people live in other places;

e) the acquisition of some practical skills." (MOE, 1962: p. ii)

The syllabus provided guidance to teachers and included the following aspects:

(1) The recommended text books cover the syllabus at the required level; however, teachers will have to outline their own terms and schemes of work. They must always be attentive to everyday examples and remain up to date with Post Office charges, costs of food, time-tables, etc.

(2) The teacher must be mindful of the following three aims:

(a) To teach "meaning" so that children learn to reason for themselves.

(b) To give children a sound basis for further study (e.g., a necessary preparation for secondary school mathematics).

(3) It is important that teaching methods be suited to the student's individual capabilities. This cannot be achieved by class teaching alone. In the initial stages, the students will often require individual attention; group teaching methods are strongly recommended at a later stage.

(4) The teacher must

(a) teach one thing at a time;

(b) ensure that he explains all processes;

(c) see that the facts of addition, subtraction, multiplication and division are systematically drilled and so thoroughly mastered that, by the end of the course, they can be assigned without hesitation.

Accuracy and neatness are most important in written work. When these are established, the

children must be encouraged to work as fast as possible. In mental exercises, speed and accuracy must be the main aims. Mental exercises must be used to practice problems that the children will encounter in their daily lives.

(5) Great care should be taken over the correct layout of work. ... The following points should also be noted:

(a) correct and uniform figuring

(b) all working to be shown as an integral part of the sum and writing calculations in the margins should not be permitted.

(c) the correct use of the sign of equality

(d) answers must be clearly distinguishable. This is best done by underlining the answer with a neat penciled line. Units must always be given when required, e.g., 20 cows.

(e) Each sum should be neatly ruled off in pencil. A ruler should also be used for drawing lines in the calculation.

(f) The use of erasers or razor blades to erase mistakes should be discouraged.

The philosophical undertones in the "guidance" to teachers may be questioned; however, at least, considerable effort was expended in providing teachers guidance with regard to the manner in which to streamline the general intentions of the syllabus.

- **Educational Reforms of 1977**

In 1997, the Government of the Republic of Zambia announced fundamental changes to the educational system in the country. At this stage, the national ideology of the country was firmly entrenched in what the then President of the Republic of Zambia termed as the philosophy of *Zambian Humanism*. This was a version of socialism. From an educational viewpoint, it involved forging closer linkages between schooling and the world of work, so that those that complete school could become self-reliant individuals. The changes in the syllabuses toward the fulfillment of the new educational vision were released in 1983. The new syllabus for Mathematics was known as the Basic Education Mathematics Syllabus: *Grades 1–-9*. The document on the syllabus states in its introduction "when constructing the aims of this syllabus, special consideration was given to the present social needs, and the traditional applications of the subject in addition to the Mathematical requirements for other subjects." The syllabus emphasized essential knowledge and skills that would aid in self-reliance.

The aim of the basic Mathematics Curriculum was to strengthen the link between schooling and preparation for working life. Students who were taught according to this curriculum were not only to acquire knowledge and skills that would enable them to become productive, but also those that would enable them to become self-reliant by the time they complete Grade 9.

A number of working skills in Mathematics were identified. These were as follows:

(1) Productive skills—defined in terms of the following features:

(a) It can be taught.

(b) It can be improved with practice and feedback.

(c) It can be applied in a variety of different skills that are usually combined to form a smooth sequence of actions directed toward a particular outcome.

(2) Social and life skills—activities and understanding required to manage one's personal life successfully.

(3) General skills—grouped into two as follows:

(a) Attitudes to work; Confidence; Commitment; Motivation; Common sense

(b) Basic knowledge of working life

-Understanding the role and purpose of work in relation to society.

-Understanding the difference between work and employment.

-Knowledge of occupation categories.

-Understanding basic economic processes at the individual, occupational, and national level.

-Knowledge of basic technological and industrial processes.

-Knowledge of self employment, such as cooperatives.

The aims of the syllabus were stated as follows:

(1) To equip the child to live effectively in this modern age of Science and Technology and enable him/her to contribute to the social and economical development of Zambia.

(2) To stimulate and encourage creativity and problem-solving.

(3) To develop the Mathematical abilities of a child to his/her full potential, and assist him/her to study Mathematics as a discipline and use it as a tool in various subject areas.

(4) To assist the child to understand mathematical concepts in order that he/she may better comprehend his/her environment.

(5) To develop in the child an appreciation of Mathematics in the traditional environment.

The specific objectives of the syllabus were as follows:

(1) To develop an interest in Mathematics and encourage a spirit of enquiry.

(2) To build up understanding and appreciation of basic mathematical concepts and computational skills in order to apply them in everyday life.

(3) To develop clear mathematical thinking and expression in the child.

(4) To develop the ability to recognize problems and solve them with related mathematical knowledge and skills.

(5) To develop and foster speed and accuracy.

(6) To provide the child with necessary mathematical knowledge and skills for him/her to be productive and self-reliant.

(7) To develop in the child a positive attitude toward production and self-reliance.

(8) To provide necessary mathematical pre-requisites for further education.

An exhaustive list of "productive skills" was also specified. These were as follows:

"PRODUCTIVE SKILLS IN MATHEMATICS

The pupils should be able to

(1) Classify objects and numbers according to a given condition.

(2) Demonstrate an understanding of number concept and numeration.

(3) Perform the four basic operations on numbers and measures.

(4) Demonstrate skills in measurement in appropriate units.

(5) Estimate and approximate numbers and measures.

(6) Translate verbal data into symbols and vice-versa.

(7) Identify plain and solid shapes and acquire an understanding of their basic properties and special relationships.

(8) Draw and construct geometrical shapes and solids.

(9) Collect, classify, tabulate, represent, and interpret data.

(10) Solve problems involving fractions, ratios and proportions, average and percentages as applied to numbers and measures.

(11) Solve problems involving household, social and commercial arithmetic.

(12) Solve problems involving measurements (length, area, volume, capacity, mass, money, time and speed, time and distance).

(13) Identify different types of symmetry and draw symmetrical figures.

(14) Read and draw compass bearings and use them in scale drawings and map reading.

(15) Use appropriate mathematical language.

(16) Construct and use graphs.

(17) Perform algebraic operations." (CDC, 1983)

The abovementioned details regarding the syllabus have been provided in order to identify points of departure between lofty statements of policy and ultimate implementation. Policy appears to have been left to implement itself. None of the ideals envisaged in the policy document were realized. With regard to the syllabus, the content basically remained unchanged. For example, it can be questioned what is *productive* about the specified "productive skills"?

- **Educating Our Future**

The next policy change in education came in 1996 in a document that was entitled *Educating Our Future* (MOE, 1996). The document filled the void left by the lack of implementation of the Education Reforms of 1977 and another document that was introduced in between—Focus on Learning (MOE, 1991), which only "focused" on Primary Education and ignored all other aspects of education. Certain salient aspects of *Educating Our Future* particularly relevant to the topic at hand were as follows:

- a recognition of the importance of mathematics and science education to national development;
- a directive that initial literacy would be in the language children were most familiar with, in this case, the local languages. (Up until now, English was the official medium of instruction at all levels of schooling. Local languages were often used in teaching but more from the point of view of common sense rather than a policy perspective.)

Educating Our Future was followed by the *Basic School Curriculum Framework* document (MOE, 2000) that aimed at providing a framework for implementing the new education policy. Again, fundamental changes for the provision of basic school education were articulated in this document. This implied impending reforms in the basic school curriculum in the following respects:

- More learning time: 20 hours of lesson time per week in Grade 1; 25 hours in Grade 2; 27 in Grades 3 and 4; and 30 in Grades 5 to 7.
- Concentration on fewer subjects
- Basic literacy and numeracy were to be accorded the status of being the highest prioritized competencies.
- Localized curriculum—in addition to the one that was centrally defined
- HIV/AIDS awareness and protection
- Life skills of various categories
- Outcomes-based curriculum
- Continuous assessment methods were to be a constant feature in all teaching and learning.

- **Syllabus of 2003: Numeracy and Mathematics**

The translation of the Curriculum Framework document came in the syllabus of 2003, which is currently the governing syllabus. The introduction of the syllabus document states the following:

"The new curriculum is outcomes based and focuses on results rather than on goals, aims and objectives. It places emphasis on observable and measurable skills, knowledge and values to be acquired by learners at specified levels of their schooling. The new curriculum emphasizes learner centeredness and provides for increased learner-teacher contact time, different ability groups and use of a familiar language for initial literacy.

Continuous Assessment is another prominent feature of the new curriculum. This allows for regular monitoring of individual learning process, diagnosis of learning difficulties and provision of remedial teaching.

The outcomes-based approach recognizes that learners do not attain the outcomes through a set of prescribed learning experiences in one Learning Area. They attain them through exposure to a wide range of experiences and varied content drawn from all Learning Areas.

This syllabus aims at enabling the learners to acquire mathematical knowledge and develop skills necessary for application in their everyday lives."

Further, the syllabus document provides the following general learning outcomes

"By the end of Grade 7, learners should be able to:

- Develop mathematical knowledge and skills.
- Communicate mathematical ideas effectively.
- Develop skills in problem-solving.
- Develop skills in social and commercial mathematics.
- Develop and foster order, speed, and accuracy in problem-solving.
- Apply mathematical concepts to their environment.
- Develop interest in mathematical skills for everyday use.
- Develop understanding of measurements and shapes.
- Apply mathematical operations in problem-solving.

Although the syllabus is in the early stages of implementation, it is clear that, once again, the content has largely remained the same except for the replacement of *objectives* with *outcomes*. The manner in which continuous assessment will be incorporated in the teaching process and the final grading of students is not clear yet. It is also unclear what assistance teachers will receive to "localize" the curriculum and incorporate the overlapping issues of HIV/AIDS, life-skills, gender, and environment.

- **Mathematics at the secondary school level**

Until approximately two years ago, Zambia was using the *University of Cambridge Local Examinations Syndicate* syllabuses, although the setting of examinations was localized much earlier. Zambia now has its own syllabus that states the following:

"This syllabus covers the topics of Arithmetic, Algebra, Geometry, Trigonometry, Probability, Statistics and Elementary Calculus. ... The aims and objectives of teaching mathematics at Senior Secondary level have been derived from three sources: the Educational Reform Document, the Structure of Mathematics as an academic discipline, and the needs of the child. The syllabus is structured in such a way that the pupil is encouraged to put emphasis on the mathematical concepts, principles and creative thinking processes.

When using this syllabus, it should be realized that Mathematics is a discipline with integrated and hierarchical concepts and skills. It is therefore recommended that an integrated and spiral approach be used (When the overall contents of the syllabus are presented in the traditional compartments)."

It is ironical that the new syllabus includes more challenging topics such as *Earth Geometry* and *Calculus* considering that the performance on preceding syllabuses was a source of grave concern.

- **Reflections**

(1) Language

In the colonial education system, initial literacy was imparted in the (seven major) local languages. After independence, it was believed that the use of a few local languages as the medium of instruction was politically incorrect as it would lead to certain tribes feeling superior and others feeling inferior. Thus, in the interest of fostering a sense of national unity, English was adopted as the official medium of instruction, including initial literacy, at all levels of education. This posed a problem for attainment of literacy (having to learn the language and to read and write in the foreign language), and caused a problem in the teaching of other subjects as well.

The country has reverted to initial literacy in local languages, but more importantly a distinction has been made between the imparting of literacy and teaching of language. In the few years of reverting to this policy on literacy, there are already indications that literacy levels have increased. However, it is not clear how the language issue will affect mathematics teaching and learning. While teachers may explain mathematics in the local language, there is no movement toward developing a mutually agreed-upon, formalized teaching system of maths in the local languages—all the books are still written in English. The most that has been done is to transfer the teaching methodology used in imparting literacy (some form of a child-centered approach) to the teaching of mathematics.

(2) Assessment

As indicated in the Basic School Syllabus of 2003, Continuous Assessment will now be a regular aspect of the mathematics curriculum. Until now, the final (Grade 7) examination has meant "everything." Thus, teaching and learning was directed mostly toward passing the

examinations.

The examination system in Zambia is norm-referenced, i.e., passing is interpreted by progression from Grade 7 to Grade 8. Only recently has the progression rate gone beyond 30%. Progression is based on the number of seats available in Grade 8 in each of the 9 provinces of the country. An aggregate score based on English, Mathematics, and Special Papers 1 and 2 ("general intelligence" papers) is used to determine progression. Thus, the achievement levels of students in mathematics are not known to the general public; in particular, it is the progression figure that captures media headlines.

(3) Agents of curriculum change

Till date, changes in the mathematics curricula have been a result of changes in the political direction of the country. There has been a lack of influence from research or practitioners in the change processes. The net effect of this is that change has been cosmetic instead of systematic. In other words, change has been affected in official documents but has not percolated down to the classroom. Where it has been "mathematics for life," and "outcomes-based" (as opposed to objective-based), the syllabus and the teaching methodology have essentially remained the same.

- **Conclusion**

The National Assessment of Learning Achievement at the Middle-Basic School level (Grade 4—based on literacy and numeracy) concluded in the report (Kelly and Kanyika, 2001) that in terms of education, Zambia was a nation at risk—very little education of the type society expects is actually being imparted in Zambian schools. There is an urgent requirement for serious reflection on the state of mathematics education in Zambia and charting a more productive way forward. "Towards Endogenous Development of Mathematics Education" cannot be a more timely initiative.

2.6.2 Basic Information

(1) Teachers' Qualification

All lower- and middle-basic school teachers are expected to have been trained for 2 years at a primary teachers' college in order to obtain Primary Certification. However, there is a shortage of teachers in certain schools, particularly in rural areas. In such cases, schools have had to hire students who have completed Grade 12 and live near a school to assist in teaching certain classes.

(2) School Calendar and Examination

The new school year in Zambia begins in January and ends in December. The school year is divided into 3 terms, as shown in table 1, and each term is of a duration of 3 months. There is a one-month break between each term.

Table 1. School calendar

Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
	1st Term				2nd Term				3rd Term		

At the end of Grade 7, students take a national examination and those who are able to acquire the cut-off marks proceed to Grade 8. All items in the Grade 7 examination are multiple-choice and presented in English. Similarly, at the end of Grade 9, students take a national examination and those who qualify proceed to Grade 10. It is planned that in the future, if there are sufficient seats available in Grade 8, Grade 7 students will be automatically promoted to Grade 8.

(3) Medium of Instruction

The official language in Zambia is English, although there are approximately 72 tribes that have their own language (dialect), which students usually speak in their homes. English is also the medium of instruction; therefore, teachers basically conduct lessons in every subject in English. However, students, particularly in the initial years of schooling, usually speak local languages outside classes and outside school. Thus, students, particularly in lower grades have difficulty in understanding and speaking English. Occasionally, certain teachers use a local language to explain certain things to students; however, the problem is that certain students may not understand the local language and therefore will not be able to communicate with the teachers. In certain cases, the teacher may not know how to speak the main local language.

2.6.3 Results from the First Year Field Survey

(1) Survey Schedule

A one-man delegation visited Zambia from January 17–27, 2005 in order to facilitate the field survey with his Zambian counterpart. This implies that data collection was conducted merely two weeks after the commencement of the first term. The detailed schedule for data collection is tabulated as follows.

Table 2. Schedule of data collection

Date	Activity
16th / Jan / 2005	Arrival in Lusaka, Zambia
17th- 19th / Jan / 2005	Preparation of the survey Discussion with District Education Offices and Targeted Schools
20th – 27th / Jan / 2005	Data collection in two sample schools in Lusaka Province and their subsequent remedial work
28th / Jan / 2005	Departure from Lusaka, Zambia

(2) Target Schools and Samples

1) Sampling procedures

From among the 9 provinces in Zambia, Lusaka—the capital province—was selected as a sample due to the time constraints for completing the data collection. According to the Central Statistic Office, the extra-departmental organization under the Finance Ministry, an urban area is defined by three criteria—population size, economic activity, and facilities available in the area[2]. Taking into consideration these criteria, from among the 4 districts in the province, Lusaka District was selected to represent an urban area and Chongwe District to represent a rural area.

For the selection of average schools in both urban and rural areas, the survey team requested each District Education Office (DEO) to recommend appropriate schools. After a discussion with the District Education Standards Officers (DESOs), we selected one average government school from both the urban and rural districts. The criteria taken into consideration were as follows:

a. Ranking of the sample schools according to the results of the National Final Exam

   and

b. Social and economical strata in the catchment area of the sample schools.

However, the survey team did not have an opportunity to go through the actual data related to

[2] In addition to this definition, an urban area must have a minimum population size of 5,000 people. The main economic activity of the population must be non-agricultural, such as wage employment. In addition, the area must have basic modern facilities such as piped water, tarred roads, post office, police station, health facility, etc.

the abovementioned criteria.

For the selection of a sample Grade 4 class from the average urban school, it was reported that classes are not created in the order of the students' results. Thus, all the classes are assumed to be uniform and one sample Grade 4 class was selected since the timing of its lesson could fit into the overall schedule for data collection. In the average rural school, there was only one Grade 4 class; thus, all Grade 4 students have been targeted in the survey.

2) Basic school information

Currently, Zambia is transforming its school system from the 7-year primary and 5-year secondary education to a 9-year basic and 3-year high school education. There remain certain basic schools, particularly in remote areas, that accommodate only 4 grades due to a number of constrains. On account of these situations, there are various sizes of basic schools depending on the level of progress in their transformation, and two of our sample schools were not exceptional.

The following table presents the details of the sample schools.

Table 3. Profile of the sample schools

	Location	No. of Pupils	No. of teachers	No. of classes per grade	Progression rate to G. 8 in 2004 (%)	Others
Urban Primary School	2 km from the capital city, Lusaka.	1657 (G.1-7) 2063 (G.1-9)	44	5	17.0	- Within the heart of the capital city/ - Beside tarred road. - Piped water & flush toilets.
Rural Primary school	58 km from the capital city, Lusaka 13 km from District centre	328 (G.1-7)	7	1	70.7	- Outside of district center - About 1 km from tarred road. - Water pump & Pit latrine.

Table 4. Details of teachers observed

		Urban	Rural
Set		Female	Male
Age		41-50	41-51
Academic/professional qualifications		- Primary teacher's certificate	- Primary teacher's certificate (ZPC) - B. Tech Education Management
Length of service		29 years (?)	18 years
Special responsibility in the school		Senior teacher	Head teacher
Teaching Experience	G. 1		1
	G. 2	3	1
	G. 3	3	2
	G. 4	2	2
	G. 5	2	1
	G. 6		2
	G. 7	2	9
INSET taken		NISTOCOL	NBTL SITE ROC

As mentioned earlier in the sample procedure, one class each from both urban and rural average primary schools has been selected for administering both the students' questionnaire and mathematics achievement tests. The same Grade 4 classes are used to observe a lesson in mathematics. According to the survey guidelines, the initial aim was to observe a topic in fractions. However, since the topic was supposed to be taught toward the end of the first term in Zambia, we agreed to tape and observe the lessons on Sets and attempted to tape the lesson on the target topic later in the same term. In this survey, we could manage to obtain a video-tape of the lesson on Fractions taught by the same teacher only from the urban school in time. Therefore, in this survey we examine the findings from lessons given on different topics.

(3) Results of Interview

The result of the interview of head teachers is presented in the following table.

Table 5. Responses from head teacher

	Interview items	Urban school	Rural school
[Problem]	1-1 What do you think is the biggest problem in teaching mathematics in your school?	Lack of teachers. Complicated process for procurement of books. Availability of text books and other T-L materials are satisfactory.	
	1-2 What kind of action do you take against that problem as an administrator		
	1-3 Do you observe lessons by teachers? Yes or No. If yes, how often do you observe them?	Not frequently, but instead, Deputy Head observes the lessons frequently.	
	1-4 What kind of advice do you give to young teachers at your school?		
[In-service training]	2-1 Do you see any impact of in-service course offered to teachers? If yes, is it negative or positive? Please describe the impact a little more	Latest system for In-service Training does not appear effective very much.	
	2-2 What kind of training do you think is necessary for teachers in your school, if a new training course is designed?	How to deliver the information such as knowledge, skills or attitudes to the pupils.	

The result of the interview of mathematics teachers is presented in the following table.

Table 6. Responses from mathematics teachers

	Interview items	Urban school	Rural school
[Problem]	1-1 What do you think is the biggest problem in teaching mathematics in your class?	Books, enough only for teachers but not sufficient for pupils. Because of that, teacher can give very few questions.	
	1-2 What kind of action do you take against that problem?	Sometimes encourage the pupils to buy books by themselves.	
[Today's lesson]	2-1 What was the purpose of today's lesson?	As shown in the lesson plan	
	2-2 How much do you think the purpose was attained?	Not available.	
	2-3 What do you think are the most important factors for successful lesson?	Teachers to do research about the topic with more than one book.	
	2-4 What kind of teaching would you like to do?		
[In-service training]	3-1 Have you ever had a teacher training after you become a teacher?	Yes, INSET at NISTICOL and the training with regards to literacy program.	
	3-2 Which kind of training, if you had before, do you think is useful for your teaching?	ZPC (previous PRESET in Zambia)	
	3-3 What kind of training do you think is necessary for improvement of your lesson, if a new training course is designed?	Workshops to learn how to teach difficult topic such as multiplication.	

(4) Results of Lesson Plan Analysis

[1] Lesson Plan of Urban School

Subject: Mathematics

Teaching Aids and References: Teachers' Book, pp. 18–20

Chart of Fractions

Students' Book, pp. 91–105

Fruits

Date: Thursday, March 10, 2005

Duration: 30 min.

Topic/sub-Topic: Fractions

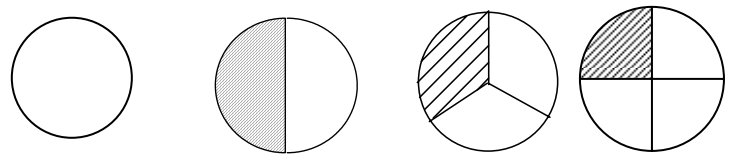
Objectives: By the end of the lesson, students will be able to

- know that fractions are equal parts of a whole,

- find the fraction shaded in each picture,
- find equal fractions from among other fractions shown,
- find the correct numeral in each box,
- put signs such as <, >, or =, and
- find the missing numbers in fractions.

Development:

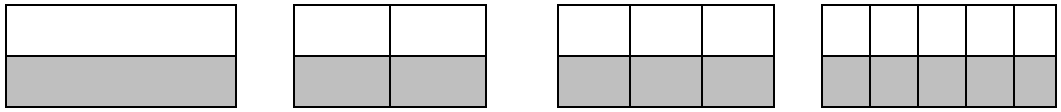
Example 1:



One whole 1/2 1/3 1/4

and 1/5 and 1/10

Example 2:



(a) How many quarters are there in 1/2?

(b) How many sixths are there in 1/2?

(c) How many tenths are there in 1/2?

1/2 is the same as 2/4, 3/6, and 5/10.

1/3 is the same as 2/6.

2/5 is the same as 4/10.

Example 3:

Put >, <, or =

One whole							
½				1/2			
1/4		1/4		1/4		1/4	
1/8	1/8	1/8	1/8	1/8	1/8	1/8	1/8

1/2 > 1/4

1/2 = 4/8

1/2 < 1/4

Equal 2/3 = 4/6

Not equal 3/5 ≠ 3/10

Example 4:

$$\frac{1}{6}+\frac{3}{6}=\frac{1+3}{6}=\frac{4}{6}=\frac{2}{3}$$

Activity: Students are to draw the shapes from example 1 as an exercise, and cut fruits in fractions in groups.

[2] Lesson Plan of Rural School

Not available at the time.

Table 7. Responses of lesson observation checklists

		Urban school					Rural school				
Introduction		0	1	2	3	4	0	1	2	3	4
	The teacher starts the class on time	-	-	-	-	-	-	-	-	-	-
	The teacher made the objective clear								√		
	The objective suits to the level of children	-	-	-	-	-			√		
	Relationship with the previous lesson is clear	-	-	-	-	-				√	
Development	The teacher gives supports to pupils who seem to have little understanding		√								√
	The expresses appreciation for pupils' thinking attitudes			√				√			
	The teacher assesses the pupils' comprehension during teaching learning			√						√	
	The teacher uses easy language					√					√
	The teacher uses an appropriate and familiar example to illustrate main concept.				√					√	
	The teacher creates friendly atmosphere					√			√		
	The teacher accommodates discussion among pupils		√					√			
	The teacher gives hand-on activity				√		√				
	The teacher enjoys teaching				√				√		
	The teacher is impatient with wrong answer		√						√		
	The teacher involves children to say opinions freely.			√					√		
	The teacher encourages children to display diverse opinions	√					√				
	The children are actively engaged in learning, such as telling opinions, asking questions, solving problems etc.			√					√		
	The teacher combines individual work and group work appropriately.			√				√			
Summary	At the end of the lesson, the teacher summarizes the lesson.	√					√				
	The teacher assigns homework at the end of lesson clearly.	√					√				
	The teacher explains about a connection between today's lesson and next lesson.	√					√				
General	The teacher prepares a lesson plan.					√	√				
	The teacher prepares a plan for taking note on the blackboard.	√					√				

Assess who dominate solving problems during the lesson observed.	Teacher dominates in solving problems.	Teacher dominates in class but students were solving problems in drill session.
Assess which of the followings is regarded as the most important in the lesson observed. Understanding concept/mastering the procedure/thinking mathematically/applying to the daily life/finding correct answer.	Understanding concept.	Understanding concept.

Rating scale: 0-never, 1-seldom/to a little extent, 2-sometimes/to some extent, 3-often/to a considerable extent, 4-very often/to a great extent

With limited information from the average urban school, it is noted that there exist certain differences in the opinions of teachers. For example, the Head Teacher felt that the availability of teaching/learning materials was not really a matter of concern, while it was taken more seriously by the class teacher. This is simply because more materials have been extended to a number of basic schools in major subjects since 2003 through the initiative of the ministry in the new educational development plan in Zambia. With regard to procurement, the voucher system has been introduced for certain grades this year; thus, each school has begun to enjoy a greater amount of freedom in selecting textbooks. These changes have probably caused the Head Teacher to become more optimistic towards the materials in school.

On the other hand, the initiatives have not been implemented fully in the schools; thus, in practice, teachers and students in certain grades have not been able to enjoy them as yet. This situation may have caused such a difference in the opinions of the Head Teacher and class teachers.

With regard to the issues of teaching in class, both the Head Teacher and the class teachers have a similar perception that delivery of information to students in class is the major problem as compared with the knowledge itself.

With regard to the issues of INSET, both parties appeared to be unsatisfied with the latest program. It can be said that this is because the new program requires a large amount of effort in terms of preparing for the lessons and assessment, which made it rather difficult for them to sustain the activities.

(5) Results of Video Analysis and Classroom Observation Checklists

The examination of the lesson plan on fractions has brought to light certain aspects, which are as follows. First, it appeared to be rather overloaded with contents, although the duration of a lesson was merely 30 min. This resulted in sparing much less time to teach the concept of fractions, although this appeared to be the first lesson in the topic. Second, there is an attempt to make the topic more student-friendly by using familiar materials like fruits; however, the relation to the essential concept was not very clear in the plan. Third, the plan did not describe the manner in which the level of understanding of the students would be assessed.

The observation of each lesson in keeping with the framework of the given checklist produced the following findings.

- There are relatively high scores in "The teacher uses easy language" and "The teacher uses an appropriate and familiar example to illustrate main concept." This implies that teachers were putting in more efforts for students to understand the topics they were teaching and follow instructions in class. Actually, teachers were occasionally using the local languages of the area, particularly when it came to the important portions of the lesson in order to supplement the explanation made in English. They also attempted to

create a friendly atmosphere in class. It was important for teachers to be considerate with regard to these aspects as students were also developing their English proficiency while learning the topic. Due to such an unavoidable situation, the lessons, to a certain extent, appeared like language lessons rather than those on mathematics.

- On the other hand, there are relatively low scores in items related to teacher's interest in the response of students or using their own thinking in class. The actual lessons themselves appeared to be dominated mainly by teachers, even at the stage of problem–solving, except in drills. This implies that the focus of teachers may be to impart knowledge to the students or the mastery of mathematical operations such as computations, rather than induction of students toward developing mathematical concepts.

There were typical situations that confirmed the abovementioned findings in both lessons. In the urban school, there was an attempt to relate one of the basic concepts in fractions to daily life by making the students cut fruits (guavas) into pieces. This appeared to be a good approach. However, the manner of cutting was left to the students and the size of the pieces was unequal; therefore, missing the point that fractions are "equal parts of a whole." This did not appear to draw much attention in the class.

At the stage of drills in the rural school, a number of students were unable to copy the questions written in English on the board by the teacher. Students appeared to not recognize the words in sentences, so they merely wrote a series of alphabets without any spaces between the words. This reveals that the students did not understand the meaning and instructions in the questions. However, both the teacher and students did not appear to be concerned about this and the students continued to answer questions. The teacher was even marking the students' answers while moving around in the class.

As a next step, these situations can be reviewed and discussed with the concerned teachers in order to ascertain the explicit or implicit intentions and reasons behind them.

- It was also a common observation that teachers neither summarize the topic nor give any assignments at the end of the lesson. They also did not relate the day's lesson to the next lesson. However, we cannot generalize these findings as a common feature of the teaching style in Zambia because we observed merely one lesson of each teacher.

As observed above, there were certain features of teaching mathematics in class. On the other hand, we did not sufficiently explore the teachers' perceptions of teaching mathematics. Thus, in the second year it is necessary to examine their perceptions with regard to the development of students, the weightage they assign to different contents, attitudes or teaching skills for mathematics, etc.

2.6.4 Results from the Second Year Field Survey

(1) Survey Schedule

The survey was conducted during the period October 17–27, 2004; the details of the schedule are presented in table 8.

Table 8. Schedule of data collection

Date	Activity
16th / Oct / 2005	Arrival to Lusaka, Zambia
17th / Oct / 2005	Discussion with Mr. Nkhata at University of Zambia
18th – 21st / Oct / 2005	Data collection in three sample schools
23rd / Oct / 2005	Departure from Lusaka, Zambia

(2) Target Schools and Samples

Urban and Rural School A were those that we targeted the last time. These were selected as the average schools in the urban and rural areas. This time, we would like to compare the result of tests that were conducted with an explanation to students in the local language and those that were conducted without such an explanation. Rural School A had only one class in each grade; thus, we needed to include an additional rural school in order to make the comparison. Therefore, Rural School B was selected as an average rural school in Mazabuka District in the Southern Province of Zambia.

(Explanation in local language implies the translation into local language of questions that are written in English, and explanation with regard to the manner in which the answers must be written, particularly in the case of multiple-choice questions.)

Table 9. Location of schools

	School location
Urban Primary School	2 km from the capital city, Lusaka
Rural Primary School A	58 km from the capital city, Lusaka 13 km from District Centre
Rural Primary School B	24 km from District Centre

Five teachers participated in this research—two of them were from the urban school and the other three from the rural schools. Table 10 provides the details.

Table 10. Brief profiles of teachers

School	Sex	Teaching experience	Subjects taught
School in urban area	(1) Female (2) Female (3) Female	(1) 29 years (2) 20 years 4 months (3) 25 years 5 months	(1) All subjects (2) All subjects (3) All subjects
School in rural area	(1) Male (2) Female	(1) 18 years 9 months (2) 22 years 4 months	(1) All subjects (2) All subjects

As is evident from the above table, a majority of the teachers who participated in the study had over 20 years of teaching experience.

(3) Results of Teachers' Questionnaire

Table 11 shows the responses of teachers with regard to their perception of the test given to students and on the teaching as well as learning of mathematics in general and fractions in particular. The following is the result of the Teachers' Questionnaire; the comments of the teachers are unedited.

Table 11. Teachers' perception on the test, teaching and learning of mathematics and Fractions

Questionnaire Items	Responses by teachers in urban school	Responses by teachers in rural schools
Teacher's forecast of s' average score	(1) forcasted 50% (2) gave no response (3) forcasted10%	(1) forcasted 20% (2) forcasted 75%
Pupils' familiarity to the given test	(1) Yes : It's one of the topics in G4 mathematics on Fractions. (2) No : They usually write multiple questions and the	(1) No : They are usually tested on a variety of topics and also materials for such testing not adequate as we usually used

	questioners are mixed not based on one topic. (3) No : They're not used to writing on such papers due to luck of paper. They're not used to reading small writings like the ones on this paper.	boards. (2) No : They are not accustomed to this kind of test because in most cases they used to have no teacher and as a result they find it very hard to answer this type of work. In short, they never break through.
Any questions which the pupils cannot solve.	(1) Yes : Pupils forget easily unless before testing them do the revision. (2) Yes : They usually mix fractions and work them as a whole number. (3) Yes : The way of question is not their level.	(1) Yes : Q7. They may not show the process. Q8. They may not do it because of language. Q10. They have problems in dealing with abstractions. Q2. They may not relate divisions to fractions. (2) Yes : 3,8,9 and 10 are hard for them because they have not yet tackled fraction. Further more, it now when they are starting G4 work. All along they have been drilled with G3 work.
Difficulties in teaching "Fractions".	(1) Easy : Teaching of Fractions is easy especially when you start with pupil using the concrete objects like orange by cutting 2 pieces, 4 pieces and even 3 pieces. (2) Difficult : When explaining they understand but when it comes to writing they write other things except a few pupils in class. (3) Easy : It is easy because when I teach, I have to use concrete objects like oranges, to show them the real parts of a whole.	(1) Easy : Easy but you need more time in order to get the concept of Fractions as they find it easier dealing whole numbers. (2) Easy : It is easy to teach Fractions depending the ability of pupils and the way you have introduced or presented the topic. In short, it is very easy to teach Fractions because in most case pupils are good at sharing things together. So Fractions involve sharing and parts of a whole.
The most difficult topic/s to teach in Grade 4.	(1) "Decimals" Pupils mostly misplace the points. (2) "Division, Fractions, Social Arithmetic" They don't complete the long division. Fractions they work out directly. (They do add denominators) They find the answer then they fail to add to get the total price. (3) "Division" It is difficult to teach division because to find the answer you have to use addition, subtraction and multiplication.	(1) "Division" Pupils fail in problem understanding the concept of division as this is not introduced in G1 and a bit of it is G2. (2) "Division and Length" Most pupils find it is difficult to solve division problems because they are lazy to master multiplication table which is a key to solve division cases. And Length also, there is a bit of problem to some pupils because they cannot differenciate centimeters and meters.
The easiest topic/s to teach in Grade4.	(1) "Fractions" Because Fractions are equal parts of a whole and you can use a lot of teaching aids/materials. (2) "Addition, Subtraction" Children find it very easy to add, subtract, make sets and identify sets. (3) "Addition and Subtraction"	(1) "Addition" Pupils normally deal with additions in their daily lives and therefore easy to relate examples to their lives. (2) Addition and Subtraction are the easiest because it is very rare for pupils to get nothing from these tow topics. Without giving them

	Because most of the pupils know on what to do through the games they play as children.	examples, they can still get them correct in each topic given.
Teacher's confidence in teaching "Fractions"	(1) confident (2) very confident (3) very confident	(1) very confident (2) very confident
Level of influence of the examination on teacher's teaching	(1) "Very little" It depends if you did not teach the topic in that G4 or may be you never explained well to pupils, it is the pupils can fail. (2) "Very much" As a teacher, you feel you have taught but when the exam comes pupils do not perform well. They do not know remember the formula used in finding certain topics. (3) "Very much" Because I will be able to learn and find whether what I taught was well understood by my pupils and be able to improve where I did not teach well.	(1) "Very much" The examinations really affect our teaching in a sense that when the examinations. Begin, no other class is allowed to come and the lessons and as a result, this makes us remain behind the syllabus. This happens because of lack of classrooms. You find all the classes are occupied by the examination classes. (2) "Very much" Once the concept are not clearly put forward to the pupils, the will not master the correct way of dealing with a problem and therefore they fail to answer correctly.
Degree of difficulty for the pupils to learn "Fractions"?	(1) easy (2) easy (3) difficult	(1) difficult (2) no response given
Points of difficulty for the pupils to learn the concept of "Fractions"?	(1) Teaching of Fractions can be easy if you use proper concrete objects. (2) They mix numbers : e.g. 1/2 of 100m instead of multiplying 1×100 divide by 2 they will just go straight to addition = 100/2 = 1+100 = 100. (3) The idea of finding the biggest fraction when there are no diagrams.	(1) They do not seem just understand the whole concepts. Difficult to pin-point exactly where and why. (2) The difficult part of it is that, when a child is not present at a time of presentation, it will be very difficult for that particular child to acquire the concept of "Fractions". At the time of presenting a topic in fractions, I very much put emphasis to pupils not to stay away from lessons.
Existence of pupils' difficulty with the medium of instruction in learning mathematics	(1) Yes : Same pupils are slow learner. (2) Yes : Language because some terms in mathematics have no names in venacular. (3) Yes : Because reading a problem to them, hence do not know what to do.	(1) Yes : Sometimes they fail to understand the question especially if it's in English. (2) No
Importance of learning "Fractions" with comparison to any other topics in mathematics.	(1) Yes : It is an important topic because Fractions can be used in our daily life. (2) Yes : Pupils do sharing every day in their activities so they should learn more on fractions to know more or sharing. (3) Yes : It involves sharing and	(1) Yes : They deal with our daily activities in life. (2) Yes : It is yes an important topic a sense that, at a lower grade like G4, where pupils are still learning sharing, it really helps a lot in that a child, can be, able to share something amongst his/her

	finding out a part of a whole.	life forends. e.g. 1/2 of an orange or 1/4 of it.
Teacher's main point/s of concern to the pupils in teaching "Fractions"?	(1) You teach them that Fractions are equal parts of a whole and it is being used in our lives. (2) The main point is to build, share and arrive at the correct answer. (3) Sharing or part of a whole.	(1) They must understand the four operations on Fractions and they should be able to apply practically. (2) The main point is that, pupils should know the names of both top and bottom numbers at a lower level, which are numerator and denominator.

The responses of teachers when asked to describe how they taught the following problem to students are presented in table 12:

"Which is longer 1/4m or 1/3m?"

Table 12. Teachers' Srategies in Taching "Fractions" (1)

Responses from teachers in urban school	Responses from teachers in rural school
(1) When it comes to meters you can use concrete objects like a ruler and then measure on the stick to get 4 quarters as well as 3 thirds. Then you can use semi- concrete objects like drawing diagrams on the board and divide them into 4parts and then 3 parts. (3) I would draw or write a meter on the board and divide it in section, then pupils will be able to find out 1/4 is less than 1/3 because 1 meter will be divided in 4 sections or parts where as 1/3 is bigger because a meter will be divided in 3 sections or parts.	(1) First of all, I will draw to different diagrams on the board for them to see and answer questions on the same as I do no explaining to them. The first one will be showing the whole thing divided into quarters. Equally the second one is longer than the other. Pupils will tell whether they are equally or one is longer than the other. By doing so, then I shall now know which method to use. (2) I would bring 2 strings of paper(same size), then divide one into quarters and the other into thirds using same scale.

When asked how they would deal with a student who when asked the question "What is half of 2m?"responds by saying "It is 1/2m," they responded as shown below.

Table 13. Teachers' Srategies in Taching "Fractions" (2)

Responses of teachers in an urban school	Responses of teachers in a rural school
(1) First of all you explain to the students or pupils that 1/2 of 2m is the same as 1/2 × 2m. Then you show how to get 1/2 of 2m using multiplication for example. 1/2 × 2m = 1m (2) I need to explain like this. 2 meters. 200 centimeters when you are traveling on a distance of 2 meters, suddenly you are told to stop in the midway how many meters have you covered. The pupil will be given a ruler to see and give a correct answer. The correct answer will be 1m or 100cm.	(1) The answering itself will tell me that the pupil has an idea. As a teacher, what I will do is just to correct him or her, to say instead of saying 1/2m, I would advise that child to say 1m, unless if he/she changes the whole number into a fraction, then she should say it as a fraction. (2) I would tell him he is right it is one out of two but I want another way we can say the same thing. Until we arrive the answer 1m.

Half of 2m is 1m or 100cm. (3) I would ask the pupils to explain how she got the answer. If she fails I will get a string of 2m and fold it into 1/2 and ask which is half of a meter.	

2.6.5 Discussion

* Experience of teachers

All teachers in this research have sufficient teaching experience. However, their prediction regarding the performance of students does not match the actual score.

* Gap between teaching and learning

Four teachers believe that students are not familiar with the type of test and all of them believe that there are certain questions that the students will not be able to solve. Two teachers feel that it is a difficult topic for students and that their performance will be rather low. The reasons for the predicted poor performance were that students are not accustomed to the quality of the test paper and the type of tests. Moreover, the predictions varied greatly with every teacher.

Four teachers believe that teaching Fractions is easy because concrete objects are a great aid in this topic. Moreover, all teachers are rather confident with regard to teaching this topic. Thus, this implies that Fractions is a topic that is easy to teach, but learning it is difficult for students.

* Easy and difficult topics

The teachers feel that the easiest topic in Grade 4 is addition and subtraction, and the most difficult is division. The reason provided for the latter is that division involves other operations and has a longer process.

* Difficulty with Medium of Instruction

Four teachers identified that there is a problem with the medium of instruction. Several teachers identified the fluency problem faced by students. One teacher identified that there is a concept gap between English and the local language. There was no statement with regard to whether or not the teachers are conscious of the students' understanding of problems.

* Influence of Examination

All teachers, except one, believe that examinations affect their teaching to a great extent. Several teachers stated that examinations affect everyday teaching. One teacher stated that the results are indicative of the students' weaknesses, thereby helping him/her to improve teaching.

*Importance of Fractions

The teachers believe that Fractions is an important topic because of its close linkage with daily life. However, no teacher mentioned the importance of fractions as a mathematical concept. With regard to the main concern in teaching Fractions, one teacher answered that four operations of fractions are important, another answered that remembering which is the denominator and numerator is the main point, and the other three teachers, who are all from the urban school, believe that the main point is "sharing."

* Teaching Strategies for Fractions

With regard to the teachers' strategies for teaching Fractions, Q14, a majority of the teachers wrote that they draw two lines or objects and cut one into three equal parts and another into four equal parts. Then, they show the difference in length to the students. In Q15, certain teachers

reveal their understanding of the state of thinking of the students, which may serve as a foundation for improving the quality of teaching.

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