Chapter IV

Problems with Cooperation in Mathematics and Science Education

1. Unique Characteristics of Mathematics and Science Education in Africa

Japanese volunteer teachers who teach mathematics and science subject in African countries often encounter quite different problem from what they experienced in Japan. Typical example of these are illustrated by the problem of BODMAS in teaching mathematics subject, and the problems of teaching scientific concepts to African students.

1) BODMAS

The problem of BODMAS is an issue related to the lack of basic calculation skill of African student, raised from time to time by Japanese volunteers as an obstacle to teaching mathematics to African students. BODMAS is an acronym which stands for 'Bracket, Of, Division, Multiplication, Addition, Subtraction', and was supposedly created to help students remember the order with which these operations are performed. When carrying out a calculation containing a number of different arithmetic symbols, firstly the contents of the 'brackets' should be calculated, then 'of', 'division', 'multiplication', 'addition' and 'subtraction'. Thus the word BODMAS indicates the correct order of carrying out calculation.

It is not known well how widely BODMAS prevails in African countries. Considering the fact that explanation on BODMAS is given in Kenya's secondary school textbooks, BODMAS is supposed to be fairly widespread at least in Kenya. In principle, BODMAS is not wrong at all as a way of doing calculation. What is wrong with it is that students very often make calculation incorrectly by applying BODMAS rule in wrong manners.

We will see how BODMAS rule is wrongly applied by African students.

Naturally, the following is the correct way of applying BODMAS rule to calculation.

$10 - 5 + 3 \div 6 \times 1/3$ of $(15 + 3)$	1) Bracket
$= 10 - 5 + 3 \div 6 \times 1/3$ of 18	2) Of
$= 10 - 5 + 3 \div 6 \times 6$	3) Division
$= 10 - 5 + 1/2 \times 6$	4) Multiplication
$= 10 - 5 + 3$	5) Addition
$= 10 - 2$	6) Subtraction
$= 8$	7) Answer

Many students, however, would tend to make calculation in the following manner by misuse of BODMAS rule at step 5. They tend to think that addition portion of equation $10 - 5 + 3$ is $5 + 3$ and not $- 5 + 3$.

Thus, the answers derived by many African students are as follows:

$= 10 - 5 + 3$	5)
$= 10 - 8$	6)
$= 2$	7)

Up until now no detailed study on the bad effect of BODMAS on mathematics education has been reported. Mr. Kurashina, a Japanese volunteer teacher posted at Kenya in 1988, however, tried to carry out a continual survey on the improvement in arithmetic skill of students at Harambee School. Because what he found in the survey on the links between BODMAS and arithmetic skills is a matter of great interest, summary of his finding will be given below.

Ninety students of Form 2 of Kenyan secondary school in 8-4-4 education system were given a series of mathematics tests to measure their improvement in arithmetic skill in five different types of problems. They are:

(1) Addition and subtraction of two-digit negative and positive numbers.

Example) $73 + (-29) - (-48)$

(2) Multiplication of a two-digit number by a one-digit number.

Example) $28 \times (-9)$

(3) Division of a three-digit number by a two-digit number.

Example) $(-442) \div 17$

(4) Division by 100 of a number obtained by multiplying a two-digit number by a one-digit number

Example) $75 \times 4 \div (-100)$

(5) Addition of fractions

Example) $1/2 + 1/3$

The test was carried out six times between February and November. Figure 4-1 shows in graph form the ratio of pupils who gave correct answer to each problems. The test results do not appear very good as the scores of Form Two student. Specifically, to our surprise, the test results of addition and subtraction problem of negative numbers are very poor.

Of course test result of 38% reported in February for the type 4 calculation, a mixture of multiplication and division, cannot be said very high, but this is still much better than the test result of 26% for the addition and subtraction problem in the same month. As is seen on the graph, the test result showed substantial improvement from February to November except for type 1 (addition and subtraction) problem. Namely, for type 2 through type 5 problems, correct answer ratio jumped up to 80% or more but only little improvement, i.e. mere 10% increase, was achieved for calculation of addition and subtraction.

Generally, the calculation of multiplication, division and fractions are taught at school after students have acquired the calculation skill of addition and subtraction. Accordingly, the problems of multiplication, division, etc. are considered for higher level student than those of addition and subtraction. Nevertheless, in this instance the student's achievement on basic addition and subtraction calculations was found very poor comparing to other type of calculation. Also, it is to be noted that in spite of the repeated instructions and exercises, improvement was very limited. This was complete contradiction to the common knowledge.

Perhaps it was because of poor capability of the student of that Harambee schools but there are no comparable data on other schools. We cannot say only from this incidence that this is common elsewhere in African countries. However, there are many Japanese volunteer teachers who reported that secondary school student in African countries could not properly carry out addition and subtraction calculation containing negative numbers, and that this is hindering progress of students in learning mathematics subject.

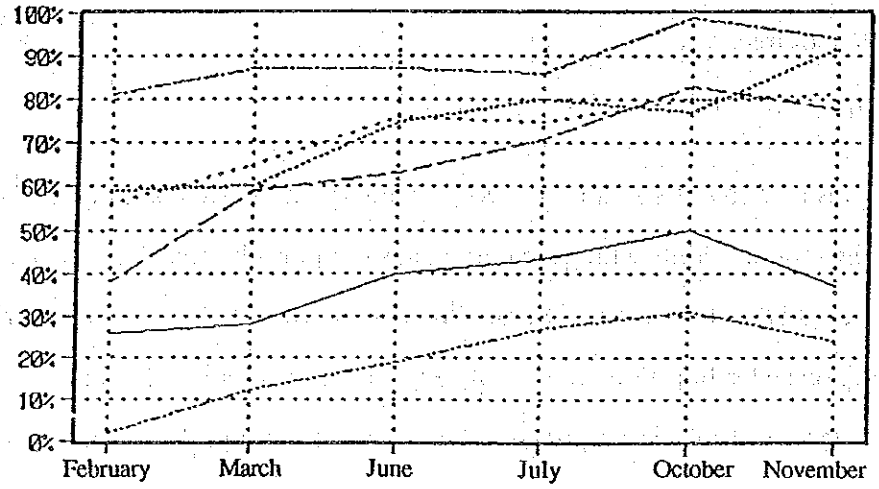

Fig. IV-1 Improvement in Basic Calculating Ability
Kenya – Harambee Schools (1989)

Then, why can't African students perform addition and subtraction calculation correctly? One of the main reasons is supposed to do with BODMAS. According to the points raised by a numbers of Japanese volunteer teachers, African students tend to regard mathematics as a subject which requires rote memory work. It is apparently just this attitude which make them apply BODMAS blindly without paying any attention to mathematical principle hidden behind BODMAS rule.

It is said that there are many African students who think that equations 1 + 3 – 2 and 1 – 2 + 3 will give different answer. Namely, the answer to the former equation is 2 but the latter is –4. Those students who answer that 1 – 2 + 3 = –4, are applying the BODMAS rule wrongly.

Moreover, some cases were reported by Japanese volunteers in which BODMAS is being taught to students incorrectly by indigenous teachers themselves. We also observe that many pupils do not have correct understanding on negative numbers. Still, it cannot be denied that the BODMAS is responsible for errors in addition and subtraction calculations.

Of course, correcting the BODMAS problem will not instantly solve the problem of enhancement of mathematical capability of the African students. BODMAS is only a part of entire problems in mathematics education of African countries. BODMAS problem implies existence of many other problems. We must teach mathematics to African students in consideration of existence of such unique problems as BODMAS in African countries.

2) The Tanzanian Study

A study was conducted by Professor Kawatoko of Daito Cultural University, on acquisition of the principle of Conservation of Weight by primary school pupils in Tanzania. The report is of considerable interest, since it would provide us with very important information which we have to take into consideration when we consider issues of science education in African countries. An outline of the research will be given below..

Two experiments related to the principle of conservation of weight were conducted in the study. Firstly, researchers investigated the cognitive development of weight in first-grade primary school pupils in Tanzania. Then, they compared their results with those obtained for Japanese children and analyzed the special features of the Tanzanian children regarding the cognitive formation of scientific concepts. The second experiment was carried out to identify the effective ways of learning the principle of conservation of weight, and to examine the usefulness of different teaching methods.

Experiment 1 involved two investigations. Firstly, the Tanzanian school children were asked whether they thought those materials such as water, air, wind, smoke, cotton, sunlight, smell, flying bird , alighting bird, heat, colour, and ball in the air have weight or not. The results were then compared with those for Japanese children. There were many children who answered incorrectly. For example, many answered that wind, smell and colour have weight, while air and smoke do not. Flying bird does not have weight, while a bird on a tree does. As a matter of fact, the responses from both Tanzania and Japan were similar. Children of both countries made the same errors.

In the second part of experiment, researchers asked the same children various questions about the change of weight in different conditions of materials. For example, "If a lump of clay of round shape was transformed to flatwise, would its weight change?" and "Which is heavier – weighing two persons standing together on the scale or one person carrying others on the back?" Here too, both Japanese and Tanzanian children made the same errors, and the ratio of children who did not answer correctly was roughly the same in both countries. However, more detailed analysis showed a difference in patterns of making mistakes. Japanese children were consistent in the types of mistakes they made, whereas Tanzanian children did not show consistency in their answers when they were asked a series of similar questions.

Experiment 2 was designed to investigate which of the two types of teaching method, Positive Question Teaching Method or Negative Question Teaching Method, is more effective in teaching the concept of conservation of weight to Tanzanian first-year primary school children. In the Negative Question Teaching Method, pupils are instructed to exercise a series of experiments with concepts not possible in reality. By forcing children to exercise unrealizable experiments, children will finally discover that the idea they originally have is incorrect and will eventually be able to acquire right concept.

In the Positive Question Teaching Method, on the other hand, pupils are told to exercise the experiments by positive instructions with which they can confirm scientific phenomenon

visually, until their accumulated knowledge leads them to right recognition. This is a more 'frontal assault' style of teaching.

The results of this experiment for Tanzanian children are extremely interesting. Pupils who received instruction by the Positive Question Teaching Method showed marked improvement, while those who received the Negative Question Teaching Method remained at most the same level as they were before. The former group of pupils correctly understood that mere changes of shape and/or appearance of materials will not affect on the original weight unless some mass are added or subtracted from the original materials. The latter did not achieve better results in the post-test, but were only left in confusion.

On the contrary, same experiments conducted in Japan showed different results, where Negative Question Teaching Method was found very effective. Then, the question will be why the teaching method found very effective in one countries is not so effective in others. The researchers put forward two possible explanations for this phenomenon. Presumably, Tanzanian children were generally found not to have consistency in the way of misunderstanding things. For such children, Negative Question Teaching Method which makes children confront with facts which conflicts rigorously with their own ideas and eventually makes them discover right scientific concept would not be considered suitable.

Another possible explanation is supposed to be related to the educational environment of Tanzanian society. Even if the children have their own ideas very firmly, that facts alone would not guarantee to make them change their cognition flexibly. From educational points of views, children's behaviors of learning are very deeply affected by the ways they are being educated in class rooms, schools and society. Tanzanian children, who appear to be taught compulsively and used to follow teacher's instruction very obediently might find it difficult to test correctness of his own ideas against conflicting facts by taking positive actions with their own initiatives.

In short, the Kawatoko's report can be said to suggest that the effective teaching method of one country will not necessarily be effective in other if there is very big discrepancy between two countries in terms of educational environment as well as cultural background of a society.

Furthermore it is to be noted that the problems observed in Tanzanian primary school should not only be interpreted as the problems specific with a Tanzanian school but also imply more broad issues of science education in African countries.

2. Activities and Issues Regarding Teaching of Mathematics and Science by Japanese Volunteer Teachers in African Countries

1) Questionnaire Survey

As observed in the previous section of the report, educational environment for teaching mathematics and science in African countries is quite different from that in Japan. Then, what is the current status of African educational environment? To what extent Japanese volunteer teachers on mathematics and science have contributed to secondary school level education of African countries under such circumstances? How can the contribution of Japanese volunteers be further intensified?

This section will describe the result of our field survey which was conducted mainly through field interviews and questionnaire survey to Japanese volunteer teachers who then stay and teach mathematics and/or science subjects in the three African countries, i.e. Kenya, Zambia and Ghana.

There were two main objectives with this questionnaire survey. The first objective is to identify the views of Japanese volunteer teachers regarding where they feel there are problems in teaching mathematics and science in secondary education in African countries. The second objective is to examine activities and performance of Japanese volunteer teachers.

The questionnaire inquired Japanese volunteer teachers to answer seven questions by choosing right response from the available options.

2) Results of Questionnaire Survey

We will now discuss the results of the questionnaire survey. The percentages shown in the following tables are calculated on the basis of the actual number of responses to each question,

but not on the basis of the nominal number of participants of this survey. The number of total participants to this survey was 5 in Kenya, 8 in Zambia, and 10 in Ghana. In addition to answering the questionnaire, these people also spared their time for discussions with us, both individually and in groups. All those invaluable information obtained through these discussion sessions are also included in the description given below.

(1) Mathematics Education

Question 1: The BODMAS calculation method, taught in many African countries, is not understood properly by many students, and BODMAS is said to be a major hindrance to teaching mathematics in secondary school. Are you aware of the fact that there are students in your class whose calculation skill are adversely affected by the misuse of BODMAS?

	Kenya	Zambia	Ghana
1. Yes	80%	88%	60%
2. No	20%	12%	40%

Presumably, this survey result provides us with an idea on how widely BODMAS has been spreading in African Continent. In the past, three volunteer teachers, two volunteers posted to Kenya and one posted to Ghana, touched BODMAS in their report submitted to JOCV head office describing BODMAS as a serious problem. Meanwhile, no volunteer teachers posted to Zambia have ever touched on this issue.

The results of Question 1 show that in the case of Kenya 80%, in Zambia 88% and in Ghana 60% of volunteers confirmed that the students in their classrooms are having trouble with BODMAS. More importantly, the most of volunteers believe that the BODMAS may not be a problem of specific to their own classes or schools but the problem which prevails nation-widely. Furthermore, based on the fact that BODMAS problem exists both on the eastern coast (Kenya and Zambia) and on the western coast (Ghana), then one can reasonably assume that it

may not be the only issues with these three countries but may probably be the issues of other African countries as well.

Question 2: How do you assess the seriousness of the BODMAS problem?

	Kenya	Zambia	Ghana
1. Very serious problem	20%	25%	60%
2. Serious but one of many problems	60%	63%	30%
3. Not so serious problem	20%	12%	10%

The above table shows that the responses from Kenya and Zambia are remarkably similar, while those from Ghana appears a little bit different from other countries. Namely, in Kenya and Zambia, roughly 60% of Japanese volunteers see BODMAS as a serious problem for learning mathematics, but at the same time they apparently think that there are another serious problems as well. Meanwhile, in Ghana, 60% of respondents appear to think BODMAS as "the most serious problem," rather than "just only one of many problems." In other words, majority of Japanese volunteer teachers in Ghana seem to conceive that BODMAS is the biggest stumbling block of mathematical education.

What cause this difference and how important is this difference?

Since there appear no fundamental differences in education system of these three countries, notable differences of percentage shown on the table are to be attributed to differences of reaction of respondents. Accordingly, significance of this table is considered not lying on the fact that there is a large gaps among the three countries regarding percentages between responses of "very serious" and "a serious" but on the fact that 80 to 90% of the respondents of all the three countries regard BODMAS as either "very serious" or "a serious" problem. In other words, it can be said that this table demonstrates that the Japanese volunteer teachers have a deep concern over BODMAS which is supposed to have a harmful effect on mathematical ability of students throughout these areas.

Question 3: What is the major hindrance of mathematical education in the country where you are teaching?

		Kenya	Zambia	Ghana
1.	Weakness in basic skills for calculation	80%	56%	78%
2.	Attitude of reliance on rote memorization and poor at solving applied problems	20%	11%	11%
3.	Dislike of mathematics and little interest in learning mathematics	0%	11%	0%
4.	Few opportunities to use mathematics and little recognition of importance of mathematics in society	0%	22%	11%

In this question, volunteers were asked their views on the problems which they see as the major hindrance of mathematical education in the countries. Apparently, it might not be easy to choose only one answer among the four responses. All of these are definitely the important problems and consist of major hindrance of mathematical education. In other words, each of these represents different aspects of the same problem and may passively be cause and effect one another.

Accordingly, in this question, it is not intended to objectively identify the most important problem of mathematical eduction of the African countries, but intended to identify views of Japanese volunteer teachers on the problem of mathematical education in those African countries where they teach.

As is shown in the table, the problem which was cited the most is "weakness of students in performing calculation." 80% of volunteer teachers in Kenya, 56% in Zambia and 78% in Ghana confirmed this as the major problem. The curriculums of secondary school education of these African countries are nearly the same as that of Japan. Nevertheless, to our surprise, the students who are equivalent with the Japanese senior high school student cannot very often solve the very basic arithmetic problem – addition, subtraction, multiplication and division.

When we visited a Harambee secondary girl school in Kenya we had opportunity to observe a class where a Japanese volunteer teacher taught "logarithm" as a mathematics subject. The class was given to solve the problem of "log (2X + 5) = log (X – 90)." In order to solve this problem students are finally required to solve the equation of 2X – X = –90 – 5. This is rather simple equation and seems easy for high school level student. Surprisingly, however, only one student out of 40 of the class was able to give the correct answer of –95 and the overwhelming majority said the answer as –85. They could not give the right answer because they did not understand how to carry out addition or subtraction of negative numbers. Accordingly, a great deal of time had to be devoted to the study of addition and subtraction rather than the study of "logarithm."

Considering these incidences, it appears very natural as well as very rational for Japanese volunteer teachers to conclude that "weakness of performing calculation" is a major hindrance of mathematics education in these regions and hence improvement of basic calculation skill through exercise is very much required.

Surely, arithmetic ability of African people, not only student but also general public seems low and inefficient. For instance, according to our experiences, we had to be very patient, not only at the small stores of remote rural town but also at the check-out counter of top-class hotel of state capital city like Nairobi and Lusaka, for taking extraordinary long time presumably due to lack of simple calculation ability of employees.

It may be wrong, however, to deem that lack of calculation ability is only the problem of mathematical education in these African countries.

Professor Kawatoko's research in Tanzania indicates that though many pupils can perform calculation correctly on the paper, they have trouble with solving mathematical problems encountered in their daily lives to which mathematical principles have to be applied.

In contrast, Professor Guberman Saxe of California University gives an extremely interesting case where very young school age children who sell candy on the busy downtown street of Brazil are reported to perform perplexing calculations quickly and efficiently. As street

vendors, even small children are required to complete their transactions very quickly and smoothly without making any mistakes. That small street vendors are required to deal with big numbers and various bank notes and coins in the notorious inflationary economy of Brazil. According to Saxe's study they devised their own way of carrying out calculations without learning arithmetic at school.

In this connection, a study conducted by Professor Carpenter of Wisconsin University of the U.S. is interesting too. According to this study primary school children could be very dramatically enhanced arithmetic ability by changing their attitude from passive learner, who just obediently follows instruction of teacher, to active learner, who try to solve the problems by himself.

This should be compared to the African students who tend to rely a great deal on memorization. According to Japanese volunteers, some African students memorize the test exercised the day before, and when they found similarly looking test problem next day, they just put down what they have memorized on the paper. This is supposed to be very extreme case but this kind of attitude of African students might put them to trouble with the BODMAS problems. It might be said that in comparison with a society like Brazil, African people are not required to use mathematics so frequently in their society.

In conclusion, Japanese volunteer teachers are required to take various African factors into consideration even in teaching mathematics subject, such as current status of African society, economy, way of life, traditions, culture, and so on.

We should also take heed of a comment made by the head teacher of a school we visited in Zambia: "The first most important thing to do in teaching mathematics in school is to get rid of the fear of students against mathematics. That makes them realize that they can do it."

(2) Science Education

Question 4: According to comparative research by Professor Kawatoko of Daito Cultural University, Japanese children tend to be taught effectively by Negative Question Teaching Method, whereas in Tanzania Positive Question Teaching Method is

the way to be effective for teaching science subjects. In the light of your own experiences, do you observe the similar trend in the country where you teach?

	Kenya	Zambia	Ghana
1. Yes	60%	78%	60%
2. No	20%	11%	0%
3. Can't say	20%	11%	40%

In Questions 4 and 5 the respondents are asked their views and opinion on how classes are to be conducted to teach science subject. Japanese volunteers are asked whether the example quoted from the Tanzanian study mentioned earlier applied in the country where they are posted. The Tanzanian study involved primary level children, while the subject Japanese volunteers are teaching secondary school students. However, the educational environment in African countries is more or less similar regardless of countries and level of schools. Due to the critical shortage of textbooks, reference books, stationeries, etc., classes have to be conducted by teachers writing on the blackboard and student are just copying what teachers write on the blackboard down on their notebooks. This hinders students from discussing problem with each other in the classroom or trying to apply new approaches, discourages them from thinking by themselves, and does little to promote the development of a positive attitude toward learning.

African students are very good student in their attitude: they are polite and obedient to teachers, and they listen quitely to what the teachers say. But at the same time they can be said passive learners, because they seem to do only what they are told to do. If this is the case, the Negative Question Teaching Method, with which children can learn by making new discoveries by themselves, is not an appropriate way of teaching to African students, as is apparently suggested by the Tanzanian study. This is what is asked in Question 4 – the validity of Negative Question Teaching Method in the three African countries.

The responses of Japanese volunteer to Question 4 were nearly the same as we had expected. Although we do not know how clearly they realize the differences between two

teaching methods, it is considered suggestive that 60% of Japanese volunteers in Kenya, 78% in Zambia and 60% in Ghana say that Negative Question Teaching Method would not be effective in the countries they are posted. Up until now, there have not been any reports of volunteer teachers who conducted any other trials through which they compared the effectiveness of the different teaching approaches to African students. The responses to this question, however, indicates that at least they recognize the fact that there is teaching method which is not necessarily appropriate for African students.

Question 5: Do you think it necessary for you to take a different approach of teaching to African student from that to Japanese student?

	Kenya	Zambia	Ghana
1. Yes	40%	33%	50%
2. No	40%	44%	20%
3. Can't say	20%	23%	30%

In this question volunteers are asked if they feel that a different approach is necessary for them to teach science subject to African students, given that the Negative Question Teaching Method were ineffective to African students. The response to this question was somewhat different to what we had originally supposed. As can be seen from the table, the proportion of respondents answering 'Yes' and 'No' are roughly the same both in Kenya and Zambia. This is probably a reflection of their belief that teaching science subjects is just teaching universal rules or principles. Therefore, teaching science must be performed in the same manner regardless of countries. If the intention of Question 5 is to ask the volunteers "what to teach" in science or mathematic education, this reaction will be very correct. But, what we are really asking is "how to teach." This result appears to indicate some weakness of Japanese volunteer teachers in terms of both lack of teaching experiences and lack of understanding of different cultures..

As mentioned earlier, the teaching environment in African society is quite different from that of Japan. African countries differ socially, economically and culturally from Japan, and so a given teaching approach effective in Japan may not be appropriate in Africa. Perception of African people on weight, width, climate, environment and so on are quite different from that of Japanese. If all these factors are taken into consideration, one may subsequently conclude that different teaching approach will be highly required for African student to learn science and mathematics effectively.

Question 6: African countries have many unfavorable conditions for science education; low awareness of science and technology in the community, and lack of experimental materials and facilities at school and so on. Under these unfavorable circumstances, what do you think is a main objective of teaching science at secondary school?

	Kenya	Zambia	Ghana
1. To have students make a good scores in the national standard examination so that they can be admitted to enter into higher level school	0%	25%	0%
2. To make student have more scientific knowledge and understanding so that the scientific knowledge can diffuse throughout the country	0%	13%	44%
3. To make students have more interest in science and technology so that scientific or technical minded people can be fostered throughout the country	100%	62%	56%

In this question, we asked volunteers how they feel the significance of science education to the nation where science and technology have not yet been developed. All of the three countries, Kenya, Zambia and Ghana have been making great efforts in promoting science education. As pointed out in Chapter 2, they realize the very important role of science and technology for the development of their countries. A number of principals whom we visited during our field survey unquestionably considered mathematics and science as very important subjects. But despite the enthusiasm of school principals, there are many difficulties associated

with spread of sciences education in these countries. Firstly, there are not enough science laboratories in schools, and a shortage of equipment and materials due to financial constraints of the nations. Experimentation and observation are important parts of science education, and it is consequently very difficult to teach science subjects without such facilities.

Secondly, lack of sufficient numbers of mathematics and science teachers is very obvious. Because of an acute shortages of teachers, in some countries some science teachers have to teach science experiments which they have never exercised by themselves, and give lecture to classes on equipment and materials to be used in science laboratories which they have never seen before. Subsequently, student may not understand what is explained.

Thirdly, there exist unfavorable educational circumstances for African students. In the first place, for African children, there are only very few opportunities to obtain scientific or technological knowledge from their immediate surroundings, with the knowledge of science and technology from daily lives. Science taught at the high school might appear far remote from their traditional world, and thus requires considerable mental effort to study it. Furthermore, as was described earlier, African pupils are relatively poor in basic arithmetic skills. A certain level of mathematical ability is necessary for studying physics and chemistry at high school level.

In addition, Japanese volunteer teachers must struggle with the problem on how to teach such an unreasonably large syllabus of science and mathematics education to the African students.

There are a number of Japanese volunteers who think that there are problems in educational circumstances of African countries, such as existence of severe exam system and undesirable attitude of African students. Whether Japanese volunteers like it or not, they must struggle to deal with these problems. Supposedly the attitude of African students who stick too much to exam scores is closely associated with education system of African countries, where very little opportunity is opened for receiving higher level education and being admitted to enter university is the only way to become the elite in the society.

Although many Japanese volunteer teachers know that a large proportion of student can not reach such level as is required for university entrance, they must still make very wasteful efforts of completing what the nationally adopted syllabus demands so that students could make higher scores in the national examinations. Of course, there are some schools where sending their student to university is not a major goal of the school. Many of those schools, however, are those small rural schools like Harambee schools in Kenya, which tend to be rather inferior in terms of student learning capability and to which Japanese volunteers are very often posted. As was described in Chapter 2 of this report such schools have very often a problem of a critical shortage of teachers both in numbers and quality. Apparently, in those schools student could not complete such too ambitious syllabus of the country.

Nevertheless, regardless of the quality of schools there are atmosphere in school where both teachers and students tend to think that making high scores, even a point higher, in the national examination is almost a sole objective of education. Encountering these problems, Japanese volunteer teachers are obliged to choose their way of teaching classes hesitantly among several options; for example, some volunteers focus their attentions on the only handful of capable students of the class who are bright enough to understand all the syllabus to be learnt for their grade. In this case, most of the average or lower than average students of the class could not understand what were taught and left out in trouble. Meanwhile, if teachers focus their attention on the lower than average students the progress of the study might be quite slow so that even capable student of the class cannot make a good scores in the national examination.

In the questionnaire, we asked volunteers about their way of approach in teaching science subjects in such difficult circumstances. There are three possible responses to the question, from which respondents can choose the most appropriate one as a main objectives of teaching science in the African countries.

Only 25% of volunteers in Zambia, and no respondents in either Kenya or Zambia, chose the response of "to have student make a good scores in the examination." In Zambia 13%, in Ghana 44%, and in Kenya 0% of volunteers said that to make student have more scientific and

technical knowledge is needed so as to promote the diffusion of scientific knowledge throughout the nation. Meanwhile, the third response, "to make student have more interest in science and technology so as to foster scientific and technical minded people" was chosen by 100% of volunteers in Kenya, 62% in Zambia, and 56% in Ghana.

The fact that the overwhelming majority of volunteers chose the third response will indicate the soundness of Japanese volunteer teachers because they are not only not short-sighted but also are well aware of long term needs of African countries on human resources development. There are many African students who reportedly show strong interest in exercising laboratory experiments. This is very encouraging sign of African countries for their future development. Because major issues of science education in African countries is to increase the number of people who have keen interest in science and technology and can lean science and technology creatively by themselves. If African science education can foster scientific or technological minded people, it will definitely a step forwards to modernizing their industry.

Another remarkable finding of the responses of this question is that there are comparatively many Japanese volunteers in Ghana who consider that making student to have more scientific knowledge is a major objectives of teaching science. No clear cut explanation can be possible but it is supposed to have some relevance with the fact that Ghana has spread their secondary education more than Kenya and Zambia have. Japanese volunteers who chose this response might believe that if science education have increased the number of students who have interested in science, then the level of scientific knowledge in society will be subsequently enhanced.

As expected, only a relatively small proportion chose the response of 1. Certainly, there are some volunteers who think that, in order to have some student make good scores in the national examinations, class has to be taught entire syllabus, even if the most of the students of the class could not catch up. But the majority of volunteers do not think this is a way science education is to be carried out although, more or less, they have to compromise with real world requirements.

(3) Principals' Expectations towards Japanese Volunteer Teachers

Question 7: What expectations do you think your principal has to you?

	Kenya	Zambia	Ghana
1. Teaching African student on mathematics, science and other subjects	20%	38%	50%
2. Bringing in materials from Japan rather than teaching African students	80%	62%	50%

The most of Japanese volunteers had wished to come to African countries because they can contributes to the development of African countries through teaching science and/or mathematics subject to African students. Then, what expectations do the principals of the schools who receive Japanese volunteer teachers have? Japanese volunteers are asked the ways they are treated by the principals of the schools which receive them.

The results suggest that 20% of respondents in Kenya, 38% in Zambia and 50% in Ghana say that their principals expect Japanese volunteers to fulfil the duty of teachers. Meanwhile, 80% of respondents in Kenya, 62% in Zambia, and 50% in Ghana feel that their principals expect them to bring in financial aids of Japanese government rather than them to teach African students at their schools. It is rather surprising that majority of Japanese volunteers feel that they are not necessarily treated correctly.

Although the number of respondents involved in this survey is too few to draw any statistically meaningful conclusions, it can nevertheless be said that a significant proportion of volunteers feel that principals do not place much importance on volunteers' teaching activities. Apparently, there is a gap between Japanese volunteers and African principals in the way the program is perceived. We cannot, however, conclude from this result that principals' expectations of Japanese volunteers as teachers are low. For one thing, we asked Japanese volunteers how they think about their treatment by principals but we did not ask the same question directly to principals themselves. We did not do so, because there appears no

appropriate way to enquire the true opinions of the principals. The principals who received Japanese volunteers would not say that they wish to have Japanese material aids more than Japanese volunteers, even this is the case.

The questions asked to Japanese volunteers may not be appropriate. In reality, principals may wish to receive both Japanese volunteer and material aid equally. In any case, given the dire shortage of materials, from ballpoint pens to teaching materials and school facilities, no African school is likely to refuse any offer of material aids.

In conclusion, though there appears some discrepancy between what principals expect of Japanese volunteers and what Japanese volunteers would like principals to expect of them, it may not be too big to be overcome. What is truly needed to resolve this difference is a spirit of respect and mutual understanding so that this cooperation between Japan and African countries can successfully be materialized.

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