

Volume 2

August 2001

Mathematics Connection

Published by The Mathematical Association of Ghana (MAG)

ISSN 0855-4706



M A G

α β φ ϕ δ λ μ π θ σ ω



MATHEMATICS CONNECTION aims at providing a forum to promote the development of Mathematics Education in Ghana. Articles that seek to enhance the teaching and/or learning of mathematics at all levels of the educational system are welcome.

Executive Editor

Dr. Kofi Mereku, Department of Mathematics Education, UCEW

Managing Editor

Mr. S. A. Gyimah, Kwame Nkrumah University of Science and Technology (KNUST), Kumasi

Editorial Board

Prof. Kofinti, Department of Mathematics, University of Ghana, Legon

Dr. B. A. Eshun, Department of Science Education (UCC), Cape Coast

Dr. K. D. Mereku, Department of Mathematics Education (UCEW), Winneba

Dr. P. O. Cofie, Department of Mathematics Education (UCEW), Winneba

Mr. J. F. K. Appiah-Cobbold, GES District Directorate, Twifo-Praso

Mrs. B. Osafo-Affum, GES District Directorate, Asuogyaman, Akosombo

Subscription rate for this Volume: ₵15,000.00 (excluding postage)

Orders with payment should be sent to

Managing Editor,

Mathematical Association of Ghana,

C/o Department of Mathematics Education

University College of Education of Winneba

P. O. Box 25, Winneba

Tel. (0432) 22139 or 22140 ext. 138

E-mail: ucewlib@libr.ug.ed.gh

ISSN: 0855-4706

Typeset: Kofi Mereku, UCEW

Published by the Mathematical Association of Ghana

© Mathematical Association of Ghana (MAG) 2001

The points of view, selection of facts, and opinions expressed in the **MATHEMATICS CONNECTION** are those of the authors and do not necessarily coincide with the official positions of **MAG**.

Mathematics Connection Volume 2, 2001



M A G

Published by the Mathematical Association of Ghana

**NOTIFICATION OF 28TH BIENNIAL
NATIONAL CONFERENCE/WORKSHOP
OF THE MATHEMATICAL ASSOCIATION
OF GHANA (MAG), AT KOFORIDUA
GHANA SECONDARY SCHOOL, FROM
TUESDAY AUGUST 27, TO FRIDAY,
AUGUST 30, 2002**

The Executives of MAG wishes to inform you officially of the 28th Biennial National Conference/Workshop, which will be held at Koforidua Ghana Secondary School, from Tuesday August 27, to Friday, August 30, 2002.

The theme of the Conference/Workshop is *'Mathematics in the Information and Communication Technology Age'*

APPRECIATION

MAG will like to express its profound gratitude to SEDCO Publishing Ltd., North Ridge, Accra, for funding the printing of this Journal, the Folders for the 28th Biennial National/Conference Workshop and all the contents of the Folders.

EDITORIAL

Communiqué Adopted at 27th Biennial National Conference

For the editorial for this special 40th anniversary edition of the *Mathematics Connection*, we reproduce the communiqué adopted at the 27th Biennial National Conference/Workshop which was held at the University of Ghana, Legon, from 28th to 31st August, 2000.

We, the Executive and members of the Mathematical Association of Ghana (MAG) (hereinafter referred to as the Association), meeting for our 27th National Biennial Conference/Workshop & 40th Anniversary, from 28th to 31st August, 2000, at the University of Ghana, Legon, focused our deliberations on the theme "Mathematics as a tool for National Development in the Computer Age", and agreed as follows:

1. That we believe our objectives are still relevant and appropriate and endeavour to pursue them with diligence, especially
 - to improve the teaching of mathematics;
 - to acquaint members with current trends in mathematics.
2. That our Association had achieved some significant successes in its 40 years of existence, notably in the following areas:
 - The association is the only subject association that developed its own syllabuses in the 1960s for the Joint Schools Project (JSP) Modern Mathematics and Additional Modern Mathematics. The West African Examinations Council (WAEC) permitted schools and their students to use the syllabuses to prepare for the Ordinary Level General Certificate of Education (GCE) examinations.
 - Through annual and later biennial conference/workshops and vacation in-service training programmes, the association had assisted hundreds of secondary and primary school teachers to improve upon their

knowledge of mathematics and its teaching.

- Through its textbook development projects, the Association had kept pace with trends and provided teachers and students quality mathematics textbooks, especially the JSP mathematics series which were second to none in the West African sub-region.
3. The association is grateful to its many benefactors, especially Ministry of Education, the Ghana Education Service, the British Council and the Longman Group which had provided needed funds and other support for the association's activities and workshop
 4. That by the efforts of mathematics teachers in the country, mathematics education in Ghana is in a promising state of affairs; for example,
 - the percentage of Senior Secondary School students obtaining grades A to E in Core Mathematics has steadily increased from 40 in 1995 to 48 in 1999.
 - the percentage of girls taking Elective Mathematics has increased from 1.4 in 1995 to 5.4 in 1999.
 5. That the slight improvement in mathematics education noted in item 4, gives no cause for complacency. The state of mathematics teaching in our school at all levels still needs a lot of improvement as observed by both His Excellency Prof. John Atta Mills, Vice-President and Hon. Ekow Spio Gbrah, Minister of Education in their

Mathematics Connection Vol.2, 2001

addresses to participants at our 40th Anniversary Conference/Workshop.

6. That we, as mathematics teachers, must accept with humility that our own lack of understanding of the mathematics content and our inability to use appropriate methods and materials to teach may be the major cause of the difficulty many students face in learning mathematics.
7. That there are currently a number of appropriate teaching materials and equipment, including the calculator and the computer as well as innovations in teaching methods and assessment processes that could significantly improve the quality of teaching and learning of mathematics in our schools.
8. That while we as mathematics teachers need to double our efforts, we honestly need significant support in terms of the provision of materials and equipment mentioned in item 7 at all levels of education: viz. primary, junior secondary, senior secondary, teacher training, the polytechnic and the university levels.
9. That we have examined and discussed the new syllabuses for the Free Compulsory and Universal Basic Education (FCUBE) programmes at

the primary and junior secondary school levels.

- We support the changes and the new ideas that have been introduced into the syllabuses.
 - We recommend that In-service Training should be organised at the national, regional, district, circuits and school levels to introduce and orient teachers to the objectives, the new ideas and approaches suggested in the syllabuses for the FCUBE programmes.
10. That the Ministry of Education and the Ghana Education Service should set up a technical team in collaboration with the Executive of the Association to examine areas that schools and in particular, mathematics teachers need assistance in order to significantly improve the quality of teaching and learning of mathematics and to make recommendations to the Minister of Education to take appropriate action.
 11. That mathematics is indeed a tool for National Development and all stakeholders should endeavour to do whatever in their power to make mathematics play its proper role in national development in this computer age.

Signed By:

J.F.K. APPIAH-COBOLD
CHAIRMAN

Signed By:

DR. B.A. ESHUN
PRESIDENT

DATE:

MAG's Message of Fraternal Greetings to STME Clinic in Central Region

The invitation of the Mathematical Association of Ghana (MAG) to the Opening Ceremony of the 3rd Regional Science, Technology and Mathematics Education (STME) Clinic for girls in the Central Region, is most welcome and heart warming. We members of MAG see this as a fulfillment of a pledge made over a decade ago by the initiators of the STME to ensure maximum collaboration between Mathematics and Science Educators to erase wrong societal perceptions of science and mathematics as male domain subjects.

In respond to your invitation therefore, the National Executive of MAG, on behalf of its Council, and the entire membership, conveys to you fraternal greetings and warm felicitations on this third milestone of your tortuous journey towards *gender equality* in attainment in the sciences and mathematics in the Central Region of Ghana.

As we share in the joy of this celebration, we find it firstly appropriate to point out that though some strides have been made in improving performance as well as number of students reading the sciences, at both SSS and tertiary levels, recent studies¹ have shown that the fear for mathematics is still stronger among girls than boys.

This is rather unfortunate, because several Mathematics Educators took keen interest in the initiation of the STME Clinics the late 1980s, and tried to make mathematics education receive as much attention as science education. But this dream is yet to realised. At this juncture, permit me to pay tribute to the following dedicated Mathematics Educators who had been in the forefront of the STME struggle in Ghana in the late 1980s:

- Mr. Nigel Langdon, (then the Mathematics Adviser to the GES Teacher Education Unit, Accra
- Mrs. Osafo-Affum, (a pioneer woman Mathematics Educator in Ghana, & then Principal of PWTC) and
- Mrs. Jean Orton, (Mathematics Education lecturer in Leeds University, who donated a shield for STME best clinic student award in 1989).

Today, the number of Mathematics Educators in the National and Regional STME teams across the country when compared to the Science Educators is insignificant. This situation has to be addressed if we should in the next ten years achieve the aspiration expressed by one of our gallant lady mathematicians, Mrs. B. Osafo-Affum, that

“Our (i.e. women mathematicians' and scientists') aspiration is to see a 50:50 rate in the proportion of girls to boys offering mathematics at all levels, or even better still, a 60:40 rate in the very near future” (Osafo-Affum², 2000:16).

It should not surprise you to hear that this has already been realised in the UK, twenty years after they have began such STME initiatives. Times Educational Supplement reported that more girls obtained the top grades in mathematics and physics in the 2000 GCSE in England.

MAG looks forward to continued co-operation and fruitful collaboration with STME Coordinators in our education endeavours to ensure that in the pursuit of mathematical knowledge for Ghana's technological development, we do not neglect girls – the “half of our future – or leave them behind.

We wish you all the best. Thank you.

Dr. Kofi Mereku, VICE CHAIR (MAG)

¹ Eshun, B. A. (2000). 'Sex differences in attitude of students towards mathematics in secondary schools', *Journal of the Mathematical Association of Ghana, Vol. 12*, p1-13.

² Osafo_Affum, B. (2000). 'Message to MAG on the occasion of its 40th anniversary celebration', *The Mathematical Association of Ghana: 40th Anniversary Brochure* Accra: SEDCO Publishers. p16.

Mathematics Crises in our Schools: Causes and Remedies

MRS B. OSAFO AFFUM, Asuogyaman GES District Directorate

Abstract

The presentation will discuss findings from an NGO project - 'Improving Teaching and Learning of Mathematics in Basic Schools'. The project has taken the presenter to several schools across the country, observing and supporting teachers in their implementation of the curriculum.

Introduction

Crises are the plural of crisis. Crisis is usually a period because of a serious problem or danger. It may sound negative because I have to talk about crises problem definition. Do we really have mathematics crises in our schools? Are there crises in mathematics education in the primary schools, JSS or SSS? Are there also such crises in the Teacher Training Colleges or Universities and other tertiary institutions? The sad fact is that there are, may be, in all.

But permit me to concentrate on the Primary schools where the foundation is laid and whatever pertains there is spread to all the other places of learning.

Factors causing mathematics crises in basic schools

The key factors that will be considered in this discussion on mathematics crises are:

- the teacher
- the pupils
- the school curriculum-syllabus, text books, timetable
- parents/guardians

I don't see a lot of problem with the last two factors to cause crises in our schools but there certainly is a lot wrong with the first two to cause crises.

Syllabus

Take the *syllabus*, i.e. the list of topics to be studied. If what is embodied in the syllabus is covered accurately there would not be any crises. But the fact is both the syllabus and the textbooks are not covered completely. Both are in the progress of being revised or are already revised so that any deficiencies are corrected.

Timetable

Maths is given 5 double periods of 60 minutes a week on the timetable i.e. there is a maths lesson on each day of the week (Monday to Friday) for regular schools and 4 double periods for shift schools. If these periods are utilised fully and profitably for doing nothing but the teaching and learning of maths, there should not be maths crises in our schools. But how do the teachers and pupils use the periods? Before we answer this question let us consider some essentials about the teacher.

Teachers' Training

At the time I was head of a Teacher Training College trainee teachers did not have the primary school maths syllabus or textbooks available to them. Even their tutors did not have in-depth knowledge of what was in both the syllabus and textbooks. Hence most trainee teachers never had the chance to study all that is in the syllabus or textbooks for the primary school. Some laid hold of them the first time they were on teaching practice. Some were given only topics to be taught but not the syllabus or textbooks. They were meant for the primary school teacher and some of them did not have the syllabus or Teacher's handbook available to them. All that they had were a few copies of the pupil's book. I am not sure if the situation is better now (9 yrs after leaving the Teacher Training College).

Hence teachers were trained without having in-depth knowledge of the syllabus or textbooks they would use later in life when practicing their profession.

The teacher was not taught *how* to teach all the topics in the syllabus to the primary school children. Most maths tutors at the teacher training colleges preferred to teach

the contents instead of the methodology of maths, because they were not taught at their training colleges or universities. The emphasis was again on contents. I don't know *many* lectures or Teacher Training College tutor who know *how* to teach each topic in the syllabus to the primary school children. But I know many tutors who teach the contents well. Many however *lecture* more than teach.

With this kind of training for the primary school teacher, what do we see in schools? It is said that teachers teach the way they were taught. So the Teacher Training College tutor teaches the way he/she was taught at the University and the primary school teacher teaches the way she/he was taught by his tutor at the training college.

Teachers' Methods

Many teachers lecture instead of teach. They give *definitions*. They don't use concrete materials and practical ways to explain mathematics concepts. At the primary school level even JSS and SSS levels *discovery* methods would have been the best; but some teachers at these levels give even notes on mathematics just as they do on history topics! Children are expected to learn off hand what they do not understand. There is the Chinese proverb:

I hear and I forget

I see and I remember

I do and I understand

Lecture methods only enable pupils/students to 'hear and forget'. The sad story is told to pupils/students in JSS, SSS and Teacher Training College who are bold enough to ask the tutors (turned lecturer) explanation of what they don't understand but they are shouted down, and ordered to keep on copying the notes. That reminds me of a bold student, a mate of mine, who asked the lecturer in education for explanation while the lecturer was busily lecturing and we were copying the notes as printing machines do. The lecturer stopped briefly and said, "with that brilliant interruption, we shall proceed!" And he did proceed without offering any explanation. None dared tempt the brilliant scholar again! So tutors at the SSS, Teacher Training College and even

teachers at the JSS and primary school levels teach/lecture the way they were taught. The result is the mathematics crises at all levels.

Teachers' Preparation

Because the teacher was not exposed to the textbooks especially the Teacher's handbook which contains the methodology for teaching each unit and materials for teaching. She/he relies on the pupils book, which contains no methods but exercises, to plan his/her lesson. The result is that teachers come out with very poor sketchy lesson plans, which do not help the teacher to teach with ease and confidence. Teachers cannot effectively use the 3 most important reference materials:

- the mathematics syllabus for primary schools
- the teacher's handbook which is "systematically written to help the teacher" and
- the pupils book which is a book of exercises for pupils to do to consolidate concepts taught/learned.

Teachers make little use of appropriate teaching/learning Material (T/LMS) in their teaching. Children learn step-by-step from the concrete to the abstract. But because teachers do not use teaching/learning materials only a few exceptionally good pupils (mathematically endowed) participate in maths lessons with some measure of understanding. This is one of the major causes of the mathematics crises in our schools.

Monitoring Teachers' Work

There is very little monitoring and evaluating of the teachers' work. Headteachers do not check to ensure that teachers teach well using appropriate teaching materials or whether they teach systematically to complete the syllabus within an academic year. Some heads are not very sure of how to vet teachers' lesson plans because they were not taught how on appointment. They also lack understanding as most were appointed without any adequate training.

Some suggestions for overcoming the crises

- Mathematics tutors in Training Colleges must
 - a. teach how to use the 3 most important materials for teaching maths adequately i.e. the syllabus, Teacher's handbook and pupils book so that teachers can plan and present their lesson well. "I write good lesson plans so that I can teach well, I teach well so that all my pupils will learn."
 - b. They must learn to teach methodology after trying their methods by giving **demonstration lessons** in a primary school.
 - Any teacher trainee in the primary school must study the Teacher's Handbooks for (p1 – p6) together with the corresponding pupils books from cover to cover and be able to work all the exercises in the pupil's books before leaving college.
 - Teachers in the field must be given INSET at which they (a) study the syllabus teacher's handbook and pupils book and (b) learn how to make and use Teaching/learning materials. Hence at least one of the circuit supervisors in every district education office or the District Training Officer must be good at mathematics and be able to organise the INSET. Where there is none now, MAG members must do the Inset in collaboration with the District Education Office.
 - There should be funds set aside for follow up work to ensure that teachers use the plans given at the INSET – many do not.
 - Every teacher must possess the 3 reference materials and must use them to plan lessons and teach well.
- Teachers must make and use appropriate teaching/learning materials
 - Mental drill should be used by teachers to introduce lessons involving the 4 basic operations. No cane should be used during mental drill or in teaching maths! They cause havoc and fear.
 - Pupils must be given the chance to work all exercises in their books from their textbooks and not from the chalkboard. Only this will consolidate the concepts and skills learnt and remove the crises.
 - Headteachers and circuit supervisors must use every effort and method to monitor and evaluate the work of teachers. E.g. "How to complete the curriculum (maths) how children learn. Units covered in English and maths""(All can be obtained from ILP/QUIPS.
 - Headteacher and circuit supervisors must ensure teachers cover all units before children are pushed to the next class. This applies to JSS and SSS.
 - Headteachers and circuit supervisors must learn to know the needs of their teachers' e.g. how to assess their pupils well or teach particular topics so as to plan INSET for them. They should teach teachers how to make and use appropriate teaching/learning materials.
 - The maths period should be used for nothing but the teaching and learning of mathematics.

Mathematics Education and Continuous Assessment in Ghanaian Senior Secondary Schools: Continuous Assessment of What?

FLETCHER, J. A.

Faculty of Educational Foundations, UCC, Cape Coast

Abstract

The last decade or so has seen major developments in the policy and practice of assessment in this country. The introduction of the criterion-referenced assessment scheme at the primary school level as well as the use of continuous assessment at almost all levels of education in Ghana reflects fundamental new conceptions of what assessment is for. The old notion of tests as something, which will sort young people into social roles they will occupy in society, is being replaced by reformed rhetoric, which asserts multiple purposes of assessment. At one level, it seems there has been growing acceptance, at least among educationists, which the primary purpose of assessment must be formative, that is, the information it gathers should be used to improve the educational process. At another level, emphasis is being laid on the summative function of assessment whereby a judgment of some kind is passed on an individual at the end of some course of work. This article examines the use of continuous assessment in mathematics at the senior secondary level in Ghana and argues that the present arrangements in the assessment of students' achievement in mathematics at the senior secondary level are not substantially different from the traditional modes of assessment which they are meant to replace.

Introduction

The goal of any scientific measurement procedure is to arrive at the best possible estimate of the 'true' value of some dimensional quality of a 'natural' phenomenon. To the extent that this goal is achieved, the measurement is said to be valid or accurate. Validity or accuracy of the result therefore becomes the yardstick for gauging the quality of any measurement procedure (Messick, 1989).

If one thinks of measurement as involving, at its simplest, a relationship between a variable which is not directly observable (e.g. intelligence) and one that is (e.g. the performance of specific tasks), then the differences in the score on the observable variable should reflect actual differences in the phenomenon being measured (Johnson & Pennypacker, 1980). Thus, if one's performance of a specific task is taken as indicative of one's general intelligence, then we would expect a 'normal' child to perform the task better than say a mentally retarded child. If this does not happen, then that specific task

simply does not measure general intelligence. In other words, if the differences in the score on the observable variable do not reflect actual differences in the phenomenon being measured, then the measurement is simply not valid (Anastasi, 1988). It is important to emphasise that the validity of any assessment scheme is in many ways related to the purposes of the scheme. And an assessment scheme may have several purposes, depending on the perspective underlying the scheme (Fletcher, 1992).

Assessment may be seen from sociological perspective primarily in terms of social management; Boules and Giatis (1976) from anthropological perspective in terms of social ritual; Berustein (1971) and from political point of view in terms of professional accountability and all kinds of other things Noss (1990). The writer appreciates the differences in the various perspectives of assessment and will therefore consider the purposes of assessment mainly from psychological standpoint laying much emphasis on cognitive issues.

It is not the propose of this paper to give a list of all possible 'psychological' uses of assessment, yet it is possible to identify three main reasons for assessing pupils' educational achievements in general and their attainment in school mathematics in particular. These are, improving the teaching/learning motivating pupils and providing information for others Broadfoot (1988). In discussing the purposes of assessment, this paper will concentrate on only the first of these three reasons. In other words, it will concentrate on diagnostic assessment.

Before discussing the role continuous assessment is meant to play in diagnostic assessment, one would like to pose a few questions about education itself. These are: What is education for? What qualities do we want from it? What balance should there be between providing for all a 'standard' offering and drawing out the interests and talents of each person? Indeed, it only when we have some clarity about what education is for, about what capabilities, attitudes and behaviours we want young people to develop and why, that it becomes appropriate to ask questions about how we can monitor progress, what we can assess, how we can assess constructively and how we can ensure that due emphasis is given to aspects of pupils' learning and development which are important. Admittedly, one cannot list all the possible reasons for educating a child but one can be convinced that the aim of education in this country, from whichever perspective, is not simply to train pupils to pass public examinations (Akyeampong et al., 2000).

Surely, there is more to education than merely passing external examinations. Over the last few decades, we have witnessed approaches of education, even if elsewhere, that are based on social priorities including preparing students to utilize freedoms in a self-directing manner and preparing them for the adult world of work (ERRC, 1994; Sawyerr, 1994). In this country, education has always been linked to our national development efforts, implying that we expect our young people to acquire skills, values and attitudes which will contribute to the building of a better,

prosperous nation (Antwi et al, 1992). Any form of education which narrows the curriculum and encourages teachers to teach to the test should therefore be ruled out.

There is very little or no gain in making only what can be assessed externally important rather than finding ways of assessing what is educationally important. Perhaps the most important question about assessment that should be asked by all is: how can we produce reliable information about pupils' progress in ways which recognize their true achievement and do not harmfully narrow the criteria on which they and their schools are judged? I will make an attempt to answer this question in relation to diagnostic assessment in mathematics education.

It is in view of this that continuous assessment was introduced into the educational system at the senior secondary school a decade or so ago. Thus continuous assessment to be essentially formative - giving continuous feedback to both the pupil and the teacher about progress in the teacher's as well as the pupils' learning.

Diagnostic Assessment in Mathematics Education

There is nothing new about diagnostic assessment, which is being discussed here. Indeed, there has always existed an awareness of the importance of formative assessment among teachers. Teachers have always taken account of learning difficulties in their classrooms and reacted to them. Questions are asked at class and individual levels, mistakes are noted as the teacher moves from one part of the classroom to the other, and errors are corrected in both written and oral work. However, this awareness of the importance of diagnostic assessment is continually being undermined by public examinations. The latter seem to direct the attention of teachers to goals beyond their own classrooms. In fact, the influence of external certificates has always had a dominant role in teacher thinking and has actually reduced the likelihood of formative assessment taking a more prominent role in the classroom. This is clearly the result

of linking pupils' examination results to teacher performance in a simplistic manner.

No matter how devoted a teacher is, any attempt to use pupils' examination results as a key indicator of her/his performance could result in the teacher subverting any assessment scheme which tends to promote individual learning at the teacher's expense. This unfortunate situation tends to create a tension between formative assessment and summative assessment. The result is that teachers tend to use summative assessment during the instructional phase with the misconceived intention of formatively evaluating the learner. This attempt to use summative assessment in place of formative assessment encourages pupils to hide their weaknesses and exaggerate their strengths. (Goldstein, 1990). Yet, the central purpose of assessment in education is to contribute to raising educational standards by assisting the improvement of teaching and learning (Winzer 1992). This can only be achieved if assessment encourages open and honest admission of failures as well as successes - which is what diagnostic assessment is designed to do.

Relating the above discussion to mathematics education, inasmuch as mathematics remains a compulsory subject in the school curriculum, sensitive diagnosis by the teacher is an essential first stage before appropriate provision can be made for each individual's needs. If the pupil is to be helped to overcome any difficulties in the learning of the subject and make progress, then this diagnosis is crucial to the teacher. (NCTM, 1995) The question is, 'do teachers of mathematics make this important diagnosis at all'?

Presently, students' achievement in mathematics at the end of the senior secondary course is assessed by a combination of external examination, by the West African Examinations Council (WAEC), and continuous assessment by the teacher. This provides teachers with the opportunity of assessing those aspects of the curriculum that are not easily assessed in time limited, pen and paper external examinations (Akyeampong et al,

2000). For example, the mathematics curriculum is made up of at least five main areas, namely, facts, skills, conceptual structures, general strategies and personal qualities. Facts include remembering terms, notation, conventions and results. Skills refer to the standard computational procedures in all the different areas of mathematics and they include performing basic operations (e.g. $35+78$), sensible use of calculator, simple practical skills in mathematics (e.g. measurement, constructions, etc) and the use of microcomputers in mathematical activities. Conceptual structures are richly interconnecting bodies of knowledge, including the routines required for the exercise of skills. These are underpinned by understanding basic concepts of say division and multiplication, the relationship between concepts, using mathematics in context and interpreting results. General strategies are procedures which guide the choice of which skills to use or what knowledge to draw upon at each stage in the course of solving a problem or carrying out investigation. These include the ability to estimate, simplifying difficult tasks, reasoning, making and testing hypotheses and proving or disproving.

Finally, personal qualities refer to good work habits in mathematics such as imagination, creativity, independent in thought and action, co-operative work, persistence and positive attitude towards mathematics (Winteridge, 1989).

It may be inferred from the above that external examinations can hardly assess the entire mathematics curriculum. Indeed, the present Senior Secondary Certificate Examination (SSSCE) in mathematics does not cover all the areas of the secondary mathematics curriculum as it can only assess facts, skills few aspects of conceptual structures and general strategies and almost no personal qualities (Acquaye, 2000). It is understandable that the external part of the examination cannot, for various reasons, cover certain aspects of the mathematics curriculum (e.g. teamwork and practical tasks) Akplu, (1989). This is why the continuous assessment scheme should be an important component of the whole

examination (ERRC, op.cit). The value of continuous or teacher assessment in mathematics is not merely assessing the pupils' throughout the course, but also one of assessing those areas of the curriculum which are not assessable by timed written external examinations. An example of this would be the case of the pupil who in the course of group work (Akyeampong et al, 2000) has helped others to understand some mathematics. This achievement clearly has elements of understanding of the mathematics in question, communication skills, and social skills. Yet it is possible for such a student to fail to exhibit this understanding in a timed written examination due to nervousness or lack of speed. If the teacher fails to take note of the pupil's understanding of the mathematical concepts involved in helping others to understand that piece of mathematics, wrong conclusions may be drawn about the pupil's achievement in mathematics. The point is, continuous assessment ought to provide a more comprehensive view of a pupil's all-round performance (Abledu, 1999).

Admittedly, this kind of assessment is eventually classificatory, but at the time it is done, it puts less pressure on the pupil. Moreover, the assessment is rooted in the daily classroom practice of the teacher and as such the curriculum does lead the examination, not the other way round. Pupils get credit for everything they do, and so there is less temptation to omit areas of experience on the grounds that they cannot be examined by a paper and pencil test (NCTM, op cit).

From the point of view of the pupils the system of short tests conducted informally and orally every three weeks or so, reduces the nervousness caused by being faced with a large number of mathematics questions on which many students are expected to fail. If there are no time limits, the emphasis is shifted from 'speed' to 'power'. The opportunity to discuss and ask questions reduces the problems involved in the possibility of misunderstanding instructions. The foregoing are but a few of the advantages of complementing external examinations with continuous assessment.

Indeed, when continuous assessment was introduced in 1987 to complement external assessment at the Senior Secondary level, the great majority of teachers welcomed the idea in spite of the misgivings about the substantial additional workload. They did so because they recognized the great gains in the validity of this form of assessment and the beneficial effect it has in supporting the day-to-day curriculum rather than distorts it. Yet most if not all senior secondary mathematics teachers have resorted to assessing pupils in the very areas that the WAEC assess them in (i.e. facts, skills and limited conceptual structures). Some have even gone to the extent to using past examination questions set by the WAEC to assess their pupils as the 'continuous assessment' part of the examination. Thus the 'continuous assessment' has become a 'top up' external assessment of pupil's achievement in mathematics (Wuddah, 1997).

This unfortunate situation has resulted from the use of pupil's external examination results to rank schools. Thus, as mentioned above, senior secondary teachers of mathematics are under immense pressure to teach to the test in order to improve their schools' results and ranking in the league table. By so doing, they have lost the opportunity of delivering the mathematics curriculum. This means that the situation now with regard to the quality of mathematics that pupils learn at that level of education has not changed much from what it was before the introduction of continuous assessment.

Conclusion

From the foregoing, and as far as the assessment of pupils' achievement in mathematics is concerned, teachers of mathematics at the senior secondary school should take advantage of the continuous assessment scheme to teach all areas of the mathematics curriculum, assess those areas of the curriculum that cannot be assessed externally by WAEC and leave the latter to deal with the rest. This is the main way to ensure that assessment develops out of the curriculum and not the reverse. It is only then that one can be certain about the validity of the

continuous assessment of the mathematics curriculum at the senior secondary level.

Bibliography

- Abledu, G.K. (1999). *The effect of alternative assessment on the attitudes and achievements in mathematics of pre-service teachers*. (Unpublished Masters Dissertation), University of Cape Coast.
- Acquaye, G. (2000). *A study of the validity of the assessment of senior secondary school elective mathematics in Ghana*. (Unpublished Research) Report, University of Cape Coast.
- Akyeampong, D.A. et. Al. (2000). *Report of the committee to review the basic education certificate examination (BECE) grading system*. Accra, Ghana: Education Service
- Ampiah G. (1999) Junior secondary school science curriculum: prescription and practice. *Journal of Science and Mathematics Education Vol. 1, 34 – 46*.
- Anastasi A. (1988) *Psychological Testing*. New York: MacMillan
- Antwi, M.K. (1992). 'Development of education in Ghana (1880-1990)'. In C.O. Abosi & J. Brookman-Amisshah (eds). *Introduction to education in Ghana* Accra: Sedco Publishing Limited. p11-29.
- Bernstein, B. (1971). 'Class, codes, and control'. *In Theoretical studies towards a sociology of language*. Routledge and Kegan Paul.
- Bowles and Gintis (1976). *School and capitalist America*. Routledge and Kegan Paul
- Broadfoot, P. (Ed.) (1984). *Selection, certification and control*. London: Falmer
- ERRC (1994). *A Report of the Education Reform Review Committee on Pre-tertiary Education*. Accra: Ministry of Education.
- Fletcher, J.A. (1992). *The assessment of mathematical performance*. London: University of London, School of Education. (Unpublished Master's Dissertation)
- Goldstein, H. (1990). 'The fundamental assumptions of national assessment'. In P. Dowling and R. Noss (eds). *Mathematics versus the national curriculum*. London: Falmer Press
- Johnson J.M. and Pennypacker H.S. (1980). *Strategies and tactics of human behaviour research*., Hillsdale (N.J.): Erlbaum
- Messick, S. (1989). Mean and values of test validation: The science of ethics of assessment. *Educational Researcher, 18(2)* p5 - 11.
- NCTM – National Council of Teachers of Mathematics (1995) *Professional standards for teaching mathematics*. Preston V.A: National Council of Teachers of Mathematics.
- Noss, R. (1990) 'The National curriculum and mathematics: a case of divide and rule?' In P. Dowling and R. Noss (eds) *Mathematics versus the national curriculum*. London: Falmer Press.
- Sawyer, H. (1995). *The state of science education in Ghana*. (Opening address on the occasion of Ghana Academy of Arts and Science Seminar on the state of science education in Ghana). Accra: Ministry of Education
- Winteridge, D. (1989). *The primary mathematics co-ordinator*. London: Paul Chapman Publishing Ltd.
- Winzer, M. (1992). *Educational psychology in Canadian classifications*. Ontario: Scanborough
- Wuddah, A.A. (1997). *Incorporating teacher assessment in the final grade*. WAEC Monthly Seminary Papers: 1996 series. Accra: WAEC Research Division.

Mathematical Investigations in the Reviewed Basic School Curriculum

M. J. NABIE (*Dept. of Math. Education, U. C. E. W.-Winneba*)

A paper presented at the 27th National Biennial Conference /Workshop & 40th Anniversary Celebration of the MAG August 28 - September 1, 2000

Abstract

Mathematics teachers are called upon to use innovative teaching methods capable of developing mathematical understanding, inquiry, problem solving skills, and interest in children. This paper examines the role of investigations in the child's mathematical development. It looks at the nature of mathematical investigations in the basic school curriculum, how mathematical investigations can be organized, and attempts to make suggestions by which teaching mathematics through investigations can be popularized at the basic school level.

Introduction

Most changes in the structure and content of school mathematics curricula came as a result of the changing needs of citizens for effective participation in the increasing technological world and the increased volume of research knowledge about teaching and learning (Clarke, 1997). In Ghana, the 1987 educational reform was based on the need for an educational system that would serve the needs of the individual, the society, and the country as a whole (MOE, 1988). To meet the needs of the individual in the changing scientific world, mathematics should not be treated as a fixed collection of facts and procedures. Instead, it should be treated as a dynamic body of knowledge that is continually enriched through exploration, analysis, generalizing and conjecturing. This then demands a move from the classroom where children memorise facts and practice algorithms to a classroom where reasoning and understanding are emphasised. Dean (1992) argues that if there is to be true understanding and consequent transfer of learning to new situations, children need to reach the point where they can formulate concepts for themselves. This is because children can go through learning procedures and provide right solutions to problems without really understanding the principles underlying what has been learnt. There is, therefore, the need for a reformed vision in the teaching and learning of mathematics.

Even though there is no 'royal' method for teaching every topic in mathematics, providing routine exercises and rules for practice whilst the teacher sits down, is discouraged. The reason is that learning mathematics goes beyond searching for answers. The need to diversify teaching and learning methods with the view to produce individuals capable of meeting the demands of the day might have triggered off the emphasis on mathematical investigations in the reviewed Basic School mathematics curriculum. This paper attempts to examine the role of mathematical investigations in learning, and also discuss how mathematical investigations can be used in lesson delivery to develop children's mathematical skills and processes.

Mathematical investigations in learning mathematics

A mathematical investigation is an exploration of a topic with the view to discover new ways of thinking and to develop in-depth knowledge about the mathematics inherent in the topic rather than to obtain specific answers (Chapin, 1998). Children, like any other person need knowledge. They seem to be aware of this right from birth. Consciously or unconsciously, they try to reach the knowledge about things, some of which are not even worth knowing, by exploring the environment in which they live. They do this by playing or interacting with materials

within their miniature world. Right from birth, children mostly explore for fun and to know more about their environment rather than finding solutions to specific situations. Investigations can, therefore, be considered as children's natural methods of learning about their environment. They are as old as man is and play a significant role on learning mathematics.

Learners can derive a lot from mathematical investigations. Mathematical investigations promote extension of knowledge (Frobisher, 1994), and leads to acquiring process skills (Dean, 1992). Mathematical processes children can acquire through mathematical investigations include:

- operational process (collecting and ordering etc)
- recording process (listing, drawing, labeling, etc)
- communication process (describing, discussing, questioning, etc)
- reasoning process (analyzing, reflecting, clarifying, etc)

Learners choose processes to match the situation, use the processes in performing the task successfully and thereby developing skills. Children develop strategies as they combine processes and skills in order to tackle the investigation.

Furthermore, investigations evoke divergent thinking and develop the sensual powers of the child (Wolf, 1990). In pursuing an investigation, learners bump into different but related ideas and concepts much earlier, think about in various ways and make connections among the different areas of mathematics.

Through an investigation, a whole class can be involved in a discussion at all levels of lesson delivery. Discussion is a way of sharing ideas. Discussions during and after an investigation can be an effective method for developing a lesson as well as assessing learners' progress. It is a fact that a teacher cannot be everywhere in the classroom or observe everything at the same time. Also, teachers cannot have time to listen to or transcribe all that their

pupils say, especially in large classes. It is on the basis of these arguments that Roper and McNamara (1992) call on teachers to encourage their pupils to do investigations and record their thoughts and actions in investigative diaries. A well-designed mathematical investigation can, therefore, be an effective way of engaging children's minds in learning whilst the teacher takes off time to do other things or rest.

Mathematical investigations are full of fun and provide the opportunity for children to formulate their own ideas. They can be used for effective lesson delivery: introduction, development, and evaluation. Using investigations in the entire lesson delivery depends solely on ones ability to appropriately structure investigative activities and the questions that follow the main activity.

Studies of teachers' mathematics classroom activities identified the basic tenets of good mathematics teaching. These include providing opportunities for students to practice procedures and explore new situations, offering specific corrective support when and where necessary (Smith, 1996), varying methods, creating and maintaining children's interest (Skemp, 1986). Mathematical investigations bring about variation in teaching and learning, generate interest, enable children to, correct themselves, practice beyond the classroom on their own, and could involve parents in the learning process of the child, especially if they are given practical take home investigations.

Mathematical Investigations in the classroom are based on the belief that children learn better when they construct their own mathematical meanings from what they do (constructivist paradigm). With this belief, teachers are required to give more attention to children's problem solving processes, probe children to develop thinking skills, allow children to question and discuss to fine tune their ideas. This is a departure from the traditional practice whereby teachers talk and 'chalk' and children take information without questioning. This approach to teaching is challenging but if children are to derive much benefit from classroom

Mathematics Connection Vol.2, 2001

mathematics, then they must be made to find out things for themselves through investigations.

Nature of the investigations in the curriculum

Considering all mathematical situations as problems, then problems that are open and divergent are classified as investigations. Divergent problems are categorized into two

1. Open-ended problems where the learner searches for *both a method and a goal*
2. Open problems comprising: (a) those the learner has to explore the situation and decide a goal and (b) those where the goal is known and the learner has to choose a method (Frobisher, 1994)

Using this categorization scheme, majority of the investigation activities at the basic school level seems to belong to the second category. For example, “*Make as many symmetrical figures as you can*” and “*Sketch as many nets of a cube as you can*”, are of the second kind.

Simple investigations that make the learner to brainstorm widely provide the child with a wider knowledge base for beginning lessons. Beginning a topic with an investigation, as in the primary texts, offers the learner to collect data and make tables. Making tables is an excellent way of improving the learner’s computational skills. Investigations with real materials develop the motor skills of the learner. Introductory investigative activities, however, do not seem to feature much at the JSS level as compared to the primary level. At the JSS level, many of the investigative activities are provided at the end of the topics and more or less serve to consolidate processes, and skills. There is the need for a balance in investigative activities in the textbooks, which are the ‘bibles’ for both pupils’ and teachers. Investigative activities should be provided for the start of concept development.

Organizing an Investigation

Teaching mathematics through investigations is considered as the most

progressive means of helping children to understand mathematics. However, many of us think that a mathematical investigation is a big thing that may require special knowledge or must involve the use of expensive materials that may not be readily available. Children do not require any special knowledge for investigations. Many investigations can be done using thrown away household materials and sheets of paper that can be found everywhere. An investigation need not be lengthy, or extensive (Cockcroft, 1982).

There are so many nice active learning tasks in the Basic School textbooks/syllabuses that time can be spent on discussing with pupils. Such discussions could begin with an interesting question or activity that may have a mathematical focus or be centered on mathematical applications. Any such question or activity that gives children the chance to discover ideas can be an investigation. In fact a question or an activity actually becomes an investigation if only it.

- is relevant and acceptable to the investigator
- does not have an easily recognizable goal
- has no readily available solution procedure
- extendible.

Children at all times may not be able to initiate an investigative process without assistance. Even at higher levels, some investigations may require some form of assistance. Consequently, mathematical investigations should not be seen as a matter presenting a situation and asking children to investigate. To organize classroom mathematical investigations very well teachers themselves must be investigative. The teacher must critically examine the topic to determine the experiences children will need to understand the topic. It is also important to consider possible investigations and try them before selecting the one likely to help children learn the topic bearing in mind the

- children’s interest in the topic

- the availability of materials, and
- children's ability to do the investigation.

For young children, it is appropriate to:

- (i) begin with investigations involving concrete materials through pictures before the use of symbolic investigations. Introducing investigations to children this way will enhance a smooth transition from one learning stage to the other.
- (ii) provide structured leading questions that direct the investigation process. Structured investigations keep what the child is learning within the bounds of the curriculum. Investigative questions must be carefully framed to force the child to think widely about the situation. Such thought provoking questions makes the child to search for strategies to carryout the task at hand. The "search for an efficient and effective strategy even provides the motivation to attain the goal" (Orton and Frobisher, 1996: 26).

Even though much learning is associated with mathematical investigations, teachers may not often do them because of

- the pressure to complete their syllabus
- the value placed on examination results
- lack of space and facilities
- natural hatred for mathematics
- challenges involved in designing investigative activities.

Conclusion

In conclusion, mathematical investigations in the Basic School mathematics curriculum are in line with the mission and vision of the 1987 educational reform programme. If learners are to understand, and apply mathematics to solve real life problems, then investigative teaching should be emphasized at all levels. Investigations introduce learners to various strategies and processes of solving problems. They help the child, to explore, think and develop skills independently.

Also, they actively involve the learner in the learning process. When teachers and pupils are used to exploring mathematical ideas and have developed a positive attitude towards mathematics, then almost every material within their environment can be used as stimulus for mathematical inquiry in the classroom. As teachers, it is our responsibility to choose activities that encourage pupils to learn mathematics themselves. This responsibility needs encouragement, time and resources to develop.

To popularize investigative teaching in Basic schools, I suggest periodic workshops/seminars on investigative teaching. Through such workshops/seminars, workbooks on mathematical investigations for pupils and Teachers' guides can be written. This is a challenge to all mathematics educators.

References

- Chapin, S. H. (1998) Mathematical investigations– powerful learning situations. *Mathematics teaching in the Middle School*, 3, 332-8
- Clarke, D. M. (1997) The changing role of the mathematics teacher. *JRME*, 28 (3), 278-308
- Dean, J. (1992) *Learning in the primary classroom*. London: Routledge.
- Frobisher, L. (1994): Problems, investigations and an investigative approach. In A. Orton & G. Wain (Eds.) *Issues in teaching mathematics*. London: Cassell, 150-172
- MOE (1988): The Educational Reform Programme. Policy Guidelines on Basic Education. Accra
- Orton, A and Frobisher, L. (1996) *Insights into teaching Mathematics*. London: Cassell.
- Roper, T & MacNamara, A (1992): Unrecorded, unobserved, and suppressed attainment- Can our pupils do more than we know? *Mathematics in School*, 25 (5) 12-13

Skemp, R. R. (1986): *The psychology of learning mathematics*. London: Penguin Books.

Smith, J. M. (1996): The efficacy of Teaching mathematics by telling: A challenge for reform. *JRME*, 27 (4), 387-402

Wolf, A (1990): Testing and investigations. In P. Dowling & R. Noss (Eds.) *Mathematics versus the National Curriculum*. London: The Palmer Press, 137-152

Research in Graphing Calculator Use: A Preliminary Report

DONTWI, I. K. Department of Mathematics, KNUST, Kumasi

Abstract

This paper focuses attention on some results obtained over the years with the introduction of Graphing Calculators into the Tutorial/Mainstream Class. Findings on Group Learning have been successfully applied. It was observed that Graphing Calculators have the potential of changing the classroom atmosphere and might have diverse implications to both teacher and student.

Introduction

The use of calculators is now acceptable at almost all levels of mathematics instruction. Its usage, though, is limited during examinations. Graphing Calculator (GC) because of its capabilities is put in its own class and together with the accompanying problems. The fact that it is possible to include it in mathematics instruction is highly controversial (Usiskin, 1978). However, a careful examination of the problems will help resolve some of them.

- Why must we prevent students having scientific calculators with graphing capabilities from using them during examinations ?
- Students have acquired these machines at a rather high cost. Mustn't we encourage them to access their machines at all times ?
- Can technology use impede or promote understanding?
- Where should paper-and- pencil be in this GC technology?
- In examinations students are prevented from using these powerful calculators primarily because they could be used to

store information for use during examinations

- Students with these calculators might have advantage over their colleagues when some algorithmic problems are to be solved.

Are these and other problems adequate enough to prevent us from encouraging and to some extent introducing or in co-opting GC usage in our curricula ? Technologies when they surface must endure the test of time. Its introduction into normal or formal life is initially slow but time and again they are eventually embraced. However, there should be some to take the initiative to use this new technology.

There has been a steady growth in the use of GC in schools. In the Department of Mathematics, KNUST, Kumasi, the situation is not very different (see Table 1).

The availability of GC has motivated us to re-examine what and how we teach mathematics especially in courses in computational mathematics for mathematics students and modeling for non-mathematical science postgraduate students.

Mathematics Connection Vol.2, 2001

Is the use of Graphing Calculator really a good thing for mathematics education? (Usiskin, 1978) Is this new phenomenon the real way forward? These are some of

outcomes of results conducted with the experimental groups being those getting graphing calculators for instruction and the control groups are those receiving

Table 1 Graphing calculator ownership in the Department of Mathematics, KNUST, Kumasi (July, 2000).

Year	# of Respondents	Ownership of GC % (#)	Assess to GC % (#)	Advocates of GC % (#)
Year 4	38	60.53% (23)	63.16% (24)	55.26% (21)
Year 3	45	44.44% (20)	73.33% (33)	93.3% (42)
Year 2	69	56.52% (39)	69.57% (48)	71.02% (49)
Year 1	134	16.42% (22)	80.60% (108)	58.96% (79)

the questions advocates and skeptics on what mathematics education have to say about the impact of this technology on teaching and learning mathematics (Dunham 1993).

There is relatively little or no research on GC technology in the literature and journals even on the international scene. As for this part of our world it is rather non-existent.

This paper presents some motivating factors as well as some preliminary results.

Tutorial Class

Some encouraging results are that after a few weeks of attempting to get students use their machines more effectively the numbers in the tutorial class started increasing. Students became very enthusiastic and expressed the interest in moving a step further by doing some more serious mathematics with their machines.

It was not really typical. The atmosphere was never formal and some Group Learning approach (see Dontwi, et al., 1999) was rather helpful. There were instances students will want to know what happens and why they did. Sometimes answers to these questions were not readily available. Such a class is not in the interest of someone who in all his/her professional carrier is used to the formal lecturing atmosphere. As an instructor there was the need to adopt new methods and outlook to the way of doing things.

Researchers have had mixed results but, to a large extent, encouraging. There are

instruction the traditional way, i.e. without the GC..

Ruthven (1990) and Harvey (1993) for example found significant differences in favour of the experimental group. In other studies Dick(1992) and Shoaf-Grubbs (1992) found no difference between the experimental and control groups, whereas Giamati (1991) found significant differences in favour of the control group.

Ruthven (1990) argues that not allowing students to use graphing technology when they have become accustomed to it forces them to do mathematics under unduly artificial conditions. This serves as a cautionary measure and one has to take a second look at the use of the technology at hand. Will it be acceptable under the current examination conditions? And what kind of education needs to go on to encourage users to cope with situations. The task ahead is not that simple. The research that must be done needs to be done carefully taking relevant issues into consideration.

In most instances experimental groups will have received different instruction and used different curriculum materials than the control groups (see for example, see (Dunham, 1998)). It must be noted that students and instructors must have the tools to use numeric and graphic strategies in the traditional paper-and-pencil algebraic techniques. Graphing Calculators furnishes those tools.

For example in mathematical modeling where real data is used graphing calculators make it more feasible. The degree of exploring and investigating during the modeling process is overwhelming. Non-mathematical science graduate students' participation is awesome. These students are no more perturbed by the hitherto frightening formulas arising out of model calibration.

Graphing Calculators and Classroom Dynamics

Classroom observation and interviews with students and lecturers suggests that GCs have significantly changed the climate in the classroom.

- Students become more active;
- Lecturers give fewer lectures and more investigations by students;
- Students consult with the technology as well as with the lecturer;
- There is a very high tendency if doing things outside planned lectures.

Conclusion

Graphing Calculators have the potential dramatically to affect teaching, learning and research in mathematics, particularly in the areas of calculus, linear algebra and generally in computational mathematics.

GC can empower students to be better problem solvers.

GC can facilitate changes in students' and lecturers' classroom roles, resulting in more interactive and exploratory learning environments.

References

Dick, T. "Super calculator implications for calculus curriculum, instruction and

assessment". *Calculators in Mathematics Education, 1992 Yearbook of the NCTM*. pp 145-57. Reston, Va. The Council 1992.

Dontwi, I.K., Asante K. and Addo S. A.. "Group Learning : 1. A longitudinal study of Mathematics students' Performance." *J. GSA (Special Edition) Vol. 2 No. 1* (1999); pp41-44.

Dunham, P.H. " Does Using Calculators Work? The Jury is Almost in." *UME Trends 5* (1993); pp8-9.

Dunham, P.H. "Teaching with Graphing Calculators. A survey of Research on Graphing Technology." *Proc. College Mathematics*; pp 89-101. Reading Mass. 1992.

Giamati, C.M. " *The effect of Graphing Calculators and Students' Understanding of Variations on a Family of equations and the Transformations of their Graphs.*" Ph.D diss., University of Michigan. Dissertation Abstracts International 52(1991), 103A.

Ruthven, K. "The Influence of Graphing Calculator Use on Translation from Graphic to Symbolic Forms." *Educational Studies in Mathematics 21*(1990): pp432-50.

Shoaf-Grubbs, M.M. "The Effect of the Graphing Calculator on Female students' Cognitive Levels and Visual Thinking." *Proc. International Conference on Technology in Collegiate Mathematics*; pp394-98. Reading, Mass. (1992).

Usiskin, Z. "Are Calculators a Crutch ?" *Mathematics Teacher 71* (1978); pp412-13.

Computers in the Mathematics Curriculum: Spreadsheets

Dr. Kofi D. Mereku

Department of Mathematics Education, UCEW, Winneba

Abstract

Today school mathematics stresses the place of information technology – calculators and computers – in the development of mathematical concepts in students. The paper examines how calculators (i.e. ordinary, scientific and/or graphic) and computers can be used to provide an ideal environment for teaching mathematics. The presentation examines how computers can be used to provide an ideal environment in exploring such mathematical topics as Statistics – averages; Graphs – bar chart, pie chart, line-graph and scatter graphs; Solution of equations – linear, quadratic and others; Sequence and functions;

Information Technology

Information technology (or IT) may be defined as the technology associated with the handling of information, i.e. its storage, processing and transmission in a variety of forms by electronic means, and its use in controlling the operation of machines and other devices. Computers have come to revolutionalise IT. Computers have come to change the way we do things in business and commercial organizations, public administration, industrial production, transport and security systems, creative and leisure activities, education and our homes. Therefore today, using computer is said to be doing information technology.

For this reason, in many countries today, information technology is studied and used at different levels of education. These include

- primary children learning to use a simple database or word-processing program;
- primary children using a programmable toy; secondary students using computer applications in various subjects in the curriculum;
- secondary students studying computer applications and functions more closely for GCE or Advanced level; and to university students studying the subject at degree or postgraduate level.

IT in the school curriculum may be identified in five main strands. These include:

- a) Communicating Information (e.g., through word-processing, DTP, etc.)
- b) Handling Information (e.g. through database applications of different types)
- c) Modeling (e.g. through simulations, modeling programs, spreadsheet work, etc.).
- d) Measurement and Control (e.g. through data-logging, control technology, etc.)
- e) Social and Economic Implications of IT.

These strands form a useful basis for mapping out the IT which can be delivered in the various subject areas which make up the whole curriculum. Some of the strands will be more evident in some curricular areas than others; it is not expected that all five strands will be covered in one subject area.

Spreadsheet

One common application programme that provides a rich environment within which better understanding can be developed in the study of mathematics is the spreadsheet. A spreadsheet can be thought of as a huge sheet of paper, part of which appears on the computer screen. You can move to other parts of the sheet using the arrow keys or by scrolling up, down, left and right with the mouse. In

spreadsheets, data is presented in the form of a matrix, i.e. rows and columns. An example is a summary of students' examination marks presented (Table 1).

In a spreadsheet the **cells** may be linked to

designed by a company called Microsoft. The instructions for Excel may differ from those used in other spreadsheets. For instance,

Formulas A formula like **A1+A2**

Table 1 Spreadsheet Screen

	A	B	C	D	E	F	G
1		Bill	Celia	Dave	Average		
2	Maths	45	72	39	52		
3	English	65	62	88	72.33		
4	French	85	91	68	81.33		
5	History	59	66	50	58.33		
6	Total	256	291	245			
7							
8							

one another. Thus changing a value in one cell will change the values in the cells linked to it. Thus if cell D9 is always twice the value of cell B9, then changing the value of B9 from 4 to 7 will lead to the value in D9 changing from 8 to 14.

Cells may be linked to more than one other cell; so one cell may contain the sum of a whole row or column of cells. Cells may contain either **text** or **numbers**, but are mainly used for the manipulation of numeric data. Figure 5.6 shows a spreadsheet used to record marks for a calculus class. Along the top are letters referring to the (vertical) **columns**, down the left are numbers referring to the (horizontal) **rows**.

Types of spreadsheet

There are many different spreadsheets available. In this paper, we shall consider the most common type of spreadsheet that is used today, "**Excel**". Excel was

starts with + in Lotus, but in Excel it is stated as **=A1+A2**. In Excel it can be either **+A1+A2** or **= A1+A2**.

Functions: A function begins with @ in Lotus and either @ or = in Excel. If a range of values is given, it is defined using a signing '@' sign (Lotus) or ':' sign (Excel). So for finding the sum of a range of numbers, we write '@SUM(A1.A10)' in Lotus, and = Sum (A1: A10) in Excel.

Spreadsheet Techniques

The basic skills that can develop using a spreadsheet program are:

- entering of items in a spreadsheet
- reading data presented in tabular form
- graphing data
- writing formulas. E.g. Putting in cell B4, the formula **=3*A4** refers to multiplying what is A4 by 3. So when this formula is copied to D4, it will change to **3*C4**.
- with copying formulas from one group of cells to another

Table 2 Finding averages with spreadsheets

	A	B	C	D	E
1		Baba	Kofi	Doe	Average
2	Maths	45	72	39	
3	English	65	62	88	
4	French	85	91	68	81.33
5	History	59	66	50	58.33
6	Total	256	291	245	

Doing mathematics with Spreadsheets: Some Examples

Finding Sums and Averages

In the end of term exams, Baba got 45, 67, 85 and 59 in Maths, English, French and History

Mathematics Connection Vol.2, 2001

respectively. Kofi's scores in these subjects were 72, 62, 91, 66. Doe scores were 39, 88, 68, 50.

Enter this information on a spreadsheet. Find the total score for each pupil and find the average score for each subject. Enter the information in a spreadsheet, with the pupil's names along the first row and the subject names down the first column. It will look like what is in Table 2.

What formula will you type for the average?

Sequence

A sequence starts with 5, and goes up by 2 at each step. Use a spreadsheet to find the first 20 terms of the sequence. What is the 20th term? Put 5 into cell A1. In cell A2 put the formula =A1+2. You will see 7 appear. This is the next term of the sequence. Copy this formula to cell A3 up to A20. The first 20 terms of the sequence will then appear down the first column. Read off the last term. The 20th term is 43

Equations

Suppose we want to solve the equation $X^2+X=3$. Put the formula =A1 *A1+A1 into cell B1. Try putting different values in A1, until B1 is close to 3. What do you get for X?

Trial and Improvement

Often equations can be solved by trial and improvement. A spreadsheet can be used to try different values until the equation is satisfied.

Example

Find integers x and y for which $7x - 9y = 1$

Keep A1 for the value of x and B1 for y . In cell A3 enter the formula =7*A1 - 9*B1. Initially the value will be 0. Enter values in A1 and B1, watching how A3 changes. If A1 contains 4 and B1 contains 3, then A3 will contain 1, and so, $7 \times 4 - 9 \times 3 = 1$

Calculators and the Mathematics Curriculum in Ghanaian Schools

DUEDU, CHARLES B.

Department of Primary Education, UCC, Cape Coast

The Basic School Mathematics Curriculum

Mathematics in the basic education is generally intended to equip pupils with basic numeracy skills necessary for everyday life and for the world of work. It is also to provide the necessary basis for further mathematics for those who will continue their education beyond the Junior Secondary School. The content of mathematics in the Primary school is geared towards helping the child to develop the language and the mathematics necessary to understand his immediate environment and the real world. Studies centre around the development of number concepts and number operations, relationships and measurement, and the concepts of shape, size and space.

Number concepts are developed through studies of collections of discrete objects. Both cardinal and ordinal uses of number are included. The operations of addition, multiplication, subtraction and division on whole numbers, integers and rational numbers are also included. The study of relationship includes matching of sets, correspondence and ratio. Elementary functions, patterns, games and puzzles are used. Pictorial representation is emphasized. Basic comparisons, for example, 'as many as', 'fewer', 'equal to', 'greater than', 'less than', are used.

Measurement is developed through the use of arbitrary units, estimation of measures and approximation (rounding off), to the realization of the need of standard

measures. The concepts of length, weight (mass), time, money, area, capacity and volume are developed and established through practical activities. These concepts are reinforced through many practical experiences of the child with the use of the standard metric measures.

Primary school mathematics gives a strong foundation for the study of mathematics in the Junior Secondary School. Thus, mathematics at the Junior Secondary School is generally a treatment of the primary mathematics to a little more depth and an extension to include a few other topics. Broadly stated, the topics covered in the curriculum include the concept of a set and operations on sets, numeration systems, plane and solid shapes, properties of numbers, operations of numbers, measurements, scale drawings, loci, simple geometrical constructions, area and volume. Other topics are ratio and proportion, percentages, exponents, algebraic expressions, symmetry, linear equations and inequalities in one variable, linear equations in two variables, introduction to graphing, introduction to statistics and probability, vectors, relations and functions, and transformations.

Introducing Calculators into the Mathematics Curriculum

The school mathematics curriculum in Ghana, as in many other countries, faces a variety of pressures as industry and society become more and more dependent on science and technology. Calculators make greatly increased computational power available to more and more people. This raises many questions about the present mathematics curriculum in our schools. Mathematics as it is currently being taught in our Primary and Junior Secondary Schools leaves much to be desired. There is the need to update it to meet the needs of today's children and the society at large. The general emphasis in mathematics in the schools therefore should be routines, which can now be done by machines, to the development of skill in problem solving. It should also be directed towards the application of mathematical ideas to real situations.

A position statement made by the National Council of Supervisors of Mathematics (1978:148) put it this way:

The present technological society requires daily use of such skills as estimating, problem solving, interpreting data, organizing data, measuring, predicting and applying mathematics to everyday situations. The changing needs of society, the explosion of the amount of quantitative data demand a redefining of the priorities for basic Mathematics skills.

There is the need to draw on recent experiences of other countries where the need has been felt and steps taken to re-direct the school mathematics curriculum in the desired direction in the present era of technology. Basically, therefore, mathematics in the primary and junior secondary school should provide pupils with the basic mathematics content and skills one will need to tackle real-life problems. It should also develop thinking and reasoning skills, and so strengthen the intellectual support of human social interactions.

Mathematics teaching and learning must take full advantage of the power of calculators at all levels. Calculators should be used in imaginative ways for exploring, discovering, and developing mathematical concepts in the classroom.

Williams and Shuard (1982) have shown how calculators can be regarded as forms of structural apparatus to enhance children's understanding of how numbers behave. They have pointed out that a simple four-function calculator can be sensibly used for exploration as soon as a child knows the meaning of the signs '+', '-', and '='. The calculator is a resource that the teacher can use, alongside other resources, in the child's search for understanding. As with all apparatus, talk and discussion are an essential part of the learning process. Calculators provide children with motivation to explore numbers and patterns, in mathematics. Johnson (1984:95) put it this way:

I think of mathematics as a subject wealthy in opportunity and one where the nature of the subject provides the

motivation to explore, and hence promote 'inquisitive behaviour.

Calculators can be used also for instructional games, and for developing problem-solving skills as a way of helping children learn mathematics in Ghanaian Primary and Junior Secondary Schools.

Calculators as an Aid to Developing and Reinforcing Mathematical Concepts

Skip Counting Activities

Activities for developing and reinforcing concepts using calculators can be planned for children in the classroom. Children can be assisted to count forwards by any specified number such as ones, twos, threes, fives, or tens by manipulating a calculator with a constant function. For example, if a child wishes to skip count in twos, the constant function is set up such that any pressing of the = key adds 2 to the number on the display. Similarly, the child can skip count backwards by any numbers desired. Through this activity the child gets a feeling for the size of numbers.

Place-value concepts

Place-value concepts can also be developed with calculators. A child may be asked to enter, say, the number 463. He is then asked to subtract a number from the given number, 463, such that a zero is obtained where the digit '6' is. The child gains knowledge of "tens place" when he finds that 60 and not 6 will give the desired result.

Properties of Numbers and Operations

Calculators can be used also to help children discover and establish for themselves some properties of numbers and operations. For example, children find out, using the calculator, that $3 + 4 = 7$ and $4 + 3 = 7$. A number of such discoveries will lead children to establish that addends can be switched and still obtain the same result for the sum. That is for example

$$3 + 4 = 4 + 3 = 7.$$

This can be extended to three numbers where children find out that, for example,

$$(3 + 4) + 5 = (4 + 5) + 3$$

Similarly this is considered for the multiplication operation.

e.g. $2 \times 3 = 3 \times 2$

$$2 \times 3 \times 4 = 4 \times 3 \times 2$$

Negative numbers

It is important to help children to develop concepts so that they do not only know how to add, subtract, multiply and divide numbers but also understand the meaning of the operations and the processes involved. For instance, through lack of understanding a child may write ' $3 - 7 = 4$ ' when using pencil and paper. It may not be obvious to the child that anything is wrong. A calculator will, however, give an answer of -4 , which could help the teacher in discussing the problem with the child.

Many such activities involving the use of calculators can help children develop other concepts and skills in mathematics.

Investigational Work and Patterns with Calculators

Calculators can be used as an aid in the classroom in investigational work. For example, a number of additions of the form $5 + 8$, $15 + 8$, $25 + 8$, ... $5 + 18$, $15 + 18$, $25 + 18$, ... can be carried out with a calculator to enable a child to find out the result of adding numbers ending in 5 and 8. Other similar number patterns can be explored.

Using any key of the calculator only once, pupils in the Primary School can be asked to make the largest number they can by adding two two-digit numbers. Similarly, they find the smallest number. They are later encouraged to extend this to two three-digit numbers. A slightly different one is when children are given the digits 2, 3, 4, 5, and 6 and asked to perform any of the operations of addition, subtraction, multiplication and division on the digits so as to arrive at a given number, say 24. They are required to use each digit once only, but can perform any of the operations any number of times.

Mathematics Connection Vol.2, 2001

Another investigational activity for Primary class 2 or 3 children can be to find the numbers which can be added to 26 so that the sum is between 60 and 70. Although this activity can be done without calculators, the immediate feedback possible with calculators allows pupils to focus on strategies and build valuable estimation skills. Similar activities can be used for multiplication, division, and subtraction and made even more challenging by reducing the specified range for Primary 4 to 6 pupils.

Another type of investigational activity allows the pupil to explore with numbers to arrive at a result or a pattern, which may not be evident initially. The anxiety to know how the activity ends or to know what the end result will be motivates the pupil to carry on with the activity. An example of such an activity is the 'subtraction magic'. Here the pupil picks any four-digit number, the digits all being different. He then rearranges the digits to make the largest possible number. Next, he makes the smallest possible number with the four digits and subtracts this from the largest number obtained earlier on. The digits in the difference are also rearranged to make the largest and smallest numbers possible, and the difference again found. This is repeated until the answer does not change. A calculator can be used for this activity. Try the activity and see if you will arrive at the final answer 6174.

Problem Solving with Calculators

A calculator is a useful aid for developing skill in problem solving. It offers a tool for pupils to use to explore, to test and eventually to formulate a solution to a problem. Problems can be of a purely mathematics nature and those that involve applications of mathematics. Both of these can be included in the Primary and Junior Secondary School mathematics curricula. With a calculator available to perform the computations, the pupil is freed from formidable calculations. The pupil is given time to think about what to try next and to reflect on what the output means. Furthermore, a wider range of strategies is possible. Also, the child is not limited to computing with simple numbers. Problems

involving decimals, non-integral quotients, and large numbers are more realistic and more easily processed with the aid of a calculator. Computational skill has no value in itself; it is important only as it is useful in solving problems. Provision for systematic attention to problem-solving processes in the classroom would significantly raise the level of mathematics instruction. The use of a calculator gives a better perspective to the purpose of mathematics instruction.

The following is an example that can provide pupils in the Junior Secondary School with problem-solving skills:

Given the digits 1, 2, 3, 4, 5, and 6, use all of these, each only once, to make two numbers that give the largest product. Suppose $56 \times 1234 = 69104$ is given by a pupil, the others are encouraged to find a larger product, if any. The problem can be extended for the digits 1, 2, 3, 4, 5, 6 and 8. (Johnson, 1984:103).

With each of these problems the teacher can motivate the children by recording on the chalkboard the 'best' answer 'so far'. The 'best' answer should be replaced by better answers, as they are found by individual children. Eventually the class should discuss why the 'best' answer is the best. This will involve a consideration to place value. Problem solving is not just a final answer. It includes the process and analysis that is involved in reaching the result. As Johnson (1984:104) pointed out, "for an activity to be truly problem-solving, it should involve some decision-making and a justification of its results".

References

- Ghana Education Service (1982) Mathematics Curriculum, for Primary Schools. Curriculum Research and Development Division. Accra: GES
- Ghana Education Service (1987) Mathematics Syllabus for Junior Secondary Schools. Curriculum Research and Development Division. Accra: GES
- Johnson, D. (1984) Informatics: Implications of Calculators and Computers for Primary-School mathematics. In Morris, R. (ed) Studies in Mathematics Education.

The Mathematical education of Primary School Teachers, Vol.3. UNESCO.

National Council of Supervisors of Mathematics (1978). Position Paper on Basic Skills. Mathematics Teacher 71, February, 1978.

William, E., and Shuard, H. (1982) Primary Mathematics Today. Third Edition for the Age of the Calculator. London: Longman.

Gender Differences in Mathematics Achievement in Primary Schools in Ghana

E. M. WILMOT

Faculty of Education, UCC, Cape Coast

Abstract

This paper examines the mathematics achievements of boys and girls in primary schools in Ghana using 450 pupils from five schools randomly selected from the Central Region. The pupils, selected from classes three, four, and six were tested on the areas of the mathematics syllabus they had commonly covered in their schools. The results of the study revealed a general poor performance by both sexes in each of the classes. Significant differences in achievement were observed in favour of boys in only P6. Suggestions have been made to improve the situation and for further research.

Introduction

The history of formal education in Ghana reveals a long-standing attempt at giving equal educational opportunities to boys and girls. Way back in 1843 when the Basel Missionaries, the pioneers of formal education in the country, opened the first boys schools at Akropong, they felt it was necessary to establish one for girls in 1847. By 1880, the Basel Mission had established 43 schools with 1200 pupils and girls to boys' ratio of 2:7 (McWilliams, 1969).

Since the various governments and non-governments organizations have put in place measures to improve the participation and retention of girls in our schools. For instance, in 1919 when Sir Gordon Guggisberg became Governor of the Gold Coast (now Ghana), apart from the fact the education became his priority, he felt strongly that female education was necessary for national development. He proclaimed, "nothing is more

detrimental to the progress of this race than the old system of educated husbands and illiterate wives" (McWilliams, 1969). It is therefore not surprising to find among his sixteen principles for education, provision made for secondary schools with educational standards for young men and women to enter university.

Mention can also be made of individuals like the late Dr. Kwegyir Aggrey who also advocated strongly for equal opportunity for girls in schools. The popular saying, "when you educate a many you educate an individual; but when you educate a woman you educate a nation", attributed to him attests to how important he viewed female education.

Now there is a Girls' Education Unit established at the Ghana Education Service (G.E.S) headquarters. Various scholarships schemes have been put in place for girls, documentaries on what the girl-child is capable of doing when given the same opportunity as her counterpart, and Science, Technology

Mathematics Connection Vol.2, 2001

and Mathematics Education (STME) clinics for girls are organized every year. The Ghanaian society now appears sufficiently convinced of the importance of girls' education. Attention now seems to be shifting towards addressing gender stereotyping in the choice of school subjects and careers.

However, since equal opportunity does not necessarily mean equal achievement, it is necessary to assess and compare the achievement for boys and girls in our schools and at the primary level in particular. This will provide information on the level of achievement and the needed actions to be taken for improvement.

Available literature shows a general poor achievement in mathematics in schools in many countries. There is a world-wide complaint of lack of basic computational skills needed to solve basic addition and subtraction problems by pupils. For instance, in reporting on the third (1982) National Assessment of Educational Progress (NAEP) in mathematics, Carpenter et al (1983) mentioned a general low performance by American students on the complex tasks and skills that require demonstration on the understanding of underlying mathematical principles. Comparing the results of the first and second NAEP in 1973 respectively, Carpenter et al (1980) observed a general decline in performance among the 17-years olds.

Mention can also be made of the problem of poor performance and lack of computational skills observed in England that led to the information of the Cockcroft committee in 1982 to evaluate the educational system and make recommendations (Cockcroft, 1982).

Several studies tend to agree that sex is a significant factor in mathematics performance, with males generally

performing better than females. For instance, in the United Kingdom, the Assessment of Performance Unit (APU) results revealed that at 11 years except on computation boys perform higher than girls in all content areas of mathematics. Even in the area of computation girls lose out to boys by age 15.

Fennema & Carpenter (1981) also reported a similar trend in America. They stated that the results of the NAEP indicated that while the achievement of boys is slightly higher at ages 9 and 13, the difference is wider at age 17. Maccoby and Jacklin (1975) have also found that males tend to perform better than females on tests of spatial visualization.

Becker et al (1990) also reported that gender differences in achievement were observed in five academic areas including mathematics problem solving. This study involved 3002 students (1642 of which were females and 1360 males) from grades 3 through 12. The results showed fairly consistent pattern of differences. It was revealed that males generally performed better at the upper percentile levels in mathematics problems solving and females perform better at the lower percentile levels in all content areas of academic subjects.

Hanna (1980) also reported difference in favour of boys in geometry and measurement by eight graders in Ontario. Significant differences in favor of boys were also recorded in omitted responses on all topics including arithmetic, algebra probability and statistics.

The situation in Ghana is no different. The 1992 report on the Criterion-Referenced Test (CRT) conducted and published by the Primary Education Programme (PREP) of the Ministry of Education is noteworthy in this respect. The report revealed that only 1.1 percent of the primary six pupils

tested achieved over 55 percent in mathematics. The problem is not limited to the primary schools alone. A good reflection of it is seen at the Junior Secondary School (JSS) and Senior Secondary School (SSS) levels. The chief examiner’s report on the Basic Education Certificate Examination (BECE) from 1992 to 1998 has stressed the poor performance in mathematics. These reports mention poor handling of mathematical operations among other things as the main problem of the pupils.

A similar pattern is observed at the SSS where Eshun (1999) observed a higher achievement of males than that of females in mathematics. Also, since 1991 various Chief Examiners’ report have also cited lack of basic computational skills in both the General Certificate Examination (GCE ‘O’ level) and Senior Secondary School Certificate Examination (SSSCE).

In terms of comparing the performance of boys and girls in mathematics at the primary level, not much has been done in Ghana. Rennie and Dunne (1994)

Methodology

The sample for the study consisted of 450 pupils in primary classes three, four, and six from five randomly selected primary schools in the Central Region of Ghana. From each of the selected schools fifteen each of boys and girls were randomly selected from each of the three classes. Thus in all, 150 pupils were selected from each of the P3, P4, and P6 classes. The selected pupils in each of the three classes were tested on the area of the mathematics syllabus they had commonly covered in their schools.

Results and Interpretations

The achievement of girls in each class for all the three schools were put together and those of boys also put together. Descriptive statistical indices for each sex were found. Table 1 shows the group statistics for each of the three classes. A cursory look at this table reveals that the mean score of the pupils in each class fell below 40%. This means that there is general low performance by both boys and girls in each of the three classes. The worse of it is that the mean score of the two

Table 1: Group Descriptive Statistics for all the classes

Class	P3		P4		P6	
	Boys	Girls	Boys	Girls	Boys	Girls
N	75	75	75	75	75	75
Mean	36.93	32.41	24.01	21.35	25.80	21.97
S.D	17.21	17.30	9.42	9.83	15.33	14.81

supported this when they quoted Strongquist (1989) and Walber (1991) that “most research on gender and education research have been undertaken in developed countries”. In this presentation, the trend of mathematics achievement of boys and girls in the primary school has been analyzed. The analyzed has been done at both the lower and upper primary levels. Suggestions have been made for improvement in pupils’ achievement in mathematics and for further research.

sexes in P3, the lower primary level, was: higher than those of the upper primary classes. It must however, be noted that the boys in each class performed slightly well, on the average, than their female counterparts. It is to find out whether these differences were significant or not that the ANOVA was conducted.

Performing One-way Analysis of Variance (ANOVA) on their scores at the 0.05 alpha level, research hypotheses of non-significant

difference in achievement between boys and girls in each of the three classes were tested. Table 2 shows the outcome of this analysis.

The outcome of this analysis shows that at the lower grade levels (i.e. P3 and P4) there were no significant difference in mathematics achievement between the boys and the their female counterparts (with $F < 3.84$ $p > 0.05$ in

The finding reveals the need for Ghana to conduct National Assessment periodically similar to the NAEP in America to evaluate the educational system in general and the level of mathematics achievement in particular. Though the criterion referenced tests (CRT) conducted by the Primary Education Programme (PREP) of the Ministry of Education

Table 2 Results of the One-way Analysis of Variance (ANOVA)

Grade	Sum of Squares	Df	Mean Square	F	P
Between Groups	763.73	1	763.73	2.57	0.111
Within Groups	44073.00	148	297.79		
Total	44836.73	149			
Between Groups	265.57	1	265.57	2.86	0.093
Within Groups	13716.65	148	92.68		
Total	13982.22	149			
Between Groups	1644.78	1	1644.78	7.24	0.007
Within Groups	101804.27	148	227.24		

both classes). However, in P6 there was a significant difference in mathematics achievement in favour of the boys ($F > 3.84$ and $p < 0.05$).

Discussions and Recommendations

The findings of this study as regards the low level of mathematics achievements of pupils in each of the three classes used have confirmed the findings of earlier studies (Carpenter et.al 1983; Becker et al, 1990).

This study has also shown that in Ghana, as the US and the United Kingdom, boys do not perform significantly better than girls do at the early stages. However, as they progress to higher grade levels differences start emerging in favour of boys (APU, 1985; Fennema & Carpenter 1981). The fact that pupils in P3 generally performed better than those the other classes means that pupils in our schools have the potential of performing lower with increasing grade level.

sought to do this, it is recommended that the scope be widened to cover all levels of the Educational system. This will help identify areas needing attention early enough for action to be taken.

The revelation in this study that the gender differences in mathematics achievement begins to widen significantly in favour of boys in the upper grade levels of the primary school points to the need to support and encourage the girls right from class one. It is recommended that teachers and parents make conscious efforts to sustain girls' interest in mathematics right from the primary school. There is the need, for instance for teachers to adopt gender sensitive approaches in the teaching of mathematics. In-service training Programme for teachers in this direction are recommended. Curriculum developers should also develop textbooks and other materials that are girl friendly to keep their interest in the subject.

Schools are encouraged to organize programmes that seek to change masculine image given to mathematics. The girl's education unit of the Ghana Education Service should organize mathematics clinics for girls even at the lower primary to prevent the gap from developing even at the level. This is because mathematics is a core subject for all students at the pre-tertiary level of Ghana's educational system. The continuing widening in performance has the potential of getting girls to lose interest in mathematics and further preventing them from choosing the mathematically related programmes, something that is detrimental to the country as a whole. It may even lead to many of the girls losing interest in education altogether.

Replication of this study is recommended to include the background of the pupils. This may help bring out factors that contribute to observed differences in the performance of boys and girls in mathematics.

References

Assessment of Performance Unit (1985). *A Review of Monitoring in Mathematics: 1978 to 1982* HMSO

Becker D. Forsyth, F. and Robert, A (1990). *Gender differences in Academic Achievement in Grades 3 through 12. A longitudinal analysis.* Paper Presented at the Annual Meeting of the American Educational Research Association Boston, MA April 16-20.

Carpenter, T. P. Corbit, M. K. Kepner, H. S. Jnr Linquist, M. M and Reys R. (1980). *Results of the Second NAEP Mathematics Assessment: Secondary School. Mathematics Teacher* 73 (5) 329-338.

Carpenter, T. P. Linguist M.M. Matthews, W. and Silver E.A. (1983). *Results of the Second NAEP Mathematics Assessment: Secondary School. Mathematics Teacher.* 76.(9), 652-659.

Crockcroft, W. H. (1982) *Mathematics Counts Reports of the Committee of Inquiry into the Teaching of Mathematics in Schools.* London; HMSO.

Eshun, B. A (1999). *The Pattern of Mathematical Achievement of Secondary School Students in Ghana: Journal of Science and Mathematics Education.* 2, (1), 22-33

Fennema, E and carpenter, T. P. (1981), *Sex-Related Differences in mathematics Results from the National Assessment Mathematics Teacher.* 74 (7) 554-559.

Hanna, G. (1980). *Sex Differences in Mathematics Achievement of Eighth Grades in Ontario. Journal for Research in Mathematics Education* 17 (3), 231 - 237.

Maccoby, E. and Jacklin C. (1975). *The Psychology of Sex Differences.* London Oxford University Press.

Mc William, H. O. A. (1969) *The Development of Education in Ghana* London: Longman Groups Limited.

The West African Examinations Council (1991-1998). *Chief Examiner's Report on the Basic Education Certificate Examination.* Accra WAEC.

The West African Examinations Council (1992-1998). *Chief Examiner's Report on the Basic Education Certificate Examination.* Accra WAEC.

The Use of Information Technology in Teacher Education

YIDANA, I & ASIEDU-ADDO S. K.

The main goals of any effective teacher education programme must address the need to relate the teacher's knowledge and performance to his responsibilities and equip the teacher with the appropriate subject knowledge within the context of its expected use. An effective and efficient teacher training programme therefore must judiciously marry the content and methodology into a harmonious package. Teaching as an art of impacting knowledge and skills has undergone various stages of development- oral, traditional, or informal form, formal school system, and distance education or correspondence system. At each phase the teacher has always felt the need to use certain aids (concrete, semi concrete and abstract materials) in the delivery of lessons. The electronic calculator and the computer are the latest candidates in the long list of teaching/learning tools in the school system. Before we continue with our discussion, let us pause to define a few of the terms or concepts that we need for our presentation.

- A **computer** is a programmable, multipurpose electronic machine that accepts data- raw facts and figures-, and processes, or manipulates it into information that is useful. The general purpose of a computer is to speed up problem solving and increase productivity.
- **Information** may be regarded as organized facts and figures. Information processing describes the use of computers in the handling of data and information.
- **Communications technology** consists of electromagnetic devices and systems for communicating over long distances. These may include

telephone, radio, television, satellite, and cable communications.

- **Connectivity** is the ability to connect computers and other information devices to each other by communications lines for the purpose of information processing and communications.
- **Online access** refers to access to databases, online services and networks, and electronic bulletin board systems through connectivity via modems or network to other computers.
- **Interactivity** refers to the ability to respond to and affect a computer or communications device. Connectivity, online access and interactivity together determine the trends in computer and communication technology.
- **Information Technology (IT)** refers to the technology associated with the handling of information- data processing, transmission and storage- by electronic means. A technology that is based on both computer and communications technologies is often referred to as **Information Communications Technology (ICT)**. It involves the application of computers and telecommunications to the collection, processing, storage and dissemination of voice, graphics, text, and numerical information
- **Multimedia** refers to communication from more than one media source that uses text, audio, graphics, animated graphics, and full-motion video.
- **Distance Learning** is the use of the computer and or audio/video networks

to teach courses to students outside the conventional classroom.

The theme of this presentation is the application of IT in teacher education. Information technology has mainly been construed to mean the use of computers in general for any purpose.

Information Technology in Education:

Our dependence on computers and communications technology and systems is phenomenal. The processing of data, transmission of information and storage of information in our society is being automated at various levels of complexity. The applications of computers and communications devices in education in supporting and managing the process of teaching and learning have been useful to the school administrators and classroom teachers. The proliferation of computer laboratories at all levels of the school system testifies the potency of the use of IT in education delivery. Despite the huge potential of IT in the efficient delivery of education in Africa, it is sad to observe that we neither have the requisite resources nor the technical expertise to tap the resource. There is therefore the need for the continent to restructure teacher education programmes to reflect the dictates of the information revolution. For us to fully benefit from ICT tools we should introduce educational computing in the teacher training curriculum. Such a new programme should include the following:

- Data processing tools
- Information transmission
- Information handling or management
- Modeling and computer simulation
- Exploratory and experimental learning
- Computer assisted instruction and programming
- Computer assisted learning
- Internet communications
- Social and educational implications of IT in the school system

Some of the administrative tasks that the computer can efficiently assist include

documentation, communication and storage of information, preparation of timetables and managing student and personnel records. These are routine uses of computers in the schools system. The new technology in teacher education should equip the teacher with the following expertise:

- Knowledge in the use of the relevant educational software packages and IT systems. This knowledge should be based on the understanding that every subject area in the curriculum has its specialised packages and that the maturity and past experiences of the learner also determine the choice of an appropriate software application.
- Ability to evaluate the impact of the use of IT on teaching and learning with the view to devising an effective and efficient ways of using IT resources to achieve learning and instructional objectives.
- In-dept knowledge of where in the curriculum the computer applications would be desirable and effective
- Appreciation of computers and their influence on social values

Influence of ICT on the School Curriculum:

The influence of the new technologies on the content and pedagogy of school subjects like Mathematics, Science, Social Studies, Business Studies, Language, Technical and Vocational subjects has generally been positive. The changes in the curriculum have been necessitated by the fact that there is an on-going inter-relationship between technology and education. This is seen in the fact that:

- Some aspects of the curriculum should be de-emphasized because the new technology replaces them
- Some aspects of the curriculum are increasing important and therefore must be emphasized because the new technology requires them
- Some aspects of the curriculum are increasingly becoming possible

because the new technology allows them.

This inter-relationship is more pronounced in the realms of Science, Mathematics, Social Studies, Business and Commercial subjects, and Technology-based subjects. Another factor worth considering is the fact that the school curriculum is demand-driven. Thus the desire to make education responsive to the demands of workplaces or job markets should reflect in the new curriculum. Making education more relevant, environment-based and interactive in its mode of delivery demands a new type of teacher who is better equipped to face the challenges of the Information Revolution. A technologically literate society requires that teacher education should include both pre-service and in-service exposure of the teacher to IT applications and their effective uses. An effective teacher education programme should therefore take cognizance of these developments if education is to benefit from the immense potentials of IT.

Applications of IT:

The use of IT in teacher education has an over all objective of making the teacher deliver his/her lesson more efficiently and effectively. The pedagogical basis of the use of IT in teacher education includes the following:

- The preparation of the future worker to face the real world where computers are used in every day life
- Equip the teacher with the effective means to offer a wide variety of learning experiences
- Equip the teacher with an effective means to design relevant individual and group activities and programmes for the achievement of learning and instructional objectives
- Train the teacher in a way that would empower him/her to whip up and sustain the interest and enthusiasm of the learner in the various subjects areas to ensure success in school
- Provision of an effective means to encourage independent learning habits of the learner

- Produce a teacher who is motivated enough to undertake life-long learning habits, and possesses a sustained quest for knowledge

The Information Technology Revolution as an all-pervasive phenomenon has not only called for the restructuring of the school curriculum, but also it demands that we change the old ways of doing our teaching. A wide range of educational computer software in all school subjects abound in the electronic market that assist all categories of teachers to carry out a variety of teaching/learning tasks. We shall look at some of the IT applications in what now follows.

(a) Use of Word Processing and Desktop Publishing Packages:

These categories of computer software applications are used for the preparation of teaching and learning materials. The flexibility of the word processor allows such materials to be edited to suite the various learning abilities of learners and changing needs of the curriculum. Where connectivity is available such materials could be placed online for students to access during their leisure periods. Through such media, tutorials and assignments may be made available online. Desktop publishing with its graphics tools adds colour and figures to such teaching materials. Teachers can also use these packages to design worksheets, assignment sheets, student report sheets, and timetables. Some of the application programs in this category include Microsoft Word, Word Perfect, Microsoft Publisher, Harvard Graphics, and CorelDraw. There are many other *specialised teacher utility programs* that directly carry out specific teaching/learning tasks. Hard copies of such materials may be obtained through output devices such as printers.

(b) Use of Spreadsheets and Databases:

An important area of school administration involves the management of large volumes of information on both personnel and students. Inventory and payrolls in educational institutions are now automated. Also teachers have the tedious task of continuously processing assessment records of students, particularly in an era of

Mathematics Connection Vol.2, 2001

the so-called continuous assessment of learners. Spreadsheets tools have come as a handy tool for the processing of such data, while databases packages form an indispensable basis of information bank for the entire school records. Students' transcripts and other important documents are easily prepared from such databases. Microsoft Office that contains Excel and Access as typical Spreadsheet and Database software can be purchased for teachers in the school system

(c) Use of Graphics:

Graphics applications come in two main categories, namely analytical and presentation graphics. Analytical graphics are forms that make numeric data easier to analyse than when it is in the form of rows and columns as in a spreadsheet. These have positive influence on the presentation of facts and figures through bar charts, line graphs and pie charts. These tools are mostly used in Science, Mathematics, Social Studies, Business Studies, and Environmental Studies. Presentation graphics on the other hand are used to communicate or make presentation of data to other users. A presentation may make use of analytical graphics, but these may look more sophisticated. The combination of both text and graphics makes a presentation more appealing. Power Point tools are very helpful in this respect There are also certain advanced graphics packages such as computer aided design (CAD) that are used by teachers of Fine Arts, Vocational and Technical subjects. These allow three-dimensional presentations and object animation on screen so that the various views of objects can be displayed.

(d) The Use of Modeling and Computer Simulations:

One of the important innovations in the teaching profession is the emphasis we now put on modeling. Computer-based simulations have made this very possible and easier. In mathematics and science as well as in other related subjects modeling is the most important step towards the solution of real-life problems. This involves the extraction of relevant data and devising an appropriate algorithm to solve a given

problem. Sometimes this process may not be easy, but through computer experimentation and other exploratory learning tools the task can be made easier. The use of digital cameras offers the classroom teacher an opportunity to mimic real life situations in the classroom. This makes class discussions more realistic and enjoyable, because three-dimensional presentations are always better understood than the two-dimensional illustrations on chalkboards. The teacher may also use the tools of computer simulation to teach students how to collect and display data. For instance, the chemistry teacher may use computer-based simulations as substitutes for lab work. The use of computer-based simulations in any form of training is less dangerous, less expensive, and less time consuming than the real experiences.

(e) The Use of Interactive CD-ROM Instruction and Learning Packages:

These are computer software applications that are prepared by experts in the various school subjects. These contain interactive instruction and learning materials that can be used in the classroom setup. They range from pre-school material to tertiary level courses. Computer assisted instruction and learning packages allow such interactive learning environment so that each learner may progress at his/her own pace. Such packages offer relevant subject materials, tutorials, and assessment modules that supplement the direct instructor-learner discourse in the traditional seatwork. Students receive immediate feedback from the computer, which controls the sequencing of the subject matter. This has the potential for identifying and meeting the individual learner's needs, the knowledge of which may guide the instructor to take the appropriate remedial measures.

(f) The Use of Multimedia Classrooms and Connectivity:

Multimedia facilities and connectivity could be used to create the opportunity for a wide variety of learning experiences. It is expected that the advent of the information superhighway would make it possible for "Virtual" classrooms and Distance Learning

to replace lecture halls and scheduled class times. Wide area networks and Internet connectivity would be a boost to teacher education through remote sites. Students from the remote sites could access library and online academic materials. The radio lecture currently being experimented with at UCEW proves that with large classes such media are effective tools for the delivery of education. With the increasing pressure on the limited facilities of the conventional school system, this possibility offers a real solution to policy makers and school administrators. Through the use of multimedia programs, workstations, and television teacher education could be carried out at remote sites. This particular endeavour may require a substantial investment by central governments that are reluctant to embrace the new technologies in education. But these are viable options that no developing nation can afford to ignore. What other options do we have, if we in Africa aspire to be active players in the world economy that is increasingly becoming information technology dependent?

(g) The Use of Computer Programming Languages:

The user-made computer software could also be used to solve real-life problems on the computer. The sequence of instructions that tell the computer how to process input data in order to solve a given problem is

referred to as a Program. In this context the user communicates with the computer through a programming language. The classroom teacher could use this tool to teach students how to obtain programmed solutions to self-made problems. Through conversational programming, the classroom teacher could generate multiple-choice and objective tests for the assessment of his/her students. The Mathematics Department of UCEW is currently experimenting with this approach in its computer-programming course.

Conclusion:

The interactive use of the computer in the classroom would allow teachers to assume the role of facilitators, designing learning experiences and individualizing instruction. The learner in this context would be subjected to less drill and practice but more problem solving and real, meaningful learning activities. An IT literate teacher would therefore be in a position to inspire, motivate and excite the learner about the remarkable tools of the computer for learning any subject in the school curriculum. We therefore have to make the necessary efforts to incorporate IT education in all teacher education programmes. The computer is here with us and we just cannot ignore it.

The Scientific Calculator as a Tool for Mathematics Teaching and Learning.

By

M. J. NABIE, & I. YIDANA

Department of Mathematics Education, U. C. E. W. Winneba

Introduction

From the early beginning of the study of mathematics, mathematicians and mathematics educators have sort to find means and ways of making computations and mathematical understanding easy for its learners. As an abstract subject involving the manipulation of complex symbols and solving complex problems, mathematicians try as much as

possible to develop devices that will ease problem solving procedures as well as simplify and speed up the calculations involved. Some of these devices include the counting board developed about 5000 years ago, Stern's apparatus developed in 1953 by Stern, the Dienes Multi-base Arithmetic Blocks developed by Zoltan Dienes in 1960, , the Napier rods and logarithms developed by John Napier in the 16th century, the cuisenaire rods

just to mention a few. These materials aim at providing learners an insight into number relationships and structure. The Napier logarithms provided the mathematical theory underlying the slide rule and the four-figure mathematical tables, which were widely used as calculation aids. Majority of the earlier devices has given way in the advent of modern technology. In fact many of us hear or read about the earlier calculating devices but have might have never seen them let alone experiencing their mode of operation.

Recent developments in modern technology have made available to mathematics teachers a variety of media and technologies that can have real value in improving instructional quality, learning outcomes and vibrant learning environments. These materials and devices are of many types and are very essential tools for effective mathematics instruction. One of these devices is the scientific calculator.

The scientific calculators are with us in different models and are in the possession of many learners in schools. Even though learners have these devices and use them for doing their class exercises and other calculations, there is no official policy in the country regarding their use in schools. In particular, the West African Examinations Council (WAEC) does not approve their use in its Basic school examinations. However, children who know the power of the calculator often defy the rule and use calculators during examinations without apprehension. This suggests that some school favours their use and that children are realising the importance of the calculator as a learning aid. It is, therefore, essential as mathematics teachers that we acquaint ourselves with these devices to enable us help learners to explore their power to the fullest.

Even though it essential for teachers to familiarise themselves with the use of the calculator as a powerful teaching-learning aid in mathematics and science, it seems the awareness is not created in this part of the world to ensure that student-teachers are given the opportunity to experience the use of calculators for instruction. In other words teacher education programmes in Ghana are devoid of courses in calculator

technology that will equip student teachers with the necessary experiences for effective classroom teaching and learning after graduation. This paper, therefore, attempts to create the awareness of teacher educators on the need to incorporate calculator technology in teacher education programmes in Ghana. It will also afford student teachers the opportunity to see the scientific calculator as an instructional aid as well as re-orientate their minds towards calculators in mathematics education.

Rationale for Calculator Technology in Mathematics Teaching and Learning

Today the application of technology is very intensive in industry, business, home and various sectors of the entire community. Consequently, children and students are growing up in a technologically oriented environment. They are constantly in touch with various assorted brands of electronic learning media. So a person nurtured in such a technological environment will indeed be a stranger in the learning environment if the environment lacks similar technologies (Tipling et al, 1989: 13). How will teachers feel if they discover that their children know more about calculators than they do?

Before calculators came to be accepted for use in schools in the Western world there was the fear that when pupils use these devices at an early age, they will neither acquire fluency in computation nor confidence in the recall of facts. This is particularly so for those who have not yet mastered the usual pencil and paper methods of computations. Another concern was the cost of calculators. However, research studies in the United States of America whereby the computational performance of users and non-users of calculators were compared, indicated improvements in attitudes towards mathematics, computation skills, understanding and in problem-solving among those who used calculators. Other studies showed no significant difference between these two categories of learners. Results of these studies more than enough convinced the Cockroft (1982) to conclude that all evidence on the use of calculators has no adverse effect on basic

computational ability and that “the availability of a calculator in no way reduces the need for mathematical understanding” (para. 377 & 378). Considering this, the committee suggested the use of calculators for investigations starting from the primary years. This means that calculators pose no greater danger to classroom mathematics instructions at all levels. What teachers only have to do is to ensure a concurrent development of appropriate pencil and paper skills alongside the calculator usage.

One of the aims of teaching mathematics is to prepare children for life. We are now in a high technological environment. To enable children cope with the technological race they should be prepared to cope with the emerging scientific materials. This means that we should make children aware and familiar with how calculators’ work to enable them fit well in the calculator world.

Some scientific calculators can do programming work. Providing children experiences on programming gives them confidence in their ability to write programs and thus laying a foundation for computer programming. This means that, besides enhancing children’s computational skills and comprehension of subject matter, calculator work also widens their scope of vocations.

The belief that mathematics is a way of thinking such that it cannot be transmitted is the main idea behind constructivism in recent pedagogical practice, which states “each individual must construct his or her own mathematical knowledge or reconstruct it in appropriate didactical situations,” (Bergeron and Herscovics, 1990: 31). Transmission learning often achieves limited success, and the severity of the limitations may not be discovered until much later, or may even never be discovered (Orton, 1992:163). Consequently, contemporary classroom instructional practice encourages the construction of understanding from activity and interactions with the environment. In this regard, self-learning, discussions and investigation methods are favoured. Also, it is widely known that practice makes perfect. As a result, mathematics teachers engage children in doing various problems

or sums to develop their computational skills. Some of these problems may be tedious and time consuming. The calculators as a learning tool will enable learners put the ideals of constructivism into practice, discover, practice, and work faster.

An aid that facilitates the learning of mathematics also facilitates the learning of other related subjects like Physics, Chemistry, Geography, and others that use mathematics. These subjects involve a lot of complex computations that can easily be solved using the calculator. Hence, the calculator facilitates learning in different fields. If we wish to promote self-learning, classroom discussions, development of children’s competencies in computational skills, in mathematics and its related subjects then the calculator is good aid as it has the power to put children in these domains of learning.

A child has to memorise a lot of facts and rules and retrieve them accurately to do mathematical computations. Using calculators save children the agony of having to memorise a lot of facts and rules, which often lead to memory load and half-remembered rules, or facts when required.

In the mathematics classroom monotony of a method can be boring to learners. Consequently, mathematics teachers are always searching for better ways of generating and sustaining children’s interest in the classroom. The use of the calculator will add to the number of instructional methods as well as generate learners’ interest through calculator explorations or investigations. They provide immediate feedback that also motivates the learner.

The discussion above amply demonstrates that the scientific calculator is a very useful tool in the mathematics classroom. The uses can be re-classified into two categories: those specific to the learner and those specific to the teacher.

Uses of the calculator specific to the learner

If instructional time is properly managed to provide children the opportunity to use

Mathematics Connection Vol.2, 2001

scientific calculators in their learning process, it will enable them to:

- practice basic skills repeatedly;
- do investigations through which they generate patterns, explore mathematical properties, as well as make and test hypothesis;
- extend skills;
- solve problems faster with little effort;
- organise, interpret and present information;
- discuss their answers;
- use mathematics in real situations and in other subjects;

In addition, the calculator

- facilitates children's understanding and concept development;
- reduce the complexity of certain mathematical concepts which children often find difficult to understand. This is particularly so for decimals, integers, and others;
- motivate learners, encourage curiosity, independence and develop and sustain positive attitudes towards learning mathematics;
- encourage discovery, exploration and creativity;
- reduce memory load and provide immediate feedback;
- do complex computations.
- remove drudgery, save time on tedious calculations.
- work is practical, convenient and efficient and less frustrating, especially for low achievers.

Uses of the calculator specific to the teacher

There seems to be a misconception among teachers that only the learners benefit from the use of teaching aids. Using the material as a teaching aid alone is the greatest benefit to the teacher. The teacher can effectively use the calculator as a teaching aid. For example, a number can be entered

in the calculator and the children asked to perform a single operation that will change the displayed number to certain desired numbers such as 408 to 4.08 or 0.00408 or 40800 and so on. This activity is to reinforce children's understanding of place-value. The area of difficulty of a child who is unable to perform the required operation can easily be determined and remedied. Hence, the calculator can help the teacher diagnose and remedy the children's learning difficulties in specific concepts and skills.

Used as a teaching aid, the calculators facilitate the teacher's work and save time and energy. Instead of talking all the time the teacher simply gives instructions that enable the children to work on their own.

Teachers are expected to mark children's exercise and give them feedback to enable them know their progress. However, marking exercises is a major problem in our large classes. Using the calculator will relieve the teacher of this burden as this device can provide learners with the feedback required to have a fair idea about their progress.

Limitations of the calculator

The numerous advantages of the calculator do not mean that there is no problem with its use as a teaching learning aid. There are a few limitations of the calculator. In using the calculator, it is easy to make mistakes undetected particularly when the calculator is faulty or when you are in the wrong mode without notice. To err is human goes the adage. So mistakes could also arise from faulty operations especially with those calculators whose operations are not displayed.

The calculator also has a finite size of number it can take. It operates within a finite range and so cannot function outside its range. For example SHARP model number EL-506P can take 2^{332} but the number like 2^{333} is displayed as error indicating that the largest number it can accommodate is 2^{332} . Also the smallest number it can accept is about 2^{-328} so that 2^{-329} is displayed as 0. Any number smaller than the smallest number this machine can take triggers off an error called 'under-flow'

and such numbers are usually set to zero (0). On the other hand, a number greater than the acceptable number give rise to 'over-flow' error. This type of error is assumed so great that the calculator terminates execution or indicates 'E' signifying error.

One other limitation of the use of calculators for instructions is related to proliferation of various types of calculators in the market. Currently, there are more than ten varieties of scientific calculators and the approach that might work in one may not work in the other. Consequently if a 'standard model' is not chosen, there may be difficulties in developing a uniform curriculum for calculator instructions in schools.

Finally, all computations in the scientific calculator are in floating point arithmetic. Usually the operation is in a binary mode. All computations in the calculator are done in this mode.

How can we ensure calculator instructions and sustain their use in schools?

'How will schools procure calculators for instructional purposes?'. How many calculators can the schools procure? Do we have the finances to procure, and provide facilities to maintain them? These and others are typical questions a concerned teacher would wish to ask especially in our large classrooms and where some teachers may sacrifice professionalism for social or material gains.

The use of calculators in the classroom for instruction will be something new to the Ghanaian. And of course every innovation is not accepted on a silver platter. Innovations pose challenges, which are seldom accepted without resignation. An innovation, however, can be easily accepted if the people involved are made to see the need for the innovation.

Currently, calculators are not officially accepted for instructions or learning tools in our basic schools yet many students have their own scientific calculators for their private use. This suggests that both learners and parents are becoming increasingly aware of the use of calculators

in the learning process. So the job of securing these devices is almost done. Scientific calculators are quite cheap for most parents to afford buying one. What is left to be done is for schools to secure few calculators of the various brands, set up a calculator room and use them in such a way that children are motivated to buy their own.

Calculator technology can be sustained if the calculators are properly managed and teachers knowledgeable in their use. In this regard we suggest that mathematics teachers in schools should be trained on the use and management of calculators through workshops/ seminars of this nature.

Conclusion

In conclusion, the scientific calculator is a powerful resource for direct and stimulated experiences. It is multidiscipline (used across subject boundaries) and benefits both the learner and the teacher. We therefore suggest that G. E. S. and teacher education institutions should have a second look at the issue of using calculators as teaching learning tools in our classrooms. Calculator technology should be an integral part of teacher education programmes. By incorporating calculator technology in the curriculum we are moving towards taking into account the needs, skills and sensitivities of our learners and society. Teachers should be encouraged to develop organisational strategies to enable children have time to have experience on the use calculators because they contribute significantly to the intellectual development of the child.

References

- Bergeron, J. C. & Herscovics, N. (1990) Psychological aspects of learning early arithmetic. *Mathematics and Cognition. ICMI Study Series* (P. Neshier & J. Kilpatrick eds.) Cambridge: Cambridge Univ. Press.
- Cockcroft, W. H. (1982) *Mathematics Count*. London: HMSO
- Orton, A (1992) *Learning Mathematics. Issues, Theory and Classroom Practice* (2 ed.). London: Cassell

How about a Career with Mathematics?

ADAJAJSA, F.

Sandema Secondary Technical School, Sandema

Introduction

It has been the wish of Mathematics teachers to inform pupils, students and the general public of the mathematics related careers. The topic "How about a Career in Mathematics" was in the print media some twenty five years ago".

I feel by now the material has gathered enough dust in the archives, hence the need to bring it up for the benefit of the reading public that might not have had the chance to see nor read it.

I am by this article urging students and any other person wishing to use mathematics to do business to read it and make a career with mathematics. Below are the mathematics-oriented careers discussed for the attention and consumption of interested persons.

Teaching

One of the unavoidable subjects in the school curriculum is that of mathematics. It is not enough for one to say that he or she is a mathematics teacher if the person is not mathematically inclined. It is academically dangerous for a mathematics teacher to instruct his/her pupil/students that:

- (i) $3^2 = 3 \times 2 = 6$ instead of $3^2 = 3 \times 3 = 9$
- (ii) $a^0 = 0$ instead of $a^0 = 1$
- (iii) $0 - 5$ is not possible instead of $0 - 5 = -5$
- (iv) $\frac{2}{0} = 0$ instead of $\frac{2}{0} = \infty$
- (v) the set of prime numbers [1, 3, 5, 7, 9, ...] instead of [2, 3, 5, 7, 11...]

The above examples illustrate how poisonous mathematics teaching can be if the teacher himself or herself is not well grounded in mathematical knowledge. A primary school teacher who teaches his pupil how to count is equally important as the university don who takes his students through a lesson in Numerical Analysis.

This goes to buttress the fact that all levels of mathematics teaching are equally important for a successful mathematics scholar. It is therefore imperative for all those in the teaching career to use mathematics to demonstrate the place of mathematics in the curriculum.

Research Worker

There has been an unusually rapid increase in the use of advanced mathematics techniques and concepts in economics psychology, sociology, political science, history, business management, medical research to mention but few. It is therefore not coincidental that a journal of mathematical psychology and management science serve a lot of the new group of applied mathematicians.

Typical issues involving the use of advanced mathematics are those of economic systems learning theory in psychology, inventory control and production scheduling in business management.

The demand for the use of advanced mathematics is even higher for students interested in researching into cell growth and the spread of diseases in biology as well as population data handling.

Electronic Data Programming (EDP)

Programming is one of the careers demanding mathematical knowledge. The Electronic Data Processing (EDP) is one of such careers. The programmer determines

Mathematics Connection Vol.2, 2001

the steps required in the solution of a problem. The programmer gives instructions in machine language to convert the problem into directions that the computer can follow. All these steps and instructional procedure require a good mathematical background.

Actuary

The work of the actuary is little known by most people. The actuary is a social mathematician. He uses his mathematical ability on behalf of the people in his community. He specializes in statistics related to the lives of people. From this information he determines the probability of the living or dying at each age. He can also predict the probability of a person or group of persons becoming disabled, hospitalized or becoming unemployed.

The actuary uses his knowledge to develop insurance plans that may keep the family in or against financial eventualities. Protection against financial disaster, which might follow accident or fire destruction require some skill of an actuary.

Mathematicians who hitherto were unaware of the profession can avail themselves of the profession by becoming actuaries.

Engineering

Mathematics as you know is the basic tool of the engineer. As you might consider becoming an aeronaut, civil, chemical, mechanical, sanitary engineer, the study and application of mathematics is unavoidable and most appropriate.

Accounting

Accountancy as a career should be most accessible to most people with adequate mathematical background beyond the senior secondary school level provided they are attracted to the profession. There has been an interesting demand for accountants by firms, corporations and institutions and therefore mathematicians should rise to the challenge to fill the vacancies, but enroll for the professional courses in accounting.

Statistics

Statistics provides an aid in physical and biological sciences, economics, sociology, psychology, agriculture, communication and industry. For example, the astronomer predicts future positions of the heavenly bodies, the pharmacist determines the potency of drugs, and a meteorologist predicts the weather conditions. Furthermore, an electrician determines the power supply; agriculturist is interested in establishing the relationship between inputs and output. The data used by these professions have mathematics as their basic tool.

Computing

The mere mention of a computer is quite satisfying. A lot of people to be associated with the computer, but the secret key to grasping computer language and concepts are mathematics. The progress of the developed world is based on the advances they have chalked in the use of the computer. Young children should be given early computer training so that they can grow up with it and apply it in life for their own progress and development of society.

It may not be too far when appointments to senior ranks and offices would demand a knowledge of the use of the computer.

Mathematics lessons should be taken seriously at the primary, junior and senior secondary school levels to sharpen the abilities of children to understand the use of computers. The use of electronic mathematical machines such as calculators are already training children towards the use of computers.

PLANNING

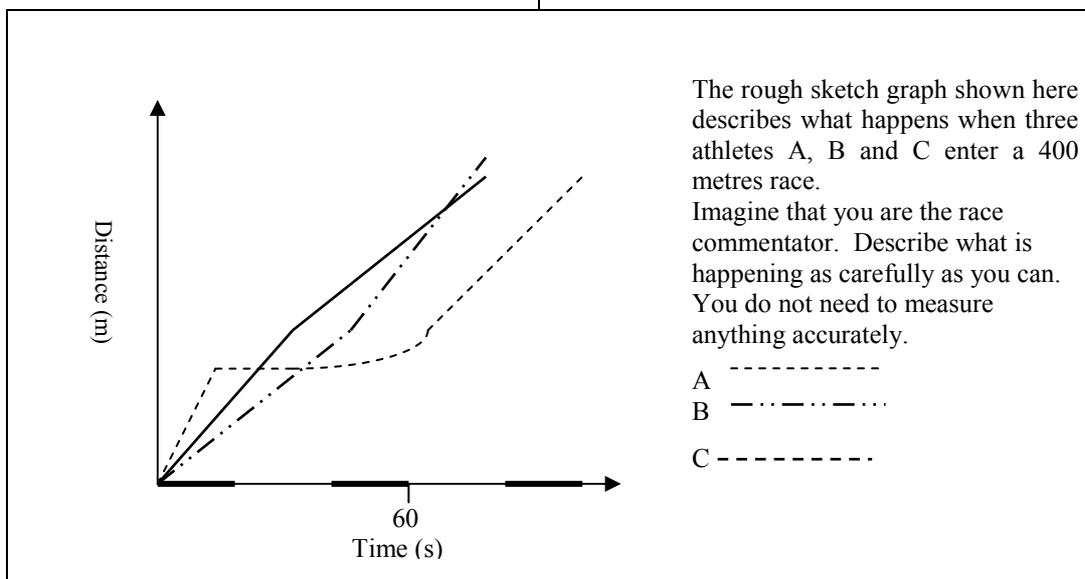
National, regional and district planning officers day in day out use mathematics in their routine duties of planning. The proportional distribution of facilities to communities is made easy by the application of mathematics. Social amenities such as schools, hospitals, roads, water systems and electricity are shared equally by the use of mathematical knowledge.

CONCLUSION

The careers under the domain of mathematics cannot be exhausted in this write-up. But it is my hope that if educational career counselors can expose their students to the benefits of studying

mathematics in relation to the above careers discussed.

MATHEMATICS WILL TAKE ITS RIGHTFUL PLACE IN THE SCHOOL CURRICULUM



MARKING SCHEME

- 1 mark** for each of the following:
 C takes the lead; C stops running; B takes over A;
 B wins.
- 2 marks** for any four of the following:
 A and B pass C; C starts running again; C runs at a slower pace; A slows down (or B speeds up); A finishes second (or C finishes last);
- Part mark:** give 1 mark if any two (or three) of the above points are mentioned.
- 2 marks** For a lively commentary.

The figure in the top box shows a specimen examination question. The box beneath it contains the marking scheme for the question. The third box below shows the answer given by a student.

Here at the start of the race, the three athletes are ready to start there off. Athlete C takes an early lead. Athlete A is clear in second and athlete B is in the rear after a bad start. They are approaching the 100m mark it is still C leading from A and B is catching up. Oh no C has fell. He's getting up and chasing A and B. At half way, A has a small lead but B is gradually catching him and it looks like C hasn't much chance of winning. They're now in their 100m A and B are neck to neck, C has just passed halfway. Athlete A crosses the line first B is only just behind him. C is about 100m out, I think C might have won if he didn't fall.

- (a) Use the marking scheme to **mark** the student's answer and state the total mark you gave the student.
- (b) Briefly explain why you awarded each mark.

REPORT ON THE 27TH BIENNIAL NATIONAL CONFERENCE/WORKSHOP

Report on the 27th Biennial National Conference/Workshop & 40th Anniversary Celebration of the Mathematics Association of Ghana (MAG) held at the Commonwealth Hall, Legon
From Monday 28th August to Thursday 31st August 2002

Arrival, Monday, 28th August 2000

Members started arriving at the venue in the early hours of the morning but could not be assigned to their various rooms since another group, which occupied the rooms, was still parking off. This kept members who arrived early up to about 10 or 11 am before they got keys to their rooms. Registration and other formalities for accommodation etc, continued through lunch/suppertime and late in the night. There was no formal activity however, council members met to finalize arrangements for the success of the conference/Workshop and the 40th Anniversary celebration

Accommodation

Members were comfortably accommodated in Block G & H of the commonwealth Hall. Each executive members had a room to himself while other members were paired up in twos and three etc. According to the convenience the rooms could offer.

Attendance

The attendance was good, in all 264

attended as indicated in the table below.

Opening Ceremony, Tuesday 29th August 200

The ceremony began with an opening prayer by Mr. I.A. Ahinful the National Organising Secretary at 9.45 am. The Chairman for the ceremony Mr. J.F. K Appiah Cobbold had been introduced to participants and invited guests by Mr. S. A. Gyimah. In his acceptance remarks, he made mention of his joy due to the presence of the Vice President of the Republic of Ghana, Prof John E. Atta Mills during the 40th Anniversary celebration of the mathematical association of Ghana (MAG).

Welcome Address

In his welcome address, Prof. Kofi Asamani, the Dean of Science faculty, University of Ghana, made mention of the following.

- (i) that the theme was very appropriate for the celebration.
- (ii) That the falling in number of

Region	Male	Female	Quiz Contestants	Total
Upper East	14	-	3	17
Upper West	2	-	-	2
Ashanti	36	7	3	46
Northern	16	3	3	22
Brong Ahafo	20	1	3	24
Volta	28	4	3	35
Greater Accra	15	7	3	25
Western Region	7	-	2	9
Eastern Region	11	3	3	17
Central Region	24	1	3	28
National Executive	7	-	-	7
Local Planning Committee	4	2	-	6
Other Council Members	8	-	-	8
Resource Persons	16	2	-	18
Total	208	30	26	264

mathematics lectures in the universities that maths lectures are now becoming “endangered species”, hence MAG should do something to rectify the situation.

- (iii) Mounting in-service trainings and workshops for teachers, so as not to let the subject die.
- (iv) The production of journals and magazines to entice children to enjoy mathematics, since the problem starts from the basic level.
- (v) That mathematics should not be seen as only a supporting subject, rather an entity on its own.

The opening ceremony which was graced by the Vice President of the Republic of Ghana, his Excellency Professor John Evans Atta Mills who was invited as the special Guest of Honour. The Director General of the Ghana Education Service Prof. Christopher Akumfi-Ameyaw, the vice Chancellor of the University of Ghana, Legon. Prof. Ivan Addae-Mensah, and the Minister of Education hon. Mr. Ekow Spio-Garbah, who were invited and could not attend, were duly represented.

In his welcome address, the Vice Chancellor compared the presence of the expatriate maths and science teachers during his school going age to the situation at the moment. He said, many Ghanaians developed keen interest in mathematics to the extent that very brilliant students from A-level opted to read mathematics at the University instead of engineering for example. Ghana becomes blessed with indigenous mathematics and science teachers especially at the secondary level. We even had enough to export to sister African countries the Universities were also endowed with qualified Ghanaian staff and all seemed to be well”.

He later lamented on the gloomy situation of mathematics teachers in our present Universities. He said the University of Ghana has only six serving mathematics lecturers out of which four are expatriates. The remaining two are professors who are on retirement contracts. In all there were 26 lecturers. He further said that the situation at UCC was no better. This situation of over loading emphasized has

left the lecturers ‘virtually no time to write books for the enhancement and advancement of mathematics”. The end result was that “We are not producing mathematics lecturers at the University level”. He therefore declared mathematics lecturers as being endangered species’ and needed special protection from the United Nations. He finally urged the MAG to find solutions to the problems and reintroduce mathematics journals.

Address by Dr. Ben A. Eshun

The welcome address was followed with an address by the President of the Association, Dr. Ben A. Eshun. In his address he expressed the Association’s gratitude to the Vice President, his Excellency Prof. J. A. Atta Mills for accepting our invitation and gracing the opening event of the celebration with his very presence in view of his tight schedule. He further extended the same welcome the Minister of Education, the Director General of the Ghana Education Service, the Vice Chancellor of the University of Ghana, Legon and all who honoured our invitation with their physical presence.

He also highlighted on the background of the Association from start to 40 years in April 2000. He later gave details of passes in SSSCE by boys and girls to prove an upward trend in Mathematics education in our schools. Copies of this address were circulated.

Copies of the Hon Minister address with advised maths teachers to concentrate more on the classroom teaching than turning their garages into part time classroom were also circulated. Copies of the keynote address by his Excellency the Vice President are also on circulation. The whole ceremony ended successfully with refreshment.

Opening Address

Mr Frank Braimah, who deputized for the Minister of Education, Hon Ekow Spio Garbah started by congratulating MAG for the meritorious work being done to promote the teaching and learning of maths in the country and promised the continued support from the state.

He stressed that for mathematics to come out of the bad situation in which it is these days; the training colleges should be looked at again.

Mr. Braimah continued by mentioning the following as some of the problems.

- (i) that children (pupils/students) do not know the goals of mathematics, thus treat the subject as a foreign entity.
- (ii) The teachers in the 2nd cycle institutions do not use the normal teaching hours effectively, they rather create private schools for themselves for money.
- (iii) That some teachers rely on pamphlets that they write instead of using the textbooks provided for use.
- (iv) That abstract/foreign examples instead of bring the subject down to everyday life situations.

He concluded by appealing to participants not to see themselves as only participants to this 40th anniversary celebration, rather as delegates from their various schools, and that, they should share all that have been learnt at the workshops with their friends back in the regional workshops. He finally declared the workshop officially opened.

Keynote Address

The special guest of honour, the Vice President of the Republic of Ghana, Prof. John E. Atta Mills started with praised for the importance of mathematics in everyday activity, saying mathematics impacts mental precision not to calculate sums only. He commented on the media, playing on the minds of some Ghanaians by using mathematical “tricks” to baffle them that VAT (Value Added Tax) had been increased by 25%.

He also commented on the theme of the anniversary and lamented on the shortage of mathematics teachers and lecturers in the country. He made mention of the Science, Technology and mathematics (STME) programme as a way the government of Ghana is bringing the problem to a halt.

The Vice President congratulated the writing committee for their effort in writing the new textbooks for the primary, JSS and SSS levels. In conclusion, he advised the participants to vote wisely in the fourth coming presidential and parliamentary elections.

President's Address

The president of the Association (MAG) Dr. B. A. Eshun in his address wished the Vice President of the nation a success in his campaigning task to take over the presidential position in the coming election. He recounted on the achievements of MAG examples of which are the JSP Mathematics series and the recent maths textbooks

He also made mention of the fact that the rate of passes in SSSCE (WAEC) has increased over the years using figures to support his findings, and that the percentage increase in the passes for girls at all levels is more than that with the boys. For failure rate, he said more than 50% are in this category. Finally, he touched on the in availability of appropriate teaching and learning materials in the system and appealed to the government to come to the aid of mathematics ' fate as a matter of emergency. He concluded by wishing MAG a happy 40th Anniversary.

Chairman's Remarks

The chairman congratulated the Vice President; Prof. John Atta Mills for honouring the invitation and all the other invited guests. He promised on behalf of MAG and on his own behalf that the package put in place by government to motivate the teachers in the remote areas would be supported in various ways in MAG to enhance the teaching and learning of mathematics in the country.

The vote of thanks was given by the national MAG treasurer, Mrs Adwoa Nkrumah. The opening ceremony come to an end at 10.45 a.m.

WORKSHOP/CONFERENCE PRESENTATIONS AND DISCUSSIONS

Participants were taken through a number of workshop/conference presentations and discussions in the afternoon of the first day and throughout the second day. The presentations and discussions were done in the following group sessions - primary methods, primary/JSS methods, JSS methods, SSS methods and the research group. The lecture halls of the Mathematics Department of the university were used. The lecturers/presenters delivered in grand style to the enjoyment of all participants. Some of the presentations are the articles presented before above this report. Summaries/abstracts of other presentation and discussion sessions whose detailed write-ups were not submitted to the secretariat have been presented below.

Summaries/Abstracts of some Presentation/Discussion Sessions

Creating 'Mathematics Team Leader (MTL) in a Basic School

Ponu Cletus, Mereku K. D. & Co.
(presentation by 4 Post-Dip B.Ed
Mathematics students in UCEW)

The mathematics team in this context is the teachers that teach mathematics within a school. The curriculum leader who is responsible for co-ordinating the activities of the mathematics team is referred to as the Mathematics Team Leader (i.e. M.T.L. for short). Staff team work is likely to help less competent teachers to benefit from the professional support and encouragement

of their colleagues. There are two main benefits to be gained from the team work:

- (i) the resource of expertise and experience help by teachers is acknowledged and utilised for the benefit of the whole school;
- (ii) the involvement of teachers in curriculum policy decision is likely to contribute to the more effective implementation of policy.

The session will examine how to establish one in a school, the qualities, and responsibilities of the M.T.L.

Cooperative Learning and Alternative Assessment of Mathematics Achievement of Senior Secondary School Students.

Dr. B. A. Eshun, J. Essuman And
B. J. Agbemakah, Department of
Science Education, University of
Cape Coast.

Students in SSS form 2 in two mixed schools in Cape Coast were taught using conventional methods and small-group cooperative learning setting as control and experimental groups respectively. The experiment group extra group and individual activities in addition to the conventional teaching discussions. Result and implications of the study were led by the investigators.

The Use of Ethnomathematical Ideas in Teaching Mathematical Concepts in Basic Schools

MR. OKPOTI, C. A., Department of
Mathematics Education, University
College of Education of Winneba

In Ghana, one can see many mathematical concepts coming out from traditional or cultural activities in each local group. Most of these activities cut across many traditional areas in Ghana. These cultural activities may be found in almost all the countries in Africa, either the same

activities or in a different form. The activities may differ from country to country, however, the same mathematical concepts may be observed in the activities. In almost all-indigenous vocations in Ghana, we can find mathematical concepts being employed or displaced. The mathematics derived from cultural activities of a group of people is what is called "ethnomathematics". Several mathematical concepts and skills are found in activities of both children and adults in the communities. In Ghana, many children are involved in their parents' vocations. Indirectly these children are the apprentices of their own parents. The children observe and learn these adults' activities. Children acquire a lot of ideas from their peers, parents and other people from their environment/community. These children's activities involve counting, measuring, estimating and creating of shapes and patterns. This shows that children possess some mathematical knowledge from home/environment before commencing the study of school mathematics. These children's knowledge on mathematics can be developed in the mathematics classroom under the formal school set up. The ethnomathematical ideas of the child can serve as a link between the home and the school during the study of mathematics in the school.

Use of Multi-base Ten Blocks to Teach Decimal Fractions

Mr. Benjamin E. Arthur, OLA
Training College, Cape Coast

My personal interaction with pupils in the JSS indicates that many of them lack the concept of decimal fractions. Although a lot of trained teachers have been taught the use of multi-base blocks in teaching decimal fractions, many still lack the confidence of using the blocks to ensure effective teaching and learning. This presentation is aimed at stimulating teachers' interest, and also building their confidence, in the use of this important instructional material.

The Finger Multiplication Extension Board

Mr. Amihere, Ahmed, Department
of Mathematics Education,
University College of Education of
Winneba

The session examines the use of manipulative – the Finger Multiplication Extension Model – as a means of developing children's multiplication concepts. Finger Multiplication was in use in the Middle Ages, and this involved representing numbers to be multiplied (any two numbers from 6 to 9) by the fingers of the hands. This presentation is aimed at stimulating teachers' interest in the use of the Finger Multiplication Extension Board in developing skills in basic multiplication facts. A trial test conducted on the use of the Finger Multiplication Extension Model revealed that they are useful tools for the development of multiplication concepts in our basic schools.

Helping Students Overcome Mathematics Anxiety

Mr. E. K Awanta, Department of
Mathematics Education, University
College of Education of Winneba

The main thesis of this article is that relationships between anxiety and the learning of mathematics is complex. Anxiety as a form of arousal, of alertness, of paying attention, can be helpful in learning. But too much anxiety, especially when combined with real or perceived lack of ability or complicated by distractions, can seriously hinder learning. Any of you who have taught a course in mathematics has surely sensed the anxiety that permeates the classroom during the first few class sessions. The sense of foreboding is not in the least lessened by the student's first glimpse of the textbook, replete with strange and incomprehensible hieroglyphics and ponderous verbiage. In fact, in my experience most withdrawal (psychological as well as physical) occurs during this first week. The article intends to outline causes of these strong negative feelings about things mathematical. It also suggests cures for mathematics anxiety.

Timetabling

Dr. J A Fletcher, Department of Science Education, University of Cape Coast

Mathematics teachers in the Senior Secondary Schools are charged with the responsibility of preparing timetables for their school. The session looks at how timetables can be prepared taking into consideration a number of constraints.

A Look at Performance of Students in the BECE and SSCE Mathematics

DR. P.O.COFIE, Department of Mathematics Education, University College of Education of Winneba

Contrary to much improvement in the academic staff of training colleges in the area of Mathematics Education as well as yearly organisation of maths and science clinics, little evidence is found in the improvement of performance of pupils/students in our schools. Improvement is measured by the performance of students at the Basic Education Certificate Examination (BECE) and Senior Secondary Certificate Examination (SSCE) the results, which seem to be very low over the years. Studies done, however, suggest that the improvement in mathematical attainment of pupils/student does not only depend on good staffing in our schools. The presentation will examine causes for the poor performance and discuss factors that will help to improve pupil/students' performance in the subject.

The Place of Information Technology in Teaching and Learning Mathematics

Mr. Issifu Yidana & Mr. Asiedu-Addo, Department of Mathematics Education, University College of education of Winneba

Computers assisted Instruction and Learning systems provide concrete applications for the teaching and learning of any subject, particularly Science and Mathematics in the school curriculum, down from the Primary to University levels

in Education. As technology gets more and more advanced, Mathematics education will also have to adapt to the new realities. There is an inherent interdependence between Mathematics and Technology. In the modern trend of teaching Mathematics the teacher may be guided by the fact that some Mathematics becomes very important because Technology requires it, some Mathematics becomes less important because Technology replaces it, and yet some Mathematics becomes possible because Technology allows it. This paper seeks to highlight the benefits of Information Technology to the teaching and learning of Mathematics. We give the merits and demerits of the introduction of computer based studies into the school curriculum. We finally offer concrete reasons for the introduction of this modern and effective tool in the Ghanaian school system.

The Dichotomy of Methodology and Content in the Teaching and Learning of Mathematics: The Way Forward

MR. S. K. ASIEDU-ADDO & MR. ISSIFU YIDANA, Department of Mathematics Education, University College of education of Winneba

This paper discusses the need of the mathematics teacher to be equipped adequately in the content areas in Mathematics, vis-à-vis the recent concerns about the poor performance of students in the pre-tertiary schools and the competence of mathematics teachers in the field. Government identifies lack of access to education, poor quality of teaching and learning, and economic constraints as the main problems facing our educational system. We as teachers cannot do anything about lack of access and funding of education. Many factors contribute to the poor quality of teaching and learning. One of such factors is the subject-based knowledge of mathematics educators. The imbalance between the content and pedagogical aspects of the mathematics curriculum is one thorny issue at the center of the crisis of mathematics education at the pre-university level of the

Mathematics Connection Vol.2, 2001

education system. This paper discusses ways of addressing this dichotomy.

Methods in Primary Mathematics Textbooks and Teachers' Classroom Practice: Implications for Curriculum Developers and Implementers

Dr. Kofi D. Mereku, Department of Mathematics Education, University College of education of Winneba

The official school mathematics curriculum – textbooks, teacher's handbooks, and syllabus – has a powerful influence on classroom practice in a developing country like Ghana, where many teachers with low teaching qualifications hardly ever have access to other sources of information and activity for their teaching. The study, which investigated the congruence between the teaching methods presented in the official curriculum materials and teachers' classroom practice, has provided further evidence to support the above supposition. It was found out that though there was rhetoric in the introduction of the curriculum materials on the use of teaching skills that suggest discovery methods, the analysis indicated that learning/teaching activities that would encourage the use of such teaching skills in the materials were not included. It was observed that both the official curriculum and the teachers, who implement it, emphasised expository teaching methods.

Learning Mathematics, a Chore or a Game? The need to introduce calculators in Junior Secondary Schools

Margaret Hutchful (Mrs.) P O Box EL88, Elmina

The presentation seeks to show that calculators can be used not only as tools for aiding computation but also as an effective means of replacing the fear associated with the learning of mathematics with an approach that brings

about enjoyment and confidence in the subject. Many students fail to do well in Mathematics due to stress factors resulting from

- a) the inability to get simple arithmetical computations correct;
- b) the lack of speed- coming out with answers quickly.

The use of the calculators enable students to overcome these stresses is giving way to positive attitudes, which in turn encourage the learning of Mathematics. Lessons in which calculators can be effectively used will be demonstrated e.g. finding the mean, identifying patterns with numbers, etc. Finally, the problems militating against the use of the calculators will be addressed namely

- a) use of the calculators not being allowed in WAEC BECE examination;
- b) high cost of calculators.

Application of Linear Programming and Theory of Games to Economics

Prof. D. N. Offei, Department of Mathematics, University of Cape Coast

In the lecture I shall consider the application of linear programming and theory of games, to branches of operations research, industry, economic planning and market economy. Also to application to the allocation of scarce resources, such as foreign currency, will also be considered.

Mathematical Modeling in Population Dynamics

Mr. S. K. Asiedu-Addo, Department of Mathematics Education, University College of education of Winneba

The growth and decline of population in nature and the struggle of species to predominate over one another has been a subject of interest dating back through the ages. Applications of simple mathematical concepts to such phenomena were noted centuries ago. This paper discusses

mathematical models in Biology, their formulation, analysis and interpretation. Much emphasis is placed on how appropriate assumptions simplify the problem, how important variables are identified, and how differential equations are tailored to describing the essential features of a continuous process. The main thrust of this paper is the practical application of mathematical models in

Quiz Competition

Each Region presented 3 contestants accepts Upper West with none and Volta with only 2. In all there were 26 contestants. One each for primary, JSS and SSS. The Quiz Master was Dr. Ben E. Eshun. The first round of the competition took contestants through to supertime. The second round was held after

QUIZ WINNERS

Primary Level

1 ST Position	:	Vera Achiaah Darko		B.A, Goodnews Baptist, Sunyani
2 nd Position	:	Obed A. Avoka	-	Upper East Bolgantanga Prep.
3 rd Position	:	Irene Koramah Frempong-		Eastern, Madonna School, Koforidua

J.S.S Level

1 ST Position	-	Yakubu A. Subuir	-	Bolgatanga Prep - Upper East
2 nd Position	-	Samira G. Nayina	-	Tamale International – Northern
3 rd Position	-	Adu Oppong	-	Holy Spirit JSS, Sunyani – B.A.

SSS Level

1 st Position	-	Ahatofu Teku	-	Keta Sec. Sch. Keta – Volta
2 nd Position	-	Edward Agana	-	Bolgantanga Sec. Sch – U/East
3 rd Position	-	Eric Boamoah Antwi	-	Kibi Training College – Eastern.

helping to unravel the underlying mechanisms involved in biological process.

The Validity of Mathematics Teacher Appraisal: A Theoretical Framework

Dr. J A Fletcher, Department of Science Education, University of Cape Coast

Ghana is currently implementing a new system of education which aims at making education both cost effective and accessible to all Ghanaian children of school going age. As part of the reform changes have been made in the appraisal system in the Ghana Education Service (GES) to enhance its ability to help teachers improve their work. This paper provides a theoretical “model” with which the validity of the appraisal system can be examined. Specifically, the “model” is designed for the purpose of examining the potential of the teacher appraisal process to help (Ghanaian) mathematics teachers improve their teaching of mathematics.

supertime it was completed late in the night. The final result was as follows:

The Annual General Meeting

The plenary session did not take its turn as scheduled due to the lack of time. However, the National Chairman took his turn to address the conference on constitutional affairs. In all four articles in the constitution were discussed. They were, the Treasurer’s imprest annual dues, Reportorial Executives and MAG’s Representative to the CCTA. The Secretary read through relevant portions from the constitution on the above articles, which were discussed, and decision taken on them.

- (i) The Treasurer’s imprest was changed from ₵50,000 to any amount to be decided from time to time.
- (ii) Annual dues was officially agreed to be ₵2,000 for ordinary members.
- (iii) Regional Executive should include the following elected members: Chairman, Secretary, and Treasurer.

Mathematics Connection Vol.2, 2001

(iv) The Secretary and not the Treasurer was to represent the Association CCTA. The Secretary and the Treasurer read their reports.

The chairman announced the vacant seats in the Executive, which were to be filled. The present Executive had exhausted their terms of office except the Treasurer who had one more term to contest. He explained that all except the chairman could contest for higher office. At this juncture he called on the Electoral Officer, Mr. Kojo Abiw- Abbaido to take over. The following release was announced. At the close of nomination.

Organising Secretary-	Mr. Hlorgbe Francis
Secretary	- Mr. Samuel Anokye
Treasurer	- Miss Adwoa Nkrumah
Vice Chairman	- Dr. Kofi Mereku
	- Mr. E. M. Wilmot
	- Mr. S. A. Gyimah

The following were declared elected unopposed:

1. Mr. Hlorgbe Francis-Organising Secretary
2. Mr. Samuel Anokye- Secretary
3. Miss Adwoa Nkrumah- Treasurer
4. Mr. S. A. Gyimah- Chairman

Election was held for the office of Vice Chairman – Dr. Kofi Mereku was elected.

Closing Ceremony/Dinner

Dinner was served during the closing ceremony. Winners of the national quiz competitions were awarded various prizes during the dinner. Special merit awards

were also made to individuals who have in the 40 years history of the association made outstanding contributions to its progress and development. The following are members who were honoured during the 40th Anniversary celebration

1. Dr. Ben A. Eshun
2. Mr S. D. Gyang
3. Mr S. A. Aboagyie
4. Mr. A. Y. Doe (Nana Addo)
5. Mr. E. B. Dogbe
6. Mr. J. F. K Appiah-Cobbold
7. Mr. J. H. Johnson
8. Mr. K. Obeng Asamoah
9. Mr. M. W. Kpo
10. Mr. S. A. Darko
11. Mr. S. E Ammisah
12. Mr. Seth Okra
13. Mrs B. Osafo-Affum,
14. Mrs Emma Afful
15. Prof. D. A. Acheampong
16. Prof. D. N. Offei
17. Prof. F. A. K. Allotey
18. Prof. J. B. Ofofu
19. Prof.N. K. Kofinti
20. The Managing Director, SEDCO

Finally the new executives elected were sworn into office.

MAG VOLTA CHAIRMAN
(HLORGBE FRANCIS)

SECRETARY'S REPORT: 2000 - 2002

National Council

The current National Council members were selected into office on 31st August 2000 at the 40th Anniversary Conference (27th Conference) held at the Commonwealth Hall, University of Ghana, Legon for a two-year term ending August, 2002.

National Executive

President - Mr. J Obeng Asamoah, c/o GES HQ, Accra.
Chairman - Mr. S. A. Gyimah, Maths Dept, KNUST, Kumasi
Vice Chairman - Dr. Kofi Mereku, Dept of Maths Educ, UCEW, Winneba'
Treasurer - Ms Adwoa Nkrumah, P. O. Box 58, Akropong-Akwapim

Mathematics Connection Vol.2, 2001

Secretary - Mr Sam Anokye, Regional Education Office, Kumasi

Assistant Secretary - Mr. Francis K. Horgbe, St. Paul's Secondary School,

Denu.

Regional Chairman

Ashanti -	Mr. K. Addae-Wireko, Kumasi High School, Kumasi
Brong Ahafo -	Mr. Cletus B. Ponu, St. James Sem/Sec Sch, Sunyani
Central -	Mr. C. E Acquah, Mfantsiman Girls Sec. Sch Saltpond
Eastern -	Mr. E. K. Tachie, Koforidua Sec/Tech Sch, Koforidua
Greater Accra-	Mr. Wisdom K. Dzeagu, Tema Sec, School, Tema
Northern -	Mr. Mahama Iddi, Tamale Training College, Tamale
Upper East -	Mr. Aloysius N. Addih, Regional Educ. Office, Bolganga
Upper West -	Mr. C. S. Paaga, District Education Office, Jirapa
Volta -	Mr. Denis M. K. Agbenuvor, Peki Training College, Peki
Western -	Mr. Mac Theo Acquaye, Takoradi, Sec School Takoradi

Honorary Members

Prof. N. K. Kofinti -	Dept of Maths, University of Ghana, Legon.
Mr. S. D. Gyan -	GES Regional Educ, Office, Ho
Mr. J. W. F. Appiah-Cobbold-	P. O. Box 637, Agona Swedru
Dr. B. A. Eshun -	Faculty of Educ. UCC, Cape Coast
Mr. E. K. Darko -	P. O. Box KF 235, Koforidua

Membership

The breakdown of our total membership for the period is as follows:

<i>Region</i>	<i>Number</i>
Ashanti	219
Brong Ahafo	32
Central	63
Eastern	140
Greater Accra	371
Northern	38
Upper East	28
Volta	80
Western	119
Total =	1,090

Committees

As constitution demands, the Council formed the following committees as advisory bodies to the Council.

Finance Committee

Ms. Adwoa Nkrumah (Treasurer, Chair)
Mr. K. Addae-Wireko
Mr. I. A. Ahinful
Ms Comfort Kissiedu
Mr. K. Abiw Abaidoo
Mr. Abdulai A. Baba
Mr. Gove Hulede

Project

Mr. Wilmot Eric (Chairman)

Mr. E. Kofi Darkoh
Mr. J. W. K. Appiah-Cobbold
Mr. M. K. Klaye
Mr. Seshie Dominic

Workshop

Dr. Kofi Mereku (Chairman)
Ms Adwoa Nkrumah
Mr. F. K. Hlogbe
Chairman Eastern Region
Secretary Eastern Region

Appointment of President

Members unanimously agreed to the appointment of Mr. J. Obeng Asamoah formerly of GES HQ, Accra as the President of the Association for a two-year term with effect from 1st September 2000.

MAG Textbooks

Longman, the publishers of MAG Textbooks, informed the Association that the Pupils Books and Teachers Guide would come out as follows:

Book 1	-	December 2002
Book 2	-	February 2003
Book 3	-	March 2003
Book 4	-	September 2003
Book 5	-	November 2003
Book 6	-	January 2004
Book 7	-	February 2003

Mathematics Connection Vol.2, 2001

Book 8 - May 2003
Book 9 - June 2003

The new syllabuses were used in writing the Books.

Translation of the Books

The Association planned to translate her Books into the following Local languages: Akan, Dagbani, Ewe, and Gonja. The exercise has been abounded due to Government Policy that English should be the medium of instruction at all levels of Education. Some members were of the view that the translation went on but lack of financial support could not allow that.

Foreign Accounts

The Executive appealed to the Ministry of Foreign Affairs to intercede and resolve the impasse between MAG and her foreign

Bankers, Nat west Response from the Ministry dated October 5, 2001 indicated that MAG's request had been brought to the attention of Ghana's Mission in London for further necessary action. Any further development would be duly communicated to MAG. The Association is yet to hear from the Ministry.

Mr. Appiah-Cobbold, the immediate past chairman, explained that efforts have been made to change the signatories and wondered why we were experiencing what was going on. It was suggested that since he had been corresponding with Nat West, he should continue till he succeeded in changing the signatories.

Mr Sam Anokye,
National Secretary MAG

HISTORY OF MATHEMATICAL ASSOCIATION OF GHANA IN ASHANTI REGION

It is not known exactly when the Mathematical Association of Ghana (MAG) started in the Ashanti Region. However, sources have it that the association might have started somewhere in the early sixties and has managed to thrive until now. Available information indicates that Ashanti and Brong Ahafo Regions had one leadership of MAG until 1980 when the two regions separated; each operating under its own leadership.

Among the leaders who sustained the Association during the period of merger are

- Mr. Joseph Obeng Asamoah who was the chairman for two terms spanning from September, 1972 to August, 1976
- Mssrs. K.A.T. Nunoo and John Adelowo who were Secretaries.

Mr. John Adelowo, however, served his second term of office as Secretary under Mr. Seth Okrah who also served two terms from 1976 – 1980 with Mr. Dan Opoku as Secretary in his second term of office from 1978 – 1980.

After the break off Mr. Raymond Opoku of Prempeh College became the first chairman of the Ashanti Regional branch of MAG on his election into office in August 1980. His secretary was Mr. A.K.Asante of Atwimaman Secondary School. The following were also appointed to co-ordinate the activities of the districts during the period;-

Mr. Seth Okrah	Bekwai
Mr. E.O. Yeboah	Offinso
Mr. Fletcher	Obuasi
Mr. R.A.Ofori	Mampong
Mr. A.K. Tweneboah	Agona
Mr. I.A. Yeboah	Tepa
Mr. Yaw Aidoo	Ejisu
Mr. K. Addae-Wireko	Nkawie

The first major assignment for the new leadership was to host an International Conference/Workshop and the 19th Annual Workshop held at Kumasi Technical Institute (K.T.I.) from 17th –22nd August 1982.

Mr. Kofi Agyapong of Atwimaman Secondary School took over from Raymond in 1982 and sailed through one term with Mr. John Opoku Frimpong of T.I. Ahamdiyya Secondary School, Kumasi as the Secretary. All the officers mentioned

Mathematics Connection Vol.2, 2001

above worked assiduously towards the sustainability of the Association in the Region.

It is on record that a symposium and the 18th annual workshop/ conference on the theme “Mathematics as a tool for Nation Building” was held at K.T.I. in September, 1992 and a workshop was organized for Primary school teachers on “Primary Geometry and Teaching aids” on 14th November, 1983.

Mr. John Opoku Frimpong served one more term as Secretary under Mr. Abiw-Abaidoo who was elected as Chairman in 1986. During Mr. Abaidoo’s tenure of office from

1986 – 1988, several workshops and conferences were held. Notable among them are”-

- The 20th National Conference/Workshop held at K.A.T.T.C. from 1st – 6th April, 1986. This event coincided with the silver jubilee celebration of the Association.
- A workshop for teachers drawn from first cycle schools in the Asante Akim District at Konongo on “the teaching of word problems in the upper primary” held on 20th February, 1987.
- A quiz competition for second cycle schools and diploma awarding institutions organized at Wesley College on the 27th February, 1987. Even though patronage was low –24 out of expected 60 schools turned up for the event – it yielded the expected results. The semi finals and the finals were held at K.T.I. on May Day, 1987.
- One day workshop at Konongo R/C Primary ‘A’ for 76 Upper Primary teachers including Headteachers on “Effective Maths teaching” and “why girls have lower achievement in mathematics than boys” on 17th March, 1987.
- One day workshop on “the place of Mathematics in the Educational reforms” held at WESCO on 12th June, 1987 which attracted 66 participants.
- One day workshop held on 20th November, 1987 on the “Role of

Mathematics in the New Educational Reforms” 75 teachers attended.

It was during this period that an International workshop/conference, the first of its kind on “The teaching of Mathematics at the Secondary/Tertiary level” was held at U.S.T. from 3 –12 August, 1987.

Co-sponsored by M.A.G., Society of African Physicists and mathematicians (S.A.P.A.M.), International Center for Theoretical Physics (I.C.T.P.), Trieste-Italy, and Mathematics Department of UST, which attracted 51 participants from Ghana, 3 each from Nigeria and Liberia, 2 each from C’ote d’Ivoire and Gambia and 1 from Britain.

MAG in collaboration with the G.E.S. organized a 3 –day workshop for ‘A’ Level Mathematics teachers drawn from schools in the Kumasi District at Prempeh College. A 3-day workshop for teachers drawn from J.S.S. in the Ejisu-Juaben and Bosomtwe District organized from 23 –25th March, 1988 attracted 63 participants. A workshop for Training College tutors and District organizers was organised on 16th April, 1988 at Wesley College. 37 tutors and 33 organisers benefited from the workshop.

Mr. Abiw-Abaidoo served another term of office as Chairman from 1988 to 1990 with Mr. Victor Owusu of Osei Kyeretwie Secondary School as Secretary. Through the dynamic leadership of Mr. Abiw-Abaidoo ably supported by an equally dynamic secretary the Association chalked more successes. From 3rd – 8th April, 1989 a workshop was organized for 80 training College tutors at Wesley College. on “Laying Effective Foundation for Mathematics Education” and on June 2nd, the same year a regional workshop on “Mathematics as a tool for Technological Development” was organized.

On 24th January, 1989, the preliminaries of inter-school/colleges Maths quiz competition was held at Wesley College; the semi finals came off on 10th March, 1989 and the finals on the 1st December, the same year. This activity which climaxed the activities for the year attracted press coverage – see Daily Graphic of 4th Dec., 1989. Training College tutors and Mathematics organizers benefited from a 5

–day workshop held at St. Louis Training College from 17th –21st April, 1990 on the theme “Practical Teaching of Mathematics” and the term of office of Mr. Abiw- Abaidoo ended with a regional workshop on 29th June, 1990 on “Problems of Mathematics teaching in schools”.

Mr. Adjei-Barfi of Opoku Ware School took over from Mr. Abiw-Abaidoo in 1990 with Mr. Samuel Anokye of Ohwimase M/A J.S.S. as Secretary. Activities organized during Mr. Adjei-Barfi’s tenure of office included among others the following :-

- A one-day Regional workshop on the theme “Teaching Syllabus-
- It is a solution to failures in Mathematics” held at Prempeh College on 6th February, 1991.
- A 2-day workshop for Primary Six teachers in Kumasi District. Zones A and C had theirs on 21st and 22nd January 1992 and Zones B and D had their turn on 28th and 29th January, 1992. The last in the series of Regional workshops was on 3rd July, 1992.

Mr. Barfi initiated the formation of District Branches of M.A.G. and so after a workshop for teachers in the Nkawie District at Toase Secondary School on 8th November, 1991 he moved straight into action by forming a branch at Ejisu on Dec., 7 1991 and swore in the Executives on 3rd March the following year after which an inter-school quiz competition was organized on 31st March, 1992.

On his appointment as the Eastern Regional GNAT Secretary in January, 1993, Mr. Adjei-Barfi could not continue as the Ashanti Regional Chairman of M.A.G. Mr. S.A.Gyimah was therefore elected by the Executive Council to act as Chairman for the remaining period of the term.

Mr. S.A.Gyimah’s competence in his acting capacity propelled him into snatching the leadership of the Association when time came for elections in 1994. Mr. Samuel Anokye was made Secretary for the second term. Mr. Gyimah during the period he was acting continued the good work initiated by his predecessor. He had a district Mathematics workshop on 1st

December, 1993 and opened 3 more District branches i.e. Bekwai (Amansie East), Konongo (Asante Akim North) and Mampongten (Kwabra) Districts.

- A day’s workshop on “Measures to improve the Teaching of Mathematics was organised on 5th March, 1993 and this was followed by an inter – District Mathematics Competition on 7th and 8th May, 1993.
- Another workshop on “The Challenges of the SSS Graduate” came off on 2nd July, 1993 at Prempeh Collage.
- The year’s activities ended with the first three of the collaborative effort of G.E.S., GAST and MAG to organise a 3-day non-residential Maths and science workshops for J.S.S. Science and maths teachers in each District of Asanti.
 - 21st – 23rd November 1993. – Kumasi
 - 28th – 30th November, 1993 – Juaso
 - 5TH – 7TH December, 1993 – Effiduasi

On assumption of office in 1994 this time as the full chairman of M.A.G, Asanti, Mr. Gyimah and his team organised a day’s workshop on 4TH March, 1994 on the theme “Improving on Examination Permpheh College and between April 5th and 9th the same year a National workshop/conference was held at the same venue. It was at this conference that Ms. Comfort Britwum of Effiduasi R/C/J.S.S was elected the Asanti Regional Treasurer in a bye-election to replace Mrs. Dina Appiah who had been to the office of the National Treasurer.

The Ashanti Regional M.A.G. lost a member, the late Samuel Kwaku Yeboah of Prempeh College Experimental J.S.S in November, 1994. May his soul rest in perfect peace.

It must be stressed that Mr. S.A.Gyimah injected more interest into the organisation of the quiz competition by looking for sponsorship. Prizes which were given out to the winners of the competition were donated by Guinness (Ghana Ltd) and Kumasi Brewery Ltd. (KBL).

Mathematics Connection Vol.2, 2001

On 3rd March, 1995 a Regional workshop on the theme :Mathematics – the key to basic skills” took place Prempeh College and a 3-day workshop for J.S.S Science and Mathematics teachers in the Ahafo Ano North District from 4-6th April, 1995 followed. The last event for the year which marked the end of Mr. Gyimah’s chairmanship was a day’s workshop on the topic “Improving the teaching of Mathematics” came off on 5th July, 1996 at Premph College.

Mr. P. Akuamaoh Boateng of G.E.S., Effiduasi succeeded Mr. S. A. Gyimah as Chairman with Mr. Samuel Anokye still serving as the secretary for a term of office from September 1996 to August, 1998. This team penetrated the Southern sector of Offinso District and organised a day’s workshop for Primary and J.S.S. teachers. In all four Regional workshops were organised during the period.

The millennium group of leaders made up of Mr. K. Addae –Wireko of Kumasi High School and Mr.Mike Adjei of Prempeh College took over from Mssrs Akuamoah Boateng and Samuel Anokye as Chairman and Secretary respectively in September, 1998. He team has left no stone unturned to hold the Association together to date. On the expiry of the term of office in August, 2000, the millennium leaders have been given the mandate once again to steer the affairs of the Association

It must be noted that the theme for one of the Regional workshops organised by the current leadership was adopted for the Biennial Conference held at St. Paul’s Secondary School, Denu.

Many association thrive amidst turbulence and problems and Ashanti Regional branch of MAG is no exception. It has been plagued with financial and other obvious problems like sponsorship for the Association’s programmes especially those at the basic level, By dint of hard work and dedication from its leadership, however, it has survived to date.

The level of competence and dedication exhibited by some of the leaders earned them the opportunity to serve on the national executive board of the Association. Some of these selfless leaders are Miss Obeng Asamoah (National Chairman) Seth Okrah (Editor), S.A. Gyimah (National Vice- Chairman), Mr.Abin – Abaidoo (National Organising Secretary and later National secretary) Mrs Dina Appiah (National Treasure) just to mention a few.

Our history will not be completed without acknowledging the valuable contributions made by the following:

late Dr. Abiw Jackson, Professor Allortey, Joseph Obeng-Asamoah, Opanin Kojo Kyereh, Raymond Opoku, Kofi Anyimadu, Adjei-Barfi, Kofi Abiw-Abaidoo, S.A. Gyimah, Samuel Anokye, A.G.Goodfellow and Mrs. Dina Appiah.

The following individuals and organisations have also been very instrumental in our efforts to promote the teaching and learning of mathematics in the region and need special mention:-

Mssrs T.A. Boateng {former Metro Director of Education, Kumasi) Guinness Ghana Ltd, Kumasi Brewery Ltd and the current leadership of the Kumasi Metro and Ashanti Regional Directorate of Education. We thank them all for their support and encouragement.

It must be stressed that he Headmaster of Prempeh College, Mr. E. A. Sekyere has been a father to the Association. He then always opened his doors to the Association for all regional workshops and conferences. He has always entertained the officers and the invited guests who do honour our invitation to our programmes. We are very thankful to him and shall continue to cherish this special hospitality he has accorded us.

Compiled by **K. ADDAE- WIREKO**

REPORT FROM THE EASTERN REGION

The Regional Executives

Chairman - Mr. Emmanuel Ofosu Baabu
Secretary - Mr. Godfried K. Tetley
Treasurer - Miss Comfort Yamoah
Assistance Secretary - Mr. S. A .Addo
Organising Secretary - Mr. Hans Out-Ofosu

Regional Conference/Workshop - 2000

The Regional Conference/Workshop was held on 21st July, 2000 at Ghana Secondary School, Koforidua. The meeting starting at 10.45am with an opening prayer by Rev. Nana Boateng from the Christ Resurrection Church, Koforidua.

Introduction of the invited guests was done by Mr. Emmanuel Ofosu Baabu, the Regional MAG Chairman. The Chairman was Mr. A. H. Awortwi, the Municipal Director of Education Ghana Education Service Kofoidua. The guest speakers were Mrs. B. Osofo-Affum former Director of Education, Asuogyaman District and Dr. Kofi Mireku: Lecturer, University College of Education, Winneba.

The first to give a speech was Mrs. B. Osafo-Affum. The theme was "Mathematics crisis consist of four major areas.

1. The teacher
2. The student
3. School syllabus and
4. Parent/Guardian

She said teachers only taught content but not the Methodology. She added that man teachers do lecture instead of teaching. Some even give notes in Mathematics. Many teachers do not use material and practical ways of teaching Mathematics at the Primary level. These are some of the few that do constitute Mathematics crisis in our schools.

She suggested some remedies. These are: MAG members should take up the job of working to organise in service training for Maths teachers. Teachers must use

appropriate learning materials. Method drills should be re-introduced in our schools. No method drill with cane, pupils must be given the chance to work all exercises in the textbooks and works a hold be marked by the teacher. Headmasters and circuit supervisors must make every effort to monitor the work of teachers. Availability of funds to follow up work. Topic should be completed.

Dr. Kofi Mireku was the next to speak. He said there is a decline of performance of the girl child as one goes up in the educational ladder. Curriculum is silent over mental and oral work in mathematics. Inadequate teachers, lack of supervision and very little had been noticed of girls doing well in mathematics. He pointed out that the syllabus had been static and there is the need for its periodic review. He also observed that a few changes have come into the curriculum, and very soon it will come out. He said very soon the syllabus will be on the market so that anyone could buy.

Prizes were awarded to the best three candidates in the MAG quiz held both at the District level and the Regional level in the primary, J.S.S. and S.S.S level. Attendance at this conference was 65.

Activities

ON 12TH July, District Maths quiz was organised at all districts in the Region. The best three candidates were selected to participate in the Regional Maths quiz. On 26th July, 2000, Regional Maths quiz was held. The best three candidates from each district in the primary level, J.S.S.level and S.S.S/Training colleges level participated. The Regional Maths quiz was held at Pope John Secondary School, Koforidua.

Compiled by the Secretary,

GODFRIED K. TETLEY

Ethnomathematics: What is it?

C. A. OKPOTI,

Mathematics Education Department, UCEW, Winneba

Abstract

This piece of work sought to look at what “**Ethnomathematics**” means, the advantages and disadvantages of ethnomathematics in mono-cultural and multi-cultural societies. Justification of employing ethnomathematical ideas during the teaching mathematics in the classroom is also discussed.

Introduction

In Ghana, one can see many mathematical concepts coming out from traditional or cultural activities in each local group. Most of these activities cut across many traditional areas in Ghana. These cultural activities may be found in almost all the countries in Africa in one form or another. Many of these activities embody mathematical concepts. Both children and adults in the communities get involved in these activities. In Ghana, many children are involved in their parents' vocations such as trading, sewing, carpentry and so on.. Indirectly these children serve as the apprentices of their own parents or other adults. The children observe and learn these adults' activities. Out of these activities a child acquires a lot of mathematical ideas from their peers, parents and other people from their environment/community. These children's activities involve counting, measuring, estimating and creating of shapes and patterns. This shows that children possess some mathematical knowledge from the home/environment before commencing the study of school mathematics. These children's knowledge on mathematics can be developed in the mathematics classroom. The mathematics embedded in some of these activities is term '**ethnomathematics**' and it can serve as a link between the home and the school during the study of mathematics in the school.

What is Ethnomathematics?

We may consider Ethnomathematics as the mathematics derived from the cultural activities of a society. Simply Ethnomathematics is “mathematics in

culture”. Ethnomathematics can be described as “the mathematics practiced among identifiable cultural groups, such as national-tribal societies, labour groups, children of certain age bracket, professional classes and so on” (D'Ambrosio, 1985). In line with D'Ambrosio, Millroy (1992) stated that “Ethnomathematics is concerned with the study of the different kinds of mathematics that emerge from different cultural groups.

Culture manifests itself through jargons, codes, myths, symbols, utopias and ways of reasoning and inferring which could be associated with practices such as counting, measuring, classifying, ordering, inferring, modeling and so on, and these constitute ethnomathematics. Ethnomathematics is given several names by different researchers. This cultural context of mathematics is termed indigenous mathematics (D'Ambrosio, 1985), frozen mathematics (Gerdes 1982), street mathematics (Nunnes et al 1993), multi-cultural mathematics (Shan and Bailey 1991).

There is variation of activities across cultures as a result of differences in school systems and in the structure of society and the job market (Nunnes et al 1982). Nevertheless, the daily activities that go on in a society involve the use of mathematical ideas. For example, fishing, farming, trading and weaving are some economic activities in many societies, which involve counting, measuring, estimating, ideas of profit and loss, creating shapes and logical reasoning. Parents and adults in the societies get children involved in these economic activities. For instance, farmers go to farm with their children, traders go to the market with their children,

Mathematics Connection Vol.2, 2001

especially the girl child. Practical, empirical evidence of this mathematics has been provided. Fishermen and peasants in Mozambique, described by Gerdes (19985, 1988); the mathematics of a shantytown in Brazil (Borba 1987a, 1987b in Millroy 1992).

Apart from what children acquire from adults, they play different games (both traditional and foreign) that can offer children some mathematical concepts and ideas. We can therefore say that children learn or acquire basic mathematical ideas from the activities of their parents, society and peers.

This suggests education, and for that matter mathematics education starts at home. This basic knowledge in mathematics a child brings from home or the society to the school can be developed in the mathematics classroom. In support of this view, Cockroft (1982) emphasized that it is possible to make positive use of mathematical ideas drawn from other cultures, especially when discussing shape and space.

Ethnomathematics in a Mono-Cultural Society

A mono-cultural society may be described as a group of people having the same culture and staying in the same environment. The people speak one language and their cultural activities are known to almost everyone. However, there may be a dilemma whether a pure monoculture exists. It may be possible that a pure monoculture exists in some parts of the country, but owing to human migration, in terms of employment, the pure mono-culture society may hardly exist. Nevertheless, with the long co-existence of the people in the community, it looks like either the mono-culture society or what is close to mono-cultural society is achieved.

Advantages

- Use of common language: language is a great instrument in communication, so the use of one language may enhance discussion in the mathematics classroom.
- Conceptualization: children's mathematical ideas from home may

aid them to develop a good concept image of what has been taught.

- Assistance from others: their parents could supplement what children learn at school at home, since parents may have some knowledge and ideas about the approach being used to teach mathematics in schools.

Disadvantages:

- Lack of mobility: it may be difficult for children to attend schools outside their cultural territory

Ethnomathematics in a Multi-Cultural Society

A society, which comprises of a mixture of people with different cultural backgrounds, may be called a multi-cultural society. The population of schools comprises of children from different cultures, as well as the cultural set up of the children.

Advantages

- Cultural interaction: children may get the chance to interact with their colleagues from different cultural areas and share some mathematical ideas and skills. Borba (1990) emphasized that ethnomathematics can offer students and teachers the opportunity to discuss the efficiency and relevance of different kinds of knowledge in different context.
- Upgrading of teacher's knowledge: Teachers may get to know different ways children approach mathematics from different cultural views.

Disadvantages

- Selection of a particular culture: there will be a problem of selecting activities which are found in some cultures, but the activities are not common to all the children and to their various backgrounds.
- Teacher's knowledge in mathematics: How can teaching and learning progress if a teacher's cultural background is different from that of the children? If a teacher has no knowledge about the culture of the children, it may be difficult to teach with ethnomathematical ideas.

Justification

Upon a care careful study of the primary school mathematics curriculum in Ghana, one may suggest that ethnomathematical ideas can assist children in the classroom to understand some aspects of the school mathematics. According to Lea (1987) “traditional mathematics is perfectly adequate unless one is involved with highly sophisticated technology”.

In brief, the following may be considered as some of the importance of using Ethnomathematical ideas in the teaching of and learning of mathematics:

- ◆ Cultural activities can assist children in their early formation of mathematical concepts.
- ◆ Higher participation in the mathematics classroom. Children may confidently participate more in the activities that are familiar to them, and as a result children easily acquire new mathematical concepts.
- ◆ Apart from the school, parents and the society as a whole can contribute to the education of children. In turn, the children may recognize and appreciate their culture.

These justifications may suggest that mathematics should not be seen as “a foreign creation” (Gerdes 1982), but it should be seen as knowledge embedded in every culture and that it can be developed to the benefit of the society as a whole. It can also be observed that children’s activities in a multi-cultural society approach that of a mono-cultural society. They use one language in communicating and playing together. Researches have shown that many activities of adults that influence children are practised across almost all the traditional areas in Ghana. These activities include farming, sewing, trading, carpentry and masonry. Children observe or are involved in these activities of their parents. Children acquire some mathematical concepts unknowingly through the numerous games that they play both at home and school.

It is the hope of the writer to establish the connections among the mathematics constructed by the children outside the school, the one embedded in everyday

cultural practice, and the one that the school aims to teach in the classroom. According to Nunnes et al (1993), educators will be interested in such questions such as, whether the children at a given level, are likely to know particular mathematical concepts from their experiences outside school and whether the new knowledge they gain in school can increase the power of their knowledge outside the school.

Suggestions

Having taken cognisance of the importance of the importance of Ethnomathematics, the following suggestions can be considered during the teaching and learning process of mathematics in the primary schools. Teachers should consider

- ❖ the activities do or the game children play, especially, those activities, which seem common to many cultures and are mathematically inclined,
- ❖ parents’ or adults’ activities that children learn from.
- ❖ activities whose resources (materials) are simple and easy to come by.
- ❖ the activities that cut across many traditional areas in Ghana (see appendix).

CONCLUSION

We can observe that, not every activity that goes on in the society may contribute to the formal learning of mathematics. Therefore it is necessary that teachers study these cultural activities and make use of those ideas that are relevant to the teaching and learning of mathematics in the classroom.

Ethnomathematical ideas in the teaching and learning of mathematics should be recognised as a tool of methodology in the teaching and learning of mathematics in the basic schools of Ghana.

BIBLIOGRAPHY

- Bishop, A. J. (1991) *Mathematics Education: A cultural perspective on Mathematics education*. Kluwer Academic Publishers, London.

Mathematics Connection Vol.2, 2001

- Borba, M.C. (1990) *Ethnomathematics and Education*. For the learning of Mathematics, 10,(1), 39-42.
- Cockroft, W.H. (1982) *Mathematics Counts*. London: HMSO.
- D' Ambrosio, U. (1985) *Ethnomathematics and its Place in the History and Pedagogy of Mathematics*. For the learning of Mathematics, 5, (1), 44-47.
- Fasheh, M.(1982) *Mathematics, Culture and Authority*. For the learning of mathematics 3,(2), 2-8.
- Gerdes, P.(1985) *Conditions and Strategies For Emancipatory Mathematics Education in Undeveloped Countries*. For the learning of Mathematics, 5,(1), 15-19.
- Gerdes, P.(1988) *On possible uses of Angolan Sand Drawings in the Mathematics Classroom*, ESM, No.19, 1988.
- Graham, B.(1982) **Mathematics and aboriginal Children**. In Bishop, A. J. (ed) *Mathematics Education and culture*. Kluver Academic Publishers.
- Lea, H (March, 1987). **Traditional Mathematics in Botswana**, Mathematics Teaching.
- Millroy, W.L. (1992) *An Ethnographic study of the Mathematical ideas of a group of Carpenters*. USA: Published by NCTM.
- Nunes, T., Schleimann, A. and Carraher, D. (1993) **Street Mathematics and School Mathematics**, C.U.P.
- Shan, S.T. and Bailey (1991) **Multiple Factors: Classroom Mathematics For Equality and Justice**. London: Trenthan Books Limited.

Appendix

The appendix below summarises certain games children play and the mathematical concepts they are likely to acquire from their activities. It also shows the various traditional areas in Ghana where these games are common or popular to other traditional areas.

Some Common Traditional Games in Ghana

Name	Concepts child may get	Region/locality game is played	Other locality/tribe name for game
"Oware"	Counting	Northern	"Wali ɔ"
	Ordinal	Upper west	"Birure"
	Base four	Upper east	"Bea"
	Probability	Volta	"Adito"
	Grouping	Greater Accra	} Awale } "Oware"
		Ashanti	
		Central	
Western			
"Ampe"	Counting	All regions in Ghana	} Ampe
	Ordinal		
	Base four		
	Probability		
	Sequence		
Olitwo or Tu-mato	Counting	Northern	"feela"
	Ordinal	Upper West	"Gollaa"
	Area	Upper East	"Falla Koleba"
	Shape e.g.	Volta	"Yevu Deka"
	Square, rectangle, circle	Greater Accra	"Tu-matu"
		Ashanti	"Atotomma"
	Central	"Atotomma"	
	Western	Atotomma"	
	Brong Ahafo	Atotomma"	
	Eastern (Akwapim)	olitwo"	

Many Rivers To Cross

COFIE, P O.

Mathematics Education Department, UCEW, Winneba

Abstract

The central concept in this article is that of “Educability” operation defined as the ‘probability that children will earn what they are supposed to learn’ and with the factors both genetic and environmental which affect this. The main emphasis, although not the only one is on factors related to cognitive development since so much of the current theory and practice of curriculum development and methods of teaching is dependent on notions about the nature of cognition. Much of the research on the development of cognitive skills and hence of the derived theory were carried out with Western children. Hardly were the minority used. Similarly most of the curriculum building based on the theories has gone on in Western educational systems. We adapt such curricula, almost unaltered and in other cases in our current jargon “adapted to meet our local needs”. But very seldom, if ever have we questioned their fundamental psychological basis. Do the theories of cognitive development on which they rest stand up in the Ghanaian context or do the children in Ghana, develop cognitive concepts in Mathematics just the same way as British children? If not, what the modes of concepts formation and Ghanaian children and what are the implications for curriculum development for teaching/learning.

Issues concerned with who need what, so far as mathematics education is concerned in my view can't always be resolved on purely logical grounds. In Ghana for example someone, or some group of persons, decide who need what. This raises the matter of the politics of mathematics education.

One thing is clear “the basics” in mathematics education – whatever they might be – are not independent of culture, and even within a single culture they vary with time.

Over the years mathematics educators have increasingly realized that mathematics education is part of general education and, therefore, is political because it is concerned with access to power and privilege. However, it is possible that many of us have failed to recognize that all mathematics education inevitably carried subtle hidden messages about how elements of culture and society should relate. As Frankenstein (1995) pointed out, everyone can recognize political overtones associated with questions in mathematics textbook in which

guerilla fighters are portrayed as helping farmers, and landlords as demanding compound interest from these farmers. Thomas J. (1992) argued that the politics of mathematics education has two dimensions; First, there is the social context which takes into account factors such as language, culture gender, socio-economic – status and access to technology and second, there are government policies and practices which have an impact on how the curriculum ought to be implemented. The question then is can mathematics be developed in countries with different cultural traditions, which may be quite different from the mathematics develop in Europe or American? Would such a mathematics serve the need of other cultures better?

There are other things we could do to understand better the gap between the mathematics children learn in school and our socio-culture context. If we examine the textbooks used in our schools, they are either direct copies or relatively mild modifications of textbook in the Western world. There is little awareness that there is a different context outside. Most tests

Mathematics Connection Vol.2, 2001

items given as assessment of these children in mathematics at JSS 3 demand computational skills.

These type of questions helps only in developing manipulative skills. The problem is that most of the concepts or skills we help develop in these children have no use for the young person dropping out of school after 12 years.

To find out the present difficulties children are facing in learning mathematics, we have to examine the history of our Social and Cultural Institutions.

Four things come into mind here.

These are:

- The relationship between similar institutions like schools in different societies (this we can call vertical)
- The relationship between different institutions in the same country (this we can call horizontal)
- The insertion of these institutions in the socio-cultural matrix that underlies our society (rootedness)
- The mode of training of our mathematics teachers

The history of social, industrial, and educational institutions in Ghana has been guided by vertical relationship. To understand our school system it is less necessary to understand the local social and cultural situation as it is to understand the British school system and to note the adaptation that have been made over the years. We can say the same regarding the system of the judiciary, hospitals, financial institutions and so on. If we can picture the development of institution like that of a tree, where the institutions represent the leaves, branches, fruits (the visible development in society) then we could picture that of Ghana like upside-down trees.

Our institutions are rooted not so much in the socio-cultural matrix of the country, as in the socio-cultural matrix of Britain. This form of *rootedness* has brought in what we may call the modernized sector and this includes the educational system. This

modernized sector is not a product of our socio-cultural matrix but rather a foreign transplant. It comes in with imported air for us to breath, and imported policies to implement.

The development of our institutions is directed by their success abroad, not by the needs in our society or complementary Institutions. Foreign experts are brought in to advice and help develop these institutions while the local experts are left out. Likewise, a leading mathematics educator from Ghana is invited to an international conference and is introduced to the new methods of teaching mathematics or to computer-assisted learning or distance educational techniques. He comes back and wishes immediately to implement what he has acquired. To him it is the latest and the best, whether or not it has serious relevance to Ghana. We really have many rivers to cross if mathematics teaching should be made meaningful to children. The norms for judging the value of our schools are often in terms of how well Ghanaian, student do in graduate school in Britain or the States (U.S.A), rather than in how they fit and contribute to the larger society. The mathematics classroom is totally unaware of the 'street' or 'village' mathematics of the young pupil inside.

Basic Education is terminal for most children in this country and in the past as at now the syllabuses are usually directed towards preparing children for secondary education. We need to take a second look at that in the light of the need of those who will never progress beyond basic education. Here the developed countries have little relevance experience to offer.

The crucial question is the provision and training of Basic School mathematics teachers. Large classes in our schools demand that the problem be approached with realism and sympathy. This is not purely a mathematical problem. Social, political and economic changes are necessary to improve the status of Basic School teachers. Graduate teachers must be encourage to teach at the Basic School level and accept postings to the rural areas.

In Ghana our educational system is so constructed that teacher-training, curriculum development and classroom practice looks like three separate activities. But change can only be very effective if and only if the three are seen as aspect of a single process. It is one thing to prescribe a new series of mathematical textbooks for classroom use, but quite another to ensure that the mathematical education of our pupils are thereby improved. It is naïve we define curriculum as the content of the textbook, or its development as the introduction of a new one. It is more realistic and more constructive if we look at it as what actually takes place in the classroom. This immediately gives the teacher a key role in curriculum innovation. In planning the mathematics curriculum then, writing-teams must include views of teachers from across the country and not be dominated by experts from the Ivory Tower. Only teachers and particularly nationals of this country, are aware of the practical realities of our school situation, of the pupil's attitudes, capabilities and responses to proposed changes.

There are three very different dimensions to the problems, which in my opinion contribute to and affect the teaching of mathematics effectively in Ghana. These are: (Namely)

- The influence of social and cultural conditions.
- The influence of our school system.
- The influence of classroom practice and classroom interaction.

Mathematical education originated in a specific western European cultural tradition. In the 19th century a canonical curriculum of 'traditional mathematics' was created as a study for an elite group, under the condition of a system of Universal Basic Education. This included the teaching of computational skills. Ghana adapted this system and it became natural for us just to copy European patterns. Forgetting that it is quite another problem to build a system of mass education in both the school situation and the specific social

and cultural context of that world. We know the problem now that curricula exist which encourage pupils to develop antipathies where our social context lacks the culturally based consensus that is found in Europe. Namely, that abstract mathematical activity is good in itself and must therefore be supported, even if it seems on the surface to be useless. This argument raises the question of the relation between mathematics and culture which should be our first problem to address if we are thinking of Basic Mathematics for all in this country.

While the particular curricular patterns of different societies vary, the subject is still constructed in most places so that few of our students who begin the study of mathematics continue taking the subject at the tertiary level. The separation of our students into groups who we tag as mathematically able and not able is endemic. Our curricula is constructed from above, starting with senior levels, and adjusted downwards. Most of us then centre on this curriculum for the able. However, we must consider also the problem of conceiving, a mathematics which is appropriate for those who will not have contact with pure mathematics after their school days. Up to now we have made most of our pupils sit at a table without serving them break fast. Most attempts to face the problem of a basic curriculum reduce traditional curriculum by watering down every mathematical idea and every possible difficulty to make it feasible to teach the remaining skeleton to the majority.

If we want to improve the situation of Universal Basic Mathematics Education (UBME), we must bring about cultural shift in our country, work towards a better integration between Basic Mathematic Education for all and the world to which we send our pupils and design appropriate mathematics program in the Teacher Training Institutions.

Finally we must change the negative attitude of our student teachers by equipping them with more of the structure and nature of mathematical concepts.

Mathematics Connection Vol.2, 2001

References

- Blok A, Gusev B. A. et al (1987) Methods of teaching Mathematics in Schools. Mir Publishers Moscow
- Cherkaso P. C. (1987) Educating the Child in the process of learning Mathematics. Mir. Publishers Moscow.
- Damerow P. & Westbury 1 (1985) Mathematics for all – Problems and implications. Journal of Curriculum Studies.
- D'Ambrosio U. (1985) Socio-cultural bases for Mathematics Education. Campunois, Brazil, UNICAMP
- D'Ambrosio U. (1994) Cultural framing of mathematics teaching and learning. In R. Biehler, R. W. Scholz et al. Didactics of mathematics as a scientific discipline (pp. 443 – 255)
- Frankenstein M. (1995) Equity in mathematics Education: Class in the World outside the class. In W. G. Secada, E. Fennema et al. New directions for equity in Mathematics Education New York, Cambridge University Press.
- Noss R. (1994) Sets, lies and stereotypes. In S. Lerman. Cultural perspectives on the mathematics classroom (pp. 37.49). Dordrecht: Kluwer.
- Thomas J. (1992) Politics and mathematics education in Australia. In B. Atweh and J. Waston (Edu.) Research in mathematics Education in Australasia (1988 – 1991) Brisbane

**JOURNAL OF THE MATHEMATICAL ASSOCIATION OF GHANA,
VOLUME 14, 2002**

CALL FOR PAPERS

The Journal of the Ghana Mathematical Association of Ghana aims at:

- reporting and disseminating theoretical, empirical and expository reports in the area of mathematics, education and mathematical education, in countries throughout the world;
- promoting the understanding of the interactions between mathematics, education, technology and industry;

The journal attaches considerable importance to research applicable to mathematics and education practice. Studies in all aspects of mathematics – pure mathematics, applied mathematics, mathematics in the primary, secondary and tertiary curriculum, and other aspects of mathematics education.

Preparation of manuscripts

Authors are reminded that the journal aims at a wide international readership. Papers should contain a clear description of the general and specific settings to which they relate. They should also point out the relevance of results and insights to other creative settings.

Papers submitted should be:

- original written in English and between 3,000 and 4,000 words (between 12 - 15 pages);
- typed using the APA format, preferably with MS-Word software, and in double-space;
- copied on a diskette and three copies printed on to A4 sized paper;
- provided with an abstract not exceeding 200 words in single line space.

Please send your contributions to:

THE EDITOR,

MAG Secretariat

Mathematical Association of Ghana (MAG),

Department of Mathematics, University of Cape Coast, Cape Coast, Ghana

Mathematics Connection

Vol. 2, 2001

CONTENTS

- EDITORIAL: Communiqué Adopted at 27th Biennial National Conference
MAG's Message of Fraternal Greetings to STME Clinic in Central Region
Mereku, K. D. 3**
- Mathematics Crises in our schools: Causes and Remedies
Osafo-Affum B, 4**
- Mathematics Education and Continuous Assessment in Ghanaian
Senior Secondary Schools: Continuous Assessment of What.
Fletcher J. A., 7**
- Mathematical Investigations in the Reviewed Basic School Curriculum
Nabie, M. J., 12**
- Research in Graphing Calculator Use. A Preliminary Report
Dontwi I.K., 16**
- Computers in the Mathematics Curriculum: Spreadsheets
Mereku K. D, 19**
- Calculators and Mathematics Curriculum in Ghanaian Schools
Duedu C.B., 21**
- Gender Differences in Mathematics Achievement in Primary Schools in Ghana
Wilmot E.M., 25**
- The Use of Information Technology in Teacher Education
Yidana I & Asiedu-Addo, S. K. , 30**
- The Scientific Calculator as a Tool for Mathematics and Learning
Nabie, M.J. Yidana I., 34**
- How about a Career with Mathematics?
Adajajsa, F., 39**
- Report on the 27th Biennial National Conference Workshop
Hlorgbe, F., 42**
- Secretaries Report: 2000 - 2002
Anokye S., 50**
- History of Mathematics Association of Ghana in Ashanti Region
Addae Wireko K., 52**
- Report from the Eastern Region
Tetteh G.K., 56**
- Ethnomathematics: What is it?
Okpoti, C. A., 57**
- Many Rivers to Cross
Cofie, P. O. 61**

ISSN: 0855-4706-

Printed by SEDCO Publishing Ltd, Accra
Tel. 021 221332 or 020 2113117