Mathematics Education in Papua New Guinea; A challenge

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Abstract: Papua New Guinea is a developing country with limited resources and a weak economy. The literacy rate among the three million population is around 40 %, majority of these are only primary school educated (UNDP, 1995). Girls in PNG are not encouraged to study, especially in rural areas. They help the families in taking care of the young siblings, gardening and other household chores. The boys are expected to study, take up jobs and make a financial contribution to family's expenses. Women in Papua New Guinea are not involved in major decisions involving social, economic and political directions of the country. This is mainly due to the reasons that they lack the necessary qualifications which would empower them to participate in these fields. There should be a policy to integrate women fully in the society as major players. It is therefore an utmost priority that women should be encouraged to take appropriate professional qualifications leading to these top management jobs. In his recent article in the Post Courier (March 2006) in Papua New Guinea, Tawaiyole (2006) explores the benefits of investing in female education and the significant social role they play.

"Most parents living in rural villages and urban settlements depend on subsistence agriculture for their livelihood. The incomes they accrue from these activities are insufficient to afford vital services, including education for their children. Research shows that many parents think that the best returns are through educating sons rather than daughters. These views affect the level of support provided for their children's access, participation, retention and completion of education at the different levels"

It is difficult for people living in the developed industrialized countries to imagine that there are still countries in the world, where education of girls is a serious issue due to lack of resources, social pressures and demands. In Papua New Guinea, it has been a challenge to educate girls at different levels of schooling. It is even more difficult at the university level. In this paper we report in brief some of the attempts made by the Department of Mathematics and Computer Science at the University of Technology in Lae, Papua New Guinea to promote Mathematics among Papua New Guineans and to attract female students to Mathematics by way of making it a challenging activity. We found that the problem solving activities in informal and more formal manners like Mathematics Competitions created interest among PNG students who come from a unique background, both socially and culturally.

In the context of ability of PNG students to solve Mathematical problems, we have to take into account that for most of them, English is a second or a third language. Therefore learning a subject in English involves multiple translations. Many times the students find it hard to interpret a problem correctly but they are able to solve the problem if it is interpreted for them (Lean, 1991). They face difficulty in solving Mathematical logic problems, especially problems which involve the correct use of English interpretation.

For example, consider the following problem:
If two dice are thrown, what is the probability of obtaining the sum of at least 8 on the top faces?

Many students would find it hard to interpret correctly the word "At least". They also have difficulty in interpreting the words like "at most, more than, less than, not more than, not less than, maximum, minimum etc". The meanings of these and similar words get distorted by the time they pass through multiple translations.

With the reduced the threat of learning Mathematics in a second language, we have found that the use of Computer Algebra Systems has helped the PNG students to improve their Mathematics (Majewski, 1995).
A list of sample questions is given in the Appendix.

Introduction:

"Women play a significant role in terms of social benefits. Current indications are that infant and maternal mortality rates are high among women, as are illiteracy and unemployment. Findings from international researchers and organisations such as the United Nations have shown a positive correlation between the education of women and improvements in the health of women and children. They have also shown a correlation between education and reduced fertility. Women's education not only has private benefits, it has substantial social benefits as well." ((Tawaiyole, 2006)

Social and cultural customs influence gender differences in education in Papua New Guinea. There is a system of "Bride Price" in PNG where a bride groom's family pays in cash and kind in order to "purchase" the bride. This bride price is determined by a negotiation between the two clans and the alliance is considered as final only when these expectations from the bridegroom's clan are met. In such circumstances, if the boy is educated, he contributes to his own bride price more effectively. The education of the girl does not necessarily increase her bride price. Hence, due to financial constraints, if parents have to make a choice, they have no incentive to spend money on their daughter's education.

Papua New Guinea is a country of countless small, isolated communities with 700 dialects and numerous counting systems (Lean 1991). Majority of Papua New Guineans speak one of the two national languages, Pidgin and Motu and their village language. 86% of the population lives in rural areas, where good schooling is very difficult to find. The children have to walk a long distance for schooling. Therefore parents in rural areas do not want their young daughters to walk for schooling due to safety reasons. With so many odds against their education, it is not surprising to see that the female literacy is low and therefore the participation of women in the work force, especially in top management jobs, is scarce.

Percentage of Females Representing Various Professions in Papua New Guinea

The following UNDP report in 1995 describes the gender differences in various fields in Papua New Guinea:

Percentage	Females	Males
Wage Income	31.2 %	68.8 %
Life Expectancy	56.7Yrs	55.2
Literate	40.3 %	49.5%
School Enrollment	30.3%	37.3%
Seats in Parliament	0.0%	100.0%
Share of top jobs in management	11.6%	88.4%
Professional and technical	29.5%	70.5%

There has not been a significant increase in the female percentages in the past ten years. The representation of women in Parliament is still less than 3%. School enrollment is increasing due to government efforts, church organizations and women's NGO's etc.

Education System in PNG

The provincial school system is an inheritance from PNG's colonial era, both in its curriculum and overall design. Structured loosely on the old missionary schools, the educational system is designed to train Papua New Guineans to become skilled manual workers or low level administrators (Sukthankar, 1999). The schooling system in Papua New Guinea is divided into three parts, 6 years of primary, 4 years of secondary and 2 years in National High schools. There are only a small number of seats available in high schools and therefore there is student- attrition at grade 6, 8 and 10. Due to a limited number of seats available in the national high schools, the privileged students who get into the national high schools try their best to complete the grade 12 year. The attrition rate for grades 11 and 12 is low (Wilkins, 1994). These are the students aspiring to take up higher education in the universities and technical colleges. The number of females entering the universities is less than 25% (Sukthankar, 1999). At the PNG University of Technology, majority of these female students opt for diplomas in applied sciences and business studies. These courses do not require higher level courses in Mathematics as their prerequisites.

Mathematics is still regarded as a male subject, especially in Papua New Guinea. Boys have always dominated the classroom discussions and are expected to do better in education than the girls. This has been the expectation of teachers, parents and also the girls themselves to a certain extent due to the social and cultural norms. The girls are often shy and are silent listeners. They do not initiate any classroom discussion or mathematical activity (Wilkins, 1994). The choice of subjects in schools and tertiary institutions for females is mostly dependent on the attitudes of parents and teachers, social customs etc. In some schools, there is a segregation of topics: drawing, wood work for boys where as sewing and craft for girls. Majority of girls try to take up a job after passing grade 10 or before. Even at the high school level, very few girls take higher mathematics courses. This prohibits them from taking courses like engineering, medicine and other professional courses at the University level.

The Department of Mathematics and Computer Science at the PNG University of Technology Lae, conceived the idea of getting involved in a programme to promote Mathematics among PNG students, especially the females. The aim was to improve overall understanding of Mathematics among PNG students in general and to increase the female enrolment in various professional courses. The staff, with the help of teachers, made special efforts to target potential students at High school and University level, encouraging them to take higher courses in Mathematics.

"Fun with Mathematics and PNG Mathematics Competition"

In 1992, to popularise Mathematics at the University and college level, we started a feature "Fun with Mathematics", by publishing mathematical quizzes, in the University of Technology weekly publication. We first introduced Mathematical logic quizzes with solutions and then converted the feature into a weekly problem solving competition. The problems were designed to create interest in Mathematics and by challenging the students to solve the problems by giving them some clues for maximum participation. We found that a little help from the lecturers made a big difference in the number of participants, who used the clues to research a particular topic and arrive at a solution. There were prizes awarded every week to the winning students. The student response to the quizzes was excellent and therefore the Department of Mathematics and Computer Science decided to extend this feature of Mathematical quizzes to publications of other universities and tertiary institutions in PNG. This idea soon culminated into the annual "Papua New Guinea Mathematics Competition" for all tertiary institutions.

The P.N.G. Mathematics Competition for University and Colleges in Papua New Guinea was started in 1992 with the main objective to create interest in Mathematics for tertiary students by giving them a challenging activity in a competitive atmosphere. We organized special meetings in cooperation with the students' unions to stress the importance of learning Mathematics and participating in the competitions. Special problem solving sessions for students were arranged. Starting with easier problems, we gradually introduced the more and more difficult problems involving logical thinking, arithmetic and algorithms. These sessions helped all the students; especially it gave encouragement to female students for participation.

The Department of Mathematics and Computer Science, University of Technology, Lae had been solely responsible in designing and execution of this competition. It is being held simultaneously in all these institutions on a fixed day of the year. In the first year of the competition, about 1500 students participated and the number has steadily increased over the years. Four universities, 14 technical and agricultural institutions took part in the competition. The competition was held in three categories, Category 1 for first and second year students, Category 2 for third and fourth year students and the open category was introduced mainly for graduate and the mathematically motivated people in the community. Ever since the competition had started, the funding for the competition had been provided by many business houses in Lae and the Vice Chancellor's office of The University of Technology.

The question paper of the competition normally consists of all multiple choice questions based on College Mathematics, Mathematical logic and Geometry. The problems are not related to the course curriculum; however the students are expected to use their Mathematical knowledge, application skills and some intuition to arrive at a solution. In the first year of the competition, the students were provided with a sample question paper. Special sessions were held on how to solve such problems. We have continued this practice ever since, which has attracted many students to come forward and make an effort to participate. The main reason to introduce "Fun with Mathematics", the weekly problem-solving feature and the annual "PNG Mathematics Competition" was to challenge PNG students to solve Mathematical problems.

Challenging Mathematical activities for female students, a case study:

A study was conducted of 10 first year female students from the PNG University of Technology. They identified themselves as having low self concept in their ability to learn mathematics. They had felt less confident in classroom discussions and always kept themselves aloof from the so called intelligent male students in the class. Their performance in the term tests showed that they were above average students in most of the subjects but they lacked the ability to do better in Mathematics. We wanted to find the reasons behind these negative attitudes and to examine whether it was possible to see any positive changes by involving them in challenging Mathematical activities,

The study was conducted over a period of one academic semester in 1997 (Sukthankar and Wilkins, 1998). During the first half, they were interviewed and were closely monitored about their performance, manner of study, class room participation. Then in the second half, they were given help individually, depending on the observations made by the researchers during the first half of the semester. The lecturers were requested to give them extra help to understand the course work. The students were given special assignments. The details of the solutions were thoroughly discussed and necessary improvements were suggested by the respective lecturers. They were also given extra help to prepare for the term tests. After the tests, their strength and weaknesses were discussed and appropriately they were tutored. The results of these efforts were very encouraging. The students were interviewed weekly and their responses were recorded.

We learnt from the interviews that the use of computer algebra systems was very beneficial for their course work and for the understanding of Mathematical concepts.

Initially the students did not show much enthusiasm in the course work since they were not performing well, but as the time passed by, we found a positive change in their attitude towards Mathematics. They began asking for more problem-solving sessions, they had the confidence and the will to do better in Mathematics. The next step was to expose the students to the competitive nature of problem solving. In fact they themselves showed special interest to participate in the weekly Mathematics quizzes and the Annual Mathematics Competition. Over the period of almost six months, we found that there were some positive changes in their attitude towards Mathematics. Their performance in their respective courses was also improving.

Although the sample is small and not random, this study tells us that it is possible to improve the Mathematical understanding of a small number of females in Papua New Guinea if they are given the right kind of atmosphere, especially when they come from a background which does not positively support or encourage their education. During the interviews, we also found that their main cause of non ability to do Mathematics was deeply rooted into the social and cultural factors of PNG Society. Overall, they felt incompetent, had a low self esteem and could not see the relevance of studying higher Mathematics once they could do the basic primary Mathematics.

These are some quotations from the interviews which give us an insight into their social and cultural issues:

Jenny:
"I felt negatively about Mathematics from grade four onwards, the topics were getting harder and I had no help from home or from my Math teacher. He used to talk mainly to the boys, who answered his questions. We girls always felt ignored and less confident since we could not answer the questions and hence we always sat at the back, hating the Mathematics class. Although I could pass my tests, it was a struggle to fit in"

Kana:
"I always liked Mathematics till I was in grade five, after that I started feeling less confident since the Mathematics was becoming more complicated and I had no help. Now I feel I would have regained my self confidence if I had somehow got over those initial difficulties; I think it is the first step towards the downfall that should be somehow avoided. The use of Computer Algebra Systems in the university has helped me to learn and visualize some of the mathematical concepts faster. I can check my working and answers using CAS. This has helped me to regain my confidence. I am not only doing better in Mathematics but also in other subjects as well."

Grace:
"Most of the lecturers in the Tertiary level were males and hence there were not many female role models. We always were made to believe that only males succeed in Mathematics. After this extra coaching and help in the University of Technology, my results are excellent. Now I try to be a role model for some of my classmates and other students in the University and the community.

Maria:
"Studying Mathematics in a relaxed atmosphere with the support of the professors helped me in regaining my confidence. Mathematics is not only for male students, females can do even better than the males as I have managed to prove for myself and many like me who have been dreading to take higher Math Courses for lack of confidence and low self esteem."

It was a common opinion of the researchers that studying Mathematics under favourable conditions boosted the confidence of these students. They found an incentive to study and discuss Mathematics, which they never had done before. This positive attitude was a deciding factor for them to compete and ultimately win in the Mathematics competition. During the following year, these girls participated in the PNG Annual Mathematics Competition. This time we found that all of them were very enthusiastic and there was an urge for them to do better. The results were very encouraging, out of 10, 4 passed, 4 received credits, 1 passed with Distinction and one of these girls, Maria, received the first prize in her category. Her new found success in the Math Competition boosted her morale. She later joined the degree course in electrical engineering. She has become a success story and a role model for other Papua New Guinean female students.

Conclusion:

To improve the quality of Mathematics Education among students in Papua New Guinea is a challenging task for Mathematics Educators. There are strong cultural and social factors which have a serious effect in educating children, especially females in Papua New Guinea. The study has encouraged us to continue our efforts to promote Mathematics, especially among females in Papua New Guinea. The feature "Fun with Mathematics" was a humble beginning and the effort has been very successful beyond our expectations. The "Mathematics Competition" has brought together all the tertiary institutions to make a joint effort to attract students to Mathematics and females in particular. We had to struggle to get the finances required to continue the competition annually, but we have somehow managed with the help of business houses and from the university grants.

There is still a lot of effort needed at the primary and high school level. It is a mammoth task, but we feel that a beginning has been made. There is awareness among the policy makers of PNG to increase the literacy. The real challenge is to break through the social barriers without any disturbance and encourage women to go for higher education and achieve their full potential.

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Appendix

Q.1 1936 was the only year in the twentieth century which shows a perfect square number. There is also only one year in the 21st century which has this property. Which year is it? There is one such year in every succeeding century after that until, for the first time there won't be a square number in a century. When will that be?

Q.2 Multiplying two numbers, we find that the last three digits in the product are 147. If the last three digits in one of the two factors are 729, what are the last three digits of the other factor?

Q.3 A cube of side 4cm is made up of individual 1cm. cubes. The number of these 1cm. cubes which are face to face with exactly four other 1cm. cubes is
(A) 20 (B) 24 (C) 48 (D) 40

Q.4 A manufacturer places a four-symbol code on each unit of a product. The first three symbols are numbers with the first not 0, and the fourth symbol is a letter other than O. How many codes are possible?

Q.5 There are 17 cubes of exactly the same dimensions, 5 red, 4 blue, 6 green and 2 white. How many distinguishable linear arrangements of all the 17 cubes are possible?

Q.6 Tim and John celebrate their birthdays today. In three years, Tim will be four times as old as John was when Tim was two years older than John is today. If John is a teenager, what is Tim's age?

Q.7 Alfred, Barbara, Charles, Dean and Emily play a game in which each is either a cat or a dog. Dog's statements are always false while cat's statements are always true.

Alfred says that Barbara is a cat
Charles says that Dean is a dog
Emily says that Alfred is not a dog
Barbara says that Charles is not a cat
Dean says that Emily and Alfred are different kind of animals.
How many dogs are there?

Q.8 On Tuesday a store advertised a special sale for Wednesday. On Wednesday it was found that 60% of customers had known about the sale and, of these customers, 40% bought a sale item. Of the customers that had not known about the sale, 20% bought a sale item. If a customer bought a sale item, what is the probability that he or she had known about the sale?

Q.9 Two fair dice are rolled twice. Find the probability of getting a total of 6 on one of the rolls and a total of 11 on the other one.

Q.10 21 is a square of 12 in the number base

(A) 5 (B) 3 (C) 7 (D) None of these