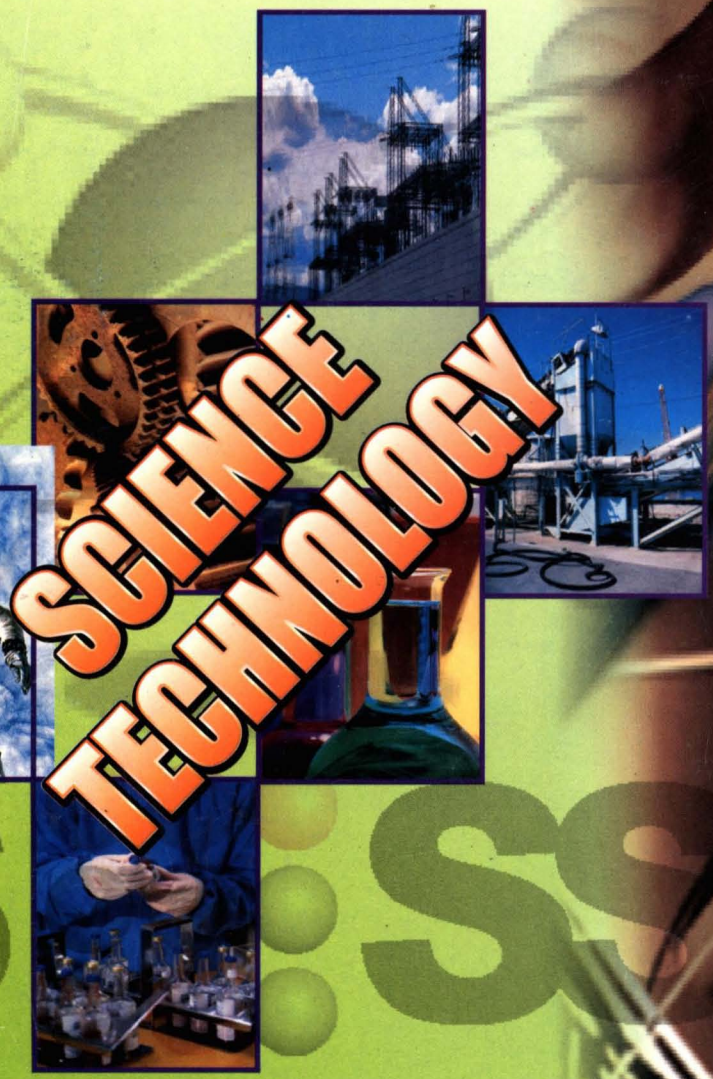
UNIVERSITI TEKNOLOGI MARA

ISO 9001:2000 No Sijil :0500132

Globalising Knowledge and Information



NATIONAL SEMINAR ON SCIENCE TECHNOLOGY & SOCIAL SCIENCES 2006

30-31 May 2006

Swiss Garden Resort & Spa

Kuantan, Pahang

The Importance of Mathematics in Computer Science

Z. Abal Abas
A.F.N. Abd Rahman

ABSTRACT

This report will analyze the performance of 220 first year ICT undergraduate in KUTKM in two subjects that are offered concurrently in order to test the initial hypotheses which stated that those who are doing well in mathematical subject are believed to do well also in computer science area especially in programming. Thus, two subjects namely BACS 1253 – Mathematic for Computer Science 1 and BITP 1113- Programming Techniques were chosen and the student's marks for the final examination and the total marks for each of them are gathered and analyzed by using SPSS. Pearson correlation is chosen since the data gained is quantitative and normally distributed with linear relationship according to the scatter plot graph. The result obtained from this report will be then used to highlight the significance of mathematical foundation in any computer science curriculum.

Keywords: *Mathematics, Computer Science, Relationship, Significance*

Introduction

Mathematics has always been considered as a tough and difficult subject among students. However, it is believed that for those who are very good in mathematics may have an excellent opportunity to be good in other subjects such as physics, chemistry and many others especially those area that required technical skills since it can help in developing logical thinking. This paper presents the relation of the performance in mathematics among ICT students in KUTKM with the performance of selected technical subject.

The purpose of this report is to :

a. Evaluate the average performance of first year ICT students in BACS 1253 -Mathematics Computer Science 1 and BITP1113- Programming Techniques in the year of 2004 through out the first semester.
b. Investigate the relation between performances in both mathematics and programming subject as there are believes among academician 'those who are strong in mathematics can be good in programming as well' as initial hypothesis.
c. To acknowledge the significance of learning mathematics in the study of computer science area.

This report is based on the study done by collecting 220 observations among first year ICT degree students in the year of 2004 in the first semester. The collected data are concerning on final examination marks and overall marks for both subjects. The selected subjects to be evaluated are only Mathematics for Computer Science I (BACS 1253) and Programming Techniques (BITP 1113) which is offered concurrently in first semester every year. Programming Techniques, which is considered as a technical subject is a core subject covering C++ language programming in Computer Science area. Meanwhile, Mathematics for Computer Science 1 covered two discipline of Mathematics; Linear Algebra and Mathematics Discrete.

The study examines the average performance of the students for both subjects throughout the semester. The result is then used to determine the existence of relation between the subjects to test the hypothesis of correlation between the performance of mathematics and computer science subjects.

This paper begins with an introduction of the report and this is expanded in the following chapter by literature review of mathematics and its relation with computer science. A discussion then follows on the methodology applied to achieve the objectives of the report followed by the result obtained using statistical analysis. Finally, the last chapter is the conclusion and recommendations for possible improvement.

The Feature of Mathematics

According to Brown and Porter (1996), "mathematics is about pattern and structure; it is about logical analysis, deduction, calculation within these pattern and structures". Mathematics is the purest among all sciences, which it is actually a concept, creativity, invention and solution.

It is not only dealing with number but it also has great contribution to human thought and creativity (Clarkson.edu 2005). The contribution is also to some extend for the wealth of the country (Brown & Porter 1996). There is a wide range of area of mathematics to be explored such as linear algebra, discrete mathematics, calculus,

numerical analysis and a lot more. It is a diverse and fascinating discipline with constantly rejuvenated and it is very much alive as it is heading into the 21st century.

Brown and Porter (1996) stated that there are some of the features that allow mathematics to provide a solid foundation to many aspects of daily life, and to give a comprehension of the complexities inherent in apparently quite simple situations. It is the methods of precise definitions; careful and rigorous argument; representation of ideas by many methods, including symbols and formulae, pictures and graphics; means of calculation; and the obtaining of precise solutions to clearly stated problems, or clear statements of the limits of knowledge.

The Importance of Mathematics

It is well known that the application of advance mathematics is widely used. It has been developed from the study of general ideas such as numbers, symmetry, area and volume, rate of change, shape, dimension, randomness and many others (Brown & Porter 1996).

Its significance can also be explained indirectly in developing imagination, training clear and logical thinking which can be related to the fundamental of human thought and creativity. This can be proved by the imagination of mathematicians stirred by its rigorous nature, which forces them to follow through the logic of their ideas. For example, the development of some ideas such as *theory of knots* since 1870 are now been applied in physics in relation to quantum theory, and in biology in relation to the way DNA unknot itself before dividing (Brown & Porter 1996).

However, Mathematics serves as a tool not only for modeling observations in the physical and biological sciences but as an instrument of imagination for peering beyond the possible (kily.sac.on.ca 2005). This can also be regards as an abstract thinking with an elegant side at many points in professional life.

Critical thinking can also be developed through the process of learning mathematics as a whole and this will leads to the way of thinking and approaching problem in a more sophisticated fashion. For example, one of the areas of mathematics; Logic and Axiomatic help in developing critical thinking tools (kings.edu 2005).

Besides that, a mathematical approach to problem solving (understanding the problem; considering a variety of possible strategies; carrying out one promising method; evaluating the solution) will serve greatly in many non-mathematical contexts (kilby.sac.on.ca 2005). It can helps in developing clarity of thought and expression.

Relation between Mathematics and Computer Science

The concept of programmable computer was first led by the analysis of the methods of mathematics by mathematicians, philosophers, logicians and engineers (Brown & Porter 2005). As a language of specification and verification for synchronizing related work, deep mathematics is highly needed and this is likely to grow. This is because the field of computer science keeps on mature, which in return, more sophisticated analysis techniques are used in practical problems. Consequently, the students need strong background in mathematics especially in discrete structure in understanding the computational techniques of the future.

In the process of understanding computing ideas, mathematics provides a language for working with ideas relevant to computer science, specific tools for analysis and verifications and a theoretical framework. This is also agreed by Knuth notes in the preface to *The Art of Computer Programming*, "The construction of a computer program from a set of basic instructions is very similar to the construction of a mathematical proof form a set of axioms" (Baldwin 2001).

According to Henderson (2001) and Baldwin (2001), mathematical reasoning reinforces abstraction techniques which are important for computer based problem solving. They strongly believes the natural synergism between mathematics, logic and computer based problem solving, where the former are powerful tools for the latter.

Methodology

In order to determine the average performance of the students for the selected subject, statistical data analysis using SPSS software is selected as major methodologies in this study after all the data had been gathered. All the data which include final examination marks together with total marks (course work and final examination) for BACS 1253 and BITP 1113 among the students were entered in SPSS data editor.

Analysis of descriptive statistics is done to figure out the average performance of the students in both subjects using total marks. To examine the existence of relation between the performances of these two subjects, a graph needs to be plotted. Analysis of correlation, which is selected for further analysis, had been done to figure out the value of the correlation if there exists the relation of these two subjects.

Correlation measure how the variable or rank orders are related. Pearson correlation is chosen since the data is quantitative and normally distributed with linear relationship according to the scatter plot graph. Correlation coefficients is range in value from –1 (a perfect negative relationship) and +1 (a perfect positive relationship). A value of 0 indicates no linear relationship. The test of significant is a two-tailed test with significant value of 0.01.

Correlation analysis is done for the overall performance of the students throughout the first semester which involve course work and final examination. Correlation analysis is also done for only the performance in the final examination.

Results

Table 1 shows the result of descriptive statistic for both BACS1253 and BITP1113. Both subjects have a normal distribution based on the histogram in Figure 1 and Figure 2. The average score for Mathematics Science Computer 1 is 63.9% with standard deviation of 13. On the other hand, the average score for Programming Techniques is 59.5% with standard deviation of 10.3. It can be noted that the average performance of the students for both subject is slightly similar.

Table 1: The Result of Descriptive Statistics

	N	Min	Max	Mean	Std. Deviation
BACS1253	220	14.00	93.00	63.9091	13.06433
BITP1113	220	9.00	93.00	59.5455	10.30329
Valid N (listwise)	220				

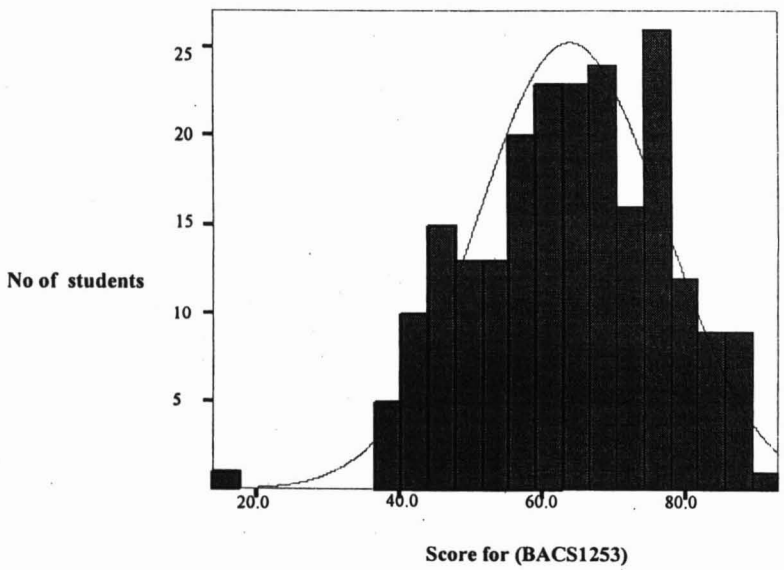


Fig. 1: The Distribution of the Score for Mathematics Computer Science 1 (BACS1253)

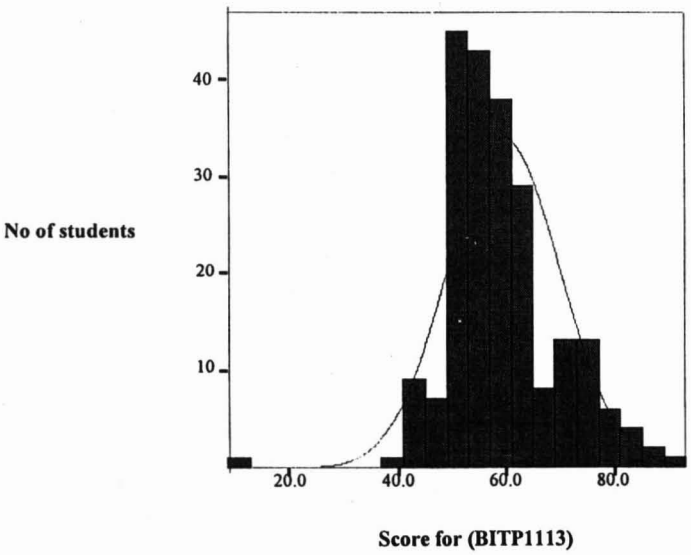


Fig. 2: The Distribution of the Score for Programming Techniques 1 (BITP1113)

Figure 3 shows the relationship between the performances of both subjects by using total marks. It can be noted that there exist a linear relationship between this two variables.

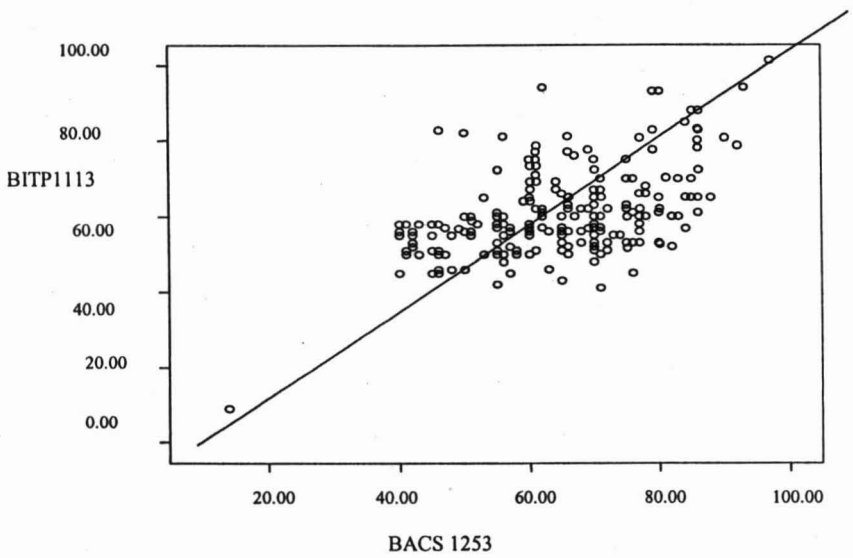


Fig. 3: Graph shows the Linear Relationship between the Performance of Mathematics for Computer Science 1 and Programming Techniques.

Table 2: Pearson Correlation analysis between Mathematics for Computer Science 1 (BACS1253) and Programming Techniques 1 (BITP1113)

		BACS 1253	BITP 1113
BACS 1253	Pearson Correlation	1	.459(**)
	Sig. (1-tailed)		.000
	N	220	220
BITP 1113	Pearson Correlation	.459(**)	1
	Sig. (1-tailed)	.000	
	N	220	220

Further analysis had been done to test the initial hypothesis. Therefore, analysis of correlation is generated and the result is shown in the table 2. The performance yields that Pearson's correlation coefficient (r = 0.459) is significant at the 0.01 level. We might suspect that the higher the performance of the students in mathematics, the higher the chances of becoming strong in programming techniques subject.

The second correlation analysis had been done concerning only the performance of the same students in final examination for both subjects. The performance yields that Pearson's correlation coefficient (r=0.552) is significant at the 0.01 level. The correlation for the performance of the students in only final examination for both subjects suggests strongly that there is relation between the performance in mathematics and programming techniques subjects.

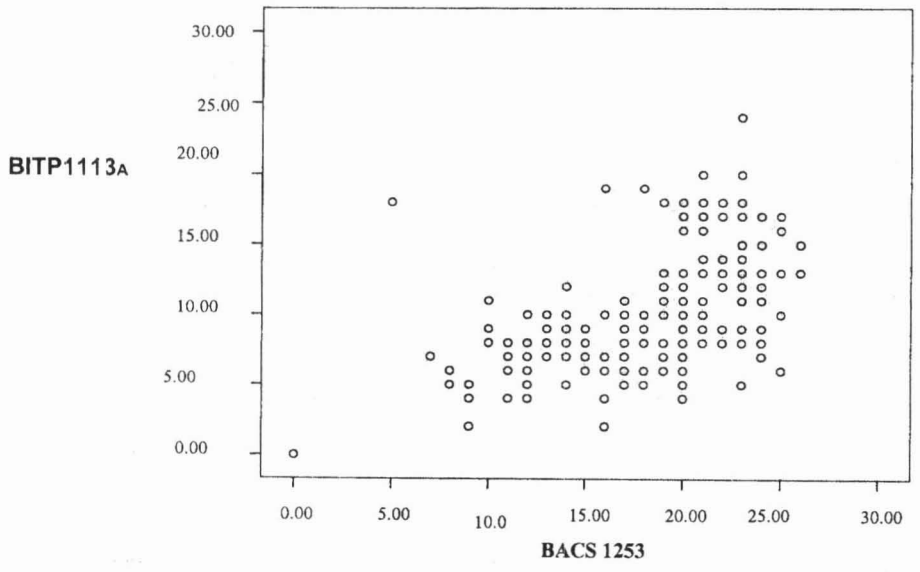


Fig. 4: Graph shows the Linear Relationship between the Performance in Final Examination for both Mathematics for Computer Science 1 and Programming Techniques 1

Table 3: Pearson Correlation Analysis between the Performance in Final Examination for both Mathematics for Computer Science 1 (BACS1253) and Programming Techniques 1 (BITP1113)

		BACS 1253	BITP 1113
BACS 1253	Pearson Correlation	1	.552(**)
	Sig. (2-tailed)		.000
	N	220	220
BITP 1113	Pearson Correlation	.552(**)	1
	Sig. (2-tailed)	.000	
	N	220	220

This proves that there is possibility of the students to be excellent in programming if they are strong in mathematics. This is true since mathematical thinking helps students understand problems, conceptualized algorithms, debug them and devise test plan (Baldwin, 2001). Hence, it is a fact that in the process of understanding computing ideas, mathematics provides a language for working with ideas relevant to computer science, specific tools for analysis and verifications and a theoretical framework as well as indirectly developing imagination, training clear and logical thinking which can be related to the fundamental of human thought and creativity.

Conclusion and Recommendation

The intent of this report is to evaluate the performance of the first year ICT students in KUTKM in mathematics particularly in Mathematics for Computer Science 1 (BACS 1253) and Programming Techniques (BITP 1113). In overall, the performance is average following normal distribution. It is also aim at investigating the existence of relation between the performances of mathematics and programming.

The study has proved that there exist quite strong relations between the performances of these two subjects whereby it suggest that the students with strong Mathematical background could have opportunity to be excellent in the programming. In general, this report reveals the significance of learning mathematics especially in advance level in relation with computer science area.

Therefore, the study of mathematics is vital to be included in the computer science curriculum since it does gives an insight into how thinking mathematically has a great potential in developing great computer skills. As a matter of facts, logic is fundamental to understanding digital logic circuits. Mathematical relations enhance understanding of database systems. Probability and counting are needed for the analysis of algorithms and systems. Graph and trees are used for modeling and problem solving. Proof techniques are important for increasing confidence in and understanding of all software systems. Logic, mathematical relations, probability and counting, graph, trees, proof techniques and a lot more are all covered in discrete mathematics. Therefore, it is recommended that discrete mathematics will be taught as one solely subject in one semester instead of combining it with linear algebra as currently so that the students will be exposed sufficiently.

In short, mathematics is not only limited as a tool in the area of computer science, but it is also a mindset that fundamentally improves one's ability to devise and implement algorithm appropriately. Therefore, it is highly crucial for the ICT students to exercise their mathematical skills as well as their computational abilities, and on the other hand, the educators need to guide the students to use both ways of thinking to solve computing problem.

References

Baldwin, D. (2001, March). *How Mathematical Thinking Enhances CS Problem Solving.* SIGCSE Technical Symposium on Computer Science Education: pp. 390-391.

Brown, R. & Porter, T. (1996). *Why Study Mathematics.* Retrieved on 7 Sept 2005. [Online]. Available: http://www.popmath.org.uk/centre/pagescpm/imahob95.html

Donald, K. (1973) *Fundamental Algorithms (The Art of Computer Programming, Vol.1)*.2nd ed. Addison-Wesley: pp. ix.

Henderson, P. (2001, Sept 20). *Mathematics and Computing Curricula 2001 Connections.* [Online]. Available: http://www.cs.geneseo.edu/~baldwin/math-thinking/math-cc2001.html

_____. (2005, Sept 7). *Mathematics majors develop a sophisticated way of thinking and communicating* [Online] Available: http://www.kings.edu/academics/newsletters/MATH%20NLTR.pdf#search='Mathematics%20majors%20develop%20a%20sophisticated%20way%20of%20thinking%20and%20communicating'

_____. (2005, Sept 11). *The Importance of Mathematics.* [Online]. Available: http://kilby.sac.on.ca/departments/math/

_____. (2005, Sept 20). *Interested in Mathematics?.* [Online] Available: http://www.clarkson.edu/prospective/academics_majors/math.html

Z. ABAL ABAS & A.F.N. ABD RAHMAN, Kolej Universiti Teknikal Kebangsaan Malaysia, Ayer Keroh, 75450 Melaka.