



UNIVERSITI PUTRA MALAYSIA

**EFFECTS OF USING GRAPHIC CALCULATORS IN THE TEACHING
AND LEARNING OF MATHEMATICS
ON STUDENTS' PERFORMANCE AND
METACOGNITIVE AWARENESS**

NOR'AIN MOHD. TAJUDIN

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By

NOR'AIN MOHD. TAJUDIN

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Faculty: Institute for Mathematical Research

Three phases of quasi-experimental study with non-equivalent control group posttest only design were conducted to investigate the effects of using graphing calculators in mathematics teaching and learning on Form Four Malaysian secondary school students' performance and their level of metacognitive awareness. Experiment in Phase I was conducted for two weeks to provide an initial indicator of the effectiveness of graphing calculator strategy on students' performance and their metacognitive awareness. Graphing calculator strategy refers to the use of TI-83 Plus graphing calculator in teaching and learning of Straight Lines topic. The first phase involved one experimental group ($n=21$) and one control group ($n=19$)



from two Form Four classes in a randomly selected school in Selangor. The experimental group underwent learning using graphing calculator while the control group underwent learning using conventional instruction. Experiment for Phase II was further carried out for six weeks incorporating measures of mathematical performance, focused on metacognitive awareness during problem solving and in addition, measures of mental effort and instructional efficiency. This phase involved two experimental groups ($n=33$) and two control groups ($n=32$) from four Form Four classes in one randomly selected school in Malacca. As in Phase I, the same learning conditions were given for both experimental and control groups. Finally, experiment in Phase III was carried out for six weeks incorporating comparison on two levels of mathematics ability (low and average) and two types of instructional strategy (graphing calculator strategy and conventional instruction strategy). Form Four students from one of schools in Malacca were the sample for Phase III. Altogether there were four groups of students given four learning conditions vis-à-vis: the average mathematical ability given the use of graphing calculators ($n=15$), the low mathematical ability also given graphing calculators ($n=19$), the average mathematical ability given the conventional instruction ($n=16$) and the low mathematical ability given also the conventional instruction ($n=20$).



Four instruments were used in this study namely, Straight Lines Achievement Test, Paas Mental Effort Rating Scale, Metacognitive Awareness Survey and Graphing Calculator Usage Survey. The data for Phases I and II were analysed using independent t-test and planned comparison test while data for Phase III were analysed using multiple analysis of variance and planned comparison test. The study shows that the graphing calculator instruction enhanced students' performance and induced higher levels of their metacognitive awareness with less mental effort invested during the learning and test phases and hence increased 3-dimensional instructional efficiency index in learning of Straight Lines topic for both groups of low and average mathematics ability. These findings indicated that the graphing calculator instruction is superior in comparison to the conventional instruction, hence implying that integrating the use of graphing calculator in teaching and learning of mathematics was more efficient than the conventional instruction strategy. The average mathematics ability group benefited more from the graphing calculator instruction as it decreased the amount of mental effort by double than the low mathematics ability group. Further, most students in graphing calculator strategy group showed an overall favourable view towards integrating the use of the graphing calculator in the teaching and learning of mathematics. Even though some students experience difficulties in using graphing calculators initially during learning, they responded overwhelmingly that



graphing calculator improves their understanding of the Straight Lines topic and hence, the usage of the graphing calculator was an effective strategy in teaching and learning of mathematics.



Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

**KESAN PENGGUNAAN KALKULATOR GRAFIK DALAM PENGAJARAN
DAN PEMBELAJARAN MATEMATIK TERHADAP PRESTASI DAN
KESEDARAN METAKOGNITIF**

Oleh

NOR'AIN BINTI MOHD. TAJUDIN

Pengerusi: Professor Madya Rohani Ahmad Tarmizi, PhD

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Tiga fasa kajian kuasi-eksperimen dengan reka bentuk ujian pos bagi kumpulan kawalan tidak serupa dijalankan untuk mengkaji kesan menggunakan kalkulator grafik dalam pengajaran dan pembelajaran matematik ke atas prestasi dan kesedaran metakognitif pelajar sekolah menengah Malaysia Tingkatan Empat. Eksperimen Fasa I dikendalikan selama dua minggu untuk memberi indikasi awal keberkesanan strategi kalkulator grafik terhadap prestasi dan kesedaran metakognitif pelajar. Strategi kalkulator grafik adalah merujuk kepada penggunaan kalkulator grafik TI-83 Plus dalam pengajaran dan pembelajaran topik Garis Lurus. Fasa ini melibatkan satu kumpulan eksperimen ($n=20$) dan satu kumpulan kawalan ($n=19$) daripada dua kelas Tingkatan Empat dalam sebuah sekolah yang dipilih secara rawak di Selangor. Kumpulan eksperimen melaksanakan



pembelajaran menggunakan strategi kalkulator grafik, manakala kumpulan kawalan menggunakan strategi pengajaran konvensional. Eksperimen bagi Fasa II pula dikendalikan selanjutnya selama enam minggu dengan menggabungkan ukuran prestasi matematik, penekanan terhadap kesedaran metakognitif semasa penyelesaian masalah dan seterusnya ukuran daya mental dan *instructional efficiency*. Fasa ini melibatkan dua kumpulan eksperimen ($n=33$) dan dua kumpulan kawalan ($n=32$) yang terdiri daripada empat kelas Tingkatan Empat dalam sebuah sekolah yang dipilih secara rawak di Melaka. Kedua-dua kumpulan eksperimen dan kawalan menggunakan strategi pembelajaran yang sama seperti pada Fasa I. Akhirnya, eksperimen Fasa III juga dikendalikan selama enam minggu menggabungkan pula perbandingan ke atas tahap keupayaan matematik (rendah dan sederhana) dan jenis strategi pengajaran (strategi kalkulator grafik dan strategi pengajaran konvensional). Keseluruhannya, terdapat empat kumpulan pelajar dengan kaedah pembelajaran masing-masingnya iaitu: keupayaan matematik tahap sederhana dengan penggunaan kalkulator grafik ($n=15$), keupayaan matematik tahap rendah juga dengan penggunaan kalkulator ($n=19$), keupayaan matematik tahap rendah dengan pengajaran konvensional ($n=16$) dan keupayaan matematik tahap rendah juga dengan pengajaran konvensional ($n=20$).



Empat instrumen telah digunakan dalam kajian ini iaitu Ujian Pencapaian Garis Lurus, *Paas Mental Effort Rating Scale*, Soal Selidik Kesedaran Metakognitif dan Soal Selidik Penggunaan Kalkulator Grafik. Data bagi Fasa I dan Fasa II dianalisis menggunakan *independent samples t-test* dan *planned comparison test* manakala data bagi Fasa III dianalisis menggunakan analisis varian univariat dan *planned comparison test*. Kajian menunjukkan bahawa pengajaran menggunakan kalkulator grafik dapat mengukuhkan prestasi pelajar dan mencetuskan kesedaran metakognitif yang lebih tinggi dengan pengurangan beban kognitif semasa fasa-fasa pembelajaran dan ujian dan seterusnya meningkatkan indeks *instructional efficiency* 3-dimensi dalam pembelajaran topik Garis Lurus bagi kedua-dua kumpulan keupayaan matematik tahap rendah dan sederhana. Oleh itu dapatan ini memberi indikasi bahawa pengajaran menggunakan kalkulator grafik didapati lebih baik daripada pengajaran secara konvensional kerana pengajaran tersebut adalah lebih cekap berbanding pengajaran secara konvensional. Pelajar dalam kumpulan keupayaan matematik tahap sederhana memperoleh lebih faedah daripada pengajaran menggunakan kalkulator grafik kerana jumlah penggunaan daya mental berkurangan dua kali ganda jika dibandingkan dengan kumpulan keupayaan matematik tahap rendah. Seterusnya, kebanyakan pelajar dari kumpulan kalkulator grafik menunjukkan pandangan menyeluruh menyokong integrasi penggunaan kalkulator grafik dalam pengajaran dan pembelajaran matematik. Walaupun



terdapat sebilangan pelajar yang mengalami kesukaran menggunakan kalkulator grafik semasa pembelajaran pada awalnya, namun mereka memberi maklumbalas yang menakjubkan bahawa kalkulator grafik dapat mempertingkatkan kefahaman mereka tentang topik Garis Lurus dan justeru itu, penggunaan kalkulator grafik merupakan suatu strategi yang efektif dalam pengajaran dan pembelajaran matematik.



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I certify that an Examination Committee has met on 9 May 2008 to conduct the final examination of Nor'ain Mohd. Tajudin on her Doctor of Philosophy thesis entitled "Effects of Using Graphic Calculators in the Teaching and Learning of Mathematics on Students Performance and Metacognitive Awareness" in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The committee recommends that the student be awarded the Doctor of Philosophy.

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DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not currently, submitted for any other degree at Universiti Putra Malaysia or any other institution.

NOR'AIN MOHD. TAJUDIN

Date: 20th May 2008



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