STUDIES OF MATHEMATICS EDUCATION AT THE FACULTY OF EDUCATION, UNIVERSITY OF MALAYA: FOCUS AND DIRECTION

Lee Siew Eng
Sharifah Norul Akmar bt Syed Zamri
University of Malaya

Abstrak

Kertas ini membincangkan ulasan dapatan 73 kajian pendidikan matematik yang telah dilaporkan dari tahun 1972 sehingga 2000 di Fakulti Pendidikan, Universiti Malaya. Ulasan ini menyediakan gambaran keseluruhan kajian dan mengambil perhatian kepelbagaian data yang ada. la juga mengenal pastifokus dan isu dalam penyelidikan yang telah dijalankan dan mengaitkan dapatan kajian kepada pengajaran dan pembelajaran matematik yang berkesan dan bermakna, serta implikasi terhadap pengajaran dalam bilik darjah. Beberapa bidang kajian yang berpotensi untuk masa depan juga dicadangkan.

INTRODUCTION

The past three decades had witnessed reforms in the school mathematics curriculum in Malaysia, the moving from traditional mathematics to 'modern mathematics' followed by the Integrated School Curriculum Mathematics in 1989 (Asiah, 1982; Lim, 1995; Ministry of Education, 1988, 1989,1989b, 1992), the SMART school program (Ministry of Education, 1998) and the implementation of teaching school mathematics using English as a medium of instruction (Ministry of Education, 2002a, 2002b). The reforms also stimulated interest and the formulation of many research studies by the mathematics education community. The Department of Mathematics and Science Education at the Faculty of Education, University of Malaya, being the premier mathematics and science education department in the country, has conducted a substantial number of studies on mathematics education. The findings of these studies are rich but scattered (Nik Azis & Ng, 1992), and hence not disseminated to the community at large to help improve mathematics teaching and learning in the classrooms.

Also, under the inspiration of 'Vision 2020', Malaysia aims to become a technological and industrialized society. As such, it needs a strong professional and technical workforce which directly and indirectly places mathematics as an important component of basic education.

The Ministry of Education has taken many steps to encourage students to pursue mathematics and science courses (Abdul Rafie Mahat, 2002; Fong, 1993; Ibrahim Md Nor, 1995). Student interest could definitely be enhanced with more effective teaching

and learning of mathematics. Findings from research studies can enlighten and enrich educators to attain these aims (Begle & Gibb, 1980; Dylan, 1998; Kilpatrick, 1993). The rich but scattered findings and the Vision prompted initiation of the present study to document and review research studies on mathematics education in the faculty. This paper provides an overview of the findings from the research studies and also identifies the focus and suggests possible direction for future research areas.

Objectives of the Documentation

Documentation of studies in education had been carried out in the past, but these are mainly brief reports of dissertations, projects and activities conducted by educational institutions, including those of mathematics education (Fan, 1977; Frank, 1978; Kanagasabai, Chew, Koh & Leong, 1980; Lai & Loo, 1992; Leonard, 1989). Fan (1977) reported the dissertation materials available in the University Malaya library. Frank (1978) gave a comprehensive bibliography of doctoral dissertations of Malaya and Malaysia. Kanagasabai et al. (1980) had prepared an annotated bibliography on studies on Malaysian education between 1931 and 1978. Lai and Loo (1992) had only compiled a limited number of studies on mathematics education in the country. Leonard (1989) had gathered a list of dissertations at the Faculty of Education, University of Malaya. As such, detailed information on the studies particularly those on mathematics education, is not readily available. Thus, the findings of those studies are not shared and utilized for the betterment of mathematics instruction. For many who are interested in exploring the findings of these studies, the task becomes very time-consuming. It is therefore essential that research studies on mathematics education be systematically compiled and documented. Documentation will provide valuable information to teachers, parents, policy makers, research students and researchers on the possible happenings and further determine future directions of research in mathematics education. The findings will assist in identifying factors contributing to effective mathematics instruction that can serve as the basis for planning and initiating steps to encourage students to learn mathematics. Besides, this type of documentation will show the direction of future research.

The researchers have compiled and reviewed 73 research studies on mathematics education conducted and documented in the Faculty of Education, University of Malaya ranging from 1972 to 2000. This compilation is the first attempt to gather mathematics education studies aimed at identifying the focus of these studies. Specifically, the objectives of the study are to:

i) review and document studies in the area of mathematics education;
ii) identify the existing focus in the studies;
iii) draw implications for the effective teaching and meaningful learning of mathematics; and
iv) suggest directions for future research.

Documentation Process

This compilation and review are based on empirical research done at the Faculty of Education, University of Malaya. For the purpose of this documentation, mathematics education is defined as sets of events and activities which are deliberately intended to help learners acquire the ability to use mathematical operations, to understand mathematical relations and to use such ability and understanding to solve problems. With this definition, any research study reported until 2000 pertaining to mathematics education is included in this review. These reports are in the form of higher education theses, research reports and project papers of the postgraduate programs pertaining to Doctor of Philosophy and Master of Education.

The process of documentation of mathematics education studies conducted by post graduate students and faculty members follows a three-stage task: (i) identify and select studies in mathematics education available in the library of the Faculty of Education, (ii) compile the abstracts indicating the title, status and key-words related to each study (Sharifah & Lee, 2000), and (iii) analyze the abstracts and synthesize into areas of focus centralizing effective teaching and meaningful learning of mathematics.

Review of Studies in Mathematics Education

Within the limitation of availability and accessibility of materials, a total of 73 documents were selected for review as summarized in Table 1. The titles of these studies are classified in chronological order as in the Appendix. These studies are postgraduate research work comprising either those for the fulfilment of Doctor of Philosophy or Master of Education under the supervision of faculty staff. For the Master level, each study is further classified into Research Report, Project Report or Thesis. The variation of the academic reports depends on the structure of the program which is mainly determined by the number of credit hours. The report or thesis is in the form of partial fulfilment towards the type of course work program.

Table 1
Postgraduate Studies at the Faculty of Education, University of Malaya, from 1972 to 2000

	1972-1979	1980 -1989	1990-2000	Total
Thesis for Doctor of Philosophy	1		4	5
Master of Education:				
1. Thesis	4	13	16	33
2. Research Report			13	13
			1998-2000	
3. Project Report			22	22
Total				73

Table 1 classifies the studies of mathematics education over the last three decades conducted in the faculty. The number pattern shows a significant increase in the volume of research, particularly in the last decade. This could be attributed to the introduction of 'Modern Mathematics' in the 1970s and the fact that research studies in mathematics education was then slowly gaining in importance. There were only five studies conducted in the 1970s, but the number more than doubled in the 1980s (13 studies). The 1990s witnessed a big jump to 55 studies. This phenomenon was accompanied by the changing emphasis in national policy towards the provision of higher degrees, resulting from increasing demand for highly qualified mathematics and science teachers in schools for the year 2020. Also, many school teachers were encouraged to pursue their education not only to enrich their knowledge, but also to face challenges in the profession. Another contributing factor for postgraduate enrolments in mathematics education shifting to the present growth state could be the aggressive recruitment marketing strategy adopted by most of the tertiary institutions.

Focus of Studies

The present documentation and analysis were based on the findings of the studies and attempted to determine the focal research questions and approaches reflected by these studies. These studies are classified into 15 broad areas of focus studied by the researchers. It should be noted that certain studies have covered overlapping areas of focus. For example, the study by Teng (1997) analyzed the errors made by primary year six pupils in solving word problems. Though the study could be classified as error analysis, the emphasis was on the 'error cause' in terms of problem solving behaviors. Hence, this study was then placed under problem solving. Therefore, the classification did contain studies with overlapping focused areas. For the purpose of the present documentation, each study was classified under one issue of concern only.

These fifteen areas together with their respective studies are displayed in Table 2. Generally, studies on the schemes of mathematical concepts and constructivism are noted to be the major focus of research comprising a total 20 studies, with one each in 1990, 1992 and 1996 by Noraini, Hasnul and Aida respectively and the remaining 17 studies between 1998 and 2000. The next area concerns the understanding and conception of mathematical terms consisting of 10 studies; followed by eight studies on problem solving abilities and related factors. The other areas are associated with only a few studies. However, it does not imply these studies are insignificant. For example, two areas concerning the 'evaluation in mathematics instruction' and 'utilization of technology in mathematics instruction' have drawn the attention of the mathematics education community. The former is the evolution of assessment to be in line with the goals and objectives of mathematics education resulted in the curriculum reforms. The latter utilizes the rapid development of technology which is believed to have the potential in enhancing mathematics learning.

It is noted that a general feature of the development of mathematical education as a research domain is the gradual widening of its spectrum of interest to encompass more and more areas for research, including various educational levels ranging from preschool education level to tertiary education level, and methods of conducting research. Based on the focused areas as outlined in Table 2 and the classification of studies in chronological order as shown in the Appendix, it is interesting to examine the focus of the studies conducted and also the research methods involved from the period of 1972 to 2000.

Development in the 1970s

In the early 1970s, most research studies on mathematics education at the faculty were occupied with mathematics curriculum and methods of teaching (Abdul Rahim, 1978; Khoo, 1972; Siong, 1979; Wong, 1975). Influenced by the behaviorist theory, the focus and issues were to identify, structure, sequence and organize the appropriate content, and to devise and implement the appropriate mode of presentation. Goals, aims and objectives of mathematics instruction became the targets of discussion and investigations. Other areas of focus were comparative studies of the experimental curriculum with a traditional one, introducing teaching aids such as concrete materials or 'new' approaches in the experiments. Gradually, curriculum development and professionalism in terms of characteristics of mathematics teachers were included in the research agenda.

Table 2
Focus of Studies

	Focused areas	Studies by names of authors
1.	Schemes of mathematical concepts and constructivisim	Aida, 1996; Ding, 2000; Fatimah, 1997; Goh, 1998; Hasnul Hadi, 1992; Haslina, 2000; Jayaletchumy, 1999; Jeevanayaghy, 1998; Kawsalya, 1998; Ng, 1999; Noor Fazilah, 2000; Noraini, 1990; Othman, 1999; Sharida, 1999; Sharifah, 1997; Sutriyono, 1997; Thayalarani, 1998; Measias, 1998; Wan Patanah, 1998; Wun, 1999 *20**
2.	Understanding and conception of mathematical terms and knowledge	Charngeet Kaur, 2000; Doraisamy, 1990; Dorothy, 2000; Giam, 1992; Lee, 1982; Lim, 1978; Logesh, 2000; Neo 1989; Ong, 2000; Seow, 1989 *10*
3.	Problem solving abilities and related factors	Chan, 1984; Faridah, 1999; Hassan, 1998; Lim, 1993; Sevanesan, 1996; Sufean Hussin, 1986; Tan, 1986; Teng, 1997

	Focused areas	Studies by names of authors	
4.	Error analysis	Kung, 1992; Lim, 1980; Lim, 1999; Wong, 1994; Wong(a), 2000; Yap, 1983	*6*
5.	Design and development of mathematics instruction	Azman, 1993; Kor, 1995; Supiah, 1995; Tay, 1994; Tham, 1995	5
6.	Mathematics achievement and related Factors	Jamaliah, 1993; Pang, 2000; Parmjit Singh, 1994; Siow, 1993; Wong(c), 2000	5
7.	Mathematical needs and prerequisites for other subj ects	Chia, 1989; Fadzilah Awang, 1985; Lim, 1998; Tan, 1984	*4*
8.	Issues concerning teaching strategies	Abdul Rahim, 1978; Gan, 2000; Tan, 1995; Wong, 1975	*4*
9.	Behaviour-characteristics of teachers, teachers' perception of selected factors and needs in teaching mathematics	Pusparani, 1998; Sinnadurai, 1993; Siong, 1979	*3*
10.	Evaluation and assessment	Jafri, 1999; Wong(b), 2000	*2*
11.	Cognitive development	Khoo, 1972; Palanisamy; 1986	*2*
12.	Perception of students on mathematical Factors	Chiu, 1994	*1*
13.	Mathematics attitudes and computer Literacy	Lim, 1991	*1*
14.	Utilization of technology in instruction	Ong, 1994	*1*
15.	van Hiele levels of geometric thought	Sarojini, 1989	

* The number indicates the total number of studies in each area

Source: Sharifah Norul Akmar bt Syed Zamri, & Lee, S. E. (2000). State-Of-The- Art review of research in mathematics education in the Faculty of Education, University Of Malaya reported up to 2000.

Development in the 1980s

Despite the development and implementation of new curricula and new approaches to teaching, large groups of students seemed to experience severe problems in mathematics learning. Apparently, improving the delivery of mathematics was not sufficient for the betterment of mathematics instruction. More detailed studies were needed to focus on what topics should be included in the delivery, on what conceptual basis and in what

order it should be. In view of these, further inquiries surfaced on issues such as 'What should the teacher do and when should the teacher do it in mathematics instruction? What are the tasks and activities that would encourage students' mathematics learning? What type of qualities should textbooks have?'

Seeking the knowledge for the many unknowns in mathematics instruction, the 1980s saw a new field of research being developed where the focus was more into students' actual learning process and the outcomes of learning. Therefore, the research questions focused more on finding answers to these two themes. Examples are factors and mechanism causing errors and misconceptions (Lim, 1980; Yap, 1983), mathematical concept formation (Doraisamy, 1990; Lee, 1982; Neo, 1989; Palanisamy, 1986; Sarojini, 1989; Seow, 1989), problem solving behaviors and strategies (Chan, 1984; Sufean, 1986; Tan, 1986), cognitive schemes and affective characteristics including mathematical needs (Chia, 1989; Fadzilah, 1985; Tan, 1984).

Development in the 1990s

The study themes of the 1980s were extended to more research areas in the 1990s. An extended research area concerned studies in epistemology, knowledge, and knowledge acquisition which focused on how an individual acquires knowledge or constructs schemes (Aida, 1996; Ding, 2000; Fatimah, 1997; Goh, 1998; Haslina, 2000; Hasnul, 1992; Jeevanayaghy, 1998; Jeyaletchumy, 1999; Kawsalya, 1998; Measias, 1998; Ng, 1999; Noraini, 1990; Noor Fazilah, 2000; Othman, 1999; Sharida, 1999; Sharifah, 1997; Sutriyono, 1997; Thayalarani, 1998; Wan Patanah, 1998; Wun, 1999) and on the status of that knowledge in relation to reality. Theoretical framework for interpreting the social origins of knowledge and consciousness began to appear in the mathematics education literature. Examples of such studies are related to radical constructivism, social constructivism, information processing theory and learning theories.

Studies on mathematics learning did not stop at the level of the individual students. In fact, the research had channelled to focus more on students' notions and beliefs with respect to mathematics and factors that influence them. Several areas were ventured. One such area focused on the mathematics classroom with regard to its communication and sociology. The interest was on the social, cultural and linguistic factors that could possibly influence the teaching and learning of mathematics (Chiu, 1994; Jamaliah, 1993; Lim, 1993; Pang, 2000; Parmjit Singh, 1994; Pusparani, 1998). Ethnomathematics was also popular where learning of mathematics is shaped in the context of everyday mathematics and situated learning (Siow, 1993; Tan, 1995; Tay, 1994). Alternative assessments in mathematics education were also explored (Jafri, 1999; Wong(b), 2000). At the same time, the advancement of technology encourages studies on the development of software to enhancing mathematics instructions (Azman, 1993; Kor, 1995; Ong, 1994; Tham, 1995).

Although new areas of studies were explored, it should be noted that research studies

of those themes in the 1970s and 1980s were still continued, such as the misconception and error analysis (Hassan, 1998; Kung, 1992; Lim, 1999; Teng, 1997; Wong(a), 2000); needs of mathematics for different disciplines (Lim, 1998; Wong, 1994); teaching strategies (Gan, 2000; Sinnadurai, 1993; Supiah, 1995; Tan, 1995); understanding of mathematical concepts (Charngeet, 2000; Dorothy, 2000; Giam, 1992; Logesh, 2000; Ong, 2000); problem solving abilities and characteristics (Faridah, 1999; Sevanesan, 1996) and relating mathematics achievements to other factors (Lim, 1991; Wong(c), 2000).

Research Methods

Besides identifying the focus of the research studies, the methods employed by these researchers were studied. Systemic approach was dominant in mathematics education research. Careful empirical or experimental designs were noted. Data analysis and interpretations were examined by means of qualitative and quantitative instruments. Most of the research studies conducted are psychological, epistemological, historical, anthropological or sociological reflections. In the 1970s, the research method was mainly of the experimental type, comprising an experimental group and a control group. Consequently, the data analysis was quantitative, comparing the performances of students (Abdul Rahim, 1978; Khoo, 1972; Lim, 1978; Wong, 1975). In the 1980s and 1990s, qualitative studies were employed totally (Aida, 1996; Noraini, 1990; Sharifah, 1997) or partially (examples: Lee, 1982; Kung, 1992; Teng, 1997) whereby researchers employed interview techniques to build a better rapport between researcher and subjects to obtain in-depth information of students' mathematics learning. The approach employed was very much influenced by the constructivist theory of knowledge and deployed the clinical method to study how students construct their concepts.

In the case of error analysis, researchers had moved the methodology from survey typed (Sufean, 1986; Yap, 1983) to employing Newman Interview Schedule method to determine the 'initial error cause' made by the students (Hassan, 1998; Kung, 1992; Lim, 1993; Teng, 1997). Interviews were conducted to further clarify the initial findings of the studies (Lim, 1999; Wong(a), 2000). In this way, the researchers would have in-depth information regarding students' understanding of concepts and misconception resulting in errors made. In fact, this method of study is predominant in the present paradigm in mathematics education research. Comprehensive interpretative theories and corresponding schools of thought inspired by psychologists such as Piaget and Vygotsky are also used in analyzing data.

Implications for Classroom Instruction

The review so far has provided information which has significant implications for classroom instruction. A major portion (20 out of 73 from Table 2) of the studies

employed the constructivist theory of knowledge and had inferred many schemes constructed by the students ranging from primary level to upper secondary level together with the teachers' schemes too. Examples of the schemes observed are: addition schemes by primary two and three pupils (Noraini, 1990) and secondary two students (Hasnul, 1992); subtraction schemes by secondary two students (Sharifah, 1997) and primary two and three pupils (Sutriyono, 1997); and problem solving schemes by secondary school mathematics teachers (Fatimah, 1997). The eliaical approach was also employed in the study of students' conceptions of various topics of mathematics. Some of the mathematics concepts studied are: ratio by secondary two students (Goh, 1998); significant figures by secondary two students (Jeevanayaghy, 1998); algorithms by secondary five students (Kawsalya, 1998); algebra by secondary three students (Thayalarani, 1998); mathematical statements by secondary four students (Measias, 1998); mathematical terms by primary one pupils (Wan Patanah, 1998); addition (Ng, 1999) and multiplication (Othman, 1999) of whole numbers. These schemes and students' conceptions open up to new frontiers for mathematics educators in understanding how students learn mathematical concepts, and assist teachers or educators in planning the curriculum and instructions. Also, the understanding of these schemes provides in-depth information that could lead to students' misconception and failure in mathematics learning which are not easily available from the normal survey of students' understanding of concepts.

Problem solving is always emphasized in the mathematics classes (Lee, 2000). The process is not as simple as portrayed whether it is in the form of heuristics or strategies. The findings from problem solving studies show that students encountered various obstacles in solving problems such as language problem (Lim, 1993) and difficulty in transformation process as noted by the Newman Interview Schedule (Hassan, 1998; Teng, 1997). It is assumed that by providing 'hints', the skill of problem solving would be enhanced, but findings have shown otherwise (Tan, 1986). These obstacles are not easily detectable without careful and systematic conduct of the research. These findings could be shared by teachers in the preparation of classroom instructions, and even for students to understand their own weaknesses in problem solving as well as how to avoid and overcome them.

Error analysis is another major area of research concern. The findings from the related studies had collected many students' "self-invented" methods of computations in basic operations (Lim, 1999; Wong(a), 2000) reflecting their misconceptions in mathematics. For higher level such as secondary school mathematics on matrices (Sharida, 1999) and college mathematics on limits (Logesh, 2000), students also seemed to have their 'interpretations' over certain mathematics terminologies. The findings also indicated that students' problem solving processes were seen to move in the opposite direction of their thought. Perhaps, all these may account for the mismatch between intended instruction and outcome of the instruction.

Another two areas ofbenefit to mathematics educators are the alternative assessments in mathematics and the development of software for classroom instruction. The mathematics curriculum has undergone many reforms, but the assessment aspects seem not to be in

line with the objectives and goals of mathematics education. Though only two studies are involved on these aspects such as the use of assignments (Jafri, 1999) and project work (Wong(b), 2000), the findings indeed provide insights into the amount of hard work as well as the obstacles encountered in the implementation process in the classroom. In fact, Wong(b) has proceeded using the project work assessment in her actual classroom and improved further on the validity and reliability of the assessment tools. As for computer software, many tools are available in the market for classroom use. Even the borderless Internet has also offered free software for mathematics instruction. The few studies in the faculty have shown that teachers and students welcomed the use of technology for enhancing learning but also noted the shortfalls of the selected software.

Many studies on other themes have also produced informative findings. For example, four studies had identified the need for mathematical skills and knowledge as prerequisites across the curriculum in subjects such as Physics, Economics and Chemistry (Chia, 1989; Lim, 1998; Tan, 1984; Wong, 1994). These studies showed that the prerequisites are well provided in the mathematics curriculum. Nevertheless, those teachers of non-mathematics subject had to teach the mathematics involved in their respective subject to their students. The findings also showed that with better communication between the teachers of various subjects and teachers of mathematics, some of the problems faced by the students and the teachers could be reduced and hence learning across subjects and disciplines could be better integrated.

In summary, it can be deduced that the findings from each study be it positive or negative, will provide educators better understanding of students' learning abilities. The community and mathematics educators should try to benefit from these findings to extend their horizon of mathematics teaching and learning.

Directions and Future Focus

The review had identified the areas of focus and related issues of research studies conducted in the faculty. However, these areas were determined by limited studies conducted. Even the predominant constructivist theory of knowledge in the research methodology covers only a few mathematical concepts. Similar situations occur for other areas of concern such us 'problem solving', 'error analysis' and 'classroom instructions' and many others. Nevertheless, it should be noted that the above research conducted are also very much influenced by the demands and changes such as the nature of mathematics, technology, views of students and changes in mathematics education in the international scene. Therefore, future studies should extend the research areas to include:

1. schemes of concepts by various age groups of learners, including the instructors
2. problem solving
3. error analysis
4. enrichment and remedial program in mathematics

5. alternative assessment
6. collaborative learning between schools using the Internet
7. development and evaluation of mathematics software
8. technology in mathematics instruction

CONCLUSION

The review is based on 73 research studies conducted at the Faculty of Education, University of Malaya, from 1972 to 2000. It cannot be denied that these studies are the requirements for the course pursued. As such, these novice researchers may not have taken all possible precautions for the design of the study and the data analysis. However, these studies were conducted under the supervision of the faculty staff and guided by the experts in their respective fields. It is noted that these studies were done on a small scale, mainly due to the time constraint of the course and the limited budget affordable by the students as well as researchers. Hence, interpretation of the findings should be considered with care and not generalized. Nevertheless, this does not negate the many implications of the studies, in terms of focus, issues and design. The findings can be utilized by the mathematics education community at large for the betterment of learners.

REFERENCES

Note: The references of the theses or research reports are listed in the Appendix.

Abdul Rafie b. Mahat. (2002). *Hala tuju dan polisi: Pendidikan matematik dan pembangunan negara.* Paper presented at the Seminar Pendidikan Matematik Dalam Pembangunan Negara, 16 Feb. 2002. Persatuan Pendidikan Matematik Malaysia and Universiti Malaya.

Asiah bt. Abu Samah. (1982). *Perkembangan kurikulum matematik sekolah di Malaysia sejak zaman penjajah.* Kertas kerja yang dibentangkan di Simposium Kebangsaan Matematik, Universiti Kebangsaan Malaysia, 12 - 14 Ogos, Kuala Lumpur.

Begle, E. G., & Gibb, E. G. (1980). Why do research? In R. Shumway (Ed.), *Research in mathematics education* (pp. 3-19). Washington, DC: NCTM

Dylan, W. (1998) A framework for thinking about research in mathematics and science education. In J. A. Malone, B. Atweh & J. R. Northfield (Eds.), *Research and supervision in mathematics and science education* (pp. 1-18). Mahwah, NJ: Erlbaum.

Fan, K. S. (1977). (Revised). *Dissertation materials in the University of Malaya Library.* Kuala Lumpur: University of Malaya.

Fong, C. O. (1993). Mathematics education in a technological society. Paper presented at the International Seminar on Mathematics Science Education, ITM, Kuching, Sarawak.

Frank, J. S. (1978). (Ed.). *Doctoral dissertations of Malaya and Malaysia: A comprehensive bibliography.* Chicago: Association of Asian Studies.

Ibrahim bin Md Nor. (1995). *Kurikulum matematik tahun 2000 daripemikiran mekanis ke pemikiran kreatif.* Paper presented at Seminar Kebangsaan Kurikulum: Kurikulum Untuk Tahun 2000 dan Selepasnya, 11 - 13 December, 1995, Bayu Beach Resort, Port Dickson.

Kanagasabai, S., Chew, S. B., Koh, B. B., & Leong, Y. C. (Eds.) (1980). *Studies on Malaysian education: An annotated bibliography.* Kuala Lumpur: Faculty of Education, University of Malaya.

Kilpatrick, J. (1993). Beyond face value: Assessing research in mathematics education. In G. Nissen & M. Blomhoj (Eds.,), *Criteria for scientific quality and relevance in the didactics of mathematics* (pp.15-34). Roskilde, Denmark: University of Roskilde.

Lai, K. H., & Loo, S. P. (1992). *State-of-the-art review of research in mathematics education in Malaysia.* South East Asian Research Review and Advisory Group. SEMEO, RECSAM. Penang, Malaysia.

Lee, S. E. (2000). *Studies on problem solving in school mathematics in Malaysia.* Paper presented at the 9th International Congress of Mathematics Education ICME-9, July 31 - August 6, Tokyo/Makuhari.

Leonard, Yong. (1989). *Educational theses index 1989, Faculty of Education,* University of Malaya.

Lim, C. S. (1995). Curriculum reform in mathematics education: A Malaysian experience. In Garry Bell (Ed.), *Review of Mathematics education in Asia and the Pacific* (pp. 117-126). Australia: Southern Cross Mathematical Association.

Ministry of Education, Malaysia. (1988). *Huraian sukatan pelajaran Matematik: Sekolah menengah.* Kuala Lumpur: Pusat Perkembangan Kurikulum.

Ministry of Education, Malaysia. (1989a). *Huraian sukatan pelajaran Matematik: Sekolah rendah.* Kuala Lumpur: Pusat Perkembangan Kurikulum.

Ministry of Education, Malaysia. (1989b). *Huraian sukatan pelajaran Matematik tambahan.* Kuala Lumpur: Pusat Perkembangan Kurikulum.

Ministry of Education, Malaysia. (1992). *Bukupenerangan Kurikulum Bersepadu Sekolah Menengah.* Kuala Lumpur: Pusat Perkembangan Kurikulum.

Ministry of Education, Malaysia. (1998). *Huraian sukatan pelajaran Matematik [KBSRJ: Sekolah bestari.* Kuala Lumpur: Pusat Perkembangan Kurikulum.

Ministry of Education, Malaysia. (2002a). *Integrated curriculum for secondary schools: Curriculum specifications Mathematics Form 1.* Kuala Lumpur: Pusat Perkembangan Kurikulum.

Ministry of Education, Malaysia. (2002b). *Integrated curriculum for primary schools: Curriculum specifications Mathematics Year 1.* Kuala Lumpur: Pusat Perkembangan Kurikulum.

Nik Pa, N. A., & Ng, S. N. (1992). *Research on mathematical learning and teaching in Malaysia*. Paper presented at the International Seminar: State of the Art of Research in Science and Mathematics Education in Southeast Asia and the Pacific, SEAMEO-RECSAM, Penang, Malaysia.

Sharifah Norul Akmar bt Syed Zamri, & Lee, S. E. (2000). *State-of-the-art review of research in mathematics education in the Faculty of Education, University of Malaya reported up to 2000.* Kuala Lumpur: Faculty of Education, University of Malaya.

Appendix

Research studies on mathematics education (1972-2000), in chronological order, conducted at the Faculty of Education, University of Malaya:

Note: ** Ph. D. Study
M. Ed. Research Report
1} M. Ed. Project Report
Titles in Malay language are translated in English and given in parentheses
From 1996 onwards, researchers have to provide the titles in Malay and English languages

Year	Name	Title of research study
1972	Khoo, Phon Sai**	Relationship between cognitive development and the learning of science and mathematics
1975	Wong, Sin Mong	Comparing four strategies in teaching selected topics in modern mathematics
1978	Abdul Rahim b. Ahmad	*Perbandingan kesan-kesan dua kaedah mengajar dalam menyampaikan konsep besaran dalam matematik kepada murid-murid Tingkatan IVsekolah menengah* (Comparison of the effectiveness of two teaching methods in presenting Enlargement concepts to secondary Form IV pupils)
	Lim, Soo Kheng	A study of the relationship between understanding of mathematical vocabulary and mathematics achievement in selected remove classes
1979	Siong, Shee Tit	Selected behavior-characteristics of perspective mathematics teachers and their relationship to teaching practice performance: A study of Malaysia Teachers' College Penang
1980	Lim, Teik Sun	Analysis of computational errors of Standard Four Pupils in three selected primary schools
1982	Lee, Siew Eng	Understanding of basic concepts in transformation geometry - a study of a sample of pupils in Forms IV and VI
1983	Yap, Yee Khiong	Addition and subtraction of fractions: Analysis of errors of a sample of Standard Six pupils

1984	Chan, Lik Hoong	Mathematical information gathering ability: A study of a sample of Form Four girls
	Tan, Hui Leng	The mathematical needs of Sijil Pelajaran Malaysia level Physics
1985	FadzilahAwang	The relevance of the first year mathematics course to the engineering degree programme at Universiti Teknologi Malaysia
1986	Palanisamy K. Veloo	Cognitive development and acquisition of the mathematical concepts of fraction, ratio, proportion: A study of a sample of Malaysian urban secondary school pupils
	Sufean Hussin	Solving open-sentences in multiplication and division: factors related to performance of primary III and IV pupils
	Tan, Hui Kien	The use of hints to solve problems in mathematics
1989	Chia, Chee Fen	Mathematical needs of Malaysian Higher School level physics
	Neo, Kian Sen	*Pemahaman istilah matematik umum diperingkat menengah atas* (Understanding of general mathematical terms at upper secondary level)
	Sarojini Devi Algaretnam	Van Hiele levels of geometric thought in relation to similarity and congruence in triangles
	Seow, Siew Hua	Conceptions of mathematics and mathematics teaching: Case studies of four trainee teachers
1990	Norainibtldris#	*Skim Penambahan nombor bulat bagi murid-murid Darjah Dua dan Tiga* (Addition of whole number schemes of Primary Two and Three pupils)
	Doraisamy, Logeswary	Levels of understanding of probability concepts among Forms Four and Six Pupils

1991	Lim, Chap Sam	Relationship between computer literacy and mathematics attitude
1992	Hasnul Hadi b. Abdullah Sani	*Skim penambahan integer bagi pelajar-pelajar Jingkatan Dua* (Addition of integer schemes of Form Two students)
	Kung, Wing Chuang	Errors in written mathematical tasks of Form Four pupils in a Malaysian Secondary School
	Giam, Kah How	Understanding of concepts in mechanics among Form Four Science students in the Klang district
1993	Azman b. Abdullah	The design, development and evaluation of an authoring language for mathematics teachers
	Sinnadurai, Wrutheran	Conceptions, perceptions and practices of year three mathematics teachers with respect to mathematically gifted pupils
	Lim, Char Bo	Language difficulties of Form Four Arts students in solving mathematics question
	Jamaliah bt Kamal #	*Kajian tentang pencapaian matematik Tahun III di Sekolah Rendah Simpang Rengam* (A study of primary three mathematics performance of Sekolah Rendah Simpang Rengam)
	Siow, Choong Fui #	Achievement of Form Five students in selected aspects of logical reasoning in mathematics

1994	Chiu, Kam Choo #	*Persepsi murid Sekolah Menengah Sri Gombak terhadap Matematik KBSM* (Students' Perception towards KBSM Mathematics in Sekolah Menengah Sri Gombak)
	Parmjit Singh Aperapar Singh #	*Kesan kekerapan pengujian terhadap pencapaian dan sikap dalam matematik bagipelajar Tingkatan 4* (Effect of frequency of tests on the mathematics performance and attitude of Form Four students)
	Ong, Chwee Kong	Utilization of television in the teaching and learning of lower secondary mathematics
	Tay,PekKi	Reading for learning in mathematics: The classification of Lower Secondary KBSM text and the use of directed activities related to text
	Wong,AhBoey#	*Keperluan matematik dalam Ekonomi Tingkatan Enam* ***dan kesilapan pelajar dalam menyelesaikan masalah*** *kuantitatif* (Mathematical needs of Form Six Economics and students' errors in solving quantitative problems)
1995	Kor.AhLian	The development and evaluation of logo-based geometry package
	Supiah bt Saad #	*Proses membentuk dan melaksanakan rancangan pengajaran individu dalam pengajaran pemulihan matematik: Satu kajian kes* (Process of designing and implementing individual teaching plan in teaching remedial mathematics: A case study)
	Tan, Chai Tin	*Pengajaran Matematik KBSR:Perbandingan dua buah sekolah rendah di Daerah Petaling, Selangor* (Teaching KBSR Mathematics: A comparison of two primary schools in Petaling District, Selangor)
	Tham, Yew Meng #	Development and evaluation of a computer-assisted instruction (CAI) package on Introductory Statistics

1996	Aida Suraya bt Hj Mohd Yunus**	*Skim nombor perpuluhan bagi murid Tahun Lima sekolah rendah* (Decimal schemes of primary school year five students)
	Sevanesan s/o Raju #	Performance of Primary Six pupils in mathematical problem solving thinking skills *(Prestasi pelajar Tahun Enam dalam kemahiran berfikir penyelesaian masalah matematik)*
1997	Fatimah Salleh**	*Skim penyelesaian masalah guru matematik Tingkatan Dua* (Problem solving schemes of Form Two Mathematics teachers)
	Sharifah Norul Akmar bt Syed Zamri**	*Skim penolakan Integer pelajar Tingkatan Dua* (Integer subtraction schemes of Form Two students)
	Sutriyono**	*Skim penolakan nombor bulat murid Dorjah Dua dan Tiga* (Whole number subtraction schemes of Standard Two and Three students)
	Teng, Pooi Kui #	Analysis of errors of year six pupils in solving Arithmetic word problems *(Analisis kesilapan dalam menyelesaikan masalah aritmetik berbentuk masalah bercerita bagi murid Tahun Enam)*

1998	Goh, Poh Chiok	*Konsepsi Pelajar Tingkatan Dua tentang Nisbah* (Form Two students' conception of ratio)
	Hassan b. Pardi #	*Kajian kes tentangpola kesilapan murid Tahun Tiga yang lemah dalam menyelesaikan rnasalah bercerita dalam matematik* (Error patterns of weak Year Three students in solving word problems in mathematics: A case study)
	Jeevanayaghy A/P Sivaratnam #	*Kefahaman dua orang pelajar Tingkatan Empat tentang Angka Bererti* (The understanding of two Form Four students on significant figures)
	Kawsalya A/P Paramasivam B	*Kefahaman tiga orang pelajar Tingkatan Lima tentang algorithma* (Understanding of three Form Five students on algorithm)
	Lim, Huey Kuin #	Mathematical needs of the Malaysian secondary school Chemistry integrated curriculum *{Keperluan matematik untuk kurikulum bersepadu sekolah menengah Kimia)*
	Pusparani Subramaniam B	*Keperluan beberapa orang guru dalam pengajaran matematik KBSR di sebuah sekolah rendah Tamil di Sg Besi* (The needs of mathematics teachers in teaching mathematics in a Tamil primary school in Sg Besi)
	Thayalarani Singayanagam B	*Kefahaman tiga orang pelajar Tingkatan Tiga tentang Ungkapan Algebra* (The understanding of three Form III students on algebraic expressions)
	Z. Measias John	*Konsepsi Pelajar Tingkatan Empat tentang pernyataan matematik* (The conception of mathematical statements among Form Four students)
	Wan Patanah B	*Konsepsi pelajar Tahun Satu mengenai beberapa istilah matematik* (Year One pupils' conception of selected mathematical terms)

1999	Faridah bt Mohd Ibrahim 13	*Penyelesaian melibatkan nombor perpuluhan oleh pelajar Tingkatan Satu* (Problem solving on decimals by Form One students)
	Jafri b. Jaafar 13	*Perbezaan markah pencapaian pelajar Tingkatan 4 menggunakan alat penilaian berbentuk ujian berbanding alat penilaian berbentuk tugasan bagi mata pelajaran Mat. Tambahan di sebuah sekolah menengah* (The difference in achievement scores Form 4 students using test as an evaluation tool compared to assignment in Additional Mathematics in a secondary school)
	Jayaletchumy a/p R.S Anantham 13	Secondary School children's understanding of the arithmetic average *{Kefahaman pelajar Sekolah Menengah tentang purata aritmetik)*
	Lim, Bee Leng (3	Division of whole number: Analysis of computational errors of Form One students *(Membahagi nombor bulat: Analisis kesilapan komputasi yang dilakukan oleh pelajar Tingkatan Satu)*
	Ng, Siew Geok 13	*Kef ahaman pelajar Tahun 4 tentang penambahan nombor perpuluhan* (Understanding of the addition of decimals by Primary School Year Four students)
	Othman b. Sodikin	*Konsepsi pendaraban nombor bulat bagi pelajar Tahun 3* (Year Three pupils' conceptions of multiplication of whole numbers)
	Sharida bt Hashim 13	*Kef ahaman pelajar sebuah kelas Tingkatan Empat tentang pendaraban dua matriks* (The understanding of a Form Four class on the multiplication of matrices)
	Wun, Thiam Yew 6	The understanding of logical reasoning among three teachers *(Kefahaman tiga orangguru tentang penaakulan mantik)*

2000	Charngeet Kaur d/o Balwant Singh 13	Understanding of percentage in relation to number sense among Form One students *(Kefahaman pelajar Tingkatan Satu tentang peratus berkaitan dengan celik nombor)*
	Ding, Hong Eng 13	*Kefahaman tiga orangguru malematik Tingkatan Empat terhadap pendekatan kemahiran berfikir secara kritis dan kreatif'dalam pengajaran statistik* (The understanding of three Form Four mathematics teachers on critical and creative thinking skills approach in statistics)
	Dorothy Dewitt 13	Quadratic equations in algebra: Analysis of written responses among Form Four students *(Persamaan kuadratik algebra: Analisis respons bertulis pelajar Tingkatan Empat)*
	Gan, Swit Peng	Effectiveness of programmed instructional material in the teaching of Reflection to Form Two pupils in a rural school *(Keberkesanan program pembelajaran terancang dalam pembelajaran pantulan untukpelajar Tingkatan Dua di sebuah sekolah luar bandar)*
	Haslina Jaafar 6	*Penyelesaian persamaan linear oleh tiga orangpelajar Tingkatan Dua* (Solving linear equations by three Form Two students)
	Logesh A/P K.Sivapakianathan 13	Understanding of the limit of functions among college students *(Pemahaman hadfungsi di kalangan pelajar kolej)*
	Noor Fazilah Abetah 8	*Penambahan pecahan oleh pelajar Tingkatan Satu di sebuah sekolah di Selangor* (Addition in fraction by Form One students of a school in Selangor)
	Ong, Saw Hoon 13	Understanding of Algebraic notation and its relationship with cognitive development among Form Four students *(Kefahaman notasi Algebra dan perhubungannya dengan perkembangan kognitifdi kalangan pelajar Tingkatan Empat)*