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Enhancing Student's Mathematical Power Through the Using ICT in the Mathematics Classroom

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Enhancing Mathematical Power Through the Use of ICT in the Mathematics Classroom

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Abstract

The fundamental mission of mathematics education is the development of mathematical power in all students.This paper describes recent professional development programmes for mathematics teachers in SEAMEO-RECSAM (Southeast Asian Ministers of Education Organisation-Regional Centre for Education in Science and Mathematics), which is designed to prepare mathematics teachers in integrating ICT in enhancing student's mathematical power in learning mathematics. The use of Hand-held Technology Calculators becomes the focus of the training. One of the aims of this programme is to fulfil SEAMEO member country teachers with experiences in integrating ICT especially Graphic Calculator in mathematics classroom in order to support MOE programmes in their respective countries. This paper describes the philosophy, the programmes and the implementation, the challenges and the problems encountered in the training, and the impact of the courses. This paper also describes the participant's perception toward the use of ICT in teaching and learning mathematics before and after the course. It also gives some examples of participant's project work in fulfilling the goals of programmes. Some recommendations and suggestions for future professional development for mathematics teachers in integrating handheld technology in mathematics classroom are also described in this paper.

Keywords*: Mathematical Power, Hand-held Technology, Professional Development, Mathematic Classroom*

A. Introduction

Mathematics education everywhere has been bombarded by call for change throughout the years. The changes derived from societal forces, professional judgments, new knowledge derived from research or technological advances. In SEA countries, for the last two decades changes have been made. In this era, critical elements such as communication and connections, tasks and discourse, alternative forms of assessment and new form of technology, and over-riding belief in "mathematics for all framed discussion and action throughout the nineties. The changes have not diminished the range of issues facing the mathematics problems and by anticipating the future needs of our society, a

strong mathematics programs that is responsive to today's issues, challenge and problems can be developed.

During the last two decades, graphic technology for mathematics classrooms experienced an explosive growth both in terms of development as well as availability. This was accompanied by an enormous enthusiasm concerning the potential of new technology for teaching and learning mathematics [Fey et al., 1984]. Many teachers in SEA countries are still struggling with the task of effectively using technology for everyday teaching, and evidence for the predicted improvement of student achievement through effective use of technology for teaching and learning mathematics is still rare. [Monaghan, 2001]. Technological advances bring about opportunities for change in pedagogical practice, but do not by themselves change essential aspects of teaching and learning.

In SEA countries such as Singapore, Malaysia, and Brunei, the use of technology, specifically graphics calculator, has been widely adopted by academic institutions and has influenced the pedagogy in the classroom. For example, while graphics calculators were designed as personal tools, research by Cavanagh (2005) reported that students tended to use them as a shared device. He found graphing calculators played an important role in group activities as a kind of conversation piece for sharing mathematical ideas and making thought processes publicly available in the classroom. The technology facilitated social interaction in the classroom because it acted as a common point of reference for students as they discussed their ideas and results. Other researchers such as White (2004) have claimed that the graphics calculator has the potential to be a pedagogical Trojan Horse, subtly influencing a change in the usual teaching practices.

Professional development for in-service teachers needs to be adapted in order to keep up with the high demands of effectively integrating technology into mathematics teaching. A focus needs to be on fostering students' understanding of mathematical concepts and creating more effective learning environments with technology (The ICMI, 2004).

B. Today's Mission: Mathematical Power for All

Building and implementing a high performance mathematics programs begin with a vision of mathematical content, mathematics instruction, and of the assessment of mathematical understanding. The fundamental mission in mathematics education is the development of mathematical power for all students. According to NCTM, mathematical power

> *"denoted an individual's capabilities necessary to explore, conjecture and reason logically, as well as the ability to use a variety of mathematical methods effectively to solve non-routine problems. This notion is based on the fact that mathematics is more than a collection of concepts and skills to be mastered. It includes methods of investigating and reasoning, means of communication, and notions of context. In*

addition, for each individual it involves the development of personal self-confidence" (NCTM, 1989)

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Moreover, mathematical power means:

- Engaging in mathematical problem solving;
- Reasoning mathematically;
- Connecting what is learned in mathematics with other topics in mathematics, with other disciplines and with daily life;
- Communicating mathematically;
- Gaining confidence in one's own mathematical ability; and
- Appreciating the value and the beauty of mathematics (NCTM, 1989) .

In its simplified form, the mathematics reform being advocated here and in the national standards stems from the clarion call for a " shift in emphasis from a curriculum dominated by emphasis from a curriculum dominated by an emphasis on memorization of isolated facts and procedures, and proficiency with paper and pencil skills, to one which emphasizes conceptual understandings, multiple representations and connections, mathematical modeling and mathematical problem solving" (NCTM, 1989, p.125).

With this new emphasis, our vision for mathematics instruction must involve working to make sense of mathematical ideas, and constructing personal meaning of these ideas. "Students are expected to and store use what they are taught to modify their prior beliefs and behavior, not simply to record what they are told. It is students' acts of construction and intervention that build their mathematical power to enable them to solve problems they have never seen before" (NRC, 1989).

Accordingly, the NCTM standards and this guide encourage four critical shift:

- *In curriculum*, shift toward a deeper study of mathematical ideas and concepts and their uses in today's world;
- *In learning*, shift toward more active student involvement with mathematics, including mathematical problems that relate o their world and the use of variety of mathematical tools for solving these problems;
- *In teaching*, a shift toward classrooms that offer stimulating learning environments in which all students have an opportunity to reach their full mathematical potential; and
- *In assessment practices*, a shift toward student evaluations that are continuous and based on many sources of evidence (NCTM, 1994)

When the shift have taken place, there are differences in the following:

- Classrooms with active environment that may be clustered into small teams to work together to solve mathematics problems or complete mathematical project.

Students use calculators or computers and involve in mathematics learning and mathematical thinking.

- Teachers' role are more toward coaches, responsible for selecting and orchestrating tasks, setting high expectations, and creating a classroom environment in which high-quality mathematics learning can flourish.
- Students take responsibility of their own learning and are challenged to meet higher expectation. They engage more in important mathematical tasks while interacting with the teacher, instructional materials, and equipments and with each other.
- Tasks are developed based on significant important mathematics and can encourage students "to reason about mathematical ideas, to make connections, and to grapple with and solve problems. Good tasks test skills development in the context of problem solving, are accessible to students, and promote communication about mathematics.
- Homework assignment must engage students in problems related to their own lives, interest, and environment and problems that require application of the skills and concepts that were studied in class.
- Tests are developed to judge about student learning based on students performance on doing projects, tests, class work, homework to furnish more complete picture of students' understanding.

In mathematics, as in any field, knowledge consists of information plus know-how. Know-how in mathematics that leads to mathematical power *requires the ability to use information to reason and think creatively and to formulate, solve, and reflect critically on problems.* The assessment of students' mathematical power goes beyond measuring how much information they possess to include the extent of their ability and willingness to use, apply, and communicate that information. The assessment should examine the extent to which students have integrated and made sense of information, whether they can apply it to situations that require reasoning and creative thinking, and whether they can use mathematics to communicate their ideas. Additionally, assessment should examine students' disposition toward mathematics, in particular their confidence in doing mathematics and the extent to which they value mathematics. As NCTM (1989) states that "the assessment of students' mathematical knowledge should yield information about their--

- *"ability to apply their knowledge to solve problems within mathematics and in other disciplines;*
- *ability to use mathematical language to communicate ideas;*
- *ability to reason and analyze;*
- *knowledge and understanding of concepts and procedures;*
- *disposition toward mathematics;*

- *understanding of the nature of mathematics;*
- *integration of these aspects of mathematical knowledge".*

The assessment of students' mathematical power is appropriate at all grade levels and should not be delayed on the grounds that students must know a great deal of mathematics before they can integrate this knowledge. Group tasks are particularly useful in the lower grades for assessing the integration of students' mathematical knowledge

C. Teacher Professional Development in ICT Integration

Shafika (2006) defines *Teacher Professional Development (TPD)* as 'a systematized, initial and continuous, coherent and modular process of professional development of educators in accordance with professional competency standards and frameworks'. Teacher professional development would also include training in the adaptation to the evolution of change of the profession of teachers and managers of education systems. The concept of Teacher Professional Development in ICT which should equip teachers not just only with basic ICT skills, but also should encourage the evolution towards *integrating* technologies into teaching subjects and practices. The implication is that TPD in ICT is not simply about how to use technologies but also about why and when to use them in transforming teaching practices.

The term 'ICT integration' there are few explicit definitions of the concept and how it can be measured. Despite this lack of clear criteria there is agreement in the literature that ICT integration denotes a change in pedagogical practices that make ICT less peripheral in classroom teaching (Law, Pelgrum & Law, 2006 cited in ibid.).

The integration of ICT in teacher professional development according to Perraton *et al.* (2001, cited in Anderson and Glen 2003) involves two sets of activities or roles: One is training teachers to *learn about ICT* and its use in teaching as computers are introduced to schools. The other role of ICT is as a means of providing teacher education, either as a *core* or main component of a program, or playing a *supplementary* role within it. Collis and Moonen (2001), cited in Davis and Kirschner, 2003) elaborate on the goals of professional *learning about ICT* as centered on:

1. *Learning how to use ICT* . When learning *how to use ICT* the instructional focus is on the use of products in or outside the classroom.

2. *Learning with ICT*. In learning *with ICT,* instruction is presented and distributed primarily through 'web environments or systems offering an integrated range of tools to support learning and communication'.

A synthesis of the two dimensions of ICT integration combining the roles and activity sets is presented in figure 1.

ICT use in the classroom as content focus of the teacher training

ICT use in the classroom as parts of method, curriculum and lesson planning
ICT use as core technology for participation
ICT used to facilitate some (non-essential) aspect of participation

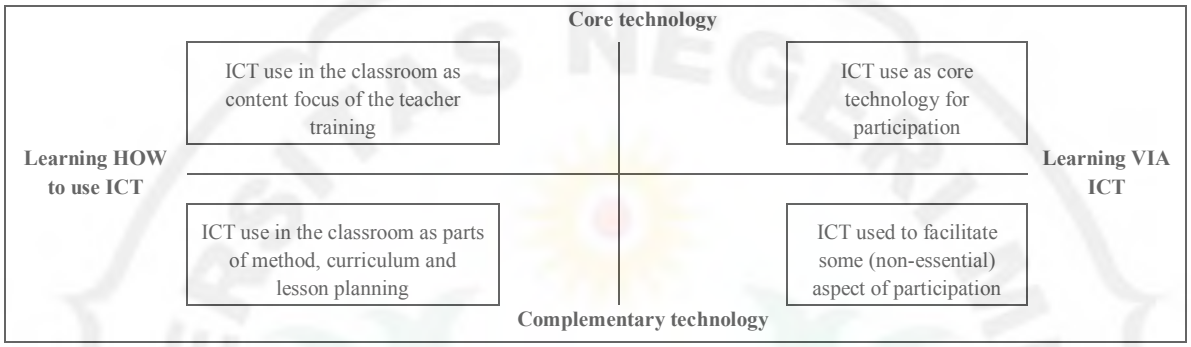

Figure 1. Two dimensions of *ICT integration* in Teacher Professional Development
Source: Collis and Moonen 2001, cited in Kirschner and Davis, 2003

Davis and Kirschner, (2003) clarify the distinction between the role of ICT as a core and a complementary (supplementary) technology for professional learning settings. A core technology role refers to 'the principle way of organizing the learning experience'. In contrast a complementary technology role is 'optional serving a valuable function but able to be compensated for via the core technology if so needed, or dropped altogether if not functioning or feasible' (p.128).

It is important to discuss various concepts related to the key terminology that will constitute the focus of this paper, in particular the use of the graphic Calculator and *Teacher Professional Development* (TPD), and mathematical power. The question remains: How can teacher preparation programs guide in-service teachers' development of a TPCK to prepare teachers for a classroom environment where technology significantly impacts and changes teaching and learning in K-12 science and mathematics classrooms Beck and Wynn (1998) have described the integration of technology in teacher preparation programs on a continuum. At one end of the continuum, the integration of technology is a course separate from the teacher preparation program while on the other end of the continuum, the entire program is changed to implement the integration. Traditionally, teacher preparation programs have depended on one course focused on learning about technology. More recently, teacher preparation programs have shifted the emphasis in this course to incorporate pedagogical concerns; now, concerns about teaching with technology have been included in the methods courses. A variety of additional approaches for preparing teachers to teach with technology have been proposed to move toward the other end of the continuum by (1) integrating technology in all courses in the teacher preparation program in order to be more supportive of the development of a technology-enhanced PCK and content specific applications and (2) requiring in-service teachers to teach with technology in their student teaching experience

(Young et al., 2000). However, little research has been conducted to identify how this more integrated approach supports the development of a PCK that integrates knowledge of technology with knowledge of the content and knowledge of pedagogy—a TPCK.

It will be useful to develop any units of work you make for assessment or for use in practice and internships by using the TPACK model to describe the idea. In this training workshop programs designing lesson using ICT following the programs are developed based on the following needs:

- The curriculum purpose and the idea for a lesson worthwhile (CK)
- The pedagogy that is embedded in the curriculum idea (PCK)
- Specific strategies might be used (PK)
- The technology use to unpack the curriculum goals change how you select activities that are authentic and meet future needs of technology literate students (T C K)
- Using technology impact on pedagogical decisions and how to manage the use of technology by the students so they achieve the goals of the lesson (TPK)
- Technical knowledge we need to use the technology to meet the curriculum goals and pedagogical approach (TK)
- How does it all come together to meet learning goals successfully? (TPACK)

Some uses of technology in schools you will see are trivial; or using technology for the sake of it. The uses of technology need to not only meet curriculum goals, but also contribute to the digital literacy of your students in ways that will serve them in the future. This view of digital literacy will also drive how you interpret the curriculum and the priorities you set in selecting what to achieve in your classroom. Thus it is crucial that the pedagogy informing your classroom teaching takes this into account.

D. The Use of Hand-held Technology to Enhance Mathematical Power

Electronic equipment in the shape of hand-held technology calculators became available in mathematics education in the mid 1970s, it was met by interest and a feeling of progression. But a number of questions were soon raised by teachers, researchers and others about the consequences for teaching and for students' learning of mathematics. Among the negative arguments were that an extensive use of handheld calculators could harm students' computational skills, both mental and by paper-and-pencil. On the other hand, many teachers could see inspiring possibilities with these new tools, especially those who tended to employ interactive or inquiry-oriented methodologies during instruction (Trouche, 2005a).

Several kinds of technologies are used in mathematics class, but in this professional development we train teachers to use ***handheld technology*** to provide the

learning environment with more interaction between students and teachers and the process and result of students' understanding to teachers. Teachers using the handheld technology have thought that classical methods of assessment are not compatible with their class. It is because the classical method of assessment has nothing to do with technology. Actually this is one of main reasons that why many teachers hesitate to use technology in their class. So, it is necessary that the learning activities and learning assess matched with their class be suggested.

The use of graphic calculator in teaching and learning mathematics support the success of students to reach the mathematical power. The training programs are developed to engage students in mathematical problem solving. The tasks demand students to solve problems using mathematical reasoning. The problems are given in connecting what is learned in mathematics with other topics in mathematics, and with other disciplines and with daily life. Participants are involved in communicating mathematically in classrooms. The program is designed to gain student's confidence in their own mathematical ability; and appreciating the value and the beauty of mathematics (NCTM, 1989) .

Graphic Calculator is the digital equipment which can store, process the information. The omnipresent ICT has been a special interest topic in educational institute, because ICT could replace the aids tools, textbooks and chalkboards, for the teacher. In some SEA countries the education authorities encourages the use of technology to upgrade teaching and learning by conveying technology as infrastructure and training teachers in first stage of the information technology (IT). It aims that to help every student would have access to technology in learning. In the professional development teachers are also trained. The aim is to rule the ICT in bringing together key areas of education such as curriculum, assessment, instruction, and professional development to build school environments that are conducive for engaged and holistic learning. The advances of technology have created opportunity in improving mathematics education. The aims of using technology are: (1) how teachers can use technological tools to replace or complement traditional media; (2) how students may benefit from learning with technology; and (3) how technology interacts with other elements of instruction.

Researchers found that calculator use during instruction does not hold back either computational skills or conceptual understanding. Instead, it improves outcome results on non-calculator tests for all ability groups of students, as was shown in a metaanalysis of the use of calculators in schools mathematics by Hembree and Dessart (1992). Scientific and programmable calculators appeared at upper secondary level in the early 1980s, and were rather uncontroversial. They were seen as handy tools replacing the extensive mathematical tables that were used before. Graphic calculators came in the late 1980s, and were at first considered mostly as visualising tools for calculus. But soon, teachers

realised their potential for new approaches in most fields of school mathematics, such as number sense, algebra, geometry, data processing and statistics, analysis, etc. In fact, it became possible to organize instruction and to make assessments of students' knowledge of mathematics in quite new ways. And it raised the pertinent question of what mathematical knowledge is and what type of skills students really should acquire during their school education. A number of questions were soon raised by teachers, researchers and others about the consequences for teaching and for students' learning of mathematics. Among the negative arguments were that an extensive use of handheld calculators could harm students' computational skills, both mental and by paper-and-pencil. On the other hand, many teachers could see inspiring possibilities with these new tools, especially those who tended to employ interactive or inquiry-oriented methodologies during instruction (Trouche, 2005a).

Early research of the use of calculators during the 1980s did not indicate that the apprehensions about their harmfulness were right. Researchers found that calculator use during instruction does not hold back either computational skills or conceptual understanding. Instead, it improves outcome results on noncalculator tests for all ability groups of students, as was shown in a metaanalysis of the use of calculators in schools mathematics by Hembree and Dessart (1992).

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E. RECSAM'S Programs in Training Mathematics Teachers

The technology integration theme highlighted in the shaded areas in Fig. 1 provided the explicit preparation of the student teachers' development of knowledge needed for the development of TPCK. For the training /workshop programs, all participants were observed, all assignments were collected and analyzed, and participants were interviewed extensively over the various parts of the program.

Amending these components with technology provides a framework for describing the outcomes for TPCK development in a teacher preparation program:

(1) an over arching conception of what it means to teach a particular subject integrating technology in the learning;
(2) knowledge of instructional strategies and representations for teaching particular topics with technology;
(3) knowledge of students' understandings, thinking, and learning with technology in a particular subject;
(4) knowledge of curriculum and curriculum materials that integrate technology with learning in the subject area (Borko & Putnam, 1996, p. 690).

With this perspective, the preparation of mathematics teachers should be directed at guiding the In-importance that learning to teach is a ''constructive and iterative'' process where they must interpret ''events on the basis of existing knowledge, beliefs, and dispositions'' (Borko & Putnam,1996, p. 674). Shreiter and Ammon (1989) have argued that teachers' adaptation of instructional practices is a process of assimilation and accommodation that results in changes in the their thinking. This perspective suggests that teacher preparation program must provide numerous experiences to engage the in-service teacher in investigating, thinking, planning, practicing, and reflecting. All the faculty and supervisors had previously taught science or mathematics in middle or high schools, providing the subject-specific context throughout the program. The methods courses were team taught by a mathematics educator and a science educator in order to provide subject specific feedback; in addition each student's subject-specific supervisor reviewed the prepared lessons and unit plans.

The training focused on instruction that maintained essential dimensions of mathematics literacy in high school mathematics (1) as a way of thinking, (2) as a way of investigating, (3) as a body of knowledge, and (4) its interaction with technology and society (Chiappetta & Koballa,2002; NCTM, 2000). Science and mathematics educators taught the pedagogy courses separately in order to focus on teaching and learning in the specific content. These courses examined explanations, models, examples ,and analogies to guide student's development of an understanding of science or mathematics. Subject-specific technology educators taught the technology pedagogy courses concentrating on subject-specific technology integration in teaching and learning.

The Objectives. The main objective of this course is to equip teachers with the knowledge and skills in using Hand-held technology effectively in teaching and learning

mathematics at the secondary school level. Several topics were given to enhance mathematical power, such as : issues and trends in using technology in teaching learning mathematics ; use various teaching strategies and approaches to support mathematics investigation, modelling and mathematical problem solving using hand-held technology; understanding of classroom-based action research using hand-held technology; assessment using, and design lessons for secondary mathematics that integrates the use hand held technology.

Technology. During the first quarter of the program, a graphic calculator technology used mathematics problem-based activities to guide the in-service teachers in learning about (a) various hand-held technologies, (b) pedagogical considerations with these technologies, and (c) teaching/learning with these technologies and (d) Designing lesson using technology. This training was first exposure to the real-time data collection devices (calculator-based ranger (CBR) or calculator/ computer-based laboratory (CBL) probes) that they were expected to teach with in their student teaching experience. The students explored a variety of mathematics problems that could be considered in the curriculum. While these activities were designed to help the student teachers become familiar with the use of the sensors for gathering real-time data, their attention was also focused on how they might design lessons to focus on specific goals and objectives in their curriculum.

Classroom Activities. This part involve a variety of hands-on and minds-on involving activities using hand-held technology. Different kinds of calculators : Simple, Scientific and Graphic Calculator were introduced in the training. To some extent, these activities embody essential elements of innovative instructional processes, including action reseach-based learning, problem/project-based learning, collaborative / cooperative learning, and performance-oriented evaluation. For the project work, focus of activities are in using Graphic Calculator. Two kinds of graphic calculator can be chosen by the participants: Texas Instruments and Casio. Participants were divided into two groups. They selected 2 mathematics topics being learned in the classrooms for Grade X and Grade XI

Peer Teaching and Practical Experience. Peer Teaching was conducted in class for each participant. Each participant selected High School Mathematics topic and focused the students on gaining teaching experience with specific instructional methods using graphic calculator. The participant teachers were expected to develop a mathematics lesson for each model (integrating technology in at least one), teach (videotaping the instruction) their lessons to their peers, and reflect (assessing and considering revisions) on the lessons using the videotapes to recall the teaching and the debriefs of the lessons by their peers and the instructor. All models included one technology lesson supporting

the discussion of important planning and implementation issues for integrating technology in the lesson.

Content, Technology, and Pedagogy. The focus of the paper is in helping students enhance understanding mathematics using ICT. In the syllabus, we attempt to make a convergence between theories, technologies and pedagogical practice, with a focus on pedagogical practice. The syllabus consist of three parts:, theoretical lectures, and using technology tools to support teaching and learning, and practical activities in class and at school.

The remaining time of the program focused specifically on providing extended practical experiences that required the participant teachers to plan, teach, and reflect on teaching mathematics with technology graphic calculator in their own classrooms. Prior to the practical teaching the choice of mathematics pedagogy includes instruction focused on teaching the interaction of mathematics, and technology. The mathematics pedagogy focused on NCTM's Technology Principle from the national standards. The Technology and pedagogy guides teachers in planning for teaching a sequence of lessons that included student practical use of graphic calculator, experiences with technology during teaching.

Participant teachers were expected to connect with their cooperating teacher, identifying reasonable places in the curriculum for an integration of technology. With limited availability of technologies at the public school site, teachers in this training were provided with classroom sets of the real-time data collection devices for hands-on student exploration. During practical teaching, student teachers were expected to adjust their plans under the supervision of their supervisor and cooperating teachers. Either the supervisor or the cooperating teacher observed the lessons and guided the participant teacher in analyzing the effectiveness of the lesson. After each lesson, the teacher prepared written reflections that considered revising plans for succeeding lessons. At the completion of the sequence, the student teacher prepared an analysis of:

(1) each student's understanding of the mathematics concepts,
(2) the success of the integration of the technology in the lessons (overall as well as recommendations for changes), and
(3) their teaching while integrating technology in teaching mathematics.

A follow-up activities after practical teaching focused teachers on an analysis of the use of technology in teaching mathematics. This activities challenged them to consider the impact of the instruction on students' understanding and thinking.

Theoretical lectures: This part includes lectures adresses innovative learning models with support of new technologies, or discusses methodological points critical to the design of creative learning systems using technology. The training programmes is targetted for 100 hour-course in 3 weeks which include 9% for general components, 85% for core components, and 6 % for enrichment components. . Figure 1 below shows the

topics offered to the participants which include: theory, pedagogy, and the technology tools and their applications.

Instructional Strategies. As other training courses, the training programme employed various instructional strategies and methodologies such as: individual, peer, and collaborative/cooperative group learning tasks; demonstrations; sharing of experiences, hands-on practice; Interactive theme presentations. The deliberate attempt was to move away from lecturing and teaching of discrete ICT skills to model various strategies that were built upon established learning theories and pedagogies. These instructional strategies included: contructivist approach to learning, direct instruction, self-directed learning, and group work. Through these processes, the trainees were also given experience in the use of ICT in teaching and learning mathematics as a tool for administration, presentation, and cog nitive processing. It included several activities designed to achieve the goals.

Participants. Ten participants attended this regular course under scholarship from RECSAM. These participants were teachers and teachers-educators from universities, teacher training colleges, department of education office and schools. They generally has been teaching high school at least 5 years in mathematics and actively involved in mathematics teacher organization, competent in English and have basic skills in ICT tools such as word processors, data bases, presentation software, e-mail and do internet browsing.

The Program Structure:The training program is designed in three part structure: Theory (lecturer), pedagogy (activities), and Technology (Tools) ***(See figure2)***

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Theory (lectures)	**Pedagogy (activities)**	**Technology (tools)**
Phylosophical Bases • Current Trends in math Education involving technology • How students learn mathematics using technology • Constructivism in the math classroom • Instructional design using hand-held technology • Classroom action research • Alternative Assessment in evaluating students' ICT environment • Seminar on writing multiplier effect proposal	**Introduction to ICT and its application in mathematics education** • TPACK • Strategies/Approaches involving Hand-Held Technology **ICT and Pedagogy** • Pedagogical principles for integraing ICT into math clssrooms • Utilizing technology in creating problem-based and project-based learning • Building critical thinking skills in the classroom using calculator • Creating lesson using calculator • Individual learning, cooperative learning, inquiry-based learning	**Teaching with educational software and other applications** • Basic ICT tools; Word; EXCEL; PowerPoint; IE Explorer; Search Engine; E-mail; Chat Room • Hand-held technology: a. Simple calculator, manipulative (primary math) b. Scientific Calculator c. Graphic calculator, Classpad 300, CBL/CBR • Mobile Learning

Figure 2. A tri-part structure of instructional technology curriculum

Project Work. At the end course the trainees were required to plan and conduct an ICT-based lesson (ICT-BL) for their project work. Our emphasis on their reflections helped the trainees to understand our philosophy, that is, learning is an internal process and "those methods and techniques which involve the individual most deeply in self-directed inquiry will produce the greatest learning" (knowles, 1980, p.56). such an experience also helped the trainees to engage in reflective practice, an essential component for bringing understanding to the complex nature of classrooms (Zeichner & Liston, 1996). The Lesson Plan project is a group-project on the development of the lesson implemented as Action Reseach project practiced in school in Penang. The projects were small units of student-centered learning activite with specific learning objectives.

The overall training strategy follow the cascade model where the participants will train group of master trainers and teacher educators in their respective countries at sub-regional training programmes. The trainee teachers have to develop proposal to conduct similar activities for teachers in their respective countries, resulting in multiplier effect.

Evaluation. At the end of each week of training and at the end of each course, a session is held to get feedback from the trainees. Participants evaluate the course programs through a structured questionnaire. The progra, is then modified according to the feedback received.

Participants Performance. A study of participants' perception of the course contents was conducted using questionners. Individual Pre-Test and Post-Test Score were given to all participants. The questionners were the participants's perceptions on the knowledge and skills in each topic of the course content. The questionners were administrated before the course started and a posttest was given att the end of the course to all participants Regular Course. The outcome of the participants'perception in each topic of the course input in general from the pretest and posttest showed that all participants enhanced their competencies in all topics and project work. Their perception toward the course was positive. They showed their enthusiastic in learning using the technology.

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Background information for deeper understanding

The original web sites about the TPACK model provide great background.
http://www.tpck.org/

Wikipedia provides a good summary
http://en.wikipedia.org/wiki/Technological_Pedagogical_Content_Knowledge