HOW TECHNOLOGY USE IS BEING REFLECTED IN JUNIOR SECONDARY MATHEMATICS TEXTBOOKS IN HONG KONG

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INTRODUCTION

- The use of digital technologies, including calculators, software and the internet
- The International Commission on Mathematical Instruction (ICMI) Study "The Influence of Computers and Informatics on Mathematics and its Teaching" in 1985.
- The Hong Kong curriculum: Continual reforms of different scales, e.g. "Learning to learn" (EDB, 2001), "The future is now: From vision to realisation" (EDB, 2009). The use of digital technologies in mathematics teaching has been promoted.
- Textbooks playing a significant role in curriculum implementation: the potentially implemented curriculum.

RESEARCH QUESTION

- How has the technology been used and reflected in the current junior mathematics textbooks (Grade 7 to Grade 9) in Hong Kong?
- A popular textbook series was analysed.
- The use of technology was categorized into:
  - the use of calculators;
  - the use of internet and the use of software,
  - internet and CD-ROM; and
  - other supplementary materials.

CURRICULUM IN HONG KONG

- Top-down approach: Based on curriculum guide prepared by the Curriculum Development Council (2002)
- To "use diversified learning activities and tools (including project learning and using IT) to arouse students' interest in learning mathematics and to foster high-order thinking skills" (CDC, 2002, p. 5)
- The objectives of the curriculum include:
  - For strands or learning dimensions of mathematics knowledge (numbers and algebra; measures, shape and space; and data handling);
  - Generic skills (collaboration, communication, creativity, critical thinking, information technology (IT), numeracy, problem solving, self management and study).

The mathematics exemplars are:

- To use scientific calculators/graphing calculators for various computational and exploratory activities (e.g. input data and create statistical graphs; draw straight lines and explore their relationship with slope)
- To use suitable software to explore the relations of numbers (e.g. number patterns), algebraic formula (e.g. formulae of area and volume) and graphical representations (e.g. pie charts and straight lines)
- To use suitable software to construct/explore appropriate statistical diagrams/graphs (e.g. bar charts, pie charts, line charts) to represent given data; to find simple statistical measures (e.g. mean, mode) and to explore the meaning of experimental probability (e.g. tossing coin simulation)

The math exemplars (cont'd.)

- To use geometry software packages to explore properties of 2-D rectilinear geometric figures dynamically (e.g. the relationship among the angles or sides of a parallelogram); to explore and visualize geometric properties of 2-D and 3-D figures intuitively (e.g. transformation and symmetry)
- To use the information obtained through Internet/Intranet in self-directed learning and when doing projects (e.g. statistical projects, projects on the development of mathematics in China, stories and achievements of mathematicians)
- To judge the appropriateness of using IT in solving mathematical problems (e.g. to calculate $2\sin 30°$ mentally)

METHOD

- Selection of textbooks: One of the most popular textbook series used in Hong Kong was selected for the study.
- Each grade consisted of two volumes with 5 to 7 chapters in each volume and there were about 40 to 60 pages for each chapter. Each volume was supplemented with a CD-ROM.
- The activities/exercises that involve the use of technological tools were coded by the use of technological tools. The activities/exercises in the topics were also categorized with the mathematics strands according to the nature of the topic.

Structure of the textbook

- **Chapter Introduction:** An interesting passage at the beginning of the chapter to motivate students to study the chapter

Main Text

- **Basic Knowledge Review:** A quick revision on the basic knowledge required for learning the chapter
- **Definitions and Concepts:** Clearly stated definitions and concepts using simple language and appropriate illustrations
- **Formulas and theorems**: Highlight important formulas and theorems
- **Activity**: To guide students to think and develop mathematical concept
- **Worked Examples**: Graded examples showing different mathematics techniques
- **Let's Discuss**: Opportunities for students to share their problem-solving methods and exchange mathematical ideas
- **Chapter Summary**: Key terms, main concepts and formulas with typical examples

Side features

- **Concept Check:** Questions for teachers to assess students' understanding of concepts taught
- **Think Further:** Questions for able students to consider and explore further
- **Solving Tips:** Tips to guide students in tackling problem
- **Reminder:** Useful skills and techniques for tacking mathematical problems
- **Using Calculator**: Clear steps for using calculators to handle calculation
- **Rough Work**: Short explanation to help students understand the steps in worked examples
- **Interesting Maths**: Relevant daily-life examples, cultural and interesting information
- *Exercises*
- **Classwork:** Simple straightforward questions for student to practice in class
- **Quick Practice**: Simple and example related questions for immediate practice
- **Further Practice**: A few integrated questions for more practice
- **Exercise:** A large number of graded section-end exercises for assignment, including open-end questions
- **Revision Exercise:** A large number of graded section-end exercises for revision, including open-end questions
- **Challenging Questions:** More challenging questions for further practice
- **Integrated Exercise:** Ample graded exercises integration knowledge acquired from different chapters with public exam multiple choice questions
- **Summative Assessment**: Questions which help to access how well students have mastered Basic Competency items taught in the year

Coding: The categorization was based on Fan's framework (2011)

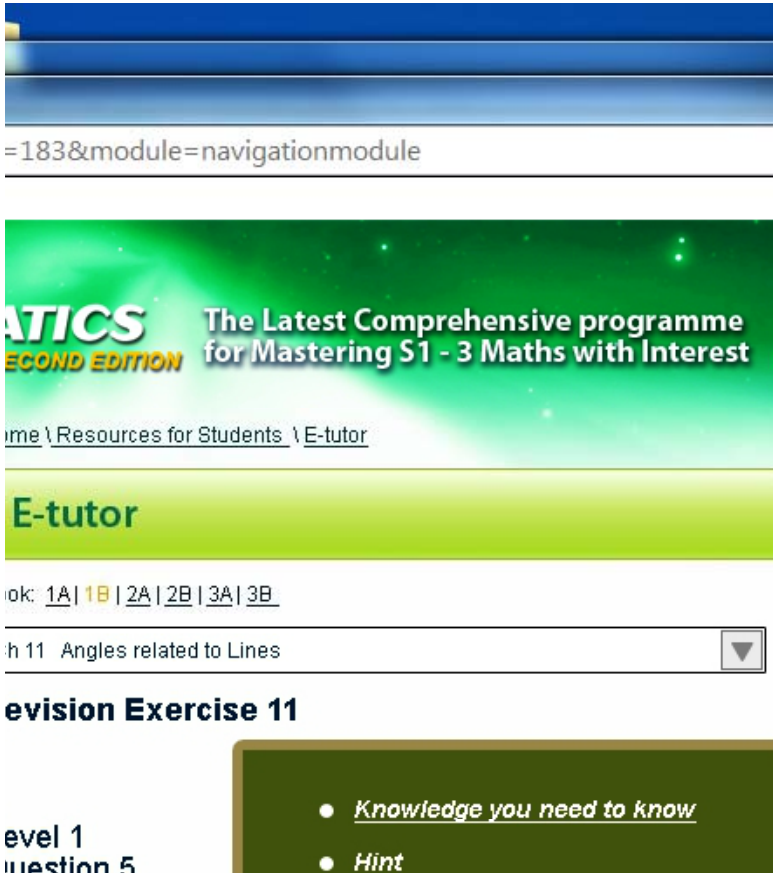
- Calculator:
- Internet E-tutor:
- Internet: Additional resources and information for projects.
- Software, Internet and CD-ROM:
  - activities uses the Internet for exploration, guided by the activity sheets and files
  - activities can be carried out in the computer offline that use software such as Microsoft Excel, Geogebra or Animation files for exploring the mathematical concepts.
- Other supplementary materials provided by the publishers: Other resources include, glossary, activity sheets, powerpoint presentation files and drilling program.

RESULTS: Calculators

- Could be used for all parts of the curriculum
- Students were expected to judge the appropriateness of using calculators for solving mathematical problems.
- Normally, no specific indication whether students should use calculators or not for a certain problem or exercise in the textbook.
- The key sequences of using the calculators (tool):
  - e.g., 'SHIFT' 'π' '÷' 9 '×' 2 '+' 6

Internet: E-tutor

- At the end of each chapter, there was a revision exercise with support was provided by the E-tutor on the internet
- For selected problems of varied difficulty for the topic.
- Students might login in their accounts to use the e-tutor in the publisher's website.
- The e-tutor provided:
  - hints, outline of method and
  - a list of the knowledge that they needed to solve the problem.
- These exercises were traditional exercises that can be completed by pencil and paper.



Some examples in the self-evaluated drilling program in the CD-ROM

(b) A product is sold at a discount of 19% for $103. Find the market price.

(c) $\dfrac{48a^9b^5}{16a^4b}$

(d) Simplify the expression and arrange the terms in descending powers of the variables.

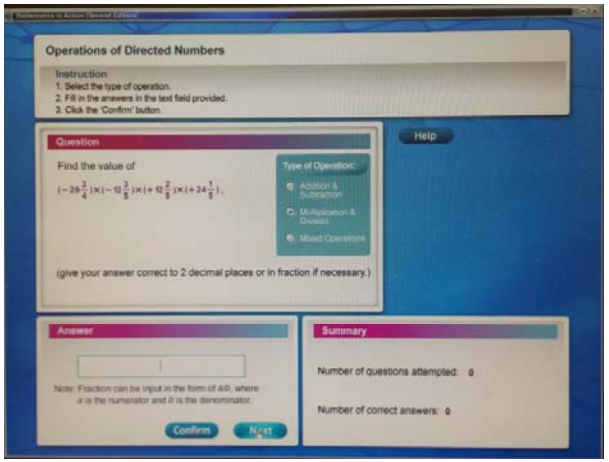


Figure. The screen display of an exercise item in the drilling program in the CD-ROM

Internet: Websites for additional resources and information

- One project for each grade:

  (1) A statistically study on the population in Hong Kong (Grade 7, Data Handling),

  (2) Pythagoras theorem (Grade 8, Measures, Shapes and Space), and

  (3) Taxation in Hong Kong (Grade 9, Numbers and Algebra).

The technological tools used in the Grade 7 mathematics textbooks

Numbers and Algebra strand

Topic	Technological tool	Exercise/Activity
Basic Mathematics		
Directed Numbers and the Number lines	E-tutor	Revision Exercise
	Learning CD-ROM	Drilling program
Introduction to Algebra	E-tutor	Revision Exercise
Algebraic Equations in One Unknown	E-tutor	Revision Exercise
Percentages (I)	E-tutor	Revision Exercise
	Learning CD-ROM	Drilling program
Manipulation of Simple Polynomials	E-tutor	Revision Exercise
	Learning CD-ROM	Drilling Program

Measures, Shape and Space strand

Topic	Technological tool	Exercise/Activity
Introduction to Geometry	E-tutor	Revision Exercise
	Software & Learning CD-ROM	Sum of all the interior angles of a triangle (GeoGebra)
Symmetry and Transformation	E-tutor	Revision Exercise
	Software & Learning CD-ROM	Rotational symmetry of plane figures (GeoGebra) & Reflection and rotational transformation (GeoGebra)
Areas and Volume (I)	E-tutor	Revision Exercise
Congruency and Similarity	E-tutor	Revision Exercise
	Learning CD-ROM	Drilling program
Introduction to Coordinates	E-tutor	Revision Exercise
	Learning CD-ROM	Order of transformations (GeoGebra)
Angles related to lines	E-tutor	Revision Exercise
	Learning CD-ROM	Drilling Program

Data handling strand

Topic	Technological tool	Exercise/Activity
Introduction to Various Stages of Statistics	E-tutor	Revision Exercise
Simple Statistical Diagrams and Graphs (I)	E-tutor	Revision Exercise
	Software	Use the "chart wizard" function of excel in Constructing Statistical Diagrams with Computer Software
Project	Internet-website	A Statistical Study on the Population in Hong Kong

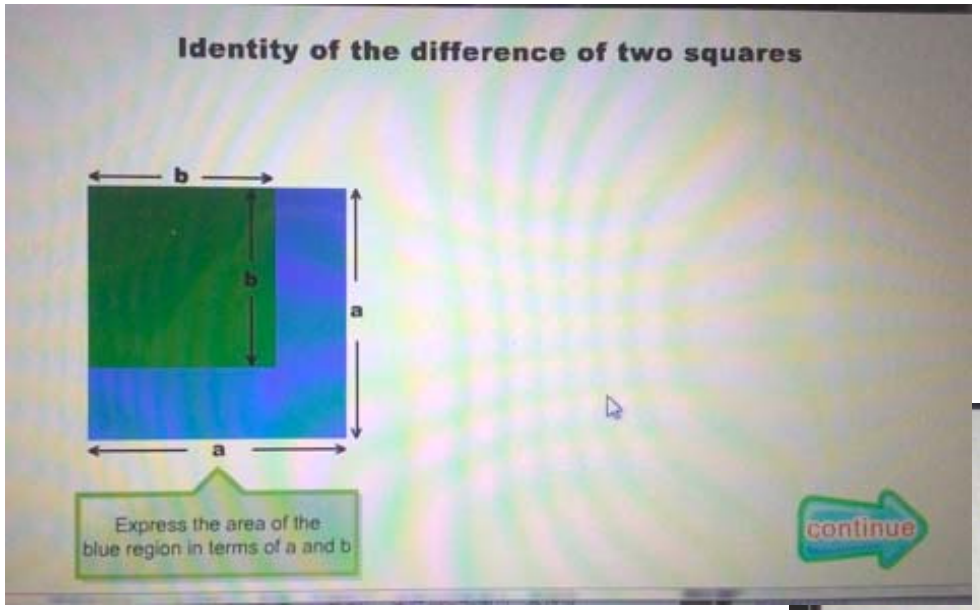
Combined strands: Number & Algebra/Measures, Shape and Sp

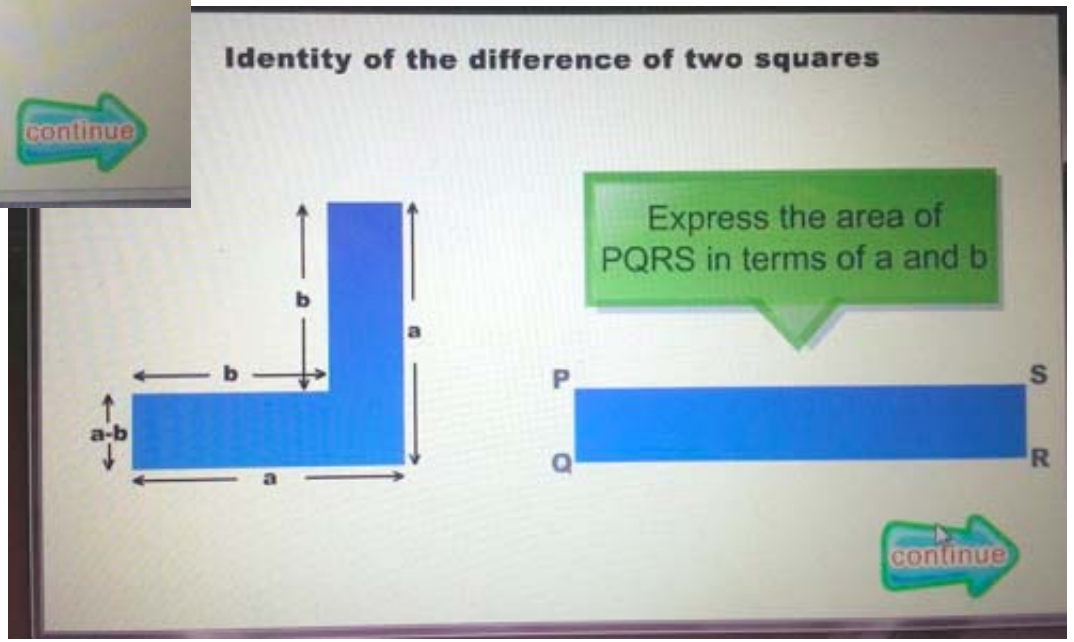
Topic	Technological tool	Exercise/Activity
Estimation in Numbers and Measurement	E-tutor	Revision Exercise
	Software & Learning CD-ROM	Estimation of π (Excel)

Software, Internet and CD-ROM IT activities

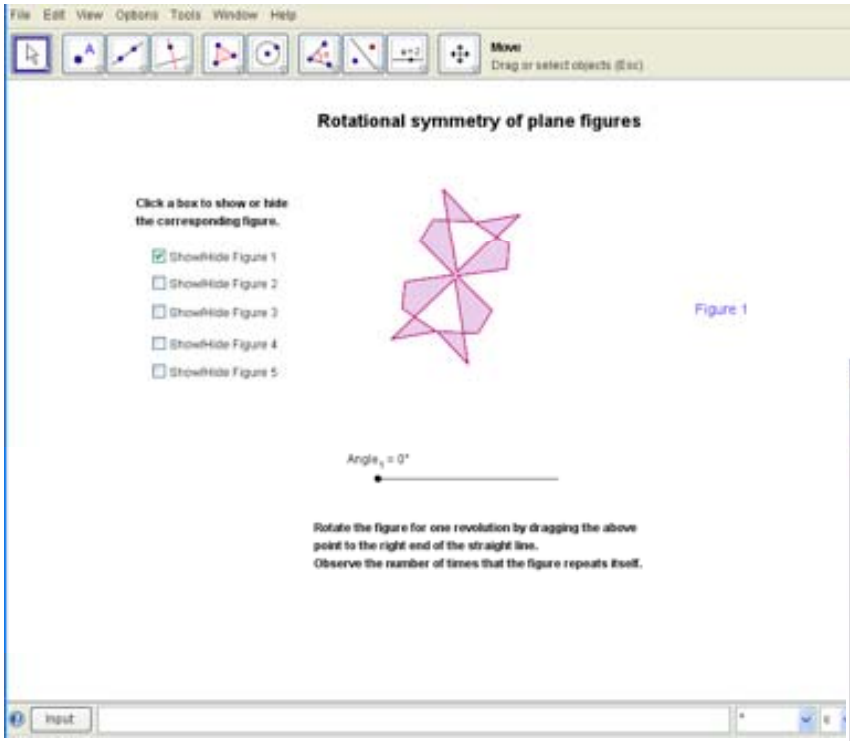
Grade 7	Grade 8	Grade 9
• Sum of all the interior angles of a triangle (Geogebra) • Rotational symmetry of plane figures (Geogebra) • Reflection and rotational transformation (Geogebra) • Order of Transformations (Geogebra) • Estimation of π (Excel) • Constructing Statistical Diagrams (Excel) • Project	• Identity of the difference of two squares (CD-ROM animation) • Investigating the graphs of linear equations in two unknowns (Excel) • The value of √2 (Excel) • Tessellation (link to activity on internet) • Proofs of Pythagoras' theorem(CD-ROM animation) • Properties of sine ratios and cosine ratios (Geogebra) • Project:	• Simple interest and compound interest (Excel) • Experimental probability (Excel) • Project

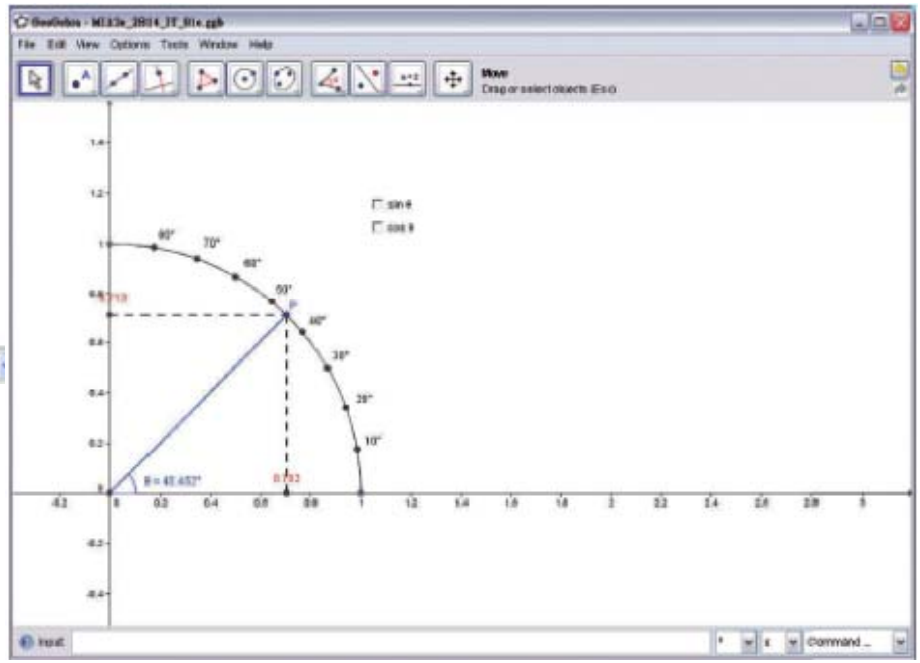
Animation in CD-ROM: Identity of the difference of two square





Activity using GeoGebra: Transformation, Trigonometry





An example (GeoGebra): Sum of interior angles of a triangle

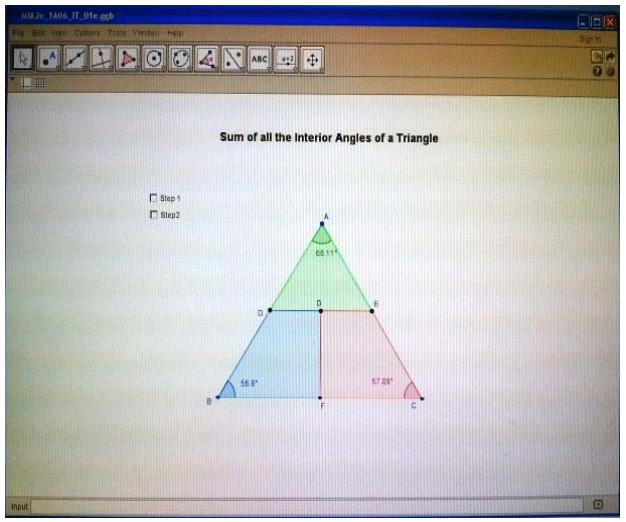


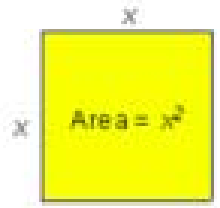
Figure 1 The GeoGebra file for the activity "Sum of interior angles of a triangle"

- Select "Step 1" and rotate ΔADE by dragging A until AE coincides with EC.
- Select "Step 2" and move the polygon DBFG horizontally by dragging B until BD coincides with AD.

1. What type of angle is formed when the three interior angles (i.e. ∠ECF, ∠ EAD and ∠ DBF) are joined together? Circle your answer below.
   (acute angle / right angle / obtuse angle / straight angle / reflex angle / round angle)
2. Will you get the same answer of question 1 for other angle? Repeat the above steps with different angels and check the result.
   (Hint: You can get the different triangles by dragging the vertices of ΔABC)
3. Write down your conclusion about the sum of all the interior angles of a triangle)

e-worksheet in the CD-ROM: Estimation of √2

	A	B	C	D
1	Find an approximate value of the square root of 2			
2				
3	x (length)	x^2 (Area)	<2 / =2 / >2	$x^2 - 2$
4	1.5	2.25	>2	0.25
5	1.4	1.96	<2	-0.04
6	0	0	<2	-2
7	0	0	<2	-2
8	0	0	<2	-2
9	0	0	<2	-2
10	0	0	<2	-2
11	0	0	<2	-2
12	0	0	<2	-2
13	0	0	<2	-2
14	0	0	<2	-2
15	0	0	<2	-2
16	0	0	<2	-2
17	0	0	<2	-2
18	0	0	<2	-2
19	0	0	<2	-2
20	0	0	<2	-2
21	0	0	<2	-2
22	0	0	<2	-2
23				
24				



'Average' Calculator					
	Input Here ↓		Input Here ↓		
The average of	1.5	and	1.4	is	1.45

Note: You ONLY need to input your guess in column A

An example (Excel): Estimation of π

1. If the radius of a circle is 1 unit, express the circumference of the circle in terms of π.

2. The following diagram show an inscribed regular 6-sided polygon, inscribed regular 12-sided polygon and an inscribed regular 24-sided polygon. (The radius of the circle is 1 unit).

(a) When the number of sides of the inscribed regular polygon increases, what is the relationship between the perimeter of the polygon and the circumference?

(b) By using the symbol "≈", express the relationship between the perimeter (P) of the regular polygon and π.

3 Open the Excel file provided in the CD-ROM (Figure 2). Input "6" into cell A2. Excel automatically calculates the perimeter of the regular 6-sided polygon as shown in the file. According to the result in question 2(b) and the datum in cell B2, write down an estimation of π .

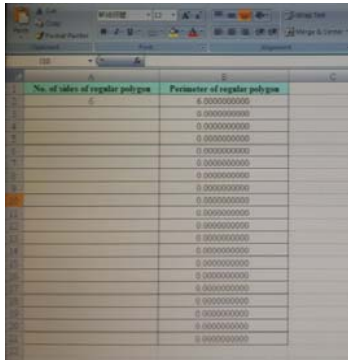


Figure 2 The Excel file

4. In cell A3 to A11, input the number of sides of other regular polygons to obtain the estimation of π. When the number of sides of the regular polygon increases, does the estimation of π become more and more accurate? Yes/No.

Other supplementary materials provided by the publishers

- Drilling program in the CD-ROM
- 5-minute powerpoint files
- Screen video and verbal instruction of using the software such as Excel, Sketchpad and GeoGebra
- Glossary of mathematical vocabulary
- "Graph and grid paper" files to be printed for use

Conclusion

- Hong Kong is used as an example of how the use of IT was represented in the textbook as a result of the top-down curriculum reforms in an Asian context.
- The use of IT depends much on the mathematical content stipulated in the curriculum.
- Three major categories:
  - self-learning platform such as drilling programme with self-evaluation: only a change of platform for the traditional pencil-and-paper test.
  - IT activities designed to make use of the advantages of specific software platforms e.g., Excel, Geogebra
  - Projects

A wish list:

- More insight into the design of the mathematical tasks and activities;
- More insight to how teachers can be supported;
- More insight to the empowerment of the students' capacity of learning.

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Thank You

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