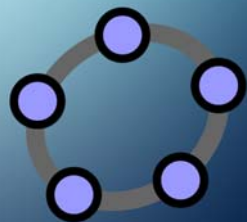# 中學數學電子學習系列：(2) 在數學課堂有效運用資訊科技（進階程度）

教育局數學教育組

2019 年 4-5 月

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GeoGebra 簡介

- GeoGebra 是為了小學到大學的教學而設計的開源 (open source) 動態數學軟體。
- GeoGebra 是一套結合幾何（平面+立體）、代數、統計及微積分等的免費動態幾何軟件，它是在 2001 年由 Markus Hohenwarter 在奧地利的 Salzburg 薩爾茨堡大學所設計。
  - GeoGebra 其實就是他的碩士論文。
  - 目前在奧地利 Linz 的 Johannes Kepler 大學（克卜勒大學）擔任數學教學研究所所長。
- GeoGebra 是由 Java 寫成的，因此可以跨平台使用。
- GeoGebra 的一些學與教用途：
  - 教師用於課堂演示互動幾何圖像；
  - 學生用於探索與發現幾何概念，猜想幾何定理。
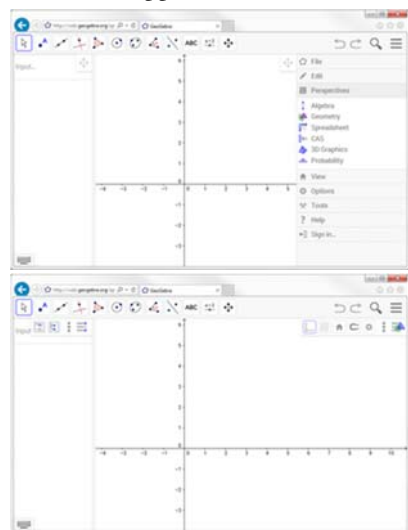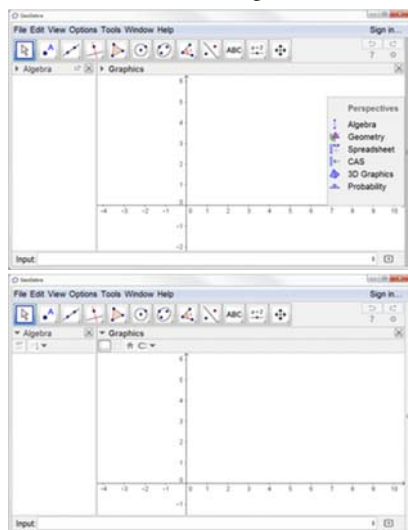- 2011: 38 developers & 200 translators Celebrating 10 years of GeoGebra

  If you want to go fast, go alone.
  If you want to go far, go together.

最近版本： 6.0.529

Stable release	6.0.452.0 (8 April 2018)
Stable release:	6.0.518 (20 December 2018)
https://en.wikipedia.org/wiki/GeoGebra	

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下載與安裝

GeoGebra 經典 6   GeoGebra 經典 5

- GeoGebra Desktop 桌機版 vs. Web and Tablet App 線上版或平板版

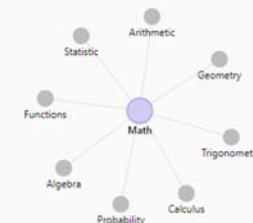## GeoGebra: Books

- Mathematical Modeling: Applications with GeoGebra
  - Hall, J., Lingefjärd T. (2016). *Mathematical Modeling: Applications with GeoGebra*. New York: Wiley. [568 pages]
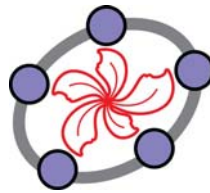- GeoGebra - 幾何與代數的美麗邂逅
  - 羅驥韡（2013）。《GeoGebra 幾何與代數的美麗邂逅》。臺北市：五南。

GeoGebra: Resources

- Find over 1 million free activities, simulations, exercises, lessons, and games for math & science!
  - https://www.geogebra.org/materials
  - https://www.geogebra.org/t/math
  - https://www.geogebra.org/m/bgmn44x5
- Tutorials:
  - https://wiki.geogebra.org/en/Tutorials
  - https://www.geogebra.org/a/14

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GeoGebra: Resources

- GeoGebra Institutes
  - https://www.geogebra.org/institutes

- GeoGebra Institute of Hong Kong (GIHK)
  - http://www.geogebra.org.hk

- Applets in Tablets: GeoGebra 數學電子教室
  - https://www.gmath.hk/
  - http://www.geogebra.hk/
  - http://www.geogebra.hk/reference

  - (Learning GeoGebra from Examples)
    https://www.geogebra.org/m/FZFjhBaa
  - (Graph Plotter 2018)
    https://www.geogebra.org/m/wQtHUaaa

gMath

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How GeoGebra (and other IT tools) may enrich classroom L&T?

Mathematics Education Section

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Advantages of GeoGebra

- Dynamic

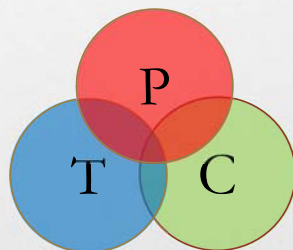- Extremely rich in functions

- Fast to observe and conclude

7

Disadvantages of GeoGebra

- Dynamic without knowing the mechanisms

- Too rich in functions without knowing the focus

- Too fast to observe and conclude only by superficial observations

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Key question

- What to teach?
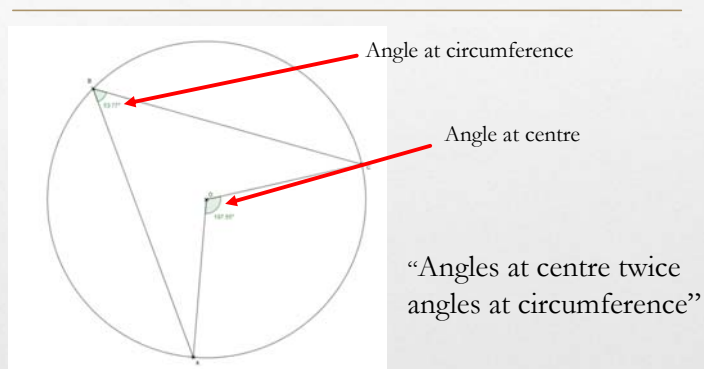
- How to use?

- How to **refine**?

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L&T in Properties of Circles

- A refinement process on L&T package using dynamic geometry software

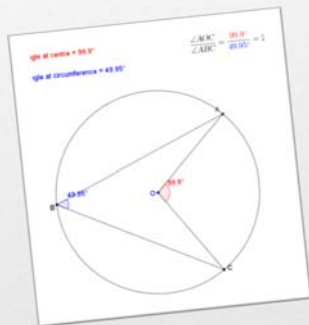- A theorem on the properties of circles

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The theorem

Angle at circumference

Angle at centre

"Angles at centre twice angles at circumference"

11

The proof

Does it work?

Pedagogical considerations?

How can a task aim at the difficulties?

What are students' difficulties?

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Refinement:
From visualisation to abstraction
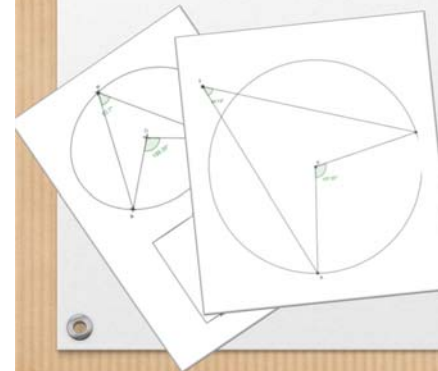
Understand the limitations

Dynamic geometry vs Euclidean Geometry?

Computation work vs Mind work

13

Refinement:
From visualisation to abstraction

Stretch the potential

Re-reading a geometric theorem:
In a circle, an angle at any points of the circumference is half of the angle subtended by the same arc of the circle at the centre.

Conditions and consequences:
Pedagogy of variations

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A complete cycle of teaching

- Examples versus verifications
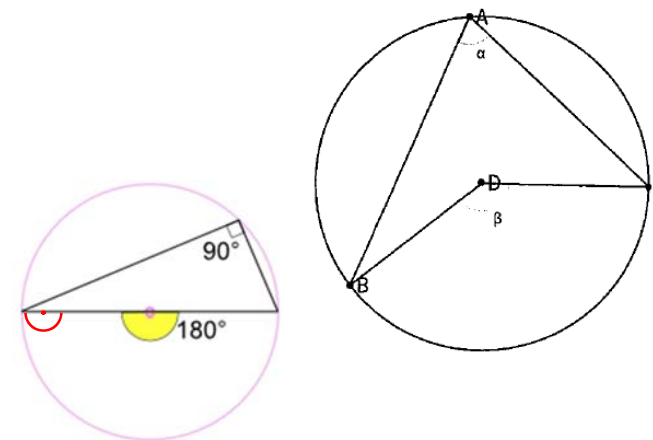
- Counter-examples versus constraints

15

Re-visit the theorem: Think about it

Section D: Think about it

Question 2

Cody claims that if $\beta = 2\alpha$, D must be the centre of the circle. Do you agree? Explain your answer.

90°

180°

16