# Using Technology in Mathematics Discover and Proof Pythagorean Theorem with GeoGebra

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Keywords: GeoGebra, Mathematics, Pythagorean Theorem, Discover, Proof.

Abstract: Pythagoras, one of the most famous ancient Greek philosophers and mathematician. One of the great contributions to science was the Pythagorean Theorem. It states that the square of the hypotenuse is equal to the sum of the squares of the other two sides. The theorem Pythagoras be written as an equation relating the lengths sides c, b, and a, often known the "Pythagorean equation" a2 + b2= c2. The evidence of the Pythagorean Theorem varies greatly. There are various ways to prove the Pythagoras Theorem a simple and complex even in the digital era can use of technology. In the 21st century the use of technology as a source of learning development. In Mathematics GeoGebra is free software and open source. Mathematics learning can be studied like algebra, geometry, calculus, and statistics. GeoGebra is an interactive software for study mathematics. The paper presents illustrate how we can use GeoGebra to guide learners in the processes of discovering and prove The Pythagorean Theorem. Teachers or students can improve their own knowledge of instruction for effective learning in 21-century learning.

## 1 INTRODUCTION

One of the first theorem when studying mathematics in primary school is the Pythagorean Theorem. The theorem is a mathematical statement that still requires proof and the statement can be shown its truth value. Pythagoras is one of the most well recognized mathematicians (Parada-Daza and Parada-Contzen, 2014). Although his figure and influence transcend the strictly mathematical. Throughout his life, he liked to travel to various places, such as Egypt and Babylon. Pythagoras taught students that everything in the universe can be expressed in numbers. Because of this, Pythagoras and his followers adore numbers and ratios that can be expressed by these numbers. The Pythagorean Theorem indicates that the square of the hypotenuse of a right triangle equals the sum of the squares of the lengths of the other two sides each. a^2+b^2=c^2 where c describes the length of the hypotenuse, a and b the lengths of the triangle's other two sides. The theorem that may be familiar to most people. A simple basic theorem, interesting and very useful to learn.

The evidence of the Pythagorean Theorem varies greatly. Bogomolny (2016) Presented there are a lot of various ways to prove the Pythagorean theorem a simple and complex even. In the digital era can prove the Pythagorean use of technology. The use of computers has been applied to learning such as in the use GeoGebra Software the mathematics field. This paper presents illustrate how we can use of GeoGebra to guide learners in process of discovering and prove the Pythagorean Theorem. Teachers or students, to help them improve their knowledge own instruction and effective learning.

## 2 DISCOVERING PYTHAGOREAN THEOREM IN REAL LIFE

The Pythagorean Theorem is closely related a square shape. If a and b are the lengths of the legs of a right triangle, c is the length of the hypotenuse, then the sum of the squares of the lengths of the legs is equal to the square of the length of the hypotenuse. This relationship is described by the formula: a^2+b^2=c^2. Let's look at the Pythagorean Theorem form on right triangle.



Faris, M.
Using Technology in Mathematics Discover and Proof Pythagorean Theorem with GeoGebra.
DOI: 10.5220/0008407200210025
In *Proceedings of the 2nd International Conference on Learning Innovation (ICLI 2018)*, pages 21-25
ISBN: 978-989-758-391-9

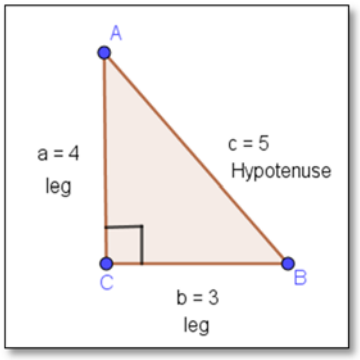


Figure 1: Right triangle ABC.

Answers :

$a^2 + b^2 = c^2$

$(4)^2 + (3)^2 = (5)^2$

$16 + 9 = 25$

This theorem only applies to an angled triangle. The sum of the squares of the lengths of both legs is equal to the square of the length of the hypotenuse side. As discovered by (basic-mathematics.com, 2016) John leaves school to go home, He walks 6 blocks North and then 8 blocks west. How far is John from the school? Here is how you can model this situation.

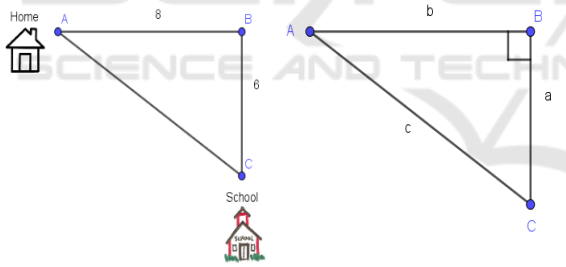


Figure 2: Representation of Pythagorean theorem.

Answer:

$c^2 = a^2 + b^2$

$c^2 = 6^2 + 8^2$

$c^2 = 36 + 64$

$c = \sqrt{100}$

$c = 10$

$the\ distance\ from\ school\ to\ home\ is\ 10\ bloks$

The Pythagorean Theorem explains in any right triangle, the sum of the squares of the lengths of the triangle's legs is the same as the square of the length of the triangle's hypotenuse. This theorem is represented by the formula c^2=a^2+b^(2 ). Easily, if we know the lengths. On two sides of a right triangle, we can apply the Pythagorean Theorem to find the length of the third side. Understanding, this theorem can work for right triangles.

## 3 GEOGEBRA

The use of technology is an important tool for students in learning mathematics. The importance of using technology in teaching mathematics has been supported by the National Council of Mathematics Teachers (National Council of Teachers of Mathematics, 2000). Technology is an essential component of the environment. One interesting tool that can be used is GeoGebra.

GeoGebra is a computer program that can be used in mathematics learning when users learn geometry, statistics, algebra, calculus. Starting from elementary school to university. M. Hohenwarter created the software GeoGebra in 2002 for the purpose of learning and teaching mathematics. Technical qualities of the software GeoGebra are (Chrysanthou, 2008):

- An open source software (www.geogebra.org).
- Opportunities to change the language (more than 50 languages), making it suitable for training of multi-ethnic groups.
- Suitable for use for different age groups at different stages of training – GeoGebraPrim.
- Possibility to modify the interface level if necessary.
- Has tools for adding animation, dynamic text; work online / offline mode
- Compatible with new hardware (GeoGebra Tablet Apps, iPhone, iPad, Android, Google Play Apps, Windows 8,10) and software technologies (GeoGebra Chrom App, GeoGebra Web Application)
- Maintain installations for widely used platforms - Windows, Linux, Mac, Ubuntu & Debian, Fedora, open SUSE, UNIX, and XO - one laptop per child.
- Ability to share materials and connection with others in the online space – GeoGebraTube.
- Access the GeoGebra UserForum where one can discuss their questions and ideas (Hohenwarter and Preiner, 2007).

GeoGebra also can be used as media mathematics learning to demonstrate or visualize mathematical concepts and as a tool to construct concepts mathematically. An environment of open source tools around the dynamic mathematics software GeoGebra where educators can join an online community for creating and modifying mathlets (Hohenwarter and

Preiner, 2007). All materials in this GeoGebra environment are subject to a Creative Commons license that allows everyone to make customized works for non-commercial purposes.

## 4 PROOF PYTHAGOREAN THEOREM WITH GEOGEBRA

This proof is the area of the square that built on each side of a right triangle and animation with translation, let's prove it.

a. Construct the right triangle and draw three square of each side.

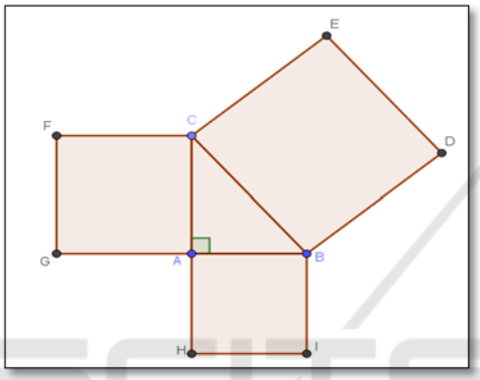


Figure 3: Right triangle and three square of each.

Right triangle ABC, the AB side is adjacent, the AC side is opposite and the BC side is hypotenuse and draws three square of each side. The ABIH square is on the AB side (adjacent). The CAGF square is on the AC side (opposite). The BCED square is on BC side (hypotenuse).

b. Draw to parallel line then the intersection of that two line.

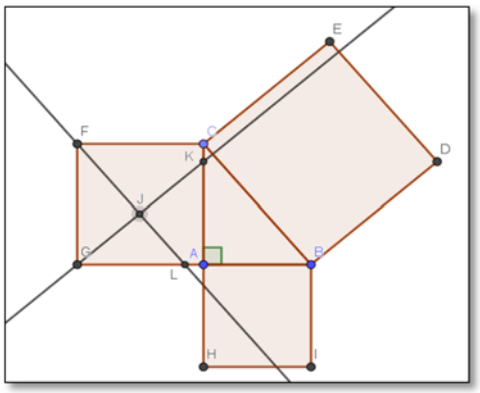


Figure 4 : Parallel line in CAGF square.

On the CAGF square draw line then intersection of that two line and create L point in AG side and K point AC and J point in the middle the CAGF square and hide to two line.

c. Draw polygons and make different colour.

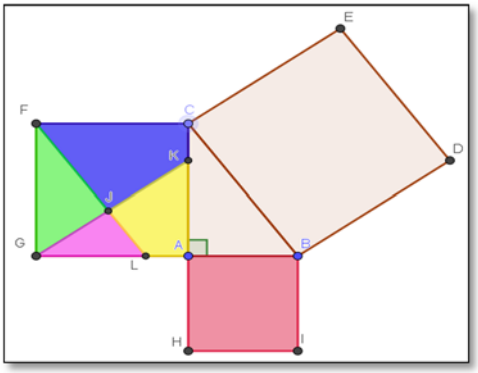


Figure 5. Different colour for polygons.

On the square of the AC side draw 4 polygons. The polygons are FJKC, FJG, GJL, and JKAL. Then each of the Polygons chose different colour including the square ABIH.

d. Draw circle with center D and radius FJ.

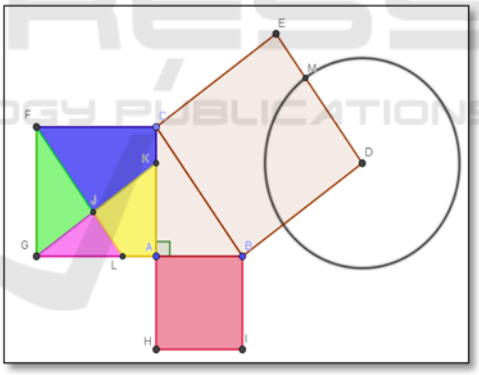


Figure 6: Circle on D point centre.

Chose icon Circle or compass name on toolbox GeoGebra and draw a circle radius F and J create a circle move to D point. Then intersect circle create M point and hide circle line.

e. Create slider input Min = 0, Max = 1, Increment = 0.01, Speed = 3 and Increasing (Once). On toolbox chose slider entry Name, Interval, and Speed.

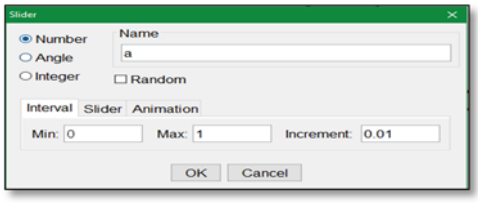


Figure 7: Slider.

f. Draw vector with input Bar enters every vector and Translation by vector.
   - u=a*Vector(J,E)
   - v=a*Vector(J,D)
   - v=a*Vector(J,B)
   - tt=a*Vector (J,C)
   - rr=a*Vector(B,M)

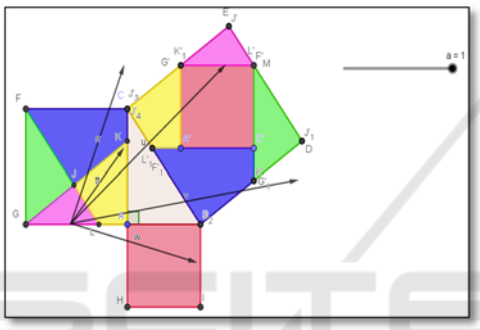

Figure 8: Translation polygon by vector.

Every input bar enters show straight line on the right. Chose icon Translate by vector on toolbox GeoGebra and translate polygon by vector until appearing toward BCED square. Every polygon will translation toward BCED square.

g. Hide all vector and points after that drag and slider to see proof Pythagorean Theorem. The proof with the GeoGebra shows animation moving the sliders a = 0 to 1.

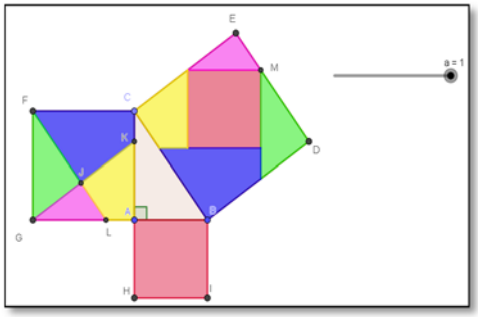

Figure 9: Proof with the GeoGebra.

The rearrangement two dimension figure the ABIH square and the CAGF square of the 4 polygons are FJKC, FJG, GJL, and JKAL then translation to the hypotenuse side the BCED square. (International GeoGebra Institute, 2018) Proven to be the sum of the square and polygon is congruent area on the hypotenuse side.

## 5 RESULT AND DISCUSSION

The Pythagorean Theorem has an important role in mathematics. In school when we learn trigonometric the Pythagorean Theorem is always used to construct concepts. Trigonometric concepts and ideas continue to be an important component of the high school mathematics curriculum (May and Courtney, 2016). In the proof, the Pythagorean Theorem is very diverse. This is approach to prove Pythagoras's theorem with GeoGebra.

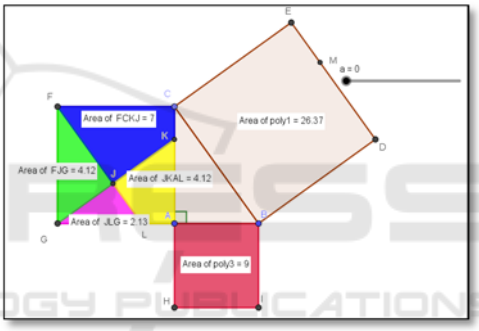


Figure 10: Area the BCED square.

Area of BCED square = 26.37 where this is the hypotenuse of the BC side. The hypotenuse is the long side of a right triangle. AB side is adjacent, area of ABIH square = 9. Ac side is opposite, area of FCGL divided by 4 polygons: FCKJ = 7 , JKAL = 4.12 , JLG = 2.13 , FJG = 4.12.

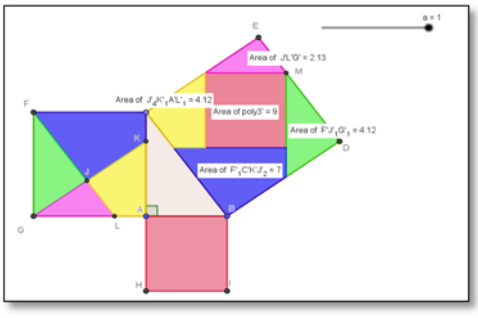

Figure 11: Translation to the BCED square.

Sum of ABIH, FCKJ, JKAL, JLG, FJG is equal to the area of BCED square. 9+7+4.12+2.13+4.12=26.37, The square on the hypotenuse of a right triangle is equal to the sum of the squares on the two legs.

This is one of the evidences in proving the truth of Pythagorean Theorem, with the use of GeoGebra. Students can explore geometric objects visually and dynamically to produce their findings. It is the ability to produce a visualization of the output of geometric objects quickly and accurately. According (Contreras, 2014), using Geogebra to guide learners to discover and extend one of the most beautiful and elegant theorems. GeoGebra would help students to explore the concept more in detail and help them to build and develop their knowledge.

## 6 CONCLUSION

This paper, I have illustrated how we can use technology as a learning resource to prove the Pythagorean Theorem by using GeoGebra programs. In addition, students and teachers will know the tools and the function of GeoGebra programs. Unintentionally it will practice their own skill. I challenge the readers for knowing GeoGebra program which can facilitate the readers to learn mathematics easily. By doing that practice, the readers are expected for getting a new point of view and paradigm about the proof Pythagorean Theorem.

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