

## Modelando para la obtención del número pi

*Modeling for obtaining pi*

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### Resumen

Si el programa Excel, una aplicación distribuida por Microsoft Office para hojas de cálculo (Wikipedia, 2013), es utilizado de forma adecuada se puede convertir en una herramienta de provecho para la obtención de números irracionales trascendentes como  $\pi$ , el número áureo y el número de Euler. Números presentados en el libro: *Matemáticas y la Imaginación* (Kasner y Newman, 2007).

En esta presentación se propone un método para la obtención del número  $\pi$ , que de acuerdo con la definición trabajada por Miller (Miller, Heeren, y Hornsby, 2006) es la razón de la circunferencia al diámetro de un círculo.

**Palabras clave:** infinito, límite,  $\pi$ , círculo unitario.

### Abstract

The software Excel, an application distributed by Microsoft Office for spreadsheets (Wikipedia, 2013), used in the proper way, turns into a tool that can be useful to get irrational transcendent numbers, like  $\pi$ , the golden ratio and the Euler's number. Editions featured in the book: *Math and the imagination* (Kasner & Newman, 2007). In this presentation, a method to get the  $\pi$  number is proposed. According to the definition developed by Miller (Miller, Heeren & Hornsby, 2006), that's the reason of the circumference to a circle diameter.

**Key words:** infinite, limit,  $\pi$ , unitary circle.

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## Introduction

There are numbers that stand out for their historical significance. Particularly in the class of Fundamental Concepts of Mathematics of Bachelor of Philosophy of the University of Guadalajara, the curiosity to discover how you could get a special number and called Pi, was the motivation for seeking a method to build without use mathematical concepts with higher levels of abstraction.

## Theoretical framework

This study was based on learning theory of Vygotsky, for whom, according to Pozo (1998), education is coordinated with the development of the student through the Zone of Proximal Development (ZPD), in which the relationship is emphasized that between learning and student development potential when in contact with others.

Another researcher, Dr. Duval, in his book: *Semiosis and human thought* (Duval, 1999) mentions that there are three representational activities inherent in semiosis. The first is the formation of a semiotic register in which a character set and determinations that constitute what is to be displayed is selected. The second corresponds to treatment, defined as the transformation of a representation initially taken as given, mentioning that the calculation is an internal treatment record. The third and last is the conversion which consists of an external transformation with respect to the registration of the representation of departure.

## Methodology

The methodology was to present the subject of rational numbers, waking up with this irrational interest. Once the issue of irrational, where each student used the Microsoft Basic program to create those numbers finished, he asked to read about the number Pi as transcendental number and investigate concepts such as trigonometric functions.

To generate the value of Pi it will be recalled that the area of a regular polygon can be obtained from the creation of many triangles with sides equivalent areas as the polygon (see

figure 1) (Hemerling, 1993). If for the perimeter of a polygon it is necessary to consider the number of sides thereof and the length of each of them, how can get the perimeter of a circle is constructed from a polygon with an infinite number of triangles?

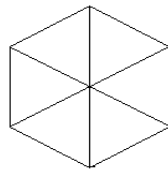


Figure 1. Polígono regular con n=6

The method for obtaining the number  $\pi$ , is to form a regular polygon with the number of sides large enough that, according to the concept of limit (Stein, 1985), the estate ceases to be and approaches a circle. The number in question will be obtained by the sum of the opposite legs of the triangles formed inside the polygon, considering the unit circle as base and Seno trigonometric function of  $\alpha$  angle, proposed by Ponce and Rivera in his book Mathematics one arithmetic and pre-algebra (Ponce and Rivera, 1998) (see figure 2).

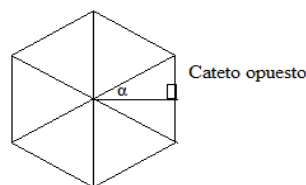


Figure 2. Triángulos isósceles construidos en el interior de un polígono regular

If each triangle is called A, the base of each corresponding to twice within the  $\alpha$  angle. Hence you are working with two unknowns:  $n$  = the number of triangles called A, and  $2\alpha$  = internal angle of the triangle A.

To reduce the number of unknowns, it is observed that  $2\alpha = 360 / n$  where  $\alpha = 360 / 2n = 180 / n$ .

According to what is shown, the perimeter of a regular polygon can be obtained with the following formula:  $2n (\sin (180 / n))$ , where  $n$  is the only unknown.

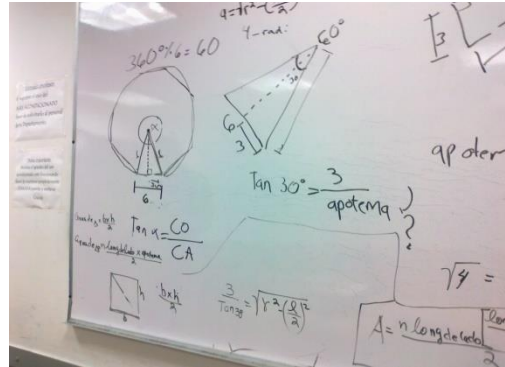
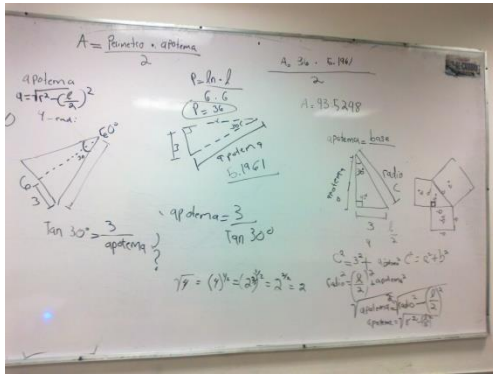
Basically, Microsoft Excel software is useful to show that as the value of  $n$  is increased, the perimeter of the polygon is closer to the circumference measurement.

If the value Pi is obtained by dividing the value of the circumference of the diameter, in the case of a unit circle it corresponds to 2, only necessary to divide the value obtained from the circumference by 2 to approximate the value of Pi.

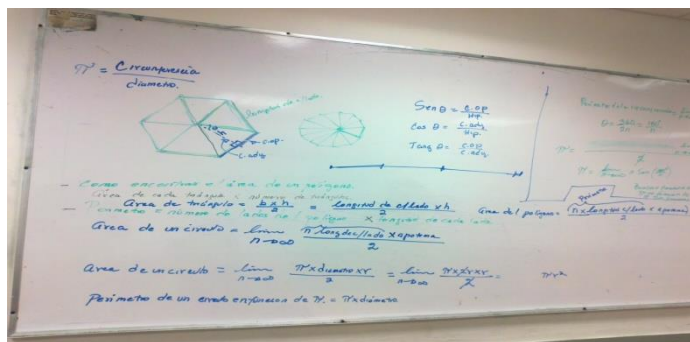
**Exposure of the proposal**

The construction of the first record was to get the concept of Pi, a process corresponding to the proposed training semiotic representation by Duval (1999).

This representation is characterized by the reproduction of a perceived edge.



The second step is to search for an analytical method to get the number. This process corresponds to the processing as it is transforming a representation taken as initially given. In this process the method was established to calculate the perimeter of a regular polygon, where with increasing number of sides approached a circle.



The third is to convert the building using the Excel program. This process, according to Duval (1999) corresponds to the conversion, which consists of transforming the analytical representation in another register, which in this case corresponds to the program Microsoft Excel.

Número de lados de un polígono regular con apotema uno	Perímetro de polígono dividido entre 2. Valor correspondiente a dos veces la apotema.
1	0,000000000000001225148454908620000000000000000000000
2	2,000
3	2,598076211353320000000000000000000000000000000000000
4	2,828427124746190000000000000000000000000000000000000
5	2,938926261462370000000000000000000000000000000000000
6	3,000
7	3,037186173822910000000000000000000000000000000000000
8	3,061467458920720000000000000000000000000000000000000
9	3,078181289931020000000000000000000000000000000000000
10	3,090169943749470000000000000000000000000000000000000
11	3,099058125255730000000000000000000000000000000000000
12	3,105828541230250000000000000000000000000000000000000
13	3,111103635738250000000000000000000000000000000000000
14	3,115293075388400000000000000000000000000000000000000
15	3,118675362266390000000000000000000000000000000000000
16	3,121445152258050000000000000000000000000000000000000
17	3,123741802881700000000000000000000000000000000000000
18	3,125667198004750000000000000000000000000000000000000
19	3,127297215339400000000000000000000000000000000000000
20	3,128689300804620000000000000000000000000000000000000
21	3,129887589696600000000000000000000000000000000000000
22	3,130926442012270000000000000000000000000000000000000
23	3,131832929213670000000000000000000000000000000000000
24	3,132628613281240000000000000000000000000000000000000
25	3,133330839107610000000000000000000000000000000000000
26	3,133953686638400000000000000000000000000000000000000
27	3,134508681381220000000000000000000000000000000000000
28	3,135005330892620000000000000000000000000000000000000
29	3,135451534294310000000000000000000000000000000000000
30	3,135853898029600000000000000000000000000000000000000
31	3,136217981610400000000000000000000000000000000000000
32	3,136548490545940000000000000000000000000000000000000
200	3,141463462364130000000000000000000000000000000000000
2000	3,141591361661760000000000000000000000000000000000000
50000	3,141592651522710000000000000000000000000000000000000
100000	3,141592653073020000000000000000000000000000000000000
1000000000	3,141592653589790000000000000000000000000000000000000
1E+15	3,141592653589790000000000000000000000000000000000000

### Experimentation

Once the necessary calculations were made to obtain analytically and graphically the number Pi, it proceeded to implement it using the Microsoft Excel software. The test consisted of entering the formula for the program and make the necessary calculations to find the perimeter of a regular polygon with four sides. Later it was increasing the number of sides with their respective calculations and found that approximates the number Pi.

To supplement the exercise you were asked to build a similar formula to find the same number, but using the tangent function. Since it was noted that work with Excel provided greater potential, they were invited to generate the same number but without the use of trigonometric functions.

results

While follow a process of construction of the concepts was not easy for students, the goal was achieved by investigating concepts such as trigonometric functions, formulas for areas and angles of regular polygons. Also, through collaborative work, the theory of Vygotski (2006), it came to the values desired.

## Conclusions

Talking of transcendental numbers such as Pi, Euler number and the number Áureo, motivated students of Philosophy class Fundamental Concepts of Mathematics, the school year 2013 B, to make an effort to understand the software Microsoft Excel as a tool with high potential, which properly programmed, it is useful to perform numerical constructions from concepts and mathematical models.

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