Blaise Pascal: Mathematician, Inventor, Philosopher

Background

Blaise Pascal was born June 19, 1623 into a cultured family in France. After his mother died, Pascal's father, also a respected mathematician, was left to raise Blaise and his two sisters. At the time Pascal's father focused the children's education on literature, philosophy and the study of languages; however, when Pascal began to display a strong comprehension of mathematics, his father allowed him to pursue an education in the field. His efforts in the field led Pascal to become famous as not only a mathematician, but as a geometer, an experimental physicist, and a practical inventor as well (Chapman 508).

Inventions

Pascal is known to have developed several different inventions. For instance, his creation of the one-wheeled wheelbarrow is still in use today. Before this development, hand-carts were used to transport heavy equipment over long distances. He is also responsible for the hydraulic press. In terms of inventions however, Pascal is better known for the Pascaline, the first arithmetic machine (Chapman 508).

Pascaline

Developed in 1645, the Pascaline was the first real calculator. Using dials to input integers, it was only capable of addition and subtraction operations. Pascal was motivated to develop the calculator in order to help his father with his profession as a tax collector (Dear 357). Over a period of ten years Pascal was able to create approximately 50 of these devices (Swaine). One was gifted to the Queen of Sweden in 1652, and there are currently seven of the devices still in existence today ("Pascal, Blaise (1623-1662)").

Hydraulic Press

The invention of Pascal's hydraulic press incorporated many areas of study including mathematics as well as physics. A few of his most famous discoveries arose from this invention. For instance, he made contributions regarding the "equilibrium of fluids… the pressure of the air, and… the creation of a partial vacuum," (Chapman 508).

Pascal's Law developed from his study of gases and liquids under pressure. He determined that the pressure in a liquid is distributed equally in all directions. In addition, he found that the pressure exerted by the liquid is directed perpendicularly onto the surface containing, or any other surface inside, the liquid ("Pascal, Blaise (1623-1662)").

Experimenting with tubes of mercury, wine and water, Pascal also discovered the concept of a vacuum. He attached the tubes to a ship and claimed that the tubes were held up by the air pressing against the bottom of the tubes. In his claim he also stated that at higher altitude levels, there will be less air above the tube and therefore, the columns in the tubes should be lower. After having his brother-in-law perform this experiment, due to his decline in health, the results proved that Pascal's original predictions were correct. Thus he proved that there was a vacuum at the top of the tube. ("Pascal, Blaise (1623-1662)").

Pascal's Hexagon Theorem

In 1640, at the age of only sixteen years old, Pascal formulated his Hexagon Theorem. It states, "If the vertices of a hexagon lie on a circle and the three pairs of opposite sides intersect, then the three points of intersection are collinear," (Yzeren 930). Pascal's original proof for the theorem was never found, leaving it open for debate among mathematicians. Several different variations of proofs have been developed over the years, but no one is certain of the original method Pascal used to prove this theorem.

Pascal's Triangle

Perhaps the most well-known contribution Pascal has made to mathematics is Pascal's Triangle. Figure 1 on the following page demonstrates the concept of the triangle (Hoffman 191). There are many properties of Pascal's Triangle, but the basic method of construction can be easily observed. The top of the triangle is composed of the number one, as are the diagonal sides of the triangle. Each inner number is determined by the sum of the two numbers diagonally above the inner number. Upon further observation a few properties may become more apparent. For example, the sum across a row, k, is equal to 2^k beginning from row zero. Additionally, by choosing any value in any row and alternately subtracting and adding the values to the left of that number, the total of the operation will be the value of the number directly above the original number that was chosen (Hoffman 194). Many more properties of the triangle have been determined which help to establish the relationship and pattern between these values. Two additional forms of the arithmetic triangle can be viewed in Figure 2 and Figure 3.

1

1 1

1 2 1

1 3 3 1

1 4 6 4 1

1 5 10 10 5 1

1 6 15 20 15 6 1

1 7 21 35 35 21 7 1

1 8 28 56 70 56 28 8 1

Figure 1: Pascal's Triangle

1											
1	1										
1	2	1									
1	3	3	1								
1	4	6	4	1							
1	5	10	10	5	1						
1	6	15	20	15	6	1					
1	7	21	35	35	21	7	1				
1	8	28	56	70	56	28	8	1			
1	9	36	84	126	126	84	36	9	1		
1	10	45	120	210	252	210	120	45	10	1	
1	11	55	165	330	462	462	330	165	55	11	1

Figure 2: Pascal's Triangle Form 2

1	1	1	1	1	1	1	1	1	1	1	1	1
1	2	3	4	5	6	7	8	9	10	11	12	
1	3	6	10	15	21	28	36	45	55	66		
1	4	10	20	35	56	84	120	165	220			
1	5	15	35	70	126	210	330	495				
1	6	21	56	126	252	462	792					
1	7	28	84	210	462	924						
1	8	36	120	330	792							
1	9	45	165	495								
1	10	55	220									
1	11	66										
1	12											
1												

Figure 3: Pascal's Triangle Form 3

Probability Theory

Pascal also made substantial contributions in the area of probability. Alongside Pierre de Fermat, Pascal experimented with a game of chance wherein a player attempts to roll a specific face on a die given a certain number of rolls. Additionally, they were interested in the amount of profit the player could make if such a game was played. The two also studied the case proposed by Chevalier de Méré wherein the game is interrupted and the proportions of the winnings for each player must be calculated. Although Pascal and Fermat arrived at the same solution, they gave different proofs of how these problems could be solved (Sury 2). From the five letters they sent to one another in regards to these games arose the development of probability theory. Using the results of their experiment as well as his own arithmetic triangle, Pascal and Fermat developed the foundation for combinatorial analysis in 1657. The following year Pascal finalized his "theory of indivisibles," making it possible to complete problems regarding areas and volumes by using integral calculus ("Pascal, Blaise (1623-1662)"). His contributions have allowed for many more advancements to be made, not only to the areas of probability and calculus, but to the field of mathematics as a whole.

Conclusions

Pascal made many contributions to the fields of math and science that have allowed the advancements that are possible today. At the age of thirty Pascal began to withdraw from the fields of math and science to focus on religious activities. Throughout the last eight years of his life he became well-known for his religious literary works, such as "Pascal's Wager", making occasional contributions in the fields of math and science. Pascal died at the age of thirty-nine due to his failing health, but because of his many contributions he will always be known as one of the brightest mathematicians of his time (Chapman 508).

Works Cited

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