

# The work of newton and leibniz philosophy essay



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“ Calculus is a means for calculating the way quantities vary with each other, rather than just quantities themselves”[1]. It is known as the greatest invention of mathematics and it was a combination of centuries of work. Over the time it expanded to all part of science such as physics, astronomy, biology, even economics. Many scientists tried to establish it but none of them came to certain results until Newton Isaac and Gottfried Leibniz revealed their work for calculus.( These two men invented calculus simultaneously and are considered as the co-inventors nowadays ). Although the pride is given to both, there was a period were a big controversy that lasted over a century came to epiphany. The question was who invented calculus first. (What set the dispute so important was the stature of the men involved, the significance of the work was in contention, the length of time through which the controversy extended and the sheer intensity of the dispute.[2]) Leibniz published his work earlier than Newton and this was a major factor for the controversy to begin. Besides this, historians found a lot of manuscripts and journals which show that Newton’s and Leibniz’s invention has many similarities as well as differences. They worked individually and had different way of thinking and methods, but they both came to the same conclusions.

### Newton’s Life

Isaac Newton was born in Woolsthorpe, Lincolnshire in 1642. His father, who was a farmer died before his birth. After few years Newton’s mother remarried and sent him to live with his grandmother. Newton’s life with his grandmother was very well as they did not suffer from poverty and she offered him everything he needed to grow up properly. He didn’t play with

other children so he created his own way of entertainment. He built up kites with lanterns and mechanical toys such as wooden clocks, waterwheels, mill that grounded wheat into flour. So he showed up early how genius he was. He attended Grantham Grammar school where he was the cleverest boy in the school. Later on, in 1661 he went to study at Trinity College, Cambridge where he earned his expenses by doing menial work[3]. He didn't know what to study so he started with Chemistry. Then influenced by Euclid, Baconian and Cartesian philosophies, Newton reached the frontiers of mathematical knowledge and were ready to make contributions of his own.[4]He remained at the university and worked as a lecturer mostly until 1696. During this period , Newton was at the height of his creative power and produced many and important inventions. Isaac Newton died old at the age of 85 and was given a state funeral at Kensington, London.

### Leibniz's Life

Baron Leibniz was born in Leipzig, Germany on June 21 1646. His father died at six and was sent to a school in Leipzig where the education was insufficient. By the age of twelve he knew Latin and Greek. Then he entered University of Leipzig at the early age of fourteen to study Law. He studied many text books in mathematics, philosophy, literature, logic and metaphysics. At the age of twenty, they offered him a scholarship for a doctorate in law which he refused and moved to Nuremberg. There he participated in a variety of projects. His passion for knowledge never stopped growing. He moved to Paris where he begun the construction of calculating machine and studied mathematics and physics. Leibniz died at Hanover on

November 14th 1716. In contrast with Newton, Leibniz was buried alone and dishonored.

Where they were influenced

The discovery of the calculus was a good and careful combination of work rather than an immediate discovery. Although acknowledgement was given to Isaac Newton and Baron Leibniz many great mathematicians contributed to the development. Both men studied the work of Pierre de Fermat, Isaac Barrow about tangents and surfaces as well as Archimedes and Euclid work on infinite and infinitesimal. According to Carl Boyer, who wrote "History of Calculus" in 20th century, for someone in the 17th century to organize his views, methods, discoveries involved in the infinitesimal analyses into a new subject characterized by a distinctive method of procedure.[5] So neither Newton's nor Leibniz's work was original. According to Rupert Hall, in his textbook "Philosopher's at War", indicates that the discovery of calculus was more than a synthesis of previously distinct pieces of mathematical technique[6].

Newton's discovery of calculus

Historians found a lot of surviving papers determining that Newton was the first to arrive at the calculus but waited 20 years to publish them. Because of the bubonic plaque he left Cambridge and moved back to Woolsthorpe.

There he secluded from everything and made his greatest achievements in a short period (two years). He first developed the method of "fluxions", after studying the work of some great mathematician such as Barrows and Wallis.

The method was explaining that if you look on a curve as the path of a

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moving particle, the first and second derivatives always exist and represent velocity and acceleration.[7] Newton used the “infinitesimal” method with respect to line and used dots above variables  $x$ ,  $y$  to denote derivatives. Not only did he discover differentiation and integration but he also found out that these applications are inverse to each other. He also studied Kepler’s orbit theories and tried to solve problems regarding gravitation and planetary motion. Newton also reformulate “Binomial theorem” to find rational numbers. He feared criticism and didn’t publish his ideas until 1687 and later. His first book was called “Principia Mathematica” and contained a full aspect of calculus, dynamics and its application to astronomy. Though a lot of people were aware of his discoveries through his letters and journals he shared with colleagues.

#### Leibniz’s invention of calculus

Leibniz studied calculus from 1672-1676 in Paris. He started studying calculus having in mind that “individually imperceptible metaphysical entities were the basis of existence and that humans experience the world as a sum of these entities”[8]. He tried to develop a different and better notation for his calculus. By 1675 he wrote his first manuscript using  $\hat{a} \ll f(x)dx$  notation,  $dy/dx$ . In 1682 he published the first article in “Acta Eruditorum” and in 1684 the second article. “Acta” was his first scientific journal and included the explanation of neglecting infinitesimals, sum of infinite series, algorithms for sum, product and quotient rule. He also rewrote Pascal’s proof of  $(\sin x)' = \cos x$ . Leibniz demonstrated his arguments by obtaining correct results to various problems such as maxima and minima,

horizontal tangents and many more. Leibniz had his own way of working and figuring out scientific problems.

### Historical Facts

In 1711 Leibniz was accused for plagiarism by the Royal Society of London over the invention of calculus. The British citizens supported that Newton was the inventor of the calculus while German people believed it was Leibniz. So a big controversy that lasted over a century started. Leibniz published his discoveries at 1684 and Newton at 1704, twenty years later. In my opinion, this is what caused the entire controversy. Newtonian camp supported that Leibniz gathered unpublished ideas of Newton, created a new notation and used alternative symbols and perform it as his own work. The other aspect says that Leibniz's unpublished manuscripts show that he came to his own results about calculus. Another argument against Leibniz was that the two men corresponded by letters regularly. They discussed about formulas, concepts of calculus, binomial theorem, fluxions and tangents where Newton stated his results but no description of his methods. Leibniz, just before his death admitted that in a visit to London he saw some Newtonian papers. As a result the Royal Society found Leibniz guilty of plagiarism and credited Newton for the invention of calculus (Ball 1908). After the outburst of the dispute England ignored the fruitful developments in mathematics on the continent and stagnated for almost a century.[9]

### Differences

The differences of the calculus that each man expounded are based of how they thought. Both men thought the same ideas but used fundamental

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concepts in unlike and various ways. Newtonian calculus relied on objective reality, limits and sequences mostly while Leibnizian calculus was based on the infinite and abstraction. Leibniz used for the first time the notation  $dx$ ,  $dy$  and denoted them as differences between sequentially values. On the other hand, Newton used quantities  $x'$ ,  $y'$  which were finite velocities to compute tangent[10]. Many historians credited Newton for differential calculus and Leibniz for integral calculus due to the fact that calculus was approached as geometrical and analytical way respectively. A major difference is that Leibniz used notation based on discrete undefined variables such as  $x$ ,  $y$ ,  $dy$ ,  $dx$  because his research to calculus applied more to geometry. In contrast Newton based differentiation on force with respect to time as we know he studied firstly physics.

As a result he represented derivatives with a dot over each variable such as “ $x\text{-dot}$ ”, “ $y\text{-dot}$ ”. The various manuscripts and journals from both men revealed that Leibniz was very conscious on using notation and put a lot of thought into the symbols he used[11]. He strongly believed that notation was the key to solve any kind of problem. Conversely Newton used any notation he thought, so every time he used different symbols.

### Similarities

Equally relevant to the issue are the questions of how the discoveries of the calculus from Newton and Leibniz have similarities. The variety of manuscripts we have from the two inventors indicates that both thought in terms of graphs and not in terms of functions. As I have already mentioned Newton's name was related with Differential Calculus and Leibniz's name

with Integral calculus. But both studied these two operations and lead to their conclusions using both, differential and integral calculus. It is important to add that Newton and Leibniz often used an intuitive idea of " limit", but none of them seemed to have a precise definition of it[12]. Moreover Newton's " theory of fluxions" was expressed algebraically, which is a way that Leibniz used for differentiation. (The arguments I have presented whether the two inventions have similarities suggest that) or (My own point of view is that)?? , Newton and Leibniz expressed their ideas in almost the same way.

#### Influence on later mathematics

Calculus was one of the most important discoveries of the 17th century and this inspired many mathematicians to work hard over the invention. In 18th century, the calculus, intuitively understood and algorithmically executed, was applied to a wide range of problems[13]. For instance, they developed new and powerful set of methods for solving equations and problems in geometry, analysis as well as in physics. Moreover problems that seemed unsolved such as equations of motion for the solar system and partial differential equation for vibrating strings were solved. It is important to refer that the Laplace transform and the calculus of variations and the gamma function were invented and applied also[14]. Both inventors used notation that made calculus an algorithm. So for people the ideas and concepts of calculus were straightforward and easy to use. In addition, Leibniz's notations and methods were more clear and generalized that they became universal. We still use in mathematics the integral sign  $\hat{\ll}$  representing an



elongated S and the “ d-sign” used for differentials. It would be unfair not to mention that Newton’s notation and symbols are still used in physics.

On the other hand the discovery of the calculus created a lot of questions to many mathematicians that criticised and found mistakes in the invention of the two men. Throughout 18th century mathematicians wondered about the definition and application of “ ratio of quantities”. Newton related ratio to the “ ultimate ratio and gave the following definition “ Ultimate ratios are limits to which the ratios of quantities decreasing without limit do always converge, and to which they approach nearer than by any given difference, but never go beyond, nor ever reach until the quantities vanish”[15]. They interpreted Newton’s word in our algebraic language but still had many questions. For example “ never go beyond” does not allow a variable to oscillate about its limit. The above definition could not be used for proofs inquiring limits as it was not understood clearly. Later on two great mathematicians L’Huilier and Lacroix tried to work on finding a new definition for limit and they conclude that the limit is not one sided. This result was used by Cauchy to proof the algebra of inequalities and revealed that calculus could be based on limits. Another amendment that was made in the 18th century was about integration and differentiation. Euler suggested a new way by approximating exactly the integral using a sum.( Newton’s and Leibniz’s infinitesimal method created some questions and critics that made the co-inventors to work harder improving the method. George Berkley , in The Analyst ridiculed the method as well as other methods of calculus.)

Through the centuries many historians analyzed and argued about the invention. In 20th century textbooks the whole dispute does not exists and <https://assignbuster.com/the-work-of-newton-and-leibniz-philosophy-essay/>

historians concluded that the invention of calculus was a simultaneous discovery. It is not a rare phenomenon in science. A 20th century example, is the theory of the big bang explanation for the origin of the universe was put forth simultaneously by two physicists, one in Russia and the other in the USA[16]. Also a modern historian, Alfred Rupert Hall who wrote “*Philosopher’s at War*” analyzed and explained the whole dispute in his book indicating that both deserve credit for the invention of the calculus. Newton was one of the greatest scientists in history and Leibniz was known as a philosopher but contributed more and important things in mathematics. In 17th century the controversy over the invention was a matter of national pride, while now is something trivial. So the most satisfactory conclusion that I can come to, is no matter who discovered calculus first, it was the most significant achievement of mathematics.