Calculus: Origin and Transformation

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Origin and Early History of Calculus

Calculus is defined as the study of change. It is employed in a number of fields that deal with the examination and evaluation of different elements: gravity, light, heat, cost minimization, navigation, planetary rotation, electricity, construction, resource allotment, and insurance valuations. Many of the groundbreaking inventions made between the 1700s and the present can draw their connection to calculus (Boyer, 1959). The very nature of everyday life with its predictable and unpredictable changes necessitates the employment of calculus in an attempt to gain control or knowledge of the factors that drive change. Calculus was developed under separate conditions by Isaac Newton and Gottfried Leibniz; however, both individuals worked on similar projects that demanded new and innovative solutions (Boyer, 1959). The two mathematicians studied the different facets of motion and area. Additionally, both their effects were hampered by the lack of knowledge on matters relating to algebra and analytic geometry. The concept of algebra was already being used and expanded upon in Arabic nations; furthermore, the Greek mathematicians had a firm, yet underdeveloped, understanding of analytic geometry through the representation of points on an x and y plane.

There is extensive evidence in ancient texts and manuscripts that early civilizations had knowledge of calculus and its underlying theorems and formulas well before the time of Isaac Newton. For example, researchers discovered ancient Babylonian tablets that are dated at least 1700 years before Christ that demonstrate the knowledge of the Pythagorean Theorem by early mathematicians. Also, similar tablets have shown the basic understanding of Pythagorean triplets that satisfy the Pythagorean Theorem (Kline, 1990). Moreover, the Pythagorean Theorem is referenced in the Indian Baudhayana Sulba-Sutra accounts, which are rumored to have been written somewhere between 800 and 400 BCE.

The usage of the “sum of integer powers” was found to have existed in 11th century Egypt due to the work of Arabic mathematician Abu Ali Al-Hassan. Trigonometric series were quite popular with Indian mathematicians in the 16th century as indicated by journals later posted by European scholars who traveled to India (Katz, 1995). Nevertheless, the mathematician, Isaac Newton, has become synonymous with the invention of calculus as a branch of mathematics due to countless publications that have credited his mathematical genius with its discovery and overall popularization in various fields such as physics, astronomy, and algebra.

The Contributions of Different People to Calculus

Three prominent mathematicians who are considered to have developed or used the concepts of calculus before Isaac Newton in the field of mathematics are Pythagoras, Euclid, and Archimedes. There are also a few others who are less known but have also played monumental roles in the advancement and development of useful calculus formulas and theorems (Bruce, 2013), including Pierre Fermat, Descartes, Pascal, and Mersennes. After the era of Isaac Newton (the father of calculus), there emerged numerous and reputable mathematicians, physicians, and philosophers who expanded the pool of knowledge that could be obtained in the field of calculus. Most notable are Laplace, Lagrange, Euler, the Bernoulli brothers, Fourier, and Riemann.

Gottfried Leibniz and Isaac Newton are the two true founders of calculus. Even though their individual discoveries led to heated disagreements between the two, it does not take away from the contribution that each of them made to the realm of calculus. Leibniz devoted new and more improved ways of tabulating the minima and maxima values, introducing the dx/dy symbols that are used in differential calculus, and the most universally recognized “=” symbol (Bruce, 2014). Three major contributions that Isaac Newton made to the world of calculus are: the method of fluent, where the operations of differentiation and integration are inverses of each other; a formula for computing the average slope of a curve; and generalization of the binomial theorem, which led to the advancement in the study of finite differences (Newton, 1736). His work with series also gave rise to the concept of infinite series and the formulas that can be used to expand or compact them.

Archimedes' work in geometry led to great contributions in calculus. He is considered to be the first person to correctly deduce the tangent to a curve that was anything other than a circle. His work in the tabulation of the sum of a geometric series laid the foundation for the topic of limits that is studied today in calculus. In addition, Archimedes is credited with the tabulation of pi, and the creation of formulas that could be used in the computation of the area under a curve, as well as the surface area and volume of a sphere (Archimedes & Heath, 2002). Isaac Barrow was a 17th-century mathematician whose discovery in the determination of tangents led to the later discovery that the processes of differential and integration are in actuality inverse operations by Isaac Newton (Barrow & Child, 1916), where the effects of integration can be reversed through the employment of differential.

One of the most important facets of calculus is limits. This area has remained unchanged for the past 50 years due to its definitive nature and rigidity to change. The limit is considered to be the paradigm of calculus that deals with the study of how functions and sequences behave as their input values are directed towards (approach) a given value (Cajori, 1929). The topic of limits plays a vital role in the study of continuity, series, sequence, derivatives, and integrals. It is one of those subgroups of calculus that students/academicians need to learn after introduction to functions, derivation of functions, and integration of functions, but before they go into learning about finding the area, surface area, and volume of a solid on a Cartesian plane or using polar coordinates. The topic of limits allows the student to gain a firm understanding of how functions behave based on values in the numerator and denominator level (Katz, 2009). This is important because knowledge of how functions move on a Cartesian plane is crucial not only in calculus but also in algebra, geometry, and trigonometry.

Conclusion

Calculus is an important aspect of mathematics that has completely elevated the world through the introduction of numerous problem-solving equations, theorems, and principals. The history of calculus is far broader than most people seem to understand because of its root in Indian, Egyptian, Arabic, and Babylonian cultures. Nevertheless, Isaac Newton and Gottfried Leibniz can still be linked or credited with the invention of calculus due to their exemplary works in the development of concepts vital to the tabulation of areas, surface area, and volume of solids, as well as the performance of differentiation and integration through the usage of signs such as $\int \quad and\ dx/dy$. There are several other notable individuals who have contributed a significant amount of knowledge to the concept of calculus over the past 300 years. Their knowledge has in turn led to the advancement of different fields like chemistry, biology, physics, astronomy, and mathematics in general.

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