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The origins of calculus date back to ancient Greece, where the method of exhaustion was used to find the areas of curves, such as the circle, which was first found by the ancient Greek philosopher Archimedes. However, when discussing the discovery of calculus, we are usually referring to the advances made by Sir Isaac Newton and Gottfried Wilhelm Leibniz near the end of the 17th century. There was serious controversy concerning which of these two men was the true inventor of the method. This controversy had effects on the mathematics community for a hundred years, and it is only with the benefit of hindsight that we can see it is likely that both men made the discovery independently of each other.

Calculus is the area of mathematics that is concerned with finding the instantaneous rate of change of a function, called the function’s derivative, and with the summation of many infinitesimal parts, called an integral. The derivative and integral are inverse functions of one another, meaning that if an indefinite integral is taken of a function and then a derivative is taken of the result, the original function is returned. This is also true in the other direction. This relationship between the derivative and integral is the first part of the fundamental theorem of calculus. This fundamental theorem is the discovery of which Newton and Leibniz are credited with

The history of calculus starts in ancient Greece, where the method of exhaustion was used to find the areas of irregular shapes and the volumes of irregular solids. This method involves inscribing polygons into the shape, and as the number of polygons increases, the area is approximated with greater accuracy. This method is conceptually similar to Riemann sums. A Riemann sum is the sum of the areas of quadrilaterals that have heights equal to the height of a curve at a point. As the widths of the quadrilaterals in a Riemann sum approach zero, the sum collapses into an integral.

About 1200 years after Archimedes calculated areas and volumes, Abu Ali al-Hasan ibn al-Hasan ibn al-Haytham, an Egyptian mathematician, developed formulas for finding sums of finite power series. These are sums of integers from one to a given number where all of the integers are raised to a particular power. He used his formula for sums of integral powers to find the volume of the solid formed by rotating a parabola around a particular line. This is what we would now call an integration and is commonly taught in Calculus 2.

In the fourteenth century, mathematicians and physicists began to ask questions such as if an object moves with variable speed, how far will it have moved in a given time, or if an object has variable temperature throughout, how much heat does it have in total (Boyer, 67). These questions are precisely those that calculus is ideal for answering. Many advances in the field of mathematics were made by considering questions such as these. For example, in the fourteenth century, a bishop by the name of Nicole Oresme created the idea of a graph of the function and quickly realized that the area under the function of velocity versus time is the distance traveled in a given time. Approximately three centuries later, Pierre de Fermat and René Descartes built upon this idea by combining algebra and geometry into analytic geometry.

Analytic geometry describes lines, solids, and shapes in terms of algebraic equations instead of using written words with labeled points and lines as had been done for millennia. With analytic geometry, it became possible to perform geometry in more absolute terms rather than using the ratios that had been ubiquitous for so long, and without this new way of relating geometry to pure analysis, calculus would never have been developed.

Fermat also made another contribution to mathematics related to calculus. In the year 1629, he arrived upon a method for analytically finding the tangents of curves. His method involves subtracting the function of x in question from the same function where x is replaced by x plus h, dividing by h, and taking the limit of this expression as h approaches zero. This is the difference quotient, and in modern mathematics is known to be the algebraic definition of the derivative.

After learning that Fermat created this method for finding what would later be known as a derivative, one might ask why it is that Fermat is not credited with inventing calculus. This is because Fermat did not view it as a method of finding a function that is a derivative of any other function. He believed that it was useful for finding the slope of the tangent line at a particular point but did not go so far as to use it to find a functional derivative. He also believed that it would only work for polynomial functions rather than any elementary function. The final and perhaps the most important reason is Fermat remained unaware of the inverse relationship between differentiation and integration.

For this reason, Sir Isaac Newton and Gottfried Wilhelm Leibniz are the inventors of calculus. These two men discovered the fundamental theory of calculus that the derivative and integral are inverse operations. They also each created the generalized ideas of the integral and derivative and notation for them.

While today it is the consensus that both men developed calculus independently, their contemporaries were not so certain. Newton employed his methods for differentiation and integration, which he called fluxions and fluents, respectively, as early as 1666 and communicated about them with some of his friends but did not publish them. His reasons for this are unknown. Perhaps it was out of a desire to be solely able to solve the related problems, or perhaps he did not believe that his methods were developed enough to be published.

Newton made use of his methods of fluxions and fluents for his “De analysi per aequationes numero terminorum infinitas” which he published in 1669, but it did not include any mention of his fluxions and fluents. It instead proved his solutions in purely algebraic terms. Regardless of his reasons, it was a poor decision because, in 1684, Leibniz published his first paper on calculus called “Nova Methodus pro Maximus et Minimis.” For fifteen years, it was the view of the European mathematicians that Leibniz was the discoverer of calculus. During those years, newton published the first edition of “Philosophiæ Naturalis Principia Mathematica,” in which he included a scholium which he intended to be a challenge to Leibniz to prove his priority over calculus. That scholium ends with the words “which hardly differed from mine, except in his forms of words and symbols,” in which he is referring to Leibniz’s method of integration.

In 1699 a Swiss mathematician by the name of Fatio de Duillier, a close friend of newton (Schrader, 390), made the suggestion that Leibniz may have plagiarized from Newton. This began a hundred-year controversy over just this fact. In 1704 Newton published “Optiks” in which he included a full explanation of his method of fluxions for the first time and explained that he included this explanation because his methods had been appearing in alternate forms, implicitly accusing Leibniz of plagiarizing him. Leibniz responded in the Acta Eruditorium of Leipzig by anonymously writing a review in which he referred to himself as the inventor of calculus which only riled the English into a frenzy.

As the conflict escalated, with each side attacking the honor of the other, The Royal Society of London decided to investigate the matter. The Royal Society is, however, an English institution and was bound to be biased in favor of the Englishman, Isaac Newton, who was also President of The Royal Society at the time. Leibniz was also given no opportunity to tell his side. This bias is clearly evident in the report produced by the investigation, which according to Schrader, “avoided the main issue and, in effect, told Leibniz that there had been no injustice done to him.” This could not have been a great comfort to Leibniz, whose reputation amongst mathematicians of the time had been seriously injured. Leibniz continued to make unsuccessful attempts to enlist the help of others in conflict and to publish further texts regarding the controversy until his death.

After Leibniz’s death, the controversy had mostly subsided, and most of the world adopted Leibniz’s notation for calculus since Leibniz had put more effort into it, and it was more useful as a result. The only major use of Newton’s notation after the seventeenth century was by the English, who obstinately continued to use his notation for over a hundred years. This stubbornness caused a rift between the advances made in continental Europe and the English mathematicians. The advances made in England were translated to Leibniz’s notation, known as differential notation, by mathematicians in the greater part of Europe, but advances made outside of England were rarely translated to fluxions. The English during this time also followed Newton’s lead by not considering analytic geometry to be rigorous enough for their proofs. This and the limitations of Newton’s notation combined with the separation from the mathematicians of continental Europe, caused a significant decline in the quality of English mathematics.

The debate over the inventor of calculus was ultimately a petty squabble among academics that slowed the advance of mathematics for over a century. History has awarded the discovery of calculus to both Leibniz and Newton independently, a rare occurrence. This is an accurate but ultimately meaningless accolade. The ideas of calculus were developed over millennia by mathematicians from all corners of the world, without whom the fathers of calculus could never have made their discovery. Newton and Leibniz merely made the final leap to a general and formalized calculus.

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