
THE IMPACT OF SIR ISAAC NEWTON'S DISCOVERIES ON 17TH CENTURY SCIENTIFIC REVOLUTION AND THE IMPLICATIONS TO THE YOUNG SCIENCE SCHOLARS

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ABSTRACT

This paper examined the impact of Sir Isaac Newton's discoveries on 17th century scientific revolution and the implications to the young science scholars. The youth are industrious, energetic, resilient and intelligent. However, the youth are easily discouraged when they face challenges. No wonder some youth embark on suicidal mission because of certain difficulties. The paper examined the life of Isaac Newton which covers his birth, educational background, theories, discoveries, age of his discoveries and the prevailing situations surrounding the discoveries. The paper aimed at uncovering some of the challenges that Isaac Newton faced before he became a notable scientist. In addition, his achievements in revolutionising the status of scientific innovations despite his challenges were equally elucidated. The focus of the paper is to show the young science scholars the ruggedness of Newton, encourage them to brace up, challenge them to make positive impacts in their generation and inspire them to build upon the scientific achievements of Isaac Newton. The researcher thereafter suggested recommendations for alleyway into scientific revolution by the young science scholars in order to attain great feat in the field of science.

Keywords: Science, Revolution, Newton, Scholar

INTRODUCTION

Sir Isaac Newton (1642-1727) was an English scientist; mathematician, astronomer, physicist, author and theologian of the 17th century who changed the way people understand the universe (Maranzani, 2018; Newton, 1934). Among the scientists of his time, he was regarded as one of the great minds of the scientific revolution and described as one of the most original and influential theorist in the history of science. He was both abstract theoretician and a practical experimenter. Indeed, he was a key figure in the scientific revolution. In 1672, Newton was awarded a Fellow of the Royal Society (FRS) which is an elite group where scientists meet to share and critique each other's work. Royal Society was the Great Britain's oldest organization of scientists. Isaac Newton was made President of the Royal Society in 1703 (Anderson, 1996; Maranzani, 2018; Newton, 1934).

Newton was also a natural philosopher. In 1687, Newton published his first book titled, "Mathematical Principles of Natural Philosophy". In 1671, shortly after his election to the Royal Society, Newton published his first paper in the Philosophical Transactions of the Royal Society. The two books revealed the philosophical approach of Newton. Throughout the ancient time, from Aristotle to the 19th century, natural philosophy was the common term for the practice of studying nature. In the 14th and 15th centuries, natural philosophy was one of the branches of philosophy, but was not a specialized field of study (Brackenridge, 1996; Maranzani, 2018; Newton, 1958; Newton, 1999). Natural philosophy was the philosophical study of nature and the physical universe. It was also called Philosophy of nature and was dominant before the development of modern science. The basic problem of philosophy was to discover the forces of nature from the phenomena of motions. That made Newton a natural Philosopher because natural philosophy (systematic study of nature) involved reasoning and explanations about nature.

Most of the novel achievements of Isaac Newton took place during his early twenties and when he confined himself in a solitary location. He used the solitude and self-isolation moment for deep thinking of things around the universe. He turned the distressed situation to a period of great achievement. According to Vaishnavi (2020), Isaac Newton was just 23 years old when the Great Plague of London hit the country. He was just a student at the Trinity College, Cambridge at that time. He went back to the farm in Woolsthorpe and remained secluded for eighteen months, during which time he not only discovered the universal law of gravity but changed the face of science (Lenka, 2020). The young science scholars can now look forward, follow his bold steps, turn the present situation around and make positive changes.

A scholar is the one who engages in constant learning and pursues academic activities. Science scholars are the intellectuals, the learned people that have gained mastery in a specific aspect of science, acquired profound knowledge in the field of science, promote academic engagements and still advance intellectual activities in the particular field of study. According to Science Council (2021), a scientist is someone who systematically gathers and uses research and evidence, to make hypotheses and test them, to gain and share understanding and knowledge. A young scientist is therefore a young person that is involved in scientific activities with relentless curiosity and systematic approach for achieving technological advancement. Friesenhahn & Beaudry (2014) affirmed that early career scholars play a central role in this new knowledge driven economy through being the key innovators and creators that provide the intellectual capital needed to grow a strong national research and innovation system.

In a global, knowledge-driven economy the keys to economic success are a well-educated work-force, technological capability, capital investment, and entrepreneurial zeal - a message well understood by developed and developing nations alike throughout the world that are investing in the necessary human capital and knowledge infrastructure (Friesenhahn et al, 2014). Fortunately, it is the young science scholars that will constitute the required work-force that the nation will need tomorrow. Unfortunately, a lot of leaders do not plan or secure a desirable place for the youth that will be the leaders of tomorrow. It is high time the young scientists are given workable environments to function maximally for national development. Ter & Stock (2010) stated that the idea of a Young Academy has been spreading around the globe, because every nation must support and develop its younger scientists, promoting their national and international mobility, competitiveness, and leadership potential. This is very important for any technological innovations. Consequently, this paper examined the life and time of Isaac Newton, a great scientist, to serve as motivation for young science scholars to embark on research work, venture into scientific productivity and prepare to take risk when challenges come their ways.

EARLY LIFE OF ISAAC NEWTON

At birth, nobody knew Isaac Newton could survive. He was born as a premature, small, tiny and weak child on Christmas Day, 25 December 1642 (according to the Julian Calendar, Old Style) or 4 January, 1643 (according to New Style, Georgian Calendar) (Wikipedia, 2021; Storr, 1985; Westfall, 2007). His place of birth is Woolsthorpe, a small settlement near Grantham in Lincolnshire, England. He was born three months after the death of his father who was uneducated but prosperous local uneducated farmer. Three years after his birth, his mother remarried to Reverend Barnabas Smith, a wealthy rector from North Witham and both of them lived together outside the hamlet. That is, at the age of three, young Isaac Newton was left under the care of his grandmother, Margery Ayscough. Newton did not enjoy motherly care, fatherly attention, parental training, paternal discipline and maternal character moulding until 1653 when his mother returned to Woolsthorpe after the death of Reverend Barnabas Smith, the second husband. At his teen-age, he was reunited with his mother together with other three children from her second marriage (Westfall, 2007; Wikipedia, 2021). Despite the ugly experience at birth, Isaac Newton made great impacts in life. This is a lesson to some young science scholars who are discouraged because their beginning was low and unpalatable.

EDUCATIONAL EXPERIENCE

Newton attended many institutions such as The King's School, Trinity College of Cambridge, Grantham University of Cambridge, Royal Society and Royal Mint. Newton started his basic education in their local school. After a basic education, he was sent to The King's School, Grantham in Lincolnshire at age twelve and was there till seventeen years old. After he enrolled, he used it as a form of boarding school by lodging in the house of the local apothecary (a local pharmacist who prepares and distributes medication). He lived there because the distance to cover for daily walk from Woolsthorpe to Grantham was too long for his fragile body (Wikipedia, 2021). When his mother returned back, she forced Isaac out of school in order to start farming and become a farmer in the future. That is, in October 1657 he was removed from the school to Woolsthorpe to start a livelihood as a farmer probably to take after his late father and take over the family farm. But Newton detested the intention of his mother because he hated farming. Fortunately for him, a master at The King's School, Henry Stokes persuaded his mother and convinced her to send him back to school in order to complete his basic education and prepare for entrance for higher education.

Newton did not excel in his basic school. However, he had the opportunity to attend Trinity College, Cambridge because he had an uncle, Rev William Ayscough, who studied at the college (Wikipedia, 2021). Based on the recommendation of his uncle, Newton was admitted to the college on June, 1661 with the intention of studying law. Hence, he left Woolsthorpe for Trinity College, Cambridge. Based on the refusal of his mother to pay for his education, he continued his education in form of work-study; working as a servant to pay his way (Wikipedia, 2021; Knox, 2003). In spite of his physically challenged body and poor financial background, Isaac did not lose heart but forged ahead to attain the peak of his educational career. He was challenged by Isaac Barrow, Cambridge's first professor of mathematics. In 1664 he secured scholarship which guaranteed him to remain in the college until he obtained his degree in Master of Arts (MA). While in the college Newton started developing ground for his future scientific discoveries. He created a notepad for his personal writings and experiments as someone destined for an intellectual life. He laid the foundation for mechanical philosophy and mathematical theory that later turned out to be calculus. He obtained his Bachelor of Arts (B.A.) in August 1665 and Master of Arts (M.A.) in 1668 (Wikipedia, 2021; Knox, 2003).

THEORIES OF ISAAC NEWTON

The period of 1665 to 1666 marked a wonderful period in the life of Newton. Before he could further his education, the institution was temporarily closed down to safeguard staff and students against plague, a highly contagious and deadly disease that ravaged the community. He went back to his hometown, Woolsthorpe and continued working on his theories on calculus, optics and law of gravitation till the compulsory closure lasted (Knox, 2003; Wikipedia, 2021). According to Vaishnavi (2020), Isaac Newton was just 23 years old when the Great Plague of London hit the country. He was just a student at the Trinity College, Cambridge at that time. For many of the young science scholars, time of closure of institution is usually wasted because they use it for unproductive engagements. Emergence of COVID-19 pandemic led to the closure of institutions for many months but many young science scholars cannot boast of any tangible achievement during the compulsory lockdown.

However, Isaac Newton used the period of lockdown in his time for something prolific and profitable for scientific revolution. He isolated himself at Woolsthorpe Manor for scientific discoveries. During the period, he laid the groundwork for his theories of calculus and laws of motion that later made him famous. Newton came up with his greatest breakthroughs in physics and mathematics during this self-confinement. Two years later, April 1667, the school reopened and he returned back to the college in Cambridge in pursuit of his education. The consequence of the isolation made him explore the nature and the theories he arrived at actually brought changes to the way we observe, understand, probe and explore the world around us. Newton is remarkable for the fact that his work as a theoretician is matched by his work as an experimentalist. Since youth are preoccupied with many mundane things, it will be profitable for government, non-governmental agencies and individuals to assist them in order to give them a new orientation for personal and national development. Therefore, understanding precisely how young scholars can succeed in and contribute to the knowledge landscape and what obstacles they encounter in the process across the world should be a timely and important focus of concern for countries around the world (Friesenhahn et al, 2014).

EXPERIMENTS OF ISAAC NEWTON

In one of his story, Newton said that the inspiration to formulate his theory of gravitation came by watching the fall of an apple from a tree. This happened while walking in his farm

and saw an apple falling perpendicularly to the ground. He observed that apple always falls perpendicularly to the earth's centre. He was puzzled with the direction of falling. Why does it fall perpendicularly down and not upwards or sideways? His study revealed that a particular power at the centre of the earth draws objects towards the earth's centre and not sideways. This led to the law of universal gravitation whose effects can be studied in the mechanical framework that he created through the laws of motion. The story of how an apple fruit dropped perpendicularly to the earth's centre actually brought about a great revolution in the field of science. Though different people understand the story in different ways as untrue, divine, mythical, fictional or coincidental, it was actually confirmed by Catherine Barton, Newton's niece, William Stukeley and Voltaire (Hall (1996), Herivel (1965), Kean (2011), Newman (2018), Numbers (2015), Wikipedia (2021)). The story provided Newton with the inspiration that made him to eventually formulate his law of universal gravitation which brought explanation for elliptical planetary orbits and virtually every other motion in the universe.

Newton attained his scientific feat in theoretical and experimental works; discoveries and inventions within the age 26 and 40 years. In our nation today a lot of young science scholars are still battling with education or unemployment at the age of 26 years. It is the responsibility of the government to provide the needed policy, framework and infrastructure at all levels of education for smooth academic programmes of the students. Newton spent a lot of time on experiments. He used his laboratory for most of the experiments. He blended theoretical study with practical work. This combination of theory and practice led him to many different kinds of discoveries (Dry (2014), Kean (2011), Levenson (2010), Mann (2014), Newman (2018)). For example, the theoretical knowledge he had about optics made him review the design of the traditional telescope, which was large and burdensome instrument to use. His works, experiments and discoveries advanced the study of physics, mathematics and science in general. His curiosity of exploring the mystery of the world made him venture into rigorous experimentation. Newton performed a number of experiments on motion, calculus, composition of light and allied science subjects; most of which formed the dominant scientific viewpoint. His discoveries laid a good foundation for future developments in science.

DISCOVERIES OF ISAAC NEWTON

Sir Isaac Newton has been described as one of the most influential scientists in history. Most of the time, Newton confined himself to a solitary place for meditation on his vague idea and integration of the ideas into a logical, articulate and scientific concepts. Most of his discoveries came from this medium. One of such time was between 1665 and 1667 when he came home after closure of the school and used the time to pursue his private study. He contributed immensely to the fields of physics, mathematics, astronomy and chemistry. His discoveries gave physics its theoretical foundation and led to a deeper understanding of the universe. Even where his discovery was wrong, the idea he put forward provided the impetus to new lines of thought in explaining the nature. In all, the inventions and discoveries of Newton in theoretical physics have substantially led to a radical change in our understanding of the world. Some of the discoveries by Newton that brought about scientific revolution are listed below (Berlinski, 2000; Dry, 2014; Kean, 2011; King, 2003; Mann, 2014; Newton, 1962; Olivier, 2012).

- 1) Newtonian Telescope: A telescope is a magnifying optical instrument for viewing distant objects. There were standard telescope which provided the required magnification before the emergence of Newton. However, the available ones caused chromatic aberrations because the refracting lenses used changed the direction of different colours at different

angles. Newton provided improved materials for the construction of the first practical reflecting telescope. He replaced the refracting lenses with mirrored ones and incorporated other items that could display the image to the eye. By using mirrors instead of lenses, Newton was able to invent a more powerful instrument which was ten times smaller than the traditional telescopes. Isaac Newton invented the modern telescope in 1668 by replacing the old refracting telescope with the new improved reflecting telescope. In fact, this invention was regarded as his entry card into the premier Royal Society of London. The organization asked for a demonstration of Newtonian telescope in 1671.

- 2) Newton's Laws of Motion: The three laws of motion were clearly documented for the first time by Newton in his book, the *Philosophiae Naturalis Principia Mathematica*, commonly known as the *Principia*. Newton published this book in 1687 and was described as one of the most important scientific books in history. The three laws of motion set the foundation for modern classical mechanics. Science scholars believe that Newton's laws of motion laid the groundwork for classical mechanics. The laws precisely defined the concept of inertia and force. The three laws as stated by Newton are:

Newton's first law of motion: A body continues in its state of rest or uniform motion along a straight line unless an external force acts on it. In other words, if no force acts on the body, the velocity of the body cannot change and the body cannot accelerate.

Newton's Second Law of Motion: The rate of change of momentum of a body is directly proportional to the applied force and takes place in the direction in which the force acts.

Newton's Third law of Motion: To every action, there is an equal and opposite reaction. When two bodies interact, they exert equal but opposite forces on each other. That is, the forces on the bodies from each other are always equal in magnitude and opposite in direction.

- 3) Law of Universal Gravitation: The historic background of this law revealed that an apple fell while Newton was doing something in the farm. This action inspired Newton and made him ask many questions which gave birth to the law of universal gravitation that is generally considered as the basis of classical mechanics at the time. Newton concluded that force of gravity played a major role in the falling of the apple. Then he resolved that the same force of gravity could be exerted on other objects of different sizes and at different heights. The law is one of the Newton's first published works on the motion of the planets and gravity. Aside from the three laws of motion, the law of universal gravitation is also included in Newton's book, the *Principia*. With this law, Newton was able to prove that all objects are subject to gravity and that movements of celestial objects can be predicted.

Newton's law of Universal Gravitation states that: Every object in the universe attracts any other object with a gravitational force of attraction which is directly proportional to the product of the masses of the objects and inversely proportional to the square of the distance between the two objects.

Mathematically: $F = G \frac{M_1 M_2}{R^2}$

Note: F is the Gravitational Force

G is the Gravitational constant

M_1 & M_2 are masses of the two objects.

Gravitational force is the force with which the earth attracts every object existing in the earth's gravitational field. This attraction is called gravitational attraction and its effect is to change the velocity of objects under its influence and cause them to accelerate.

- 4) Newton's Law of Cooling: The law states that the rate of cooling in a body is directly proportional to temperature difference between the body and its surroundings. The law explains the rate at which hot cup of liquid cools.

Mathematically: $\frac{dT}{dt} = -K(T - T_s)$

Note: The derivative is 'negative' as the body is cooling

$\frac{dT}{dt}$ is a time derivative representing change of temperature

K is a constant

T is the temperature of the body

T_s is the temperature of surroundings.

CONTEMPORARY SCIENTISTS

Sir Isaac Newton's connection and association with scientists of his days were both positive and negative. While displaying a robust and modest interaction with some of his colleagues, his comportment with other scientists around him revealed elements of secrecy, rivalry, jealousy, vindictiveness, ego, fear of critics and lack of forgiveness. According to Joseph-Louis Lagrange, a great mathematician, Newton was the greatest genius who ever lived. But Steven Weinberg, (2015), a Nobel laureate in physics, evaluated the attitude of Newton towards Robert Hooke and Gottfried Wilhelm Leibniz and described Newton as "a nasty antagonist" and "a bad man to have as an enemy" (Brackenridge (1996), Mann (2014), Wikipedia (2021). The young science scholars should learn from the reactions of Isaac Newton to issues and cultivate the right ethical conduct and scientific attitude.

Ethic is concerned with what ought to be: what we ought to do, what we ought to be, the right and the wrong. There are more to science than the collection of facts. The way and manner the findings are presented are very important and germane. A proposed law of science may cover all the relevant phenomena yet be unsatisfactory if it lacks the explanatory frame work or input. The concerns of science are not limited to covering facts but the facts are to be explained and presented in a logical and ethical manner. Every scientist is expected to develop the right attitude. Scientific attitude is a composite of a number of mental habits or tendencies to react consistently in certain ways to a novel or problematic situation. It is the attitude and character that defines a good scientist. It is the attributes that scientists manifest when engaging in an inquiry, explanation or investigation. The attribute of scientific attitudes that are qualities of a scientist include humility, objectivity, open-mindedness, perseverance, curiosity and inquisitiveness.

THE DEATH OF ISAAC NEWTON

Newton became a famous scientist and later became wealthy but had few friends and remained unmarried. In 1678, Newton suffered a serious emotional breakdown, and in the following year his mother died. In 1693, Newton suffered a severe nervous disorder after working for many nights without stopping. There is a saying that all work and no play makes Jack a dull boy. In addition, health is wealth and rest is sweet after labour. This indicates that the young science scholar need to rest after scientific task in order to obtain good health for achieving lofty discoveries. Newton's health started deteriorating in his old age and his

movement and diet became restricted. In 1725 he fell ill with gout. In 1726 he suffered hemorrhoids, experienced digestion problems. Due to a weakness in the bladder, he was plagued by a stone in the bladder and suffered from incontinence when he was eighty years old. As a result of increasing pain from his bladder stones, he blacked out on 19 March, 1727 and never regained consciousness. He died the following day on 20 March, 1727 at the age of eighty-five and was buried like a king and national hero in Westminster Abbey.

RECOMMENDATIONS

1. Young science scholars should be challenged by the achievements of Isaac Newton and make a lot of scientific advancements in their generation.
2. The young scientists should strive to use any available time, opportunity, industrial action, and pandemic holiday such as COVID-19 to create, discover or develop something that will make life better to live in.
3. Government should provide conducive environment for the youth in order to attain the peak of their education and career at the right time.
4. Parents should give appropriate and timely parental support to their children and encourage them to attain greatness.
5. Private organisations should assist the government in establishing less expensive educational institution for the downtrodden but intellectually and scientifically sound.

CONCLUSION

Newton's father died in 1642; his mother died in 1679 and he himself died at age 84 on 20 March, 1727. Within 84 years of sojourning on earth, the tiny boy that was born at Woolsthorpe, a village in south western Lincolnshire, England, contributed tremendously to scientific revolution. Newton made discoveries in mathematics, motion and optics. He advanced the work of previous scientists on the laws of motion and other allied topics in physics and mathematics. As a great author, he published many books, notable among which was "Philosophiae Naturalis Principia Mathematica" (Mathematical Principles of Natural Philosophy) which he published in 1687. It is described as his most acclaimed work and regarded as the single most influential book on physics. Newton worked assiduously and achieved major progress in the following areas: centripetal force, inverse-square law, bodies in motion and the variations in tides due to gravity, universal gravitation, centrifugal force, reflection, refraction and diffraction of light. It is obvious that the achievements of Isaac Newton laid a solid theoretical foundation and provided powerful scientific tools for physics and mathematics. He is described as one of the greatest physicists. It is obvious that when the young science scholars give all it takes to the study of science, scientific discoveries and technological advancement will be a regular manifestation in all fields of science and consequently lead to greater scientific revolution. According to Friesenhahn et al (2014), the young scholars of today will be the pool from which the scientific leaders of tomorrow emerge; the science system of the future in any country can only be as strong as its pool of young talent today.

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