Greek Exploring Mathematics and the Natural Sciences: Pythagoras Theorem

A fundamental purpose of human social structures is to capture knowledge and convey it to succeeding generations. Individuals must acquire that knowledge through observations made within these structures, such as culture and education. Knowledge is defined as facts/skills acquired through the theoretical or practical understanding of a subject. It is clear that much of our current knowledge is a culmination of centuries of knowledge evolving into what it is today. To me, the title implies that what we already know is the sole determinant of what we are going to know, thus insinuating that knowledge production cannot take place if no past experiences are available. Present knowledge can (and in almost all cases does) build upon past knowledge, but exactly how much is dependent is questionable. I agree with this title to a large extent as no knowledge arises from nothing, nor does anything material or virtual come from nothing in this reality. However, in order to affirm this claim, I will need to ensure that there are no Areas of Knowledge in which current knowledge is not wholly dependent on past knowledge. Through exploring Mathematics and the Natural Sciences, I will endeavour to ascertain whether the title is unerring.

Inherently connected to reason, all current knowledge in mathematics is supported by the most basic concepts developed in the past. Mathematics is an Area of Knowledge which is the study of numbers, quantities, shapes and the relations between them. Mathematical proo fs in all fields (e.g geometry and arithmetic) have similar logical structures to follow, and everything I have learnt in my IB SL Maths class up to now depends on basic arithmetic calculations and axioms. The continuous historical development of modern arithmetic can be traced back to the age of Thales of Miletus (624-548 BC) in ancient Greece, where the two earliest mathematical theorems, Thales' theorem and Intercept theorem are attributed to. Although it is unknown whether he was the one who introduced into mathematics the logical structure that is so ubiquitous today, it is known that within two hundred years of Thales the Greeks had introduced the idea of proof into mathematics. Another important figure is Pythagoras of Samos (580-500 BC). He developed the Pythagoras theorem, which states that the square of the hypotenuse of a right triangle is equal to the sum of the squares of its other two sides, or a^2 + b^2 = c^2. This theorem is not only the basis of trigonometry but can also be expanded and used in fields ranging from astronomy to social networking. There is little doubt that Pythagoras and his groundbreaking ideas helped shape the way we currently view the impact of numbers in our daily lives. Lastly, Gerolamo Cardano, an Italian polymath, was one of the most influential mathematicians of the Renaissance and one of the key figures in the foundation of probability and the binomial theorem. Today, he is well known for his achievements in algebra, making the first systematic use of negative numbers in Europe, acknowledged the existence of imaginary numbers and published the solutions of cubic and quartic equations. Moreover, the methodology on the number theory, mathematical analysis, integral calculus and applied mathematics are based on discoveries of past mathematicians.

However, although long held mathematical reasoning is useful, new insights often require thinking outside of the box. All past knowledge is only in the past- the present is innovation of knowledge that must be dealt with. Recently developed maths theories have revealed the nature of numbers. Ken Ono, an Emory mathematician, proved that partition numbers behave like fractals, discovered the divisibility properties of partitions, and developed a mathematical theory for seeing their infinitely repeating structure (that wasn't anticipated a few years ago). Additionally, he devised the first finite formula to calculate the partitions of any number, which has changed how mathematicians study partitions.

To measure linear dependence, scientists use the correlation coefficient, which was first introduced by Sir Francis Galton and justified by Karl Pearson. However, if the dependence between the variables is non-linear, the correlation-coefficient is no longer a suitable measure for their dependence. A solution to this problem was developed by Dr Björn Böttcher in 2019- a dependence measure called 'distance multivariance', where not only the values of the observed variables but their mutual distances are recorded and the distance multivariance is calculated. This allows for the detection of complex dependencies and can be applied when big data sets need to be analysed.

On the other hand, in the Area of Knowledge of Natural Sciences, the production of current knowledge cannot be accurate without considerations of past observations and experiences. In my IB Biology class, I learnt that biodiversity conservation requires decades of data from observations and experiments. Conservationists monitor the fluctuations of natural populations in order to perceive correlations and hence reason what factors might be causing dangers to various species and prevent extinction- a fundamental ecological process and the ultimate fate of all populations. A thorough and reliable understanding of processes that influence extinction risk inform multiple applied ecological problems, including habit restoration, biological control and conservation of endangered species. Plausible explanations were developed due to the knowledge of past extinctions such as the End Permian occurring 251 million years ago and the K-T mass extinction 65 million years ago. Scientists can presently understand that species go extinct primarily as a result of a combination of changes to their environment, reduced food supply and competition with others.

In an ever changing world of newer technology, the past seems irrelevant. However, the events that took place in the past wholly tackle the present and help understand the physics of our ever changing natural world. One of the largest areas of concern is the South Atlantic Anomaly, a dip in the magnetic field over the southern parts of the Atlantic Ocean which is exposed to more harmful cosmic radiation. To better understand how Earth's magnetic field truly works, the study of history comes into play. During the Iron Age in 1000 AD, tribes in Southern Africa would occasionally burn down their houses for cleansing. The process would heat up mineral rich floors to 982 degrees celsius and the moment they cooled they would capture the Earth's polarity. This has allowed modern scientists to consider the Earth's polarity dating back thousands of years in the exact area where the South Atlantic Anomaly is studied. "All signs point to the magnetic field being comparable to today's anomaly holding situation, a piece of information that finally exists with proof behind the find". Understanding the history of the planet is essential in the mystery of the South Atlantic Anomaly.

Evolution is another process that come under clear focus once studied through the lens of both history and science. Relying on natural selection, it is the change in the characteristics of a species over several generations. Biology can only be truly understood by first understanding evolution. There is information hidden in evolutionary history of life on Earth that can illuminate what happens in mammals today and to stay ahead of pathogenic diseases, researchers must study the evolutionary histories of the disease-causing genes, allowing us to gain insight into other gene regulatory pathways and improve human health.

However, when there is not much past knowledge available on a specific field, knowledge production requires more new explorations than old experiences. Two teams of physicists have obtained the first glimpse of the surface of a pulsar. Newly created maps of the that surface reveal bright blemishes in the star's southern hemispheres, hinting at the presence of complex magnetic fields. This new data could help researchers understand how matter behaves under extreme pressure. Additionally, recently discovered neutron stars themselves can give us hints and contribute to fundamental physics. 'The data points to magnetic complexity. Though this is not a breakthrough yet, more understanding will come out of this, says astrophysicist Feryal Özel. Humans have the intangible desire to explore and challenge the boundaries of what we know- depending wholly on past knowledge cannot truly allow for in-depth explorations of present and future knowledge.

Overall, to a large extent present knowledge is wholly dependent on past knowledge. In the AOK of Mathematics, current knowledge depends considerably on the most basic axioms and since it is largely invented by people, almost all mathematical theories depend on the common mathematical reasoning, as illustrated by the examples of Thales, Pythagoras and Cardano. However, new insights often require separation from basic conjectures and recent mathematical theories have allowed for detection of complex dependencies and revealed the true nature of numbers. Knowledge production in the Natural Sciences is influenced much more by current needs than mathematics is. Much of our biological knowledge is derived from observable truths, such as monitoring physical patterns of various species. These truths are not falsifiable and can act as evidence for knowledge production. However, knowledge production in physics requires new explorations rather than old experiences. Recently obtained data may shed light onto magnetic complexity and how matter behaves under pressure, which can contribute tremendously to fundamental physics and allow for direct support of current knowledge production that is not wholly dependent on past knowledge.