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Prescribed Title 3: Is there solid justification for regarding knowledge in the natural sciences more highly than another area of knowledge? Discuss with reference to the natural sciences and one other area of knowledge.

Natural sciences offer peace of mind simply because their importance and vast applications to humankind are undeniable *("Major in Natural Sciences: Natural Sciences Degree Programs.")*. This prescribed title stipulates that with sufficient justification, natural sciences can be considered more valuable relative to another AOK. This essay investigates the comparative value of knowledge between natural sciences and mathematics. To determine the degree of solid justification present, individual scientific disciplines (Biology, Chemistry and Physics) are explored. The main focus of the prompt is undermined by the fact that these AOKs are auxiliary disciplines accompanied by an interdisciplinary framework and amalgamation of knowledge, which prevents the prioritization and value of one AOK over another. Furthermore, prioritizing a discipline over another is subjective from person-to-person; therefore, a more appropriate method is to consider the applications of the two AOKs. Henceforth, the comparative importance of AOKs is justified via their discrete contributions to essentials of life including modern research, technological progress and acquisition of new knowledge.

It is irrefutable that medicinal research and human anatomy gave birth to countless life-saving treatments and pharmaceuticals that provide more rewarding benefits than mathematics. Firstly, the penicillin discovery helps in human survival and strengthens the cell wall to prevent bacteria growth *(Bradford).* This scientific development made a profound impact in treating infections that were previously considered fatal and severe *("Penicillin: An Accidental Discovery Changed the Course of Medicine.").* This proves that

discoveries in life sciences not only foster human growth but also increase life-expectancy (Human Development Index Indicator) implying that applications of biology are indispensable in comparison to the pursuit of mathematical knowledge. Similarly, the evolution of analgesics, anaesthetics, and antiseptics support safe surgical-methods and pain-free operations with reduced suffering – an ultimate goal of human life *("Blessed Days of Anaesthesia").* The outcome of biological research and medical processes allows the achievement of basic human rights: the right to good health and well-being *("UN-SDG Goal 3: Good Health and Well-Being.")*. This justifies why it is rational to regard natural sciences more highly. Besides, MRI, X-rays and Computed Tomography have aided experts to diagnose injuries, diseases and tissue-damage invisible to the naked eye. These scientific advancements (of greater 'monetary' value than mathematics) improve the quality of life and provide methods to acquire new knowledge on the evolution of species and mutations of life-threatening viruses. These concrete and tangible benefits of biology enable natural sciences to be regarded more important than mathematics.

In contrast, mathematics explores abstract theories, axioms and conjectures. This, however, does not provide discrete applications to mankind apart from understandings of observable patterns in nature like the Golden-Ratio (in spirals), Fibonacci's Sequence (in flower petals), and fractal geometry in snowflakes *(Lassiter)*. Simply put, this provides superficial judgement of the world which is pursued for pleasure and can only be employed in gaining knowledge of the aesthetics of nature. Such an understanding is a product of general intellectual-curiosity, which is inessential for human survival and neither does it have any practical applications to human life. This reiterates that there is subtle evidence to regard natural sciences as invaluable. Mathematics governs the

evolution of animals by providing awareness of intricate patterns and colour-schemes which help disguise predators and attract mates. For example, the diamondback rattlesnake exploits perfect geometric ornamentation to blend into its surroundings. Therein, mathematics of aesthetics seems to be more useful for survival to animals than to humans and it seems natural and instinctive for humans to classify scientific knowledge as superior to mathematics. Comparatively, mathematical symmetry is exhibited by animals including spherical-symmetry in volvox and rotational-symmetry in starfish that allow prey attacks from multiple directions *("Math in Nature: 5 Stunning Ways We See Math in the World.").* Although these understandings facilitate the pursuit of behavioral knowledge of nature, they are inessential to mankind's survival, unlike natural sciences. Humans gain explanations about nature from such mathematical knowledge as to why seashells curve or rivers bend – ideas that have limited importance to human vitality. The scope of scientific knowledge rests upon sensory-evidence and experimentation on nature, in contrast to mathematical scope which is established upon imagination, observation and deductive-reasoning of nature. This difference of scope allows natural sciences to dominate mathematics.

Analogously, knowledge in chemistry possesses a strong influence in medicinal, food and environmental chemistry, which are utilized frequently for chemical analysis and synthesis of chemical compounds, unlike mathematics which is used only for abstraction. For instance, nanotechnology involves the study of individual particles that aid in agricultural systems, disease-treatment-delivery methods and pathogen-detection at submicroscopic-level. Such versatile and multipurpose applications of chemical knowledge substantiate natural sciences of more value than mathematics because of

their regular and tangible contributions to human life. Correspondingly, food chemistry plays an important role in the production of food-additives/preservatives and improving shelf-life, which is used daily and thus is more vital for living. Additionally, chemical awareness can help in the development of food supplements, artificial flavourings and improve interactions of biological and non-biological components of food. This transferable nature of knowledge in chemistry makes it indispensable, unlike mathematics, and hence gives a solid reason to regard it more highly than mathematics. Furthermore, knowledge of chemistry has profound applications in speeding up reactions using suitable catalysts in industrial processes: Haber and contact process ("*IB DP Chemistry Syllabus Guide"*). This helps minimize cost and optimize the yield (more economically favourable), which is extremely beneficial to mitigate the risk and maximize efficiency. Thus, natural sciences, from a chemical point of view, can provide more diverse utilization in industrial processes, unlike mathematics which only contributes to industrial processes by mathematical modelling and optimization through calculus which justifies its superiority over mathematics.

Nevertheless, calculus is the backbone for maximizing efficiency and profit in current businesses. Hence, it is irrational to underrate its importance relative to natural sciences. Differential calculus *("IB Mathematics: Analysis and Approaches Guide - Holy Heart of ...")* helps optimize the efficiency of variables in industrial processes for example maximizing the volume or cross-sectional area of a commodity, minimizing the amount of paint utilized or surface area of packaging. Calculus allows humans to engineer "Best Designs" with maximizing parameters like productivity, durability, and efficiency. This industrial contribution not only allows the efficient use of resources and costs of

production but also improve the performance of systems – integral to the workflow and profit – which justifies why mathematics is, at times, more valuable than scientific knowledge. More importantly, calculus can help predict the intensity and direction of particular weather conditions like storms and tornadoes *(Satbhai).* Although natural sciences yield obvious and life-saving treatments, it is important not to underestimate mathematics as a tool to help save future lives. This explains that there is evidence to regard natural sciences more highly, however, it is limited by the ancillary applications of mathematics in multiple domains. Furthermore, not all situations yield measurable (empirical) data, thus natural sciences cannot be considered more highly in all circumstances which hinder the prompt's focus and renders mathematics more valuable. Equivalently, mathematics is employed to analyze market data and compound interests annually in banks, which subsequently makes mathematics universal to support trading schemes and modern economies: an observable advantage that corroborates the superiority of mathematics.

Contrary to life sciences, physics cannot be regarded more highly than mathematics because mathematics serves as a tool to decipher and simulate scientific phenomena like fluid dynamics or relativistic motion. Hence, physics is only valuable because of the assimilation of mathematical relationships indicating the superiority of mathematics. Mathematical knowledge (Binary-counting and Discrete Mathematics) is useful for developing algorithms and computer-graphical analysis. Computational mathematics helps in machine learning and artificial-intelligence: areas that firmly bring technological progress (a human desire to instil innovation and economic growth) rendering it more useful than Physics. Physics have only enabled humans to explore

outer space, visualize planetary motion, and understand the transfer of energy and waves. It assimilates understandings of the world to help analyze situations and build safer infrastructures – from banking roads (to reduce dependence on friction during rains) and operating flights (using aerodynamics). Though physics does yield tangible applications relative to mathematics, it is inessential to human vitality because it only improves the luxuries of life.

Like mathematics, physics also postulates certain arguments: for example assuming air resistance is negligible when using SUVAT equations *("IB Physics Syllabus Guide")* or assuming that all planets act like point masses in Newton's Law of Gravitation. These abstract limitations limit the validity of calculations making it implausible to regard natural sciences more highly. Furthermore, generalizing that all applications of natural sciences are useful is misleading and in fact is more harmful than mathematics, which undermines the prompt's focus, suggesting that there isn't enough evidence to regard scientific knowledge as more significant. Developments in physics lead to creations of nuclear weapons, radioactive waste (from nuclear reactors) and the utilization of fossil fuels that are more toxic to human health and survival than mathematical inventions. These scientific processes pollute the environment and bring climate change that has countless other implications – eventually making humans more vulnerable. Hence, assuming that natural sciences can be regarded more highly is illogical.

Ultimately, mathematics presents abstraction as a tool to adopt semantics of scientific and mathematical discourse. It doesn't, however, provide empirical evidence, concrete application or interpretation of knowledge like natural sciences. Therefore, the notion of regarding natural sciences more highly than mathematics, as underscored by

the prescribed title, depends largely upon the individual discipline put on the weighing scale with mathematics on the opposite end. Life sciences, for example, are deemed critical to human vitality, unlike mathematics which disseminates financial and aesthetical knowledge. That being said, it is appropriate to regard natural sciences as more valuable because of the empirical and diverse applications of scientific knowledge that provide solid justification of natural sciences as pivotal and vital. While considering physics, however, mathematics is described as superior to physics because it facilitates a medium to model scientific phenomena and acquire new knowledge. Subsequently, there is sufficient evidence to regard natural sciences more highly, but it varies from the reference frame of the scientific discipline.

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