Nothing is more exciting than fresh ideas, so why are areas of knowledge often so slow to adopt them? Discuss with reference to the human sciences and one other area of knowledge.

"Innovation is about seeing what everybody has seen and thinking what nobody has thought" Dr. Albert Szent-Györgyi. According to this quote, novel ideas have the power to captivate individuals since they haven't been envisioned by others. However, the adoption of these ideas takes a considerable amount of time across specific areas of knowledge. In this context, "adoption" refers to the acceptance and integration of these innovative ideas. When we apply this concept in various fields of study, key terms such as "understand," "approve," "prove," and "use" closely represent the stages of adoption. The reason behind this incident will be explained by two subjects considered AOK: human sciences and mathematics. My examples considered from AOKs will be main explanations that indicate the reason why fresh ideas are so slow to get adopted in these fields.

In the realm of human sciences, rituals, habits, and traditional rules wield significant influence, gradually embedding themselves into humanity's consciousness. When a movement or vaccination attempts to uncover the drawbacks of a strong inclination towards one side, it indeed intrigues people to implement the news, but the adoption process demands considerable time. Similarly, mathematical formulas, hypotheses, and theories establish sturdy customs, fostering deep reliance through repetitive use. However, what occurs when a groundbreaking idea challenges previously held beliefs? It undoubtedly sparks excitement among experts eager to explore uncharted territories. Yet, why does it often take a substantial amount of time for mathematicians to fully embrace new concepts? Underestimation, perhaps, plays a role—a cautious approach rooted in the need to ensure the solidity of these radical innovations before integrating them into established frameworks.

One of the trilling cases is about the rigorous proof of Fermat's Last Theorem. [1]The history of French mathematician Pierre de Fermat's most famous mathematical conjure begins as

[1] DigitalCommons@USU | Utah State University Research. Accessed 10 Dec. 2023, from

far back in 17th century. The conjecture, known as Fermat's Last Theorem, has roots that date back about 3600 years. Fermat postulated the theorem more than 350 years ago; however, the proof of it was not realized until 1994. For over three centuries, mathematicians grappled with Fermat's tantalizing claim, yet the proof remained elusive. Countless tried and failed, some even devoting their entire careers to unlock the mystery embedded within Fermat's scribbled note. The theorem itself seems simple: there are no whole number solutions for $a^n + b^n = c^n$ when n is greater than 2. But simplicity belies the complexity lying beneath. Thousands of mathematicians have worked on proving Fermat's Last Theorem. Most have not succeeded. However, by establishing the theorem for some values of n, a number of mathematicians have advanced. [2]Leonard Euler demonstrated in the seventeenth century that the equation $x^3 + y^3 = z^3$ has no positive integer solutions. Fermat's Theorem was therefore verified by Euler for the case n = 3. The theorem for n = 5 was then separately established in the nineteenth century by Adrien Marie Legendre and P.G. Lejeune Dirichlet. In 1839, Gabriel Lame demonstrated it for n = 7.

Until June 23rd, 1993, Fermat's Last Theorem had been a persistent challenge for many mathematicians attempting to grasp Fermat's groundbreaking theorem. After working in secret for six years on a problem with a rich history spanning roughly 358 years, the English mathematician Andrew Wiles finally cracked it. [3]The main reason it took so long to prove Fermat's Last Theorem was the complexity of the mathematical techniques required to tackle it. Mathematicians attempted various approaches over the centuries, but the problem resisted resolution due to its intricacy and the need for advancements in various mathematical fields.

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https://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=1300&context=honors#:~:text=Fermat's%20last%20theorem%2C%20as%20the,a%20judge%20and%20amateur%20mathematician

[2] Euler's Work on Fermat's Last Theorem. Accessed 10 Dec. 2023, from

https://www.slideshare.net/ProfStemkoski/eulers-work-on-fermats-last-theorem

[3] "Why Did It Take so Long to Solve Fermat's Theorem?" Quora. Accessed 10 Dec. 2023, from

https://www.quora.com/Why-did-it-take-so-long-to-solve-Fermats-Theorem#:~:text=Simply%2C%20because%20a%20solution%20to,exactly%20the%20statement%20of%20FLT

In contrast, the human sciences have no reason to be slow in adopting fresh ideas due to the techniques and tools that have emerged from mathematics. One notable example is the Culturalization Movement in Mongolia. [4]From 1959 until the end of 1963, the Mongolian authorities made a decisive shift from nomadic living to a more modern daily lifestyle. It was initially intriguing to many people because the change in society was like stars hidden behind the daylight. One particular case is importing edible products from Russia. For the first time, seeing candies or any delicatessens was totally capturing the attention of citizens who lived a traditional lifestyle. However, digesting those kinds of foods was a main problem because people were already accustomed to dairy products, not in high-calorie products. Similarly, parts of the Culturalization Movement, like teaching to be polite and good personal hygiene, result in complaints, which have been described in the movie as "Соёлын довтолгоо" translated as "Cultural Invasion." In this historical movie, I have seen strong emotional states from the people who resisted this change, especially when it challenged existing religious beliefs or paradigms that were previously regarded as mainstream. One strange sample is having regular showers considered an evil eye in herders, and it digresses to link to the Buddhist religion. So, it took roughly 4 years to introduce why we should stop believing in superstitions. Changing the mindsets of people was not easy at all, as the movie showed, and demanded more than 4 years to adopt in the whole of society, even after the Culturalization Movement.

Another mathematical concept of imaginary numbers first came up by Girolamo Cardano (1501-1576). Cardano, an Italian mathematician, physician, and astrologer, played a crucial role in the development of algebra and made significant contributions to the understanding of complex numbers. [5]Cardano's seminal work "Ars Magna," published in 1545, investigated cubic equation solutions and discovered what we now call imaginary numbers. While attempting to solve seemingly intractable cubic equations, Cardano came upon square roots of negative values

[4] Gogo.mn. "Мартагдсан Түүхийг Харуулсан 'Соёлын Довтолгоо' Кино. Accessed 10 Dec. 2023, from

https://gogo.mn/r/xkxgm

[5] "Mathematical Treasure: Cardano's Ars Magna." Mathematical Treasure: Cardano's Ars Magna | Mathematical Association of America. Accessed 10 Dec. 2023, from

https://maa.org/press/periodicals/convergence/mathematical-treasure-cardanos-ars-magna

as intermediate steps in his calculations. He didn't entirely comprehend or accept these strange creatures, but he accepted their presence as "fictitious" or "false" answers. Cardano's work established the groundwork for future mathematicians to go deeper into the area of imaginary and complex numbers. It wasn't until the 17th century, thanks to the efforts of mathematicians like John Wallis and Rafael Bombelli, that an understanding of imaginary numbers began to emerge. René Descartes invented the term "imaginary" in the 17th century, cementing the notion as an intrinsic component of mathematical discourse. [6]This complex system was explored with increasing intensity over four centuries as it became increasingly commonly recognized as mathematical reality, whether for representation's sake at first or subsequently by choice. However, what made the terminology of imaginary numbers so slow to adopt in mathematics?

The main reason behind it over centuries is the Lack of Real-World Application. Initially, mathematicians were primarily concerned with addressing real-world issues, and the concept of negative square roots appeared abstract and unconnected to actual circumstances. Some mathematicians may have questioned the value of imaginary numbers due to their lack of immediate applications. Moreover, the mysterious character of imaginary numbers provided a difficulty for mathematicians seeking practical applications. Unlike many other mathematical notions that have found practical applications in domains such as physics, engineering, and economics, the value of imaginary numbers was not immediately apparent. The lack of an obvious and direct link to real-world situations hampered their adoption and applicability.

"Your health is your wealth." [7]Hepatitis B, an infection of the liver discovered by Dr. Baruch Blumberg in 1965, is one of the most common viruses. This infection can present as either acute, with a sudden and severe start, or chronic, with a long-term presence. Hepatitis B is

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[6] Therealityofthecomplex: TheDiscoveryandDevelopmentof Imaginarynumbers. Accessed 10 Dec. 2023, from https://maa.org/sites/default/files/images/upload_library/46/HOMSIGMAA/Peters-Christen-HOM-SIGMAA-2018.pdf

[7] "Hepatitis B." World Health Organization, World Health Organization. Accessed 10 Dec. 2023, from https://www.who.int/news-room/fact-sheets/detail/hepatitis-b#:~:text=Overview,from%20cirrhosis%20and%20liver%20cancer

a chronic illness that increases the risk of complications such as cirrhosis and liver cancer, potentially leading to death. [8]To prevent the widespread transmission of this virus, Irving Millman, a microbiologist, collaborated with Dr. Blumberg to create a blood test for the hepatitis B virus. Blood banks began employing the test to screen blood donations in 1971, and the risk of hepatitis B infections from blood transfusions was reduced by 25%. Drs. Blumberg and Millman produced the first hepatitis B vaccine, which was initially a heat-treated version of the virus, four years after identifying the hepatitis B virus. After their hard work, the FDA authorized a more advanced plasma-derived hepatitis B vaccine for human use in 1981. From the given information, it is evident that the approval of the jabbing process in use has persisted for roughly 10 years, which is quite a significant duration. Over the course of a decade, extensive research, development, and clinical trials were conducted to ensure the vaccine was perfectly formulated, with no adverse effects on humans. The vaccine undergoes three phases, initially testing safety and dosage in small groups, then assessing efficacy in a larger population, and finally confirming effectiveness, monitoring side effects, and comparing with existing treatments in thousands of individuals. In other words, the examination process of the hepatitis B vaccine consisted of a variety of investigations into its harmfulness, protectiveness, effectiveness, etc.

In summary, Dr. Albert Szent-Györgyi's statement underscores the inherent allure of new ideas due to their unexplored nature. However, the adoption of such ideas within the fields of mathematics and human sciences, my chosen Areas of Knowledge (AOKs), has been so slow. This delay can be attributed to challenges like insufficient mathematical tools, a knowledge gap, a disconnect between theoretical concepts and practical applications, and valid safety concerns. Each cause holds significant priority within its respective domain, leading us to generate incredible ideas that are completely adopted. No matter what inquiry or tricky question comes about that hypothesis, confidently giving an exact answer is important. In the human sciences, changes in society and vaccinations can influence both the states and well-being of individuals.

[8] "History." Hepatitis B Fondation | Baruch S. Blumberg Institute. Accessed 10 Dec. 2023, from

https://www.hepb.org/prevention-and-diagnosis/vaccination/history-of-hepatitis-b-vaccine/#:~:text=Four%20years%20after%20discovering%20the,treated%20form%20of%20the%20virus.&text=In%201981%2C%20the%20FDA%20approved,B%20vaccine%20for%20human%20use

In contrast, mathematics relies on building upon prior discoveries to make further advancements. So, “Time is of little concern, as quality remains essential.”

Word Count: 1596 words

Bibliography

1. DigitalCommons@USU | Utah State University Research. Accessed 10 Dec. 2023, from

https://digitalcommons.usu.edu/cgi/viewcontent.cgi?article=1300&context=honors#:~:text=Fermat's%20last%20theorem%2C%20as%20the,a%20judge%20and%20amateur%20mathematician

2. Euler's Work on Fermat's Last Theorem. Accessed 10 Dec. 2023, from

https://www.slideshare.net/ProfStemkoski/eulers-work-on-fermats-last-theorem

3. "Why Did It Take so Long to Solve Fermat's Theorem?" Quora. Accessed 10 Dec. 2023, from

https://www.quora.com/Why-did-it-take-so-long-to-solve-Fermats-Theorem#:~:text=Simply%2C%20because%20a%20solution%20to,exactly%20the%20statement%20of%20FLT

4. Gogo.mn. "Мартагдсан Түүхийг Харуулсан 'Соёлын Довтолгоо' Кино. Accessed 10 Dec. 2023, from

https://gogo.mn/r/xkxgm

5. "Mathematical Treasure: Cardano's Ars Magna." Mathematical Treasure: Cardano's Ars Magna | Mathematical Association of America. Accessed 10 Dec. 2023, from

https://maa.org/press/periodicals/convergence/mathematical-treasure-cardanos-ars-magna

6. Therealityofthecomplex: TheDiscoveryandDevelopmentof Imaginarynumbers. Accessed 10 Dec. 2023, from

https://maa.org/sites/default/files/images/upload_library/46/HOMSIGMAA/Peters-Christen-HOM-SIGMAA-2018.pdf

7. "Hepatitis B." World Health Organization, World Health Organization. Accessed 10 Dec. 2023, from

https://www.who.int/news-room/fact-sheets/detail/hepatitis-b#:~:text=Overview,from%20cirrhosis%20and%20liver%20cancer

8. "History." Hepatitis B Fondation | Baruch S. Blumberg Institute. Accessed 10 Dec. 2023, from

https://www.hepb.org/prevention-and-diagnosis/vaccination/history-of-hepatitis-b-vaccine/#:~:text=Four%20years%20after%20discovering%20the,treated%20form%20of%20the%20virus.&text=In%201981%2C%20the%20FDA%20approved,B%20vaccine%20for%20human%20use