BIP Program “AI and STEAM: Changing Learning, Shaping Futures”

# Designing and Developing an Integrated STREAM Curriculum on Topic “Global Health”

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## 1. Research and Understanding

### 1.1 Scientific principles of topic “Global Health” and related challenges

According to Beaglehole R et al.'s combined definition, Global Health is *collaborative, transnational research and action aimed at promoting health for all*. The term *collaborative* emphasizes not only the necessity of cooperation among nations but also among scientists from diverse fields. Multiple factors influence global health, either empowering or threatening it, and these factors can be categorized based on the scientific disciplines most relevant to them.

From a biological perspective, infectious diseases remain a critical global health challenge, particularly in developing countries, where they account for 70% of premature deaths (Sarmah et al, 2018). These diseases are caused by microorganisms known as pathogens. A successful pathogen must have the following capabilities to survive and multiply in a host: 1. colonize or invade the host, 2. spot a nutritionally rich place in the host body, 3. avoid, destroy or defeat

the host innate and adaptive immune responses, 4. multiply, using host resources, and 5. escape and colonize the new host (Sarmah et al, 2018).

Bacteria, such as *Mycobacterium tuberculosis*, are a type of pathogen that continues to cause millions of new infections and deaths annually, despite significant advancements in antibiotic research. In fact, antimicrobial resistance (AMR) is a growing concern, as the excessive use of antimicrobial drugs not only makes microorganisms resistant but also leads to more severe infections that are increasingly difficult to treat (Sarmah et al, 2018). Pathogen survival and transmission are closely linked to virulence, which refers to the harm a pathogen causes to its host. The classic theory of virulence evolution is based on a trade-off between pathogen growth and transmission versus host survival. This concept is particularly relevant to viruses, which are conventionally defined as ultramicroscopic particles of organic matter that can only multiply with the help of a host cell. Because viral replication depends on host infection and transmission, epidemics often become an essential mechanism for their continued spread (Jankowski, 2020).

Beyond understanding the biological structures of health threats, research on chemical compounds that can counteract these threats or enhance human well-being, and immune function is equally crucial. Synthetic chemistry, the preparation of specific compounds under controlled laboratory conditions, plays a fundamental role in this process. In fact, bacterial infections, HIV/AIDS, and malaria are now largely treatable in the developed world, thanks to groundbreaking innovations driven by synthetic chemists working alongside experts from various scientific fields (Campos et al, 2019). Continued excellence in synthetic chemistry remains essential at every stage of drug discovery and development. Recent advancements in synthetic methods, biocatalysis, chemoinformatics, and reaction miniaturization have the potential to accelerate research and improve the quality of pharmaceutical products, further strengthening global health efforts (Campos et al, 2019).

Moreover, doctors and healthcare professionals continuously work to preserve human health through both academic research and hands-on practice. They examine symptoms, alleviate pain, and monitor patients' responses to various medications, serving as a bridge between laboratory research—conducted by biologists and chemists—and its real-world application in patient care. Particularly those working for non-governmental organizations and offering their services in underdeveloped countries play a crucial role in expanding equal access to healthcare, making the notion of global health imaginable in the first place (Anbazhagan, 2016).

Mathematical modeling and statistical analysis are crucial for understanding disease transmission trends and predicting the evolution of epidemics. These models are typically classified as deterministic or stochastic and include statistical methods for surveillance, mechanistic state-space models, and empirical learning models. Using systems of differential equations, they calculate *the rate of change* in metrics like the number of susceptible, infected, and immune individuals. For instance, the Gaussian Model (GM), based on the Central Limit Theorem, has been especially effective in predicting COVID-19 outbreaks by showing that the sum of independent random variables tends to a Gaussian distribution (Vytla et al, 2021). Interestingly, Gaussian modeling techniques are also applied in some so called “within-host” models, which focus on disease transmission rates within the cells of an infected individual’s body. These models are instrumental in evaluating the effectiveness of treatments, such as antiretroviral drugs for HIV (Ogunlaran & Oukouomi, 2016).

Along with mathematical modeling, information technology and data science come into play when studying global health and addressing its related challenges. AI-driven health interventions could lead to improved health outcomes in low and middle-income countries, focusing primarily on communicable diseases like tuberculosis and malaria (Schwalbe & Wahl, 2020). We can expect to see increasing use of telemedicine for remote diagnostics and treatment, protocol-driven health care to improve quality of care, and better access to goods and services through changes in the organization of transportation and delivery services. Data will become central to health systems, whether big data and artificial intelligence tools for surveillance, planning, and management or “personalized data” in the form of universal electronic record systems and customized treatment protocols (Mitchell & Kan, 2019).

Lastly, social scientists and legal professionals argue that global health is deeply intertwined with socioeconomic, political, and cultural factors, beyond its clinical and biological dimensions. A key social theory suggests that global health issues and interventions acquire culturally specific meanings in different local contexts, creating tension between global policies and local realities—an ongoing challenge in medical and public health practice. Moreover, socioeconomic and political forces can directly contribute to disease, as seen in how extreme poverty fosters tuberculosis and antibiotic resistance. The theory of social suffering further blurs the line between health and social issues, highlighting the need for integrated policies (Kleinman, 2010).

## 1.2 Connection to ST(R)E(A)M disciplines

Global health is closely linked to the STEM principles, as it involves various scientific disciplines that work together to address complex health challenges. As

demonstrated by the research above, global health is a multifaceted issue that aligns with the ST(R)E(A)M principles in the following ways:

- **Science (Biology, Chemistry, Medicine, and Pharmacy):** Research on pathogens, including their reproduction and survival, is essential for understanding the biology of diseases. Chemistry plays a role in testing the effectiveness of substances like antibiotics, while medical and pharmaceutical sciences contribute to the development of treatments and strengthening the immune system.
- **Technology:** Technological innovations, such as AI-powered pandemic prediction models, are crucial for forecasting disease outbreaks. Additionally, diagnostic digital imaging tools enhance medical diagnostics, improving health outcomes across the globe.
- **Engineering:** Engineering contributes to global health by advancing telemedicine, particularly through the development of robots that assist in patient care, expanding access to healthcare services remotely.
- **Mathematics:** Mathematical and statistical models are key in predicting the evolution of diseases, whether tracking trends within populations or assessing the progression of illness within infected individuals.

Art and literacy components can be easily integrated into the topic due to its broad influence and significant impact on shaping the contemporary world. Specifically, today's learners have recently witnessed a major global health threat, the COVID-19 pandemic—which radically changed our lives. Students can be encouraged to express their thoughts and emotions about this pandemic, as well as other global health challenges, through artistic forms such as painting, music, and creative writing. Additionally, they can be prompted to explore scientific papers and literature related to the topic, such as *Mountains Beyond Mountains: The Quest of Dr. Paul Farmer* and *A Life Decoded: My Genome*.

# 2. Creative Design and Innovation

## 2.1 Design Proposal

After reviewing relevant literature, I became interested in exploring the connections between various scientific fields and their collective contribution to strengthening global health. To address this, I developed a web application designed to assist teachers, lecturers, and learners across all educational levels in understanding global health challenges, key historical events, and influential scientific figures who have significantly impacted the field.

The application begins by prompting users to enter their preferences regarding the educational activity's duration, the age group of the learning audience, and the scientific fields they wish to emphasize in relation to global health (Figure 1).


*Figure 1: User Prompt for Educational Activity Characteristics*

Once the user selects the desired characteristics, they are directed to a page displaying an interactive world map with multiple markers. By clicking on any marker, users can access a short, engaging story about a historical event or a prominent scientific figure associated with that geographic region and their contribution to global health (Figure 2).


*Figure 2: Interactive World Map with Marker-Based Pop-Up Stories*

A key feature of the application is the dynamic generation of these stories using Artificial Intelligence. The content is tailored to the learner's educational level, available time, and chosen focus areas, ensuring a personalized and engaging educational experience. By emphasizing the role of STEM disciplines in global health, the application helps learners grasp the interdisciplinary nature of the field and appreciate its real-world impact.

This tool is versatile and accessible to educators from various disciplines who wish to integrate it into their courses as part of an interactive, interdisciplinary learning process. It serves as an engaging resource for illustrating how different scientific fields contribute to one of today's most critical global challenges: ensuring equitable and universal access to healthcare.

You can explore the application at the following link: *Global Health: AI-powered educational resource*. For more information about the technical aspects and potential limitations, you can visit the project's open-source repository on GitHub.

# 3. Reflection Paper

Throughout this experience, I learned about current global health challenges and the groundbreaking scientific advancements that have significantly improved life expectancy and quality of life worldwide. I also developed essential skills, such as reviewing scientific literature, conducting research, and connecting ideas to real-world issues to propose effective solutions.

The interdisciplinary approach greatly enhanced my understanding of global health by encouraging me to explore its complexities through multiple scientific perspectives. This process revealed the intricate connections between fields and the collaborative efforts required to achieve global health improvements. I found the cultural and socioeconomic aspects particularly fascinating, as they were initially less obvious to me but proved essential in understanding the broader challenges. These factors, often influenced by political and economic interests, present significant obstacles to implementing the notion of global health in a globally interconnected economy. Overall, this research deepened my appreciation for the multifaceted nature of global health and the importance of cross-disciplinary collaboration in addressing its challenges.

Through the design process, I deepened my software developing skills and acquired new technical knowledge, associated with the usage of Artificial Intelligence APIs in web applications. Moreover, I needed to face decisions regarding project and time management, thanks to which I evolved both professionally and academically.

Lastly, I was thrilled to bring my idea to life and explore its potential applications in real-world learning environments. The application can serve as an engaging tool for individuals seeking to deepen their understanding of one of the most critical global issues today. In a similar but more structured way, it can be integrated into school curricula across various educational levels and subjects, including science, math, biology, and social or political studies. Educators are encouraged to introduce the resource with a discussion on the topic of "Global Health", fostering awareness and ensuring a solid grasp of its core principles. Subsequently, they have the flexibility to tailor the application to their needs—whether maintaining a broad focus on global health challenges and historical developments or specializing in the intersection of their subject area with global health dynamics. From this perspective, the application is not only an educational and informative resource but also a tool to raise students' awareness, potentially inspiring future scientists across disciplines to advocate for equitable and universal access to quality healthcare.

# 4. AI Integration Reflection

The rapid evolution of Artificial Intelligence (AI) in recent years has profoundly transformed the way research is conducted, and models are developed. From selecting a research topic and defining research questions to implementing reliable, large-scale applications and presenting findings to the world, AI tools can significantly streamline the research process when used wisely.

In my own project, I leveraged AI at various stages, including software development and presentation enhancement. However, I particularly appreciate AI's contribution to the literature review and the composition of the research paper. The nature of my research required concise yet comprehensive overviews of several scientific principles relevant to the topic. Without AI and the Consensus academic search engine, identifying high-quality, representative research papers for each principle would have been a time-consuming and tedious task.

Consensus offers a user-friendly interface where users can enter a research question or topic and receive a synthesized answer drawn from multiple up-to-date scientific articles. This not only provides direct, literature-backed insights into the research question but also facilitates access to reliable sources for further study. By integrating this powerful tool into my research process, I was able to deliver clear, concise, and well-supported answers to the diverse questions posed by my investigation.

Additionally, to ensure my paper was free of spelling and syntax errors, I used the AI-powered proofreading tool Grammarly. Grammarly simplifies the writing process by suggesting alternative phrasings, helping me communicate my ideas more

clearly in a language that isn't my native one. Overall, I believe Grammarly—and similar proofreading tools—play a crucial role in facilitating seamless collaboration among scientists from different countries by eliminating language-related barriers.

Overall, I am confident that I utilized Artificial Intelligence ethically and constructively throughout this project. AI tools greatly accelerated the process, but they never replaced my involvement. Instead, they allowed me to concentrate on the more critical and complex aspects of the research, such as synthesizing and critically analyzing the existing literature, rather than spending excessive time searching for relevant papers. The responsible and beneficial use of AI in research is further ensured by the fact that the outcomes of my work are firmly grounded in established scientific literature, rather than relying on rushed, AI-generated responses. This approach not only enhances the quality of the research but also upholds its integrity and credibility.

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