

A Modern Paradigm of Teaching Scientific Disciplines to Health Professionals at Unicamillus: Connecting Innovative Education and Global Health Perspectives

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Abstract

Scientific disciplines in general, and physics in particular, are often perceived as a dry and challenging subject, and have a reputation for being difficult to understand and engage with, especially for students new to the field. Traditional teaching methods often focus on equations, abstract concepts, and rigorous problem-solving. In the present paper we report on a modern teaching approach in the context of the Physics and Statistics Integrated Course at the Saint Camillus International University of Health Sciences, based on innovative and creative teaching tools. The adoption of these new teaching methods in scientific disciplines can enhance the education of health professionals, equipping them with critical thinking and problem-solving skills essential for addressing global health challenges.

Keywords

Health science education, innovative teaching, global health.

1. The Physics and Statistics Integrated Course

The Physics and Statistics Integrated Course at the Saint Camillus International University of Health Sciences

offers healthcare students a comprehensive foundation in Applied Physics, Medical Statistics, and Informatics. This course provides students with essential skills to understand the physical principles underlying medical technologies, apply statistical methods in

clinical research and healthcare data analysis, and utilize informatics tools for evidence-based decision-making, fostering a multidisciplinary approach to modern healthcare practice.

During the course, future health professionals learn the application of the scientific

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method to the biomedical phenomena, and the working principles of the equipment commonly used for diagnostics and therapeutics. Likewise, the students learn how to use Information Technology (IT) and medical statistics tools useful for their profession both as workers, even when interpreting the results of patients' diagnostic tests, and as researchers in the medical sector.

2. The Teaching Tools

The teaching paradigm is a crucial element in the learning process of the students, and, for the professors at Unicamillus, developing a student-customized approach is the core of their work. The teaching tools play a central role, one that cannot be easily replaced by other methods (e.g., such as Artificial Intelligence (AI)): behind a textbook or a university course lies a “Weltanschauung” (worldview), as simply stating a series of notions is very different from truly knowing and applying a science.

This article stems from the teaching experience built by the authors over more than a decade, not only in university classrooms but also in secondary schools – ten years of engagement and interaction with

students in these fields. The challenges faced by students involve tackling a subject that is inherently complex, while teachers struggle to identify materials that highlight the connection between purely theoretical concepts and their application in a reality that is familiar to the student.

The teaching approach chosen by the authors begins with the statement of scientific laws, the latter forming the backbone of the learning phase, and unfolds around a carefully selected series of practical examples rooted in the student reality. As Nobel Prize winner Giorgio Parisi said in a recent interview, if you don't understand the roots, you can't understand how the tree works, and it's useless to focus only on the fruits.

Starting from the general Law allows the student to grasp the context behind the phenomenon they are approaching and provides guidance in understanding relationships beyond the physical quantities involved, while the use of practical examples stimulates the deductive reasoning essential in their future work, according to a logic that is developed in the following paragraphs.

Then, the teacher's presentation must not be a juxtaposition of laws and notions, but rather a narration that is articulated through stories, images, and videos, all conveyed in a language that is familiar to the student. Images are actually designed to convey information through an everyday reception tool, helping to simplify complex concepts, and also stimulating interest and attention. Unlike words, which require cognitive processing and interpretation, images engage a communication channel that resonates with the viewer on a more intuitive and emotional level. This ability to evoke immediate responses allows them to communicate in a way that is often more impactful than verbal or written language.

Using also interactive tools to engage the students, such as Mentimeter (an audience engagement online platform that enables the lecturer to boost participation), helps the students not to feel a passive object of the lesson [1].

As the philosopher Umberto Galimberti would say, engaging young students on an emotional level means finding the gateway to reach their intellectual level; if the emotional dimension is ignored,

then you will never reach their minds.

Moreover, visual learning can help include students with different cognitive and learning styles, for example the increasing number of students with Specific Learning Disorders (SLD), making the teaching approach more inclusive and effective.

3. The Student's Cultural and Professional Experience as a Bridge Between Theory and Practice

The idea behind this modern teaching methodology is that the choice of the language plays a central role as the primary tool for conveying complex information. Subjects like physics should not be presented as abstract disciplines detached from the healthcare student's course of study but rather integrated with topics already part of their field of interest. This approach ensures that communication with students is conducted in the language they are familiar with, i.e. medical terminology. For example, the application of mechanics to the functioning of the cardiovascular system or the use of optical physics to explain diagnostic instruments like microscopes can become

part of an integrated and effective approach for teaching.

Physics as a discipline occurs in the scholar's study curriculum, since it explains many phenomena occurring in the human body, as well as in the healthcare professional reality when using medical equipment. Using examples related to physiology, anatomy, and medical devices enables students to immediately understand the importance of physical concepts in the surrounding world and in the professional context. This boosts interest and facilitates the learning process, as students are able to identify the immediate applicability of the acquired notions in their future practice. For example, understanding the physical principles behind Magnetic Resonance Imaging (MRI) or ultrasound technology is crucial for correctly using these tools in clinical settings.

Otherwise, many students may perceive scientific subjects as difficult and "distant" from their interests.

If theoretical concepts are introduced through practical examples that are already part of the cultural and professional background, their understanding becomes more intuitive. Active learning, based on exper-

ience and direct application, sparks the student's interest, as they no longer see the subject as something far away, making the concepts easier to remember and master.

This approach takes into account that healthcare students already possess a strong and specific body of knowledge and context of reference. Integrating scientific subjects into this context builds on existing knowledge and motivates the student further. They don't have to imagine how to apply an abstract concept to medicine – they immediately see it in action. For example, fluid dynamics can be illustrated through blood circulation in blood vessels, or equilibrium conditions in dynamics can be presented applied to musculoskeletal apparatus as well as thermodynamic principles can be related to macromolecules structure and function and numerous other examples that could be mentioned.

As said, teaching physics through the equipment used in the medical field is another way to closely link theory to practice and using a language that makes interaction more direct. Students can learn the laws of physics by understanding how the devices they will use daily

in their careers work, such as radiology, ultrasound, thermography, or equipment for monitoring vital signs. This approach not only reinforces their understanding of physics but also makes students more confident in using these technologies.

Then, this method addresses two fundamental needs: on one hand, it offers more targeted and focused learning for medical students, and on the other, it promotes a deep understanding of the scientific phenomena underpinning many medical technologies. Additionally, it facilitates a smoother transition from theory to clinical practice, as students already learn how scientific concepts deeply affect their future professional practice.

The examples chosen by the teachers are not only aimed at understanding the subject through experience, but also at paving the way for future healthcare professionals who must use physics and statistics as essential tools for their work. The professional who can use these tools has long since replaced the figure of the doctor who could rely solely on personal experience and intuition.

In conclusion, the approach described is not only valid but strategically very effective, as

it creates a direct link between scientific disciplines – a subject commonly perceived as abstract and domain of a few scientists in laboratories – and the professional context in which the student will operate. According to this approach, each lesson can have multiple levels of understanding.

Moreover, students who choose a course that qualifies them for healthcare professions often come from educational backgrounds that do not always include physics and other scientific subjects as a part of their study.

This is especially true at Saint Camillus International University of Health Sciences where students come from a lot of different countries, cultures, and languages, showing how a narrative and intuitive system works better than a more theoretical approach.

This article proposes a teaching paradigm that uses a rigorous yet accessible presentation, even for those who have not previously studied scientific subjects in high school.

4. The Importance of Storytelling in Scientific Communication

Conventional teaching techniques for scientific dis-

ciplines commonly emphasize equations, or theoretical ideas. However, there is a growing body of evidence that suggests the integration of storytelling into academic teaching can significantly enhance the learning experience [2]. Storytelling is a key tool to bridge the gap between abstract concepts and real-world applications, making the material more accessible, relatable, and engaging for students.

Storytelling has long been recognized as one of the most powerful methods of communication. According to Bruner [3], narrative is a fundamental way through which humans make sense of the world. It provides a structure that helps people understand and remember information more effectively. Storytelling stimulates emotional responses and enhances memory retention by connecting the listener's prior knowledge with new content, which is crucial in the learning process. In the context of physics education, storytelling has the potential to transform dry scientific concepts into captivating narratives that not only engage students but also help them understand the relevance and applications of the subject. Research suggests that

storytelling can lead to a deeper understanding and retention of concepts because it allows students to contextualize the material within a coherent framework [4].

Scientific storytelling can take various forms, such as historical narratives, personal anecdotes, case studies, or hypothetical scenarios that illustrate key concepts. This method can make the learning experience more engaging by creating a context that relates the abstract theories of physics to the real world. For example, discussing the historical context in which Isaac Newton formulated his laws of motion can make these principles more vivid and relatable to students. Instead of presenting Newton's laws as mere equations, a lecture can delve into the story of Newton observing the falling apple and reflecting on the forces at play. A similar approach is used to introduce the laws of probability, using the story of Chevalier De Mere, his passion for gambling and the wise advice received by his friend Blaise Pascal.

The use of storytelling can also humanize the subject matter, which is often considered impersonal or intimidating. By sharing stories about the lives

of physicists and their struggles, educators can present physics as a dynamic, evolving field driven by curiosity and perseverance, thereby enhancing student engagement and motivation to learn.

As an example, the Snell's law, which describes the relationship between angles of incidence and refraction when a wave passes from one medium to another, can be successfully applied to the "lifeguard problem". Storytelling has the powerful ability to anchor a seemingly difficult concept in students' minds if it is explained through a story with which the students are familiar:

Imagine a lifeguard standing on a sunny beach, scanning the horizon when suddenly, they spot a swimmer struggling in the water some distance away. The swimmer isn't directly in front but off to the side, in a diagonal direction. The lifeguard knows that every second counts and must make a critical decision: what is the fastest way to reach the swimmer? Running on sand is much slower than swimming in the water, but they can't dive straight in; they need to find the quickest path. This is

where Snell's law, a principle usually used to describe how light bends as it passes from air to water, becomes a surprising hero. Just like light takes the path that gets it from one place to another in the least time, the lifeguard must find the exact spot on the shore to enter the water, minimizing the rescue time. By thinking like a beam of light and using Snell's law, the lifeguard can calculate the perfect point where the shift from running to swimming happens, ensuring they reach the struggling swimmer as quickly as possible. (Figure 1)

In this way, the laws of physics don't just explain the universe – they can save lives.

In conclusion, the integration of storytelling in physics lectures proved a promising approach to make science education more engaging, relatable, and effective. It leverages the natural human affinity for narratives to enhance understanding, retention, and enthusiasm for learning. By contextualizing abstract concepts within meaningful stories, educators can bridge the gap between theory and practice, making physics more accessible to students. As the educational

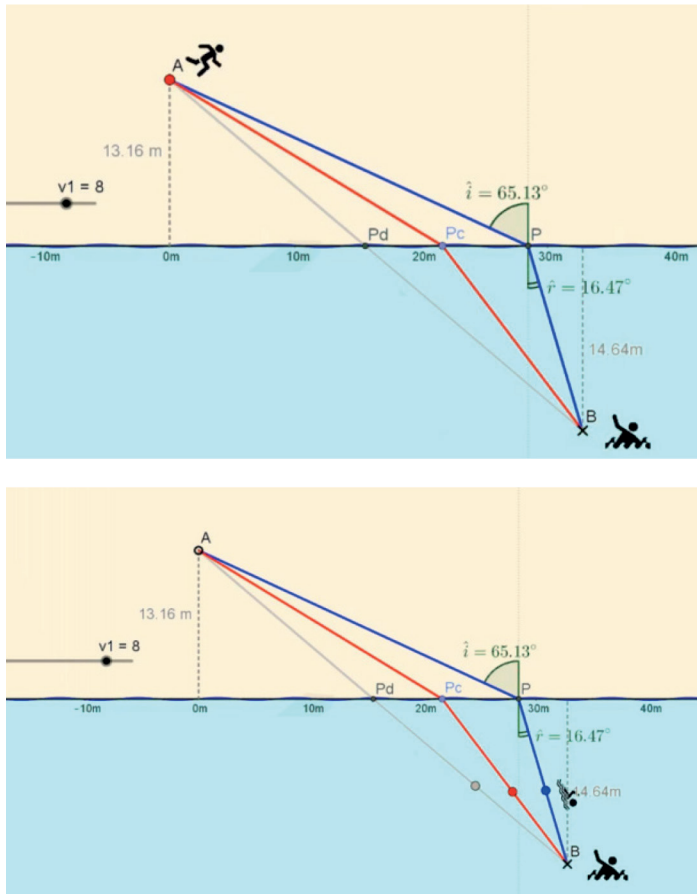


Figure 1. Using a familiar story can help students grasp challenging concepts as storytelling has a strong ability to make the information memorable. For instance, the Snell's Law can effectively be used to solve the "lifeguard problem" by demonstrating how angles of incidence and refraction are related when a wave moves from one medium to another.

landscape continues to evolve, adopting innovative methods like storytelling will be crucial in inspiring the next generation of scientists and thinkers.

5. Applied Physics

The word physics derives from the Greek "τὰ φυσικά", meaning "natural realities". True to its name, over its four centuries of existence, physics has provided a description of

natural phenomena. At their core, phenomena in life sciences are explained by the theories of physics, and every operating room shows how science and medicine are inseparable, offering the teacher countless practical examples. Frequency of the heartbeat, systemic arterial and venous blood pressure, pulmonary blood pressure, oxygen saturation and body temperature are typical physical quantities monitored routinely

in patients in the operating room, as well as the electrical potentials at the skin's surface, correlated with the physiological states of the heart (ECG), and the Bispectral Index (BIS), which monitors brain activity and provides an estimate of a patient's depth of anesthesia (Figure 2).

Our perception of reality is a mere physical process: sensory perceptions are nothing but electrical stimuli (all five sens-

es), and for example, movement in the static magnetic field of MRI scanners modifies them (metallic taste, phosphenes, tinnitus, tactile perceptions).

Moreover, citing again Professor Giorgio Parisi, physics is becoming wider and wider, and it contains many areas of knowledge that did not exist in the past or were not part of physics.

According to this view, the authors have given a more modern approach to the course of applied physics by introducing the basics of life science, which studies the physical principles governing living organisms, and medical physics: modern health technologies are presented, discussing the physical principles behind medical imaging (e.g., X-rays, MRI, CT scans), radiation therapy, ultrasound, and biomedical sensors.

6. Medical Statistics

Medical sciences largely rely on statistics for the collection, analysis, and interpretation of data. Statistics are essential for verifying scientific hypotheses and validating new discoveries. We can easily say that statistics play a key role in everyday physician decision-making: the diagnostic process is a pathway through different probabilities.

A basic knowledge of the underlying principles empowers the medical student of today, and the doctor of tomorrow, to read medical literature with a mind of their own, able to judge upon the credibility of a research, of a new drug, of a proposed surgical technique, and even to embrace a career where creating medical knowledge is an option on top of just consuming it. An example of involving students in descriptive statistics was to propose short surveys covering family, everyday life, or media reports aimed at both the professional and the citizen, such as those prepared for the Covid-19 reporting [5]. Similarly, in order to introduce the concept of multivariate analysis, workshops were held to discuss interaction and confounding in the analysis of health determinants.

7. Computer Science and the Interdisciplinary Approach

Medical technologies have profoundly transformed diagnosis, treatment, and patient management, making medicine more precise and efficient. To place the students into this rapidly evolving context, enabling them to manage new technologies, the integrated

course has been structured in a manner that involves an interdisciplinary approach, with physics, statistics, and computer science concepts seen as interconnected rather than separate disciplines.

An important focus in computer science is understanding how analog signals are transformed into digital signals, essential for using advanced medical technologies. In classes, practical teaching aids connect theoretical ideas by incorporating hands-on displays using stethoscopes, sphygmomanometers, oxymeters and thermometers, available in analog and/or digital designs. The use of these devices in class keeps the students' attention engaged, as they use these instruments for the first time in their lives, and they are eager to try them and to know how they work.

In this way, students better understand how signal sampling and quantisation concepts work since they have just seen in-action devices that monitor vital patient data such as temperature and blood pressure. Hence, the distinction between analog (that is, actually, the real world that follows the physics laws) and digital (that is what a computer can han-



Figure 2. Physical quantities monitored routinely in patients in the operating room.

dle) goes beyond theoretical computer science and directly influences diagnosis and patient care. Through statistical methods, noise in physiological signals can be minimized. For instance, filtering techniques remove artefacts from heart rate or blood pressure signals, allowing for cleaner data that reflects a patient's true condition. Moreover, probabilistic models and statistical inference allow AI systems to extract insights from sampled data, estimate unknown parameters, and calculate the likelihood of specific outcomes.

8. Conclusions

The three teaching subjects entrusted to the authors of this essay, *i.e.* physics, statis-

tics, and computer science, are characterised by a set of successive steps of abstraction that the student must carry out in order to properly understand the topics discussed in class. This is true for physics, since the students, in their first year, have great difficulty in superimposing what is studied in physics, even in mechanics, directly with the reality of the world around us. And it is even more true for both statistics, which deals with quantities and measurements that are not immediately traceable to concrete facts and properties for a young student, and for computer science, which makes virtualisation and abstraction its strong points.

In this framework narration through examples and

storytelling become the most effective teaching tools, since through them the teacher leads the students to be aware not merely of the solutions presented to them, but of the motivations that led researchers and technicians to find those solutions, making them become not only subjects of the presentation but active part and even main character of the process taking place in class.

Furthermore, the proposed interdisciplinary approach among computer science, physics, and statistics shows students how these fields work together to use diagnostic and therapeutic tools. Physics provides the theoretical foundation to understand biological signals' functioning and the

properties of materials in medical devices. Statistics assists in understanding data, allowing the transformation of this data into useful clinical observations. Computer science manages signals, physics explains their operation, and statistics aids in reaching credible conclusions to support clinical decisions based on solid scientific evidence.

By means of this method, students gain a deep knowledge of technology in healthcare, and approach the medical profession with

a thorough, interdisciplinary perspective. This equips them with advanced critical thinking and problem-solving skills, enabling them to adapt to diverse medical contexts, and address complex global health challenges, particularly in resource-constrained settings where innovative and interdisciplinary approaches are most needed. In developing countries, this approach could bridge knowledge gaps, empower local healthcare systems, and improve health outcomes by fostering new

generations of well-prepared practitioners.

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