



CHAPTER – 5

NALANDA TO NANOTECHNOLOGY - INDIA'S LEGACY OF INTERDISCIPLINARY SCHOLARSHIP

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1. Introduction: The Continuum of Knowledge in India

For a long time, people have hailed India as a country where ideas can flow freely in various areas, including science, technology, philosophy, literature, and more. Putting concepts together has been more significant than tearing them down in Indian philosophy's past. People now consider knowledge as one objective instead of a group of goals since this happened. Indian brains have always been unique because they can think creatively and logically at the same time. The oldest Vedic songs, for instance, used beautiful language to talk about strange notions about the world. Panini's methodical sutras used language with the same level of mathematical accuracy. Numerous people believe that studying numerous subjects at once leads to fresh ideas, but it's vital to realize that this way of thinking has deep cultural roots in India.

Vikramshila, Takshashila, and Nalanda are among well-known schools that use this method of teaching. In addition to offering specialized instruction, these institutions also fostered healthy intellectual ecosystems that facilitated the coexistence and growth of diverse information kinds.

Many intellectuals at Nalanda study Buddhism while also fighting about language, medicine, space, and logic. This was one of the many things that students at Takshashila studied. They learned a lot of subjects, like commerce, law, welding, and surgery. Students couldn't become experts in just one thing since they could talk to each other about what they were learning. They didn't do that. Instead, they sought for the building blocks and links that diverse types of information had in common. There is no doubt that professionals and students from China, Korea, Tibet, Mongolia, and Southeast Asia desire to go to these schools. This is why people from all over the world flocked to India to learn.

There were more than one group doing this kind of intellectual endeavor. Indian philosophers show in their writings that they can connect things that don't seem to belong together. Aryabhata believed that astronomy was a fundamental part of math. Charaka's philosophical beliefs on how the mind and body work helped people stay healthy. Sushruta's medical writings were full of practical advice and insightful views about life. The Mahabharata and the Ramayana are epic stories that mix real events from history with myths, politics, morals, and religious ideals. This is an excellent example of how to mix different kinds of writing and topics without any difficulties. Indian wisdom has always strived to look at the world and ourselves from many angles instead of breaking things down.

In the twenty-first century, India is forging a name for itself in the scientific and technical world by building on its tradition of combining knowledge. India is a leader in many fields, including biotechnology, AI, nanotechnology, and space science. These changes don't happen because one profession works on its own; they happen because professionals from numerous professions work together to research them. Computer science, physics, engineering, materials science, and systems management are all growing better. The Indian Space Research Organization (ISRO) is a fantastic example of this. Innovations in biotechnology and nanotechnology must integrate science, engineering, biology, and health. India has been doing intellectual research for hundreds of years, using both old and new instruments and methodologies.

The purpose of this segment is to convey how magnificent this trip was from the busy towns of Nalanda to India's sophisticated, cutting-edge labs. Indian research gets people from a variety of various fields to work together. This is an interesting way to connect the past to the present. The history of Indian knowledge systems demonstrates that novel concepts and discoveries have never emerged from a singular discipline in isolation, but rather from the interaction between various fields. We know that this method of thinking is very old in India's culture and history. Experts all across the world are starting to believe that working with experts from other areas is the best way to solve hard challenges.

2. Nalanda and the Ancient Universities: Cradle of Interdisciplinary Thought

Nalanda is a great example of India's heritage of culture and learning. The Gupta dynasty ruled from the fifth century CE to the present day. They constructed Nalanda University. It was one of the top places to learn in the world for roughly 700 years. At its heyday, Nalanda had more than 10,000 students and 2,000 teachers. The school taught more than just Buddhism. The school taught a lot of different subjects, like astronomy, linguistics, algebra, philosophy, logic, architecture, the arts, and medicine. People said that Nalanda possessed at least two libraries with volumes on every subject you could think of. People from all around Asia came to it since it featured so many learning tools.

Nalanda was just like any other place. People said that Taxila, which was founded in the sixth century BCE, was a fantastic place to learn. People currently conceive of Takshashila as one group, although it wasn't. It seemed more like a school or department where famous professors might give presentations on some topics. Chanakya, also known as Kautilya, taught these concepts regarding politics and government. He wrote about these principles in the Arthashastra, which is the most important texts on strategy and political economy. Jivaka, Magadha's royal doctor, learnt how to do surgery and medicine there. I appreciate how this shows that kids learn in different ways.

King Dharmapala of the Pala kingdom built Vikramshila in the seventh century. People also learned here. A lot of people heard about it because it was about Buddhist theory, logic, and tantra. It also improved other areas of study, such as languages and astronomy. Vikramshila's work, along with that of Nalanda and Odantapuri, played a big component of keeping India at the top of higher education in the globe.

Different schools teach different subjects in different ways. Indian philosophy holds that all knowledge is interconnected. It's apparent that schools didn't have separate rooms for each subject because they weren't built that way. If a doctor wants to be better, they should learn how to think and act morally. To understand the universe, a philosopher needs to study science. After discussing about philosophy, we changed our opinions about health, ethics, and life in general. Advances in math also had a huge effect on the math used in astronomy. Scholars from other fields made crucial contributions because they casually shared their ideas, which led to new ways of thinking.

It was exciting to think that there might be more organizations like this in other regions of the world. Teachers and students from China, Korea, Tibet, Mongolia, and Southeast Asia poured into India, turning Nalanda and its sister schools into venues where people from all over the world could share their ideas. Xuanzang and Yijing, two famous Chinese travelers, journeyed to Nalanda for many years to learn about Buddhism, Indian arts and sciences, and other things. They learned more about the many educated people who lived in India as they brought back Chinese copies of Buddhist books. Their experiences indicate that these clubs are welcoming to people from all walks of life, which is incredibly essential. These exchanges had an effect on educational traditions that reached far beyond India. Because of this, news spread swiftly over the world.

In the 1200s, invaders devastated Nalanda and its homes and documents. It was the end of a thousand years of fighting in the mind. People stated that the vast library had been on fire for months, destroying one of the world's

biggest stores of information. The principles underpinning transdisciplinary study persisted on long after the classes were completed, though. Ideas in South and East Asia were influenced by spoken, written, and monastic works. The fact that India's universities are still having an influence show how much the country values education and global awareness.

You may still apply a lot of what the schools in Vikramshila, Takshashila, and Nalanda taught. People from all over the world used to meet together and converse with each other more than a thousand years ago. They wanted to accomplish the same thing for other fields of study. Schools today want students from diverse areas to work together so they may be more creative. These antique Indian buildings reveal that people in India have been striving for universal truths for a long time. They were not only schools; they were also places where individuals could discuss their opinions, where moral principles could be applied to healthcare, and where intellectual and scientific ideas could be brought together.

Nalanda and other universities from the middle Ages reveal that Indians thought of knowledge as a search for general truths. This means that they are more than merely important artifacts from the past. Their narrative shows how earnest study may emerge when people from diverse backgrounds and points of view communicate about important matters. There is no such thing as a lesson that doesn't help.

3. Knowledge across Disciplines: Ancient Indian Contributions to Science and Technology

India's early scientific and technological accomplishments demonstrate that its people were highly intelligent and did not distinguish between philosophy and science or between theory and practice. Ancient Indian thinkers thought that the search for knowledge was a broad endeavor that included all areas of study and saw them as connected rather than separate. Mathematics has impacted astronomy, ethics and philosophy have shaped medicine, and the domains of spirituality, the arts, and science have engaged with one another. This combination technique led to the creation of a new and useful body of knowledge that drew on ideas from different times and places.

3.1 Mathematics is the basis of scientific study.

India has a long tradition of doing well in math. The addition of place value, the decimal system, and the zero to the number line changed the way many people thought about numbers and math. Aryabhata figured out the number π with amazing accuracy and wrote about the theory in the fifth century CE that the globe rotated around its axis. This revolutionary idea linked math and science directly. Brahmagupta showed a high level of reasoning in the seventh century by coming up with systematic ways to solve quadratic equations and work with negative integers. These mathematical innovations had effects that went far beyond theory; they affected fields as different as astronomy, architecture, and economics. They gave people the tools they needed to come up with new ideas that might be used in real life.

3.2 Making a cosmic map with astronomy

India created astronomy by logically combining math and observation. Aryabhata's *Aryabhatiya* introduced trigonometric functions that were very useful in celestial arithmetic. It also included models of how planets move and how eclipses happen that didn't use myths. Varahamihira's huge book, the *Brihat Samhita*, was more than just basic astronomy. His study included astronomy, geography, meteorology, and even cultural practices like astrology and omens. Based on this summary, it is obvious that Indian astronomy was not a separate field of study, but rather one that was connected to many others. Eventually, the Islamic world was able to read Indian astrological writings that had been translated into Persian and Arabic. They moved to the Middle East, where they had an effect on Islamic academics like Al-Khwarizmi and Al-Biruni, who then had an effect on European philosophers throughout the Renaissance.

3.3 The Medical Component of Life Science

The Ayurveda system is another great example of a system that has a lot of knowledge. The *Charaka Samhita* and the *Sushruta Samhita* are two old texts that talk about Ayurveda. They stress that people should think about their surroundings as well as their physical and emotional health. Charaka laid the groundwork for internal medicine by stressing the importance of diet, lifestyle, and preventive care. Sushruta's descriptions of surgical tools and methods, on the other hand, were spot on. His stories of having rhinoplasty and cataract surgery show how good the medical care is in India. But traditional Indian medicine was much more than a book. It was also based on theory and morality, with a focus on the healer's duty to keep everything in balance and harmony. The combination of scientific knowledge and moral ideals turned Ayurveda from a medical practice into a way of life.

3.4 The technological culture of engineering and metallurgy

India's skill in engineering and metalworking is a good example of how scientific information may be used in real life. The iconic iron pillar in Delhi shows how far metallurgy has come as it has been rust-free for more than 1,600 years. Metallurgists in ancient India made wootz steel, which was quite popular and sold in Europe and West Asia since it was so good.

They also came up with a way to separate zinc from other metals. Engineers, mathematicians, and artists all worked together to build the temples' tall shikharas and detailed sculptures. These technological advances show that Indian knowledge systems were based on a complete view of the universe. Their cultural and religious surroundings weren't outside of them; they were a part of who they were.

3.5 Ways to learn through the arts and literature

In India, literature and the arts were never thought of as apart from science and philosophy. The Ramayana and the Mahabharata are two great examples of epics that tell stories about politics, morals, the universe, and the afterlife. People say that Bharata's Natya Shastra is just a book about drama, but it's not. It also looks at art, music theory, psychology, and acoustics. People thought of the performing arts as both fun and serious academic subjects (shastras) with set rules. This shows that in Indian culture, reason and creativity were not considered as opposites, but as things that worked well together.

An Internet Database: These achievements illustrate a paradigm shift towards perceiving knowledge as an interconnected web of disciplines rather than a mere aggregation of independent fields. Math had an effect on astronomy, philosophy had an effect on medicine, and faith and art had an effect on technology. Someone in India's intellectual elite a long time ago said that different fields should work together. This is where the foundation for modern interdisciplinary work was created. Indian academics have been using it for a long time before the name was made up. What they left behind still has an effect on schooling today.

4. Colonial Encounter and the Reawakening of Indian Scholarship

When India became a colony in the 18th and 19th centuries, it changed the way people thought in a fundamental way. Changes in society and politics over the last several hundred years have made it tougher for conventional forms of teaching, such those used in gurukuls, madrasas, and schools run by churches and monasteries, to succeed. The British colonial authority pushed these native institutions even farther to the side by putting in place a new school system that was more about satisfying the empire's bureaucratic needs than stimulating intellectual exploration.

The Minute on Indian Education, authored by Thomas Babington Macaulay in 1835, is the most important source that indicates this transformation. It made English education more important than Sanskrit, Persian, and other native languages. Macaulay remarked that the purpose of education should be to create "a class of people who are Indian in blood and colour but English in tastes, morals, opinions, and intellect." This technique made English the main language of instruction, which pushed aside India's traditional learning traditions. Because of this, India's intellectual history was very different from the present colonial educational system. The main purpose was to teach individuals how to be clerks, translators, and low-level officials for the colonial government. Because of this, there weren't many chances for people to study on their own or come up with new ideas within their own cultures.

This disturbance, in a bizarre way, also started a fresh mental awakening. A collection of Indian thinkers and reformers came of age in the 1800s. They saw that India's own ways of learning needed to be brought back and that colonial education had flaws. Raja Ram Mohan Roy, who is widely called the father of the modern Indian renaissance, fought for rational and scientific education while also emphasizing on India's rich religious and philosophical background. Ishwar Chandra Vidyasagar, on the other hand, was particularly interested in classical Sanskrit education and desired to make society better, especially when it came to women's education and widows being married again. Swami Vivekananda talked to people from all around the world during the Parliament of Religions in Chicago in 1893. He advised Indians to embrace modern science and technology and reminded everyone of how deep Indian thought is. These reformers showed how to maintain and keep India's cultural history alive while simultaneously accepting modernity in their work.

In the late 1800s, the institutions that support modern Indian science were also built up. Dr. Mahendra Lal Sircar created the Indian Association for the Cultivation of Science (IACS) in Calcutta in 1876. This was a major step in the right direction. This was India's first university that only taught science. It proved that it wanted to learn for its own purpose, not only for helpful colonial reasons. This institution made it possible for Sir C.V. Raman to

discover that light scatters after many years. He won the Nobel Prize in 1930 for this discovery, which put Indian science on the world scene.

In 1857, modern universities emerged in Calcutta, Bombay, and Madras. This helped a new group of Indian scientists and thinkers grow. These institutions began by training administrators in a colonial style, but they eventually produced ground-breaking scholars who merged Western and indigenous views.

India's scientific ingenuity and resilience against colonialism were further exemplified by significant personal accomplishments during this period. Jagadish Chandra Bose's ground-breaking work in plant physiology goes against strict Western science categories by proving that plants react in the same way to things that animals do. He also made key contributions to wireless communication, which helped future technologies move forward. A lot of people say that Prafulla Chandra Ray is the "founder" of contemporary Indian chemistry. He connected science and nation-building by creating India's first chemical company and achieving advancements in chemical research. Satyendra Nath Bose and Albert Einstein came up with the ideas of "bosons" and the basics of quantum statistics. These concepts continue to influence contemporary physics. Even though these experts were well knowledgeable about Indian intellectual traditions, they were receptive to modern scientific approaches and added to what was already known. This is what interdisciplinary entails.

Colonialism unintentionally generated a counter current of new ideas and rebirth in India to stop intellectual freedom. Synthesis was a key element of the intellectual ferment of the time. This meant that Indian scientists and philosophers thought thoroughly about Western science and philosophy while also using their own ideas. This mix not only maintained some portions of traditional knowledge alive, but it also allowed India a chance to take part in modern science on its own terms.

In this way, the colonial conference was both a story of fighting back and staying strong. A new generation of smart people came after the chaos. They maintained India's intellectual tradition alive and made it possible for the scientific and educational rebirth of the 20th century.

5. From Independence to Innovation: India's Scientific Renaissance

The year 1947 saw the start of a new era in politics and ideals for India. Being a colony hurt India's scientific infrastructure, and the country required a brave plan for innovation and knowledge to get back on its feet. Jawaharlal Nehru, India's first prime minister, came up with this idea and pushed for the development of a "scientific temper." Nehru believed that science encompassed more than mere research and technology. He thought it was about getting people to think, ask questions, and assist society move forward. When India got independence, it spent a lot of money on creating new schools for research, applied science, and higher education. This was done to set the stage for a new era of science.

5.1 Making Institutions

Setting up organizations that might assist people learn and grow their skills in a lot of different areas was one of the first things that needed to be done. The Indian Institutes of Technology (IITs) have evolved significantly since they established in the 1950s. They are now known all over the world as centers for engineering and technology. The Council for Scientific and Industrial Research (CSIR) also established up a network of labs for applied science all around the state. The Bhabha Atomic Research Center (BARC) led research into nuclear energy, while the Indian Space Research Organization (ISRO) became a symbol of freedom and inventiveness in space science. Homi J. Bhabha, a visionary, headed both of them. Sociologists collaborate with technologists, physicists engage with engineers, and biologists partner with chemists. The purpose of these groups was to get people from different fields to work together. This mode of thought was like the old Nalanda, where no one domain of knowledge stood on its own.

5.2 Scientific breakthroughs

Having their own India's scientific effort got off to a terrific start right away, and it had tremendous results in several fields:

a) **Space Science:** The successful landing of Chandrayaan-3 in 2023, the success of the Mars Orbiter Mission (Mangalyaan, 2013), and ISRO's straightforward launch of the Aryabhata satellite in 1975 are all examples of fresh ideas that emerge from many sectors. People with skills in astrophysics, computer programming, materials science, and flight engineering had to work together for each trip.

b) **Nuclear Science:** Homi Bhabha's notion for safe nuclear energy, which merged physics, chemistry, and engineering, was the start of India's nuclear program. After that, India was able to offer both strategic security and energy.

c) **Agriculture:** The Green Revolution of the 1960s and 1970s, directed by M.S. Swaminathan, showed how genetics, ecology, and social sciences might be combined to solve one of India's biggest problems: food security. India used to not have enough food, but today it does because it grows high-yield crops, has better drainage, and uses scientific fertilizer.

d) **Information technology:** India's emergence to become a major IT power in the 1990s illustrated how computer science might be employed with management, economics, and international trade. Indian IT workers are becoming tremendously vital to growth all across the world, and the countries own businesses are pushing digital revolution.

5.3 How Multidisciplinary Frontiers Have Expanded

During the late 20th and early 21st centuries, India became more open to new sectors that were naturally cross-disciplinary. The barriers between traditional fields started to dissolve in biotechnology, artificial intelligence, green energy, and nanotechnology. Nanotechnology was the best example of how India's idea of all-around education works. Physics (on the structure of atoms), chemistry (on nanoreactions and synthesis), biology (on nanomedicine and drug transport), and engineering (on nanomaterials and nanoelectronics) all need to work together in nanoscience.

The country is a prominent player in this field thanks to its universities, IITs, and research facilities like the Institute of Nano Science and Technology in Mohali and the National Center for Nanoscience and Nanotechnology in Mumbai. Scientists in India work with some of the top research teams in the world, write a lot of articles that are published in foreign publications, and make technologies that help people in the area and around the world.

5.4 Nanotechnology Case Studies

India still has a strong multidisciplinary spirit when it comes to modern studies, as these cases show:

a) **Nanomedicine:** Researchers in India are researching on ways to use nanoparticles to deliver drugs to help cure cancer. This will make it possible to give more individualized care with fewer negative effects.

b) **Agronanotechnology:** Scientists are testing nanobiosensors and nanofertilizers to see whether they can boost agricultural yields without harming the environment. This is done by using new technologies to address long-standing worries about food security.

c) **Energy:** Nanocoatings help India reach its green energy ambitions and keep its international climate promises by making solar cells last longer and operate better.

5.5 Keeping Your Word

These instances show that India's successes today are not merely the consequence of modern needs, but are part of a long-standing intellectual tradition. Scientist's today work together from different professions to solve big problems, just like Aryabhata did when he integrated math and science and Sushruta did when he mixed philosophy and medicine. So, the resurgence of Indian science after independence reveals both the resuscitation of institutions and the revival of a mode of thinking that perceives knowledge as a whole.

India has proved that creativity flourishes when borders are broken by constructing great institutions, setting records in many scientific domains, and making breakthrough discoveries in subjects like nanotechnology that cross disciplines. So, since India became free, it has made sure that it stays an active contributor to world knowledge by transferring the deep learning legacy of civilization into the present day.

6. Conclusion – India's Timeless Legacy of Interdisciplinary Knowledge

You can see how knowledge is connected if you look back to Nalanda, where nanotechnology was born. This is an important idea in India's long history of thought. For thousands of years, Indian scientists, institutions, and philosophers have realized that working together across fields is better than working alone. This thought still has an impact on India's long-standing cultural contributions to the world's knowledge today.

In the past, holistic schools like Nalanda, Takshashila, and Vikramshila taught thinkers how the arts, sciences, and health might all work together in a good way. The medical, astrological, metallurgical, and mathematical achievements of the ancient world were not just impressive technological accomplishments but also components of

a broader worldview that integrated ethics and science, as well as theory and practice. The scientific correctness in writing and the arts illustrates that creativity and reason may coexist without conflict.

Colonial forces intended to stop this practice and set up a better manner to teach when they got involved. But the schism itself led to a rebirth, with scientists and reformers improving India's intellectual reputation. Raja Ram Mohan Roy, Jagadish Chandra Bose, Prafulla Chandra Ray, and S.N. Bose proved that India could take ideas from other countries and still be its own country by putting together ancient and new scientific facts.

The CSIR, ISRO, BARC, and IITs are only a few of the study institutions that were created up after India became independent. They have all preserved the "scientific temper" that Nehru admired. In the past few years, people from different areas working together has led to remarkable things in computer science, nuclear power, space research, and farming. India has come up with new biotech, nanotech, and green energy approaches that have kept some of Nalanda's work alive in labs today.

The scientific rebirth in India doesn't mean rejecting tradition; it means building on it. India is an excellent illustration of how far research into humans may go. Many areas of study, from space science to the old sutras, work together to find the truth and serve people.

References

1. Kadaba, M. K. M., Aithal, P. S., & K. S., K. S. (2023). Ancient Indian universities “institutional repository” to create global visibility for learning and research – Review based analysis. *International Journal of Philosophy and Languages (IJPL)*, 2(2), 115–128. <https://ssrn.com/abstract=4770796>
2. The Hindu. (2024, January 21). Nalanda University: An ancient centre of learning. *The Hindu*. <https://www.thehindu.com/news/national/nalanda-university-an-ancient-centre-of-learning/article68321755.ece>
3. Nalanda University. (n.d.). History and revival. Nalanda University. <https://nalandauniv.edu.in/about-nalanda/history-and-revival/>
4. Indiafirst Life. (n.d.). The rich history of Nalanda University. Indiafirst Life Insurance. <https://www.indiafirstlife.com/indias-firsts/places-and-people/rich-history-of-nalanda-university>