

# Midterm - INTD262

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## 1 Unit 0

1. Offer some reasons why the Spaniards created the *virreynatos* of Nueva España and Perú in their respective locations, with Tenochtitlan and Lima as capital cities.

When it came to Nueva España, there were already certain systems in place. The easy access to resources also gave it the potential for economic prosperity. Lima's coastal location made it easier to access trade and communication with Spain.

2. Was there a link between the introduction of capitalism and the growth of scientific activity in Latin America, or did the growth of modern science precede capitalism?  
the growth of science and the capitalism developed with one another while scientific activity definitely arose before the full emergence of capitalism capitalist economies would eventually come to rely on science to support industrial growth.

3. Given the definition of *peripheral* scientific activity in the Introduction, can you give an example of the creating and transmission of scientific results from the periphery to the center of science?

The indigenous of the Andean highlands used bark from the Cinchona tree to treat ailments and fevers. When Spanish colonizers arrived in South America they learned of its medicinal properties, and it came to be used as the main treatment of Malaria for quite some time. A gigantic breakthrough in medical science at the time.

4. Give some examples of *pseudo-scientific* beliefs regarding mythical places the colonials sought in the New World.  
Places like El dorado the city of gold and myths like the fountain of youth were believed to actually exist and some colonists actually sought out these things for their own personal gain.

### 5. Multiple Choice - Nahua scientific activity, first period

- (a) Which of the following were media through which inhabitants of the Mexica empire recorded scientific observations about the natural world?

- A: *Axolotl* (codices) and *huitzitzilin* (paintings, stelae)
- B: *Amoxtl* (codices) and *tlacuillol* (paintings, stelae)
- C: *Tomatl* (plume, writing tool) and *altepetl* (city-state)
- D: *Quetzal* (plume, writing tool) and *huitzitzilin* (city-state)

Answer: B

- (b) Using information from *Historia natural y moral de las Indias* (de Acosta), *Historia general y natural de las Indias* (Oviedo), *Décadas del Nuevo Mundo* (Anglería), *Historia de Nueva España* (Hernández), match the European story to the indigenous story or piece of knowledge.

- (1): Ponce de León and the Fountain of Youth
- (2): Griffins so large they capture people and calves as prey, with feathers as large as an arm.
- (3): "A fountain running with hot water and as the water runs it turns to stone."
- (4): "fish that as they leave the water turn into butterflies."
- (5): "...a monstrous animal, with the face of a fox, a tail of a cercopithecus, ears of a bat, human hands, and feet of a monkey." Carries young on the belly.

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- A: A flying fish
  - B: A condor
  - C: A mercury mine
  - D: The belief about a certain river among the Lucayo and Carib indigenous
  - E: The Mexican opossum

## 6. Nahua scientific activity, second period

- (a) Father Bernardino de Sahagún translates from Nahuatl a description of a “tiger” that the indigenous say can do the following: (a) see small things even though there is fog or darkness (b) creates sounds “through the air” to intimidate hunters. What does this writing tell us about the Nahua understanding of physics? He understands that some animals have enhanced vision and that natural phenomena can have effects on vision and perception. He is likely referring to the tiger’s growl when he mentions the sound through air. The phrase through the air suggests an intermediate understanding of sound waves.
- (b) Why did the Spaniards and Aztec believe that hummingbirds were connected to immortality? While Spaniards saw hummingbirds in the light of Christianity as a symbol for eternal life, Aztecs believed it was the reincarnation of fallen warriors and that hummingbirds represented their God of War.

7. Suppose the following statement is given: “If someone was born between 1945 and 1991, then they have Strontium-90 in their bones.” Which of the following statements is *deductively valid*?

- Adam was born in 1963. Therefore, Adam has Strontium-90 in his bones **This one.**
- Eve has Strontium-90 in her bones. Therefore, Eve was born between 1945 and 1991.

8. Consider the following passage from Chapter 1 of *The Scientific Attitude*:

In 1981, the state of Arkansas passed Act 590, which required that public school teachers give “balanced treatment” to “creation science” and “evolution science” in the biology classroom. It is clear from the act that religious reasons were not to be offered as support for the truth of creation science, for this would violate federal law. Instead, the curriculum was expected to concentrate only on the “scientific evidence” for creation science. But was there any? And, how precisely was creation science different from creationism?

Explain the arguments used in court to thwart Act 590 the following year.

Creation science and evolution were at the time essentially only theories. They lacked stone cold evidence and any scientific backing. The case also highlighted the importance of secularization in schools.

9. Thomas Kuhn wrote a famous book entitled *The Structure of Scientific Revolutions* (1962). Rather than describing science as a global accumulation of progress, he argues that, sociologically, scientists move between periods of “puzzle-solving” within an accepted framework and revolution triggered by unavoidable experimental anomalies. (a) Give one example of a scientific revolution, and note the anomaly. (b) Do you think that the colonization of Nueva España triggered a scientific revolution?

The Copernican revolution of the 16th century was a major change in the way we understand our standing in the solar system. We switched from geocentric (believing we were at the center of the universe and the sun moved around us) to Heliocentric which is the opposite. The anomaly being that the retrograde movements of planets like Mars were unexplainable. I think in terms of the new world, science began to move a lot faster after the establishment of Nueva España. While it did not have gigantic breakthroughs in the beginning, more scientific activity definitely began to pick up.

10. Fill in Tab. 1 below, using Fig. 1.

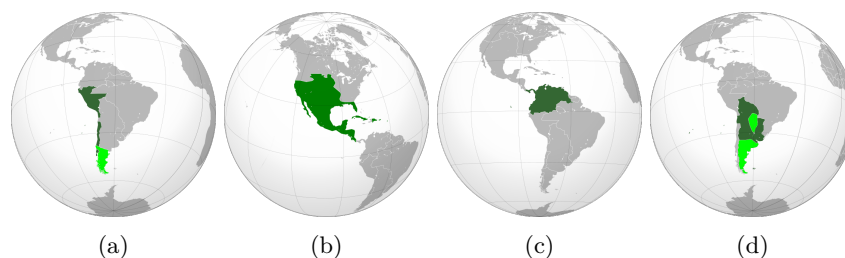


Figure 1: Maps depicting *virreynatos* in Latin America, 17th and 18th centuries.

Map in Fig. 1 (a-d)	<i>Virreinato</i>	Capital
B	<i>Nueva España</i>	Mexico city
C	<i>Nueva Granada</i>	santa fe
D	<i>Río de la Plata</i>	buenos aires
A	<i>Perú</i>	Lima

Table 1: Fill in the missing information.

11. Consider the library of José Ignacio Bartolache. (a) What does the distribution of texts in this library tell us about the scientific attitude of Latin Americans in the 18th Century? (b) What other scientific items did Bartolache own, and what clues does this add to our picture of the scientific attitude in that time and place? (c) Considering these collections were built before 1760, draw a comparison to the state of science in the American colonies (later the United States).

We know that Bartolache has math astronomy philosophy and history texts and that they were from all over the world. This tells us that he among other in the scientific community were not only interested in science but heavily influenced by transnational ideology. The instruments he acquired also tell us that he is interested in applicable science.

## 2 Unit 1

1. In Chapter 2 of *The Scientific Attitude*, we encounter the following quote:

Samir Okasha recounts the example of John Couch Adams and Urbain Le Verrier ... they were working (independently) within the Newtonian paradigm and noticed a slight perturbation in the orbit of the planet Uranus.

Newton's Law of Gravity predicts perfectly elliptical orbits for the planets, with no perturbations. Was the law of gravity therefore *falsified*? What solved the problem in the end?

Instead of throwing Newton's law out right away they opted to investigate further, they hypothesized that instead of a flaw in Newton's law the orbit was being disrupted by an undiscovered planet. In the end they calculated the location of this unknown planet and ended up discovering Neptune.

2. **Bode's Law** was an attempted mathematical explanation of the planetary orbits. Bode's sequence was the pattern 0, 3, 6, 12, 24, ..., plus 4 to each, then divide the sequence by 10. The result is 0.4, 0.7, 1.0, 1.6, 2.8, 5.2, 10.0, 19.6, 38.8, 77.2, ... . At the time (1772), the radii of the planets from the Sun were 0.387, 0.723, 1.0, 1.524, 5.203, 9.539. Nine years later, Uranus was discovered at 19.18. Twenty years later, the asteroid belt between Mars and Jupiter was discovered at 2.77. Did Bode's Law become a scientific fact because it fit the data?

It is not recognized as a scientific principle simply for the fact that it is only applicable in one scenario and is not grounded in any scientific theorization. It is recognized as a science artifact.

3. In 1761, Judge Francisco Javier Gamboa created a set of legal and scientific studies that were meant to reform the mining industry, to make it more efficient. Recall some scientific results that he shared within his *Comentarios a las ordenanzas de minas*. What chemicometallurgical technique, important for ore extraction, did he share with The Crown? What institutions did he suggest creating?

One of the biggest contributions he made was his mercury amalgamation improvement in order to pull more metal from the ore they were mining, he also suggested institutions he would hope progress the scientific attitude in Nueva Espana, Mining schools to create more miners and research institutions that focused specifically on mining to improve the industry.

4. *El Real Seminario de Minería* was created by Joaquín Velázquez de León, Fausto de Elhúyar, and others. However, several factors might have driven it to bankruptcy. Describe the Mexican efforts to preserve it.

Economic instability was one of the key factors that led to bankruptcy. It relied on mining revenue to continue operation and often couldn't keep up. War also drove resources and money out of things like education to better provide for war effort. Things like government involvement, international support and a call for education reform were all efforts to sustain the Seminar.

5. What are the two tenets of the scientific attitude, or ethos, according to the author of *The Scientific Attitude*?  
Skepticism and openness to change are the two foundations for a prosperous scientific attitude.

6. Recall the story of Ignaz Semmelweis and antiseptic handwashing in maternity wards. Discuss how the scientific attitude was applied in this situation.

He noticed that the high mortality rate was a direct consequence of the poor hygiene practices in the maternity words. He implemented a strict handwashing protocol as he thought that might fix the problem. Even though he was doubted by many he continued with his hypothesis and affected many health outcomes.

7. Recall the story of the false discovery of cold fusion. (a) Discuss how the scientific attitude was not applied in this situation. (b) Now select a piece of science from Latin American history that we have encountered thus far, and apply the criteria of the scientific attitude to it.

They were too excited to have possibly made a breakthrough. They lacked skepticism and resisted any criticisms and were dead set on making scientific discovery.

### 3 Unit 2

1. (a) In what viceroyalty (Fig. 1) was the city of Santa Fe de Bogotá? (b) Discuss the scientific implications of the “half century-long polemic on Copernican theories, which started in 1773 between José Celestino Mutis and the Dominican Congregation of Santa Fe de Bogotá. (c) In 1783, the Expedición Botánica began in Santa Fe. What were some of its goals and achievements?

The city of Santa Fe de Bogota was located in the viceroyalty of Nueva Granada. the polemic brought the science community closer and sparked way more debate from differing viewpoints which had many implications for future research. The Expedicion Botanica aimed to catalog and classify different plant species of Nueva Granada. It also laid the groundwork for other institutions.

2. (a) In what viceroyalty (Fig. 1) was the city of Caracas? (b) In 1767, the Jesuit order was expelled from the Spanish colonies. The Dominican order recovered authority over some colleges and universities. What was the implication for science?

The city of Caracas was also located in the viceroyalty of Nueva Granada.

While this now meant that theology would be prioritized over other studies there was a shift in focus on education.

3. What scientific publication was created by José Celestino Mutis?

A series of Botanical illustrations and a catalog of botanical species in Nueva Granada. Flora de Nueva Granada

4. Evaluate the logical truth of this claim: “anti-vaccination campaigns do not have the scientific attitude, therefore these are not scientific endeavors.”

If there are already signs of bad side effects from a certain vaccination an anti-vax campaign does not have to precede with the scientific attitude.

5. Discuss one example we have encountered from our scientific history that should count as science, even though it has not traditionally been considered scientific.

In class we discussed in our small groups family remedies that are used to cure certain sicknesses or temporary conditions. While they aren't professionally tested, they are scientific nonetheless.

6. In Chapter 3 of *Science in Latin America*, we encounter the following quote:

*La Universidad Gregoriana* in Quito alone had “seventy-one foreign professors teaching at the university ... Native professors were twenty-one, of whom five were from Loja, four from Quito, three from Guayas, three from Cuenca, three from Riobamba, two from Ibarra, and one from Ambato.” ... As a consequence, it is not strange that in a center of cultural ferment such as Quito, intellectual Jesuits were most closely linked to the Franco-Spanish geodetic mission directed by La Condamine and Jorge Juan.

- (a) What scientific transition began to take place as a result of the interaction between foreign and Ecuadorian professors? (b) What can we infer about the ratio of the native professors at the university? (c) Consider Father Fransisco Javier Aguilar, who taught physics and mathematics at Universidad Gregoriana. He taught no less than five world systems, and focused on three: Ptolemaic, Copernican, and Tyconic. What distinguished these?

7. In 1767, Mutis published *Reflexiones sobre el sistema tyconico*. (a) What were the main points of this publication? (b) Was it considered controversial?

The point of this publication was to reject the Copernican heliocentric model in defense of the Tyconic model. It was controversial because it rejected the heliocentric model just as it was beginning to gain traction.

8. When Joaquín Velázquez de León and José de Gálvez arrived in Baja California, they remained there for three years. (a) What types of measurements did they make? (b) How did this improve local knowledge of Nueva España? (c) Velázquez de León communicated with Chappe d’Auteroche that he would help with the Venus transit measurements, and d’Auteroche suggested that Velázquez de León remain in Real de Santa Ana, while

d'Aueroche would work in San José del Cabo. What happened as a result?

9. What was notable about the explorations of José Sanchez Labrador?

He did some of the first South American ethnographic studies and contributed heavily towards natural history with a focus on botany and zoology.

## 4 Applications, Mayan and Incan Number Systems

1. Work out the following exercises *using the Mayan system*.

(a)  $365 + 365 =$

$$365 = 18 \times 20 + 5$$

$$730 = 36 \times 20 + 10$$

(b)  $1024 - 512 =$

$$1024 = 2 \times 400 + 12 \times 20 + 4$$

$$512 = 1 \times 400 + 5 \times 20 + 12$$

2. Work out the following exercises *using the Incan quipu*:

(a)  $512 + 256 =$

(b)  $365 - 67 =$

3. Suppose we are looking for a set of trees tall enough to supply sixteen four-meter beams. Using the Mayan system, create a calculation showing that the total number of beams is sixty-four.

4. Suppose you have six terrace plots in the Andean mountains to use to survive. You and your cohort of fellow Incans decide to grow potatoes and quinoa. Quinoa actually do better at higher altitudes than potatoes. So the plan is to use the two lowest terraces for potatoes, and the upper four for quinoa. Each terrace is 30 meters by 5 meters. A potato plant requires a 0.2 meter by 0.2 meter patch, and a quinoa plant requires a 0.3 meter by 0.3 meter patch. How many potato plants and how many quinoa plants can you plant? Store the results in a diagram of quipu knot system.

## 5 Modern Science in Latin America - Gamma Ray Astrophysics

1. What is a gamma-ray?

- A: A charged particle with mass
  - B: A neutral particle with mass
  - C: A quantum of light
  - D: A radio wave
- Correct answer: C

2. What was the purpose of the Milagro experiment?

- A: To observe the direction of incoming gamma-rays
- B: To observe the energy of incoming gamma-rays
- C: To observe the direction and energy of incoming gamma-rays
- D: To observe the charge of incoming gamma-rays

Correct Answer: C

3. What upgrades to the Milagro concept were made that produced the HAWC design?

- A: Using oil instead of water as the detection medium
- B: Increasing the amount of water tanks to improve the sensitivity
- C: Moving the tanks to a higher altitude
- D: Both B and C

Correct Answer: D both B and C

4. List some of the discoveries of HAWC and/or Milagro in the field of gamma-ray astrophysics.

Milagro discovered new sources of Gamma energy and contributed to the understanding of anisotropy

HAWC was able to detect the dispersion of gamma rays that entered the atmosphere and laid the foundation for other high altitude gamma ray detection studies.

## 6 Modern Science in Latin America - Cosmic Ray Physics

1. What is the purpose of the Pierre Auger Observatory?

It was used to study gamma rays along with other cosmic energies and their relationship and interactions with our atmosphere. It is also used to determine the origin of certain gamma radiation.

2. What is the typical energy of a cosmic-ray observed at Auger?

- A:  $10^{12}$  eV
- B:  $10^{14}$  eV
- C:  $10^{16}$  eV
- D:  $10^{18}$  eV

Correct Answer D