

Midterm - INTD262

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1 Unit 0

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

They chose these areas because of the natural resources available.

There was water surrounding these areas. It was also already a civilization so they wouldn't need to create everything from scratch.

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?

This has been an ongoing debate, but the author of the introduction stated that scientific activity came before capitalism & if that wasn't the case & capitalism had come first then science would've never come.

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?

Marcos Cueto studied modern & creative work in the traditional & peripheral contexts together & he transmitted it by showing that biomedical research in Peru in the 1st half of the 20th century was displaying academic excellence.

4. Give some examples of *pseudo-scientific* beliefs regarding mythical places the colonials sought in the New World.

The fountain of youth; the 13 skies & 9 levels of the underworld inhabited by multiple gods; a snake with 2 heads: one where the head should be, other where the tail should (maquizcoatl)

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 *tlacuiloll* (paintings, stelae)
- C: *Tomatl* (plume, writing tool) and *altepetl* (city-state)
- D: *Quetzal* (plume, writing tool) and *huitzitzilin* (city-state)

- (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.

D • (1): Ponce de León and the Fountain of Youth

B • (2): Griffins so large they capture people and calves as prey, with feathers as large as an arm.

C • (3): "A fountain running with hot water and as the water runs it turns to stone."

A • (4): "fish that as they leave the water turn into butterflies."

E • (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.

4 • A: A flying fish

2 • B: A condor

3 • C: A mercury mine

1 • D: The belief about a certain river among the Lucayo and Carib indigenous

5 • 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? They understood vision & how the "tiger" (really a Jaguar) sees & hunts prey. They also understood the physics of sound & what noises would scare away the Jaguar to protect themselves.

(b) Why did the Spaniards and Aztec believe that hummingbirds were connected to immortality?
Because of the way they would stick their beaks in a tree & stay there for 6 months throughout the winter as though they're dead.

Then they would "come back to life" the other 6 months of the year.

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
- 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.

It was considered bad science. It was non-scientific because it did not follow the scientific method & everytime evidence was provided to prove creation science wrong, they explained it away by saying "but god," "because of god," etc.

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?

One example of a scientific revolution was the copernican revolution: figuring out that the sun doesn't revolve around the earth & it's the other way around. The anomaly before this discovery was the other planets moving around the sun. B) In part, it helped with the finding of new data & observations. It spread Syphilis & the colonizers looked to the indigenous people for the cure after not believing them at first.

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

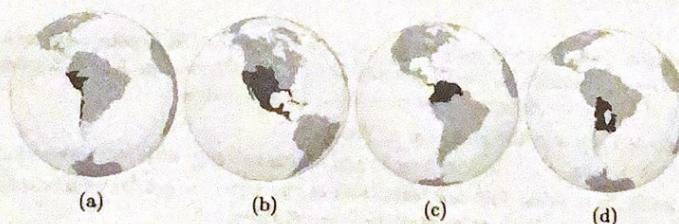


Figure 1: Maps depicting *virreinatos* in Latin America, 17th and 18th centuries.

Map in Fig. 1 (a-d)	Virreinato	Capital
b	Nueva España	Mexico city
c	Nueva Granada	Bogotá
d	Río de la Plata	Buenos Aires
a	Perú	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).

They had international trade because of the books coming from France. It also showed their interest in the Arts & Science. He had scientific items like a microscope, magnifying glass, and thermometer which shows us that science was of importance at the time. He used them to do actual experiments & as a point of reference. They had been doing science in Latin America before they were even independent.

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?

They were trying to figure out whether or not Newton's law was truthful & if it could be falsified but instead continued to do more scientific research on it & understand it more instead of falsifying it.

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?

Bode's law did not become a scientific fact, it was just seen as a crazy coincidence & correlation.

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?

He shared the patio process: getting the silver out of the oars. He suggested creating schools for miners' children because schools were controlled by the crown before. They would involve mining, chemistry, medicine, physics, etc.

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. They mainly had support from the mine owners & guilds. They would translate scientific texts into Spanish. They cut the crown out of the process & funded it themselves & created the new miners (called them engineers).

5. What are the two tenets of the scientific attitude, or ethos, according to the author of *The Scientific Attitude*? That we care about empirical evidence & are willing to change because of it.

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 women working with nurses were dying more than with midwives. When the nurses & midwives switch switched wards, the mortality followed & he realized it was because the nurses weren't washing their hands & were coming straight from working on autopsies. They used the scientific attitude to figure this out & observed what was happening, made assumptions, & tested them.

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. In the false discovery of cold fusion, they falsified the results & treated the data to make it seem like they found something when in fact, they didn't. They used the scientific model on the Nahuatl stories of how the tiger had "special powers" & "super vision!" They applied the scientific method to figure out optics, vision, the physics of sound, etc.

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 Bogotá was the capital of the viceroyalty of Nueva Granada. The half-century-long polemic caused an intellectual shift & challenged the church's views on science & the enlightenment. Some of the goals were to study the plants & environment in the area.

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?

In the Viceroyalty of the New Kingdom of Granada, the Jesuits then became more engaged with the colleges & universities & education & in turn science. They created their own schools as well.

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

José Celestino Mutis created the Flora de Nueva Granada that was focused on the flora around current Colombia.

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

This has logical truth because anti-vaccination people don't revise or allow for evidence to influence their beliefs.

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.

The categorization of species. It is not considered science but should count because it is differentiating between how species (& sub-types in species) evolved & learning more about it.

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 Francisco 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 Tychonic. What distinguished these? They began involving different thoughts as how the world worked. For the most part, they had a heliocentric world view. Ptolemaic = each planet revolves uniformly along a circular path, the centre revolves around Earth along a larger circular path. Copernican = Earth is another planet revolving around the fixed sun once a year & orbiting on its axis.

7. In 1767, Mutis published *Reflexiones sobre el sistema tycónico*. (a) What were the main points of this publication?

- (b) Was it considered controversial?

The main points were that the Earth moved like other planets, the sun stays in one spot & spins on its axis. It focused on a heliocentric world view which aided in the big change of how everyone viewed the universe.

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

they made astronomical & geographical measurements. This helped because it allowed them to have more accurate maps of Nueva España.

d'Auteroche would work in San José del Cabo. What happened as a result?
 d'Auteroche became super successful but ended up dying from a disease.

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

José Sanchez Labrador's explorations & addition to geography & biodiversity.

4 Applications, Mayan and Incan Number Systems

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

$$(a) 365 + 365 = 720 + 20 = 720$$

$$365 \div 20 = 18 \text{ R} 5 \quad 36 \times 20 = 720$$

$$18 \times 20 = 360 \quad 10 \text{ left over}$$

$$5 \text{ left over}$$

$$(b) 1024 - 512 = 512 \div 20 = 25 \text{ R} 12$$

$$1024 \div 20 = 51 \text{ R} 4 \quad 25 \times 20 = 500$$

$$51 \times 20 = 1020 \quad 12 \text{ left over}$$

$$4 \text{ left over}$$

$$\begin{array}{r} 720 \\ 365 \\ 365 \\ \hline 720 \end{array} \quad \begin{array}{r} 18 \\ 20 \\ \hline 360 \\ 10 \text{ left over} \end{array}$$

$$\begin{array}{r} 720 \\ 512 \\ \hline 208 \\ 12 \text{ left over} \end{array} \quad \begin{array}{r} 512 \\ 20 \\ \hline 1024 \\ 4 \text{ left over} \end{array}$$

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

$$(a) 512 + 256 =$$

$$\begin{array}{r} 512 \\ 256 \\ \hline 768 \end{array}$$

$$(b) 365 - 67 =$$

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.

$$16 \times 4 = 64$$

$$\begin{array}{r} 16 \\ 4 \\ \hline 64 \end{array}$$

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.

$$30 \times 5 \text{ m} = 150 \text{ m}^2 \quad 2 \times 150 \text{ m}^2 = 300 \text{ m}^2$$

$$\frac{300 \text{ m}^2}{0.2 \text{ m}^2} = 300 \times 25 = 7500 \text{ potatoes}$$

$$30 \times 5 \text{ m} = 150 \text{ m}^2 \quad 4 \times 150 \text{ m}^2 = 600 \text{ m}^2$$

$$\frac{600 \text{ m}^2}{0.3 \text{ m}^2} = 600 \times 25 = 15000 \text{ quinoa}$$

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

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
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
4. List some of the discoveries of HAWC and/or Milagro in the field of gamma-ray astrophysics.
Some of the discoveries included the observations of supernovas & cosmic rays.
- ## 6 Modern Science in Latin America - Cosmic Ray Physics
1. What is the purpose of the Pierre Auger Observatory?
The purpose was to better understand where high-energy cosmic rays were coming from & what they are made out of.
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