

# Midterm - INTD262

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## 1 Unit 0

- 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 Created *virreinatos* of Nueva España and Perú in their respective locations because they already had civilization/culture and access to water (and natural resources).
- 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?  
 There was a link between modern science because it provided competition and funding, but it is important to remember that science overall still preceded capitalism general.
- 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?  
 Peripheral scientific activity is where science was developed more recently (open mindedness). Example of the transition is European to American (old vs new).  
 a few examples of pseudo scientific beliefs of the new world were El Dorado and the Fountain of Youth.
- Give some examples of *pseudo-scientific* beliefs regarding mythical places the colonials sought in the New World.

### 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 *tlacuilo* (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.
- 

- 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

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).

a) There was a wide variety of books in the library and this indicates a strong desire to learn more about science, although the church was limiting their education.

b) He also owned telescopes and other tools to further his studies which showed science is independent of the church.

2. Unit 1 c) This furthering of science was ahead of the state of science in the American colonies because they started to have advanced colleges of science and education.

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?

The law of gravity was not falsified; it only further proved the idea of gravity because since there were slight perturbations in the orbit of Uranus, it had to have been caused by the presence of another planet, which

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 fits the data for certain planets, but it is less statistically based and more patterned based. It happens to be correct on a few planets like Neptune, but a patterned sequence cannot accurately predict planet locations.

For example: Neptune did not follow Bode's law

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" (extracting silver from mercury) with the Crown and he suggested creating more mining schools to promote the metal/mining 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.

They decided to try to preserve it by trying to convince the public the mining industry had to stay

↳ putting more money into mining education, etc

5. What are the two tenets of the scientific attitude, or ethos, according to the author of *The Scientific Attitude*?

The two tenets of the scientific attitude are skepticism and empirical evidence.

↳ willing to change based on evidence

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

It was applied in this situation because in one ward women were getting sick (dirty tools) and in the other ward they were not (clean tools). Which proved existence of germs (germ theory)

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.

a) It was not applied in this situation because they refused to change (they didn't have to make a high energy plasma)

b) Leeches being used to cure ultimately led to other diseases

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

- a) they made Astronomical and geocentric measurements
  - b) they used these measurements geographically to find locations for mining
  - c) As a result, he went back to France because France wanted 2 observations of the transit to compare data
9. What was notable about the explorations of José Sanchez Labrador?

Something notable about the explorations of José Sanchez were that it opened communication between the potosi and paraguay.

## 4 Applications, Mayan and Incan Number Systems

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

(a)  $365 + 365 =$

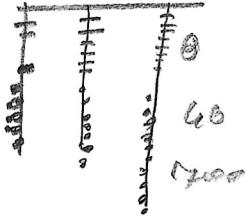
$$\begin{array}{r} \overline{\overline{\overline{\circ}}} \\ + \end{array} \quad \begin{array}{r} \overline{\overline{\circ}} \\ - \end{array} \quad =$$

(b)  $1024 - 512 =$

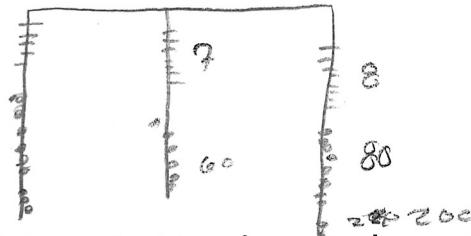
$$\begin{array}{r} \overline{\overline{\circ}} \\ - \end{array} \quad \begin{array}{r} \overline{\overline{\circ}} \\ - \end{array} \quad =$$

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

(a)  $512 + 256 =$



(b)  $365 - 67 =$

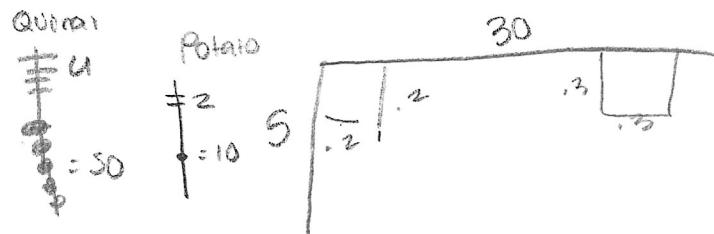


3. Suppose we are looking for a set of trees tall enough to supply sixteen four-meter beams. Using the Mayan system, create a calculation showing that the total number of beams is sixty-four.

$$\overline{\overline{\circ}} \times \overline{\overline{\overline{\circ}}} = \overline{\overline{\overline{\circ}}}$$

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.

$$\begin{aligned} 4 \times 150 &= 600 \\ .3 \times .3 &= 0.09 \text{ m}^2 \\ \frac{600}{0.09} &= 54 \end{aligned}$$



## 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

### 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?
  - a) It was in Nueva Granada
  - b) It got in the way of religion because it was the idea that the earth was not flat and that we live in a heliocentric solar system  
↳ It would take away from God
  - c) they were able to travel and take longitude and latitude (exploration)
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?
  - a) Caracas is in Nueva Granada
  - b) the implication of science was that the Jesuits/education were against the enlightenment and would interrupt the goal of political power.
3. What scientific publication was created by José Celestino Mutis?

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

This claim is true because since the campaigns do not have skepticism or empirical evidence, they can not be proven to be scientific endeavors.  
Scientific attitude / endeavors go hand in hand.
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.

One example is Hummingbird classification  
↳ look similar but have different properties  
↳ evolution
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?
    - a) It started to transition into an exchange of ideas / evidence / discoveries
    - b) we can infer that there are much less native professors at the university
    - c) Ptolemaic - earth is center of universe Copernican - sun is center Tychonic - earth is center and everything else around Sun and earth
  7. In 1767, Mutis published *Reflexiones sobre el sistema tycónico*. (a) What were the main points of this publication?
    - (b) Was it considered controversial?
      - a) the main points were that the sun and stars were stagnant and that the Copernican theory did not oppose the bible
      - b) It was controversial because it scared people who thought the sun was much smaller
  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 Chénne d'Auteroche that he would help with the Venus

## 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?

*This tells us that the Nahua people can understand Sight/Vision Sound.*

- (b) Why did the Spaniards and Aztec believe that hummingbirds were connected to immortality?

*The Spaniards and Aztecs believed that hummingbirds were connected to immortality because the hummingbirds would hibernate but always return.*

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.

*There wasn't any scientific evidence for creation science because there was a belief that god could have created the fossils too. Creation science is the belief that everything was made but we still evolved and changed (backed by scripture) whereas creation is broader*

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?

a) One example of scientific revolution would be the idea of a solar system (sun with earth moving around it) and the anomaly was that the data was not explained currently.

b) Yes because it rose questions and they were able to utilize more tools/resources scientists in order to set fire to a scientific revolution.

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

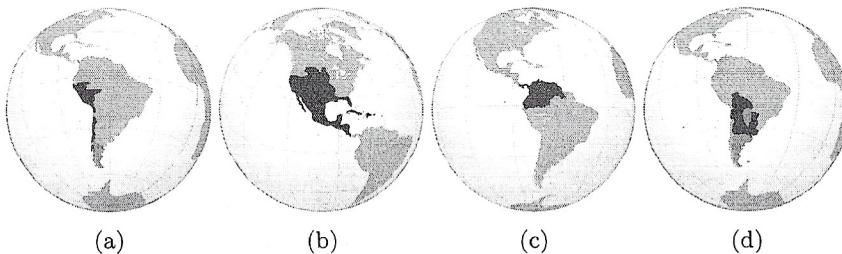


Figure 1: Maps depicting *virreinatos* in Latin America, 17th and 18th centuries.

Map in Fig. 1 (a-d)	Virreinato	Captial
b	Nueva España	Mexico City
c	Nueva Granada	Bogota
d	Río de la Plata	Buenos Aires
A	Perú	Uma

Table 1: Fill in the missing information.

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 discoveries of milagro were a new TeV at low declinations and  
new TeV gamma ray sources

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

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

the purpose of the pierre Auger observatory is to study cosmic rays (high energy particles)

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