

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.

The Spaniards created virreynatos in Nueva Espana and Peru because they were cities with large indigenous populations that were used for slave labor, and they had large quantities of wealth in the form of silver.

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?

There was a link between capitalism and scientific activity in Latin America because these discoveries began as a way to improve the techniques that would maximize their profit such as for silver mining and production.

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?

An example of the creation and transmission of scientific results from the periphery to the center of science is the use of the patio process to extract more silver from the mines.

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

An example of the pseudo-scientific beliefs for mythical places is the fountain of youth which Ponce de Leon believed to return youth to the old. Another example is the river of hot water that would turn to rock which was actually a mercury mine.

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. |

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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?

Father Sahagun's writings indicate that the Nahua Understood sound waves and light waves and the way they travel through space.

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

They believed that hummingbirds were connected to immortality because hummingbirds hibernate through the season making it seem like they were reborn after they “died.”

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.

The scientific evidence for creation science was the evidence for evolution in a way that was warped and worded to fit the evidence for creation science. Both creationism and creation science believe that nature was a divine creation. However, creation science attempts to follow scientific theories.

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?

An example of the scientific revolution is the change from the Ptolemaic system that focused on the earth at the center of the Galaxy to the Copernican sun model which focused on a sun centered galaxy.

I don't think that the colonization of Nueva Espana completely triggered the a scientific revolution. I think it triggered a revolution that emphasized a Eurocentric view of science into the New World, but mesoamerica prior to the colonization already had valuable scientific knowledge.

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

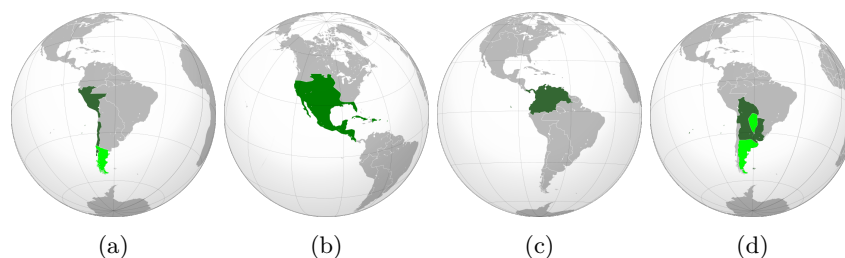


Figure 1: Maps depicting *virreinos* in Latin America, 17th and 18th centuries.

Map in Fig. 1 (a-d)	<i>Virreinato</i>	Capital
B	<i>Nueva España</i>	Mexico City
C	<i>Nueva Granada</i>	Santa Fe de Bogotá
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).

The distribution of texts in Bartolache's library tells us that the scientific attitude in Latin America was heavily eurocentric, with some native books focused on enlightenment. Despite its focus on european discovery, there were large varieties of resources with various forms of methods. Bartolache owned books on travel, music, languages, geography and dictionaries. these texts display the advancement of science in a way that focused on research and methodology. Despite these scientific advancements, the colonies lagged behind in their scientific development.

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?

In a way, the law of gravity was falsified. But instead of starting over or completely accepting that the theory might be wrong, the scientists adjusted for change and solved the problem of the law.

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 fact because the discovery of Neptune and Pluto falsified the data and it was eventually assumed to be a 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 gave a description of the patio process which was a chemicometallurgical technique that involves crushing silver ore with salt, water, copper and mercury. This mixture is then laid out to dry in the sun. This process and many others were useful for miners, so he proposed creating schools for miners children in order to produce an efficient labor force.

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.

To help preserve the semineria, mine owners worked to help financial problems, scientists in the college began to teach science and locals translated texts.

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

One tenet is that scientists and their research focuses on empirical evidence. The second is that scientists must be willing to change their theories in light of new evidence.

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

The scientific attitude was applied in this situation because as Semmelweis realized that his theories were wrong, he accepted new evidence and created changes to the system in light of new evidence.

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.

The story of the false discovery of cold fusion does not follow the scientific attitude because the two researchers falsified evidence in order to prove their theory correct instead of accepting the evidence and making new changes. A piece of science in Latin American history that is an example of this is the Spanish who adopted indigenous practices but were dishonest of how they adopted it and dismissive of the indigenous contributions to science.

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 in the viceroyalty of Nueva Granada. The Ptolemaic on Copernican theories created two groups to dominate education to try to institutionalize enlightenment thinking. The Expedition Botanica debated the inclusion of new philosophy and attempted to reform and secularize education.

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 in the viceroyalty of Nueva Granada. After the Jesuit order was expelled, the Dominican order wanted to secularize scientific education in universities.

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

Jose Celestino Mutis was responsible for the Expedicion Botanica.

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 logical because if the campaigns don't follow a scientific attitude then they cannot be considered proper scientific endeavors.

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.

An example of something that is science even though it is not considered science is evolution, Evolution includes categories that are created by people for classification of species.

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?

The interaction between foreign and Ecuadorian professors led to a multitude of theories and debates that began to focus on the methods of science. The three world systems that Father Aguilar taught were differentiated by what was considered the center of the universe. The Ptolemaic system was a geocentric system and the Copernican system was a heliocentric system. The Tyconic system had the earth at the center orbited by the sun and the sun was orbited by All the other planets.

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 main points of this publication focused on defending the Copernican ideas by arguing that the earth moves with the other planets, but the sun and the stars don't move at all. Mutis also argued that this system doesn't oppose the holy scriptures, so it could not be argued against through a religious lens. This view was somewhat controversial because the institutions were still conservative.

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?


Velazquez de Leon and Jose de Galvez took astronomical and geographical measurements that helped create accurate scales of maps in Nueva Espana and draw a more accurate line of the borders. As a result of

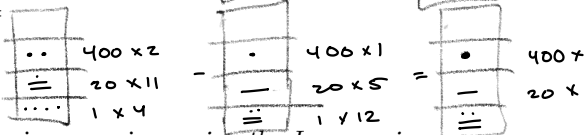
9. What was notable about the explorations of José Sanchez Labrador?

Labrador managed to establish a direct line of communication between Paraguay and potosi through Santa Cruz de la Sierra. He also reported the maps of the Paraguay River and other waterways which led to more accurate navigation through the jungle.

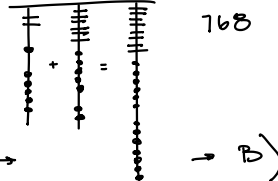
4 Applications, Mayan and Incan Number Systems

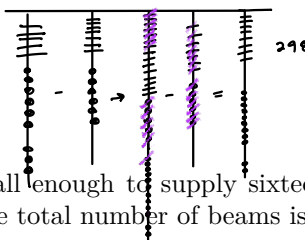
1. Work out the following exercises using the Mayan system.

(a) $365 + 365 =$  400×1 $400 + 320 + 10 = 730$

(b) $1024 - 512 =$  400×2 20×11 1×4 400×1 20×5 1×12

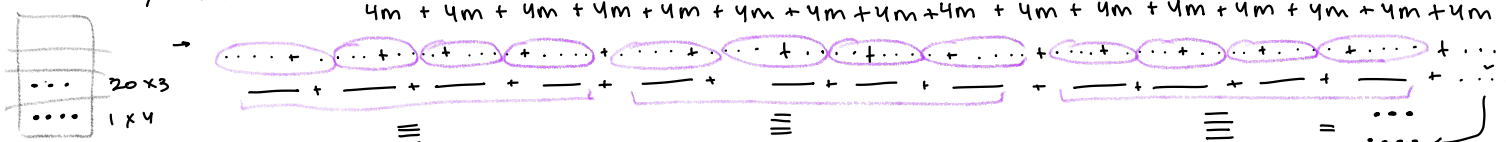
2. Work out the following exercises using the Incan quipu:

(a) $512 + 256 =$  768

(b) $365 - 67 =$  298

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.

$16(4m) = 64m$

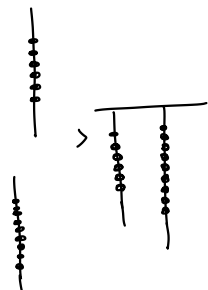
 20×3 1×4 $4m + 4m + 4m + 4m + 4m + 4m + 4m + 4m + 4m + 4m + 4m + 4m + 4m + 4m + 4m + 4m$

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.

$30 \times 5 = 150m^2$

$0.2 \times 0.2 = 0.04m^2 \rightarrow 150m^2 \times 0.04m^2 = 60 \text{ POTATOES}$

$0.3 \times 0.3 = 0.09m^2 \rightarrow 150m^2 \times 0.09m^2 = 90 \text{ QUINOA}$



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.

By analyzing gamma rays the HAWC system has discovered gamma rays emitted by the sun at energies above 100 TeV. The HAWC system has also explored the molecular clouds in our galaxy.

6 Modern Science in Latin America - Cosmic Ray Physics

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

The Pierre Auger Observatory studies air showers caused by Gamma rays.

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**