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.

Since Tenochtitlan was the center of the Aztec Empire, the Spanish took advantage of the robust infrastructure to consolidate their control, and they also had control of the wealth that the Aztecs received from other regions. And Lima was chosen as the capital of the viceroyalty due to its proximity to the seat of the Inca Empire (Cusco), and it also facilitated communications and trade with Spain through maritime routes.

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?

   Yes, there was a link between the introduction of capitalism and the growth of scientific activity since in the 19th and 20th centuries during the industrial revolution, science developed significantly to meet the demands of the capitalist economy. Therefore, capitalism promoted scientific areas such as engineering, agronomy and mining, which are necessary for the exploration of natural resources.

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?

   For example the use of quinine to treat malaria

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

El Dorado, The Fountain of Youth, The Seven Cities of Cibola

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

(a) Which of the following where media through which inhabitants of the Mexica empire recorded scientificobservations 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 Espańa* (Hernández), match the European story to the indigenous story or piece of knowledge.

- (1): Ponce de León and the Fountain of Youth D: The belief about a certain river among the Lucayo and Carib Indigenous
- (2): Griffins so large they capture people and calves as prey, with feathers as large as an arm. B: A condor
- (3): “A fountain running with hot water and as the water runs it turns to stone.” C: A mercury mine
- (4): “fish that as they leave the water turn into butterflies.” A: A flying fish
- (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. E: The Mexican opposum
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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 opposum

6. **Nahua scientific activity, second period**

(a) Father Bernardino de Sahagún translates from Nahuatl a description of a “tiger” that the indigenous saycan 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?

In A) the Nahuatl probably understood that certain animals had sharper senses than humans and in B) they demonstrate that they had a basic knowledge of the medium through which sound travels

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

For the Aztecs they were associated with Huitzilopochtli (the god of war and the sun) whose name means "hummingbird of the dream" for the Aztecs believed that hummingbirds represented the soul of warriors killed in battle

And for the Spanish, as they did not have any in Europe, their movements caught their attention and they associated them with immortality.

7. Suppose the following statement is given: "If someone was born between 1945 and 1991, then they haveStrontium-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 onlyu on the "scientific evidence" for creation science. But was there any? And, how precisely was creation science different from creationism?

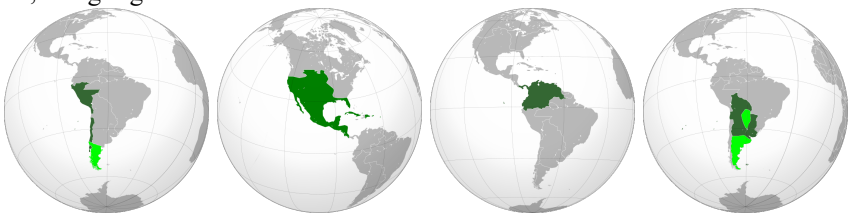
   Explain the arguments used in court to thwart Act 590 the following year.

   The arguments that creation science is a form of religion and not a science, scientific experts testified and argued that there was no valid scientific evidence to support creation science. Furthermore, creation science does not meet the criteria of science.

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) The change from the geocentric model to the heliocentric model is known as the Copernican revolution
   b) It did not trigger a scientific revolution but it did have a significant impact

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



(a) (b) (c) (d)

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

Map in Fig. 1 (a-d)	***Virreinato***	Captial
B	*Nueva España*	Ciudad de Mexico
C	*Nueva Granada*	Bogota
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 tellus 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).

What the author tells us is that the scientific attitude in Latin America was greatly influenced by the scientific advances that occurred in Europe. Bartolache had telescopes, barometers, thermometers and fundamental tools for observation and experimentation. The United States was also influenced by European advances, but with a focus on agriculture, navigation and medicine. However, they were also empirical and applied.

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?

No, Newton's law of gravity was not falsified by perturbations in Uranus' orbit. Adams and Le Verrier proposed that an unknown planet was causing anomalies and thus Neptune was discovered.

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?

No, Bode's law did not become a scientific fact simply because it agreed with the data.

3. In 1761, Judge Francisco Javier Gamboa created a set of legal and scientific studies that were meant to reform themining 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?

Gamboa presents the use of the amalgamation technique (use of mercury) for the extraction of precious metals.

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 bankrupcy. Describe the Mexican efforts to preserve it.

   There are efforts such as government support, since it was attempted to finance it with public resources. In addition to a restructuring of programs, the curriculum was modernized focusing on areas such as metallurgy and chemistry and finally with internal initiatives.

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

   The two fundamental principles of the scientific attitude are openness to evidence and honesty in facing error.

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

   History applied the scientific attitude when it shows openness to evidence, since although his hypothesis went against medical beliefs, he remained open to empirical evidence. The other is honesty in the face of error, since although his ideas were not accepted, he had the disposition to challenge conventional beliefs.

7. Recall the story of the false discovery of cold fusion. (a) Discuss how the scientific attitude was not applied inthis 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) For example, in the case of cold fusion, the scientific attitude was not applied because there was a lack of openness to evidence when the experiments that supported cold fusion were not replicated by other scientists and the lack of honesty in the face of error when, despite the questions and failures, the researchers continued to promote their discovery.
   b) The openness to evidence since it opened up to new techniques based on observation and experiment, which is the scientific attitude

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) in the city of Santa Fe de Bogotá. b) the dispute reflects a conflict between science and religion. c) Its objectives were the study and categorization of flora and the development of botanical science in America.

2. (a) a) the city of Caracas was in the viceroyalty of New Granada (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) in which viceroyalty was the city of Caracas? b) the expulsion of the Society of Jesus is due to the fact that the Jesuits had been promoters of education and science?

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

   The Secret of the Quina

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

   Anti-vaccine campaigns lack openness to evidence as they do not show solid scientific evidence supporting how good they are for public health. and the lack of honesty in the error since they do not correct the errors when it shows that the hypothesis is scientific

5. Discuss one example we have encountered from our scientific history that should count as science, even thoughit has not traditionally been considered scientific. Knowledge of cinchona and its medicinal use must be considered scientific since it has an empirical method and builds on the scientific

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

> *La Universidad Gegoriana* 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 Tychonic. What distinguished these?

The scientific transition was when the interaction between foreign and Ecuadorian teachers and the system of native teachers and the Optlemic, Copernic and Tychonic system

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 of his work without the description of the Tychonic system, the scientific viability and the critical evaluation of the Copernican and Ptolemaic models. b) whether the publication was controversial since it still defended an aspect of geocentrism

8. When Joaquín Velázquez de León and José de Gálvez arrived in Baja California, they remained there for threeyears. (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'Auteroche would work in San José del Cabo. What happened as a result?

a) the measurements were geodetic, astronomical and topographical. b) they improved knowledge by providing a more precise cartography of Baja California, which helped in the planning of economic development and territorial administration. c) the result of this collaboration was more successful observations of the transit of Venus.

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

The explorations were remarkable as he worked and explored unexplored areas and in this he made detailed observations of local flora and fauna. He also documented aspects of the culture and customs of the indigenous peoples of the region.

4 Applications, Mayan and Incan Number Systems

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

   (a) 365+365= 365 =18 x 20 +5 his means that 365 has 18 units of 20 and 5 single units

   730÷20=36 with a remainder of 10.

   36÷20=136÷20=1 with a remainder of 16.

   730 in the Mayan system would be 1.16.10

   (b) 1024−512=1024 in the Mayan system is 2.11.4 and 512 in the Mayan system is 1.5.12 so 1024 − 512 is 1.5.12

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

   (a) 512+256= " 12 in base 10 is:

   5 hundreds

   1 ten

   2 units

   " 256 in base 10 is:

   2 hundreds

   5 tens

   6 units

   So, 512 + 256 = 768

   (b) 365−67= 365 − 67 = 298

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

16x4= 64 64/20= 3 with a remainder of 4, 64 in the Mayan system would be written as 3.4

4. Suppose you have six terrace plots in the Andean mountains to use to survive. You and your cohort of fellowIncans decide to grow potatoes and quinoa. Quinoa actually do better at higher altitudes that 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.

   Potato plants: 7,500
   7 thousands (represented by 7 knots in the thousands position)
   5 hundreds (represented by 5 knots in the hundreds position)
   Quinoa plants: 6,666
   6 thousands (represented by 6 knots in the thousands position)
   6 hundreds (represented by 6 knots in the hundreds position)
   6 tens (represented by 6 knots in the tens position)
   6 units (represented by 6 knots in the units' position

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.

Detection of Galactic gamma-ray sources, Observation of TeV gamma rays, extended gamma-ray emission from pulsar wind nebulae, Gamma-ray emission from supernova remnants

6 Modern Science in Latin America - Cosmic Ray Physics

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

Is to study ultra-high-energy cosmic 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