Filip

Midterm - INTD262

Dr. Jordan Hanson - Whittier College Dept. of Physics and Astronomy

October 18, 2024

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.

Tenochtitlan and Lima were strategic, economic and political centers, facilitating control and resource management in the New World.

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 introduction of capitalism and scientific activity in Latin America are intertwined, with economic demands often driving scientific exploration and vice versa.

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 is the collection~~ Indigenous ~~collection of~~ knowledge of plants used in medicine (like quinine from the Andean regions) was adapted into european pharmacology.

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

-the search of mythical places like El Dorado or the fountain of Youth.

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

(a) Which of the following where 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.

- 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 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?

The Nahua likely believed that animals had heightened senses and could perceive things (such as sounds and movements) even in challenging conditions like fog or darkness

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

Hummingbirds were often associated with gods and warriors in Aztec culture. They symbolized resurrection and soul's journey after death. Spaniards might have adopted these ideas from the Aztecs.

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 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 main argument was that creation lacked scientific evidence and was based on religious views, violating the constitutional separation of church and state.

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) - Copernican Revolution. The anomaly was that the geocentric model couldn't explain planetary motion as well as the heliocentric model.

b) While colonization did not trigger a full scientific revolution, it did lead to accumulation of new knowledge that expanded European scientific horizons

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*	Mexico City
c	*Nueva Granada*	Bogotá
~~a~~ d	*Río de la Plata*	Buenos Aires
~~b~~ 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).

a) The Library likely contained European scientific works, reflecting an interest in modern science in Latin America but showing dependence on European sources.
b) Bartolache may have owned instruments for astrology, mathematics, or medicine. c) Science in American colonies relied heavily on European knowledge, however colonial America emphasized practical applications.

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?

Newton's law was not falsified. The slight perturbations in Uranus' orbit were eventually explained by the presence of another planet (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?

Bode's law fit many of the known planetary distances, but it was not considered a true scientific law because it lacked a theoretical foundation and did not explain why planets follow this pattern.

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?

Gamboa suggested improvements in silver amalgation and advocated for the creation of mining schools and institutions to better train workers and improve efficiency in mining.

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.

Despite its potential the institution struggled with mismanagement, lack of funding, and a declining mining economy. Efforts to preserve it include reorganizing of curriculum and securing state support.

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

The two tenets are openness to criticism and the demand for evidence, meaning science relies on empirical data and is always opened to revision based on 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.

Semmelweis applied the scientific attitude by using empirical data to show that handwashing reduced mortality in maternity wards, though his ideas were initially rejected because they contradicted established medical beliefs.

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) The cold fusion announcement lacked peer review, replicability, and sufficient evidence, violating key aspects of scientific attitude, such as the need for rigorous testing and openness to criticism.
b) One example is the discovery of quinine in the treatment of malaria, where indigenous [redacted] was subjected to empirical testing and eventually accepted into European medicine based on evidence.

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?

1(a) Viceroyalty of Nueva Granada (b) The debate showed resistance to heliocentrism in Latin America but also opened discussions about modern astronomy. Jose Celestino Mutis supported Copernica ideas.
c) The expedition aimed to catalog the flora of the region

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?

1a) Viceroyalty of New Granada. (b) The Dominican orders control over educational institutions led to changes in curriculum. The expulsion of Jesuits affected scientific progress, as Jesuits were key promoters of education and scientific thought in the region

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

" c) Arcano de la Quina", detailing the medicinal properties of the cinchona tree (quinine).

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

- Anti vaccination campaign lack the scientific attitude because they often reject evidence and are not opened to criticism or empirical testing, making them unscientific.

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.

- Indigenous knowledge of plant medicine should be considered scientific due to its empirical nature and effectiveness, though it has not traditionally been recognised as such by Western Science.

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?

(6a) The transition involved the incorporation of European scientific methods and theories into local educational systems, enhancing scientific understanding of Ecuador.
(6b) There were significantly more foreign professors.
(6c) He taught Ptolemaic, Copernican and Tychonic systems.

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

(7a) Mutis supported Tychonic system. (7b) Yes it was controversial because it challenged traditional views of cosmos.

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

(8a) They made astronomical and geometrical measurements, including observations of the Venus transit
(8b) Their work helped improve mapping and geographic knowledge of the region.

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

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

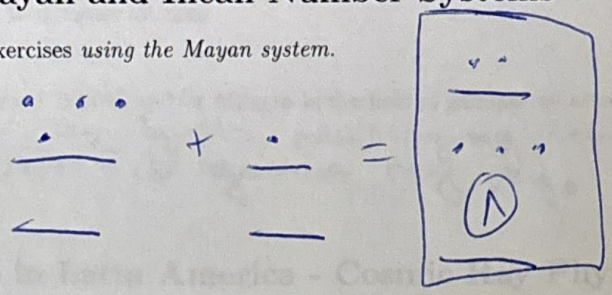
His explorations were notable for their detailed documentation of flora, fauna and indigenous cultures in the Paraguay and Paraná river regions.

4 Applications, Mayan and Incan Number Systems

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

   (a) $365 + 365 =$

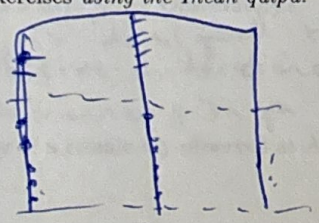
   (b) $1024 - 512 =$



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

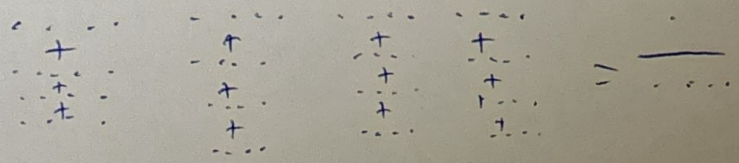
   (a) $512 + 256 =$

   (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.

16 x 4 = 64



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 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.

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.

detecting gamma ray bursts, identifying sources of cosmic rays, and mapping the TeV gamma ray sky.

6 Modern Science in Latin America - Cosmic Ray Physics

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

-the observatory is designed to detect and study ultra-high-energy cosmic rays to better understand their origins and the mechanisms behind their extremely high energy

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