

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.

AS there was already an abundance of natural resources such as agricultural, economic resources, the Spaniards saw it as an already established civilization fit for life.

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 author argues that if Capitalism was indeed linked to the growth of Scientific activity in Latin America, how would we be able to explain the already established, prior scientific activity that proceeded even the

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?
- In the 1980s, marcos culto studied the unique combination of modern and creative work in supposedly traditional and peripheral contexts, far from the world centers of science, demonstrating that biomedical research in Peru showed academic excellence.

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

The mercury mines, fountain of youth, and paradisical islands with milk mountains are some examples of mythical places described as antidotes that discoveries in America made tangibly real.

5. Multiple Choice - Nahuatl 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: *Azotl* (codices) and *huitzitzilin* (paintings, stelae)
- B: *Amoztl* (codices) and *tlacuicoll* (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.

- | | |
|------------------------------------|--|
| <input checked="" type="radio"/> D | • (1): Ponce de León and the Fountain of Youth |
| <input checked="" type="radio"/> B | • (2): Griffins so large they capture people and calves as prey, with feathers as large as an arm. |
| <input checked="" type="radio"/> C | • (3): "A fountain running with hot water and as the water runs it turns to stone." |
| <input checked="" type="radio"/> A | • (4): "fish that as they leave the water turn into butterflies." |
| <input checked="" type="radio"/> 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. |

-
- | | |
|------------------------------------|---|
| <input checked="" type="radio"/> 4 | • A: A flying fish |
| <input checked="" type="radio"/> 2 | • B: A condor |
| <input checked="" type="radio"/> 3 | • C: A mercury mine |
| <input checked="" type="radio"/> 1 | • D: The belief about a certain river among the Lucayo and Carib indigenous |
| <input checked="" type="radio"/> 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? *It tells us how the nahua understood physics through their desire surrounding boars' vision, sight, and ocular vision when hunting for prey, as well as the physics of sound, learning noises that would protect against such creatures.*
- (b) Why did the Spaniards and Aztec believe that hummingbirds were connected to immortality? Protect against Due to their belief that hummingbirds would "come back to life" after being dead for 6 months through the tree that would bring them back when actually IS the natural way ~~habit~~ of sleeping through the winter by striking their beaks into the tree, for 6 months
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. *were Through modus tollens, Popper's ideas ultimately were able to prove that a theory could indeed be scientific without necessarily having to be true, and was in fact possible and plausible.*

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 Copernican Revolution was a scientific revolution that discovered that the Sun does not revolve around the earth, but instead that the earth revolves around the sun.*
- (b) *yes, due to it helping to find new, unknown data and findings within science, although it spread disease in which pushed colonizers to turn to the Indigenous people for a cure for Syphilis.*

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

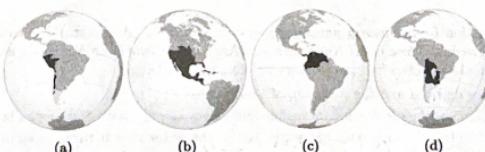


Figure 1: Maps depicting *virreinatos* in Latin America, 17th and 18th centuries.

Map in Fig. 1 (a-d)	<i>Virreinato</i>	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).

There was a concern with carrying out social norms and an interest with arts that were viewed as productive for society. (Individual interest) He possessed a microscope, hydrometer, magnifying glass, and a thermometer, which tells us that for circles who espoused enlightenment ideals, modern scientific culture, and traditional culture, where an important element

2 Unit 1 In their intellectual formation.

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?

There were questions raised about the turn to Newton's law, due to it contradicting empirical evidence and observations showing that orbits experienced perturbations from gravitational interactions with other bodies. Rather than being

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. Scientists 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. Instead 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 was seen as merely a remarkable artifact of native correlation.

attempted to
other
Understand it.

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?

the chemicometallurgical technique was one that included a systematic and complete description of the patio process, revealing chemicometallurgical techniques never seen before. He suggested creating a school of specialized instruction for minor's children and a program However, several factors might have driven it to bankruptcy. Describe the Mexican efforts to preserve it. of modern the Mexican efforts included efforts from mine owners, scientific and guilds, as well as a translation of texts surrounding scientific language to into Spanish.

4. *El Real Seminario de Mineria* was created by Joaquín Velázquez de León, Fausto de Elhiyar, and others.

However, several factors might have driven it to bankruptcy. Describe the Mexican efforts to preserve it.

5. What are the two tenets of the scientific attitude, or ethos, according to the author of *The Scientific Attitude*?
1) the caring and understanding of evidence (empirical).

1) the caring and understanding of evidence (empirical).

- 2) the willingness to change and learn science based on evidence.

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

the use of science here was applied through semmelweis rather than assuming that he already knew the answer to the question, and instead examined similarities and differences, learning through observation and controlled experiment, allowing him to create hypothesis.

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) they falsified and tweaked the results and data.

(b) the nahuahtl description of a tiger having the ability to see in the dark of fog, and create sounds to imitate winters using air applies the scientific attitude by employing two main principles

1. caring about empirical evidence

2. willingness to change theories in the light of new evidence allowing them to learn observe, hypothesis, and prove.

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 capital city of the Viceroyalty of New Granada.
as they did not know their countries borders, they
were unable to do cartography without physics
and astronomy, as well as enlightenment techniques.
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) the Viceroyalty of the new Kingdom of Granada.
(b) the Jesuits became active in transmitting knowledge and promoting education and scientific exploration, creating many colleges and assisting in expansions of natural sciences, mathematics, and astronomy.
3. What scientific publication was created by José Celestino Mutis?

He created the Flora de Nueva Granada which was a scientific publication about the flora surrounding what is now Colombia.
4. Evaluate the logical truth of this claim: "anti-vaccination campaigns do not have the scientific attitude, therefore these are not scientific endeavors."

Because people who are anti-vaccination do not revise or adapt findings/ ideas based on evidence which influences their beliefs, there is logical truth to this claim.
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.

Differentiating evolution and our understanding of it, as it relates to our scientific categorization 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 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 adapted a heliocentric view of the world, which was new and a large result of the interaction. Ptolemy's works established a geocentric model of the universe in which everything revolved around the earth in complicated patterns. Tychonic - an alternative to Ptolemaic where the sun, moon, and stars circle earth and five planets orbit sun.
7. In 1767, Mutis published *Reflexiones sobre el sistema tycónico*. (a) What were the main points of this publication?

(b) Was it considered controversial?
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 Chappé 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 he traveled to Spain.

(a) astronomical/geographical measurements.
(b) these measurements were essential to correct the scale of the maps from new Spain. Stars help understand orbit of earth, and coordinates system.

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

(C) Auteroche was successful in his findings, but died due to an outbreak of disease.

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

his explorations were notable for their contributions to the understanding/knowledge of the geography and biodiversity of the environment.

4 Applications, Mayan and Incan Number Systems

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

(a) $365 + 365 = 730_{20}$

$$730/20 = 20 \times 36 = 720 \text{ r } 10 = \begin{array}{r} \overset{1}{\cancel{3}} \\ \cancel{3}6 \\ \hline 10 \end{array}$$

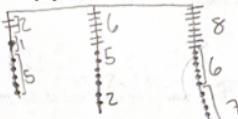
(b) $1024 - 512 = 512$

$$512/20 = 20 \times 25 = 500 \text{ r } 12 = \begin{array}{r} \overset{1}{\cancel{5}} \\ \cancel{5}0 \\ \hline 12 \end{array}$$

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

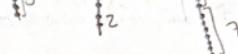
(a) $512 + 256 =$

$$\begin{array}{r} 512 \\ 256 \\ \hline 210 \end{array}$$



(b) $365 - 67 =$

$$\begin{array}{r} 365 \\ 67 \\ \hline 310 \end{array}$$



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.

$$3 \times 5 = 15 \rightarrow \begin{array}{c} \text{---} \\ \text{---} \end{array} + \begin{array}{c} \text{---} \\ \text{---} \end{array} + \begin{array}{c} \text{---} \\ \text{---} \end{array} = 64$$

$$3 \text{ bars (15)} + 4 \text{ dots (4)} + 3 \text{ bars (60)} = 64$$

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 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.

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? *had 20 choices but had most of them taken out*

- 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 of HAWC and milagro included the detection of cosmic rays, pulsar wind Nebulae, and observation of supernova remnants.

6 Modern Science in Latin America - Cosmic Ray Physics

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

To study ultra-high-energy cosmic rays and understand their interactions, origins, and composition in relation to earth's atmosphere / magnetic field.

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