Teaching Human Dignity

Exploring China's One-Child Policy

with Exponential and Logarithmic Functions

STUDENT PACKET

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University of Notre Dame | McGrath Institute for Church Life

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Limited Review of Exponential Functions and Equations

Preliminary Problem

There are 103 students in the senior high school class. They are planning a class trip to the zoo. Only 25 students can fit on a bus. How many buses does the principal need to arrange to get all of the students to the zoo?

a) 3.12

b) 4

c) 4.12

d) 5

PBS RetroReport: "The Population Bomb"

- What is the new kind of fear that began to spread in the 1960s?

- Describe the sources of this new fear?

- What is zero population growth (ZPG)?

- What techniques did advocates push in order to decrease the birth rate?

"Population Bomb: The Overpopulation Theory That Fell Flat" by Kit R. Roane and Sarah Weiser *Retro Report on PBS*, October 22, 2019, https://www.retroreport.org/video/the-population-bomb/

PBS RetroReport: "The Population Bomb" cont.

- Why did India's elite think the poor were poor? What other reason does the speaker give that might be why the poor are poor?

- Accordion to the video, why aren't insect models appropriate for modeling human populations?

- How has the shift towards urbanization and the rise of the green revolution impacted family size?

Review Problems

1. Without a calculator, evaluate the following expressions.

   a) 3^2

   b) 2^4

   c) $(1+3)^2$

   d) $2(1+1)^3$

2. With a calculator, evaluate the following expressions.

   a) 2.51^3

   b) $(1+0.02)^{23}$

   c) $563(1+0.015)^{2020-1979}$

- What rounding would be expected if these were monetary units?

- What rounding would be expected if these were humans?

What is exponential growth?

Exponential growth is _____

_____

- What is the structure of an exponential function?

- What is a simple exponential function that can be used to model population growth?

Practice Problems

3. Without a calculator, evaluate the following expressions.

   a) 4^3

   b) $2(3+1)^{5-3}$

4. The exponential population model for Anytown, USA is $P(t)=200(1+0.032)^{t-1947}$. Without performing any calculations, answer the following questions.

   a) Written as a percentage, what is the growth rate?

   b) What does the number 200 represent?

   c) What would P(1975) represent?

5. In 1990, Whoville had a population of 2,000,000 residents. Its population growth rate was 0.45%.

   a) Create an exponential function to model the population of Whoville.

   b) Use your model to predict the population of Whoville in 2010.

   c) If Whoville sustained this population growth rate, in what year would Whoville reach 2,250,000? How did you find your answer?

Review of Logarithmic Functions and Equations

- How do you undo the operation of addition?

- What is a logarithm?

  Simply put, a logarithm _____

  A logarithm answers a simple question: _____

  If $y=b^x$, then

6. Rewrite the following exponential equations as logarithmic equations.

   a) $6=3.2$ b) $14=5^x$

- How are logarithms used?

7. Solve the following equations for x. Round to the nearest tenth.

   a) $56=4^x$

   b) $31=4(5.1)^x$

   c) $50=27(1.27)^{x-3}$

8. Go back to #5c, and solve it algebraically (using a logarithm).

- If your computation had yielded 2,019.84, how would you have reported your answer?

b) Hometown is a small town with a population of 3,500 in 2000. In that year, the growth rate was measured to be 2.4%. If that growth rate remains consistent, when would the population reach 10,000?

c) Explain how you arrived at your answer to 8b. This "explanation" can include an explanation of your computation as well as any rounding that may have happened.

Here's How China's One-Child Policy Started in the First Place

- When did China implement the one-child policy?
- What was China's one-child policy?
- What was the goal of China's one-child policy?
- Why did China implement the one-child policy?
- Give at least three examples of how the Chinese government enforced the one-child policy?
- According to the article, was the one-child policy successful?

"Here's How China's One-Child Policy Started in the First Place" by Tessa Berenson, *TIME*, October 29, 2015, https://time.com/4092689/china-one-child-policy-history/

Development of the One-Child Policy

The year is 1979, and you are a data analyst preparing a report regarding future projections of the Chinese population using an exponential model. Solve the following equations for x. Round to the nearest tenth.

9. You are using data from the previous year (1978) to make your projections. This data is found below.

Year	Population (total)	Population growth (annual %)	Birth rate, crude (per 1,000 people)	Fertility rate, total (births per woman)	Death rate, crude (per 1,000 people)
1978	956,165,000	1.34	18.25	2.94	6.25

Build an exponential model based on this data for China's population (P) as a function of the year (t).

10. Use your model to estimate China's population in the following years:

    a) 2000

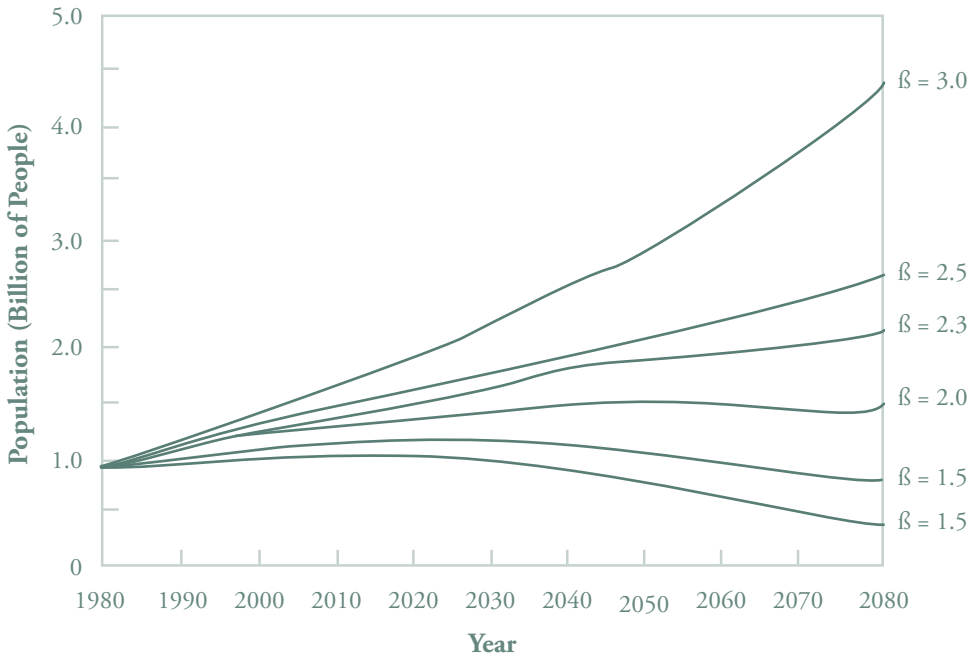
    b) 2040

    c) 2080

11. The team of scientists and other analysts claimed that the population of China needed to be kept under 1.2 billion in order to avoid mass starvation and country-wide disaster. Use your model to predict the year in which the Chinese population would reach 1.2 billion.

12. Chinese scientists built complex models to make the same types of projections. Below is a graph of one of the projections used by the Chinese government before instituting its one-child policy.

In this graph, ß represents the total fertility rate (number of births per woman).



Source: Song Jian Li Guangyuan, "Renko fazhan wenti dingliang yanju" ("Qunatitative research on the problem of population development") Jingi yanjiu (Economy Research), No. 2, pp 60-67. Reproduced in Greenhalgh, "Science, Modernity, p.180.

a) Which of the values of ß found on the graph most closely matches the total fertility rate from 1978?

b) Use the graph's projection for this ß-value to make estimates of China's population in the following years:

1. 2000

2. 2040

3. 2080

c) How close are the above estimates to your calculations from #10?

13. The group of researchers that created the graph above believed the "ideal" population size of China in 2080 was between 650 million and 700 million people. Based on the projection in the graph shown above, what would the total fertility rate (number of births per woman) need to be in order to achieve this target population?

Moral Considerations of the One-Child Policy

Role of the Government

"In the Catholic tradition, government has a positive role because of its responsibility to serve the common good, provide a safety net for the vulnerable, and help overcome discrimination and ensure equal opportunity for all. Government has inescapable responsibilities toward those who are poor and vulnerable, to ensure their rights and defend their dignity. Government action is necessary to help overcome structures of injustice and misuse of power and to address problems beyond the reach of individual and community efforts. Government must act when these other institutions fall short in defending the weak and protecting human life and human rights."

- How does this quote describe the role of the government?

- What are some keywords the bishops use to describe the role of the government?

- Based on this quote, can you brainstorm some concrete examples of things a government might be expected to do or not to do?

"A Place at the Table: A Catholic Recommitment to Overcome Poverty and Respect the Dignity of All God's Children," U.S. Conference of Catholic Bishops (USCCB), 2022.

Human Dignity

"Man [all human beings] alone is called to share, by knowledge and love, in God's own life . . . This is the fundamental reason for his dignity. Being in the image of God, the human individual possesses the dignity of a person, who is not just something, but someone…He is capable of self-knowledge, of self-possession and of freely giving himself and entering into communion with other persons. Further, he is called by grace to a covenant with his Creator, to offer him a response of faith and love that no other creature can give in his stead."

- What words or phrases catch your attention?

- How does this quote describe human beings?

- What does it mean to be a *someone* rather than a *something*?

- With whom are we called to be in relationship? What does this quote imply about what our relationships should look like?

Catechism of the Catholic Church, Libreria Editrice Vaticana, 1997, §356-57.

What Human Dignity Requires of Us

"If we really believe that we are temples of the Holy Spirit, that we are vessels of the Divine, and icons of the Trinity, that, when God the Father looks at us, he sees the face of his Son, Jesus, can you imagine how differently we would treat ourselves and other people? That is morality, is it not? "

These quotes transition from human dignity broadly to the ethical commitments that human dignity requires of us.

- What words or phrases catch your attention?

- What does this quote say about morality?

"Whatever is opposed to life itself, such as any type of murder, genocide, abortion, euthanasia or wilful self-destruction, whatever violates the integrity of the human person, such as mutilation, torments inflicted on body or mind, attempts to coerce the will itself; whatever insults human dignity, such as subhuman living conditions, arbitrary imprisonment, deportation, slavery, prostitution, the selling of women and children; as well as disgraceful working conditions, where men are treated as mere tools for profit, rather than as free and responsible persons; all these things and others of their like are infamies indeed. They poison human society, but they do more harm to those who practice them than those who suffer from the injury. Moreover, they are supreme dishonor to the Creator."

"The Dignity of a Human Person: A Catholic Doctrine" by Cardinal Timothy M. Dolan, April 4, 2016
https://churchlifejournal.nd.edu/articles/the-dignity-of-a-human-person-a-catholic-doctrine/

Gaudium et Specs 27

The ghost children: In the wake of China's one-child policy, a generation is lost

- According to this article, was China's one-child policy succesful?

- What does it mean to be a ghost in China?

- Name three things that happened to Mr. Feng and his family after his wife became pregnant with their second child.

- By the time the article was written:

  How many births did China claim the one-child policy avoided?

  How many total abortions have happened?

  How many total sterilizations have been completed?

  How many children have been termed as "ghosts"?

"The ghost children: In the wake of China's one-child policy, a generation is lost" by Nathan Vanderklippe, *The Globe and Mail*, March 31, 2015, https://www.theglobeandmail.com/news/world/the-ghost-children-in-the-wake-of-chinas-one-child-policy-a-generation-is-lost/article23454402/.

- Name two other benefits the article mentions about China's one-child policy.

- Why does Ms. Li, a ghost of China, not have friends?

The Teaching of the Church on Population

- On the global scene, how did nations view the Catholic Church and its role in the world population?

- What is the difference between population control and birth control?

- According to the developmentalist approach, what can the government do in terms of population? What decisions should be left to the family?

- The document lists ten points. Pick one and explain why you think it is important.

"The ghost children: In the wake of China's one-child policy, a generation is lost" by Nathan Vanderklippe, *The Globe and Mail*, March 31, 2015, https://www.theglobeandmail.com/news/world/the-ghost-children-in-the-wake-of-chinas-one-child-policy-a-generation-is-lost/article23454402/.

Evaluating the One-Child Policy

14. One of the original goals of the scientists and data analysts was to keep China's population below 1.2 billion. They did not meet this goal. According to the table below, in what year did the Chinese population actually reach 1.2 billion?

Year	Population (total)	Population growth (annual %)	Birth rate, crude (per 1,000 people)	Fertility rate, total (births per woman)	Death rate, crude (per 1,000 people)
1990	1,135,185,000	1.47	21.06	2.31	6.67
1991	1,150,780,000	1.36	19.68	2.14	6.70
1992	1,164,970,000	1.23	18.27	1.98	6.64
1993	1,178,440,000	1.15	18.09	1.84	6.64
1994	1,191,835,000	1.13	17.70	1.73	6.49
1995	1,204,855,000	1.09	17.12	1.66	6.57
1996	1,217,550,000	1.05	16.98	1.62	6.56
1997	1,230,075,000	1.02	16.57	1.61	6.51
1998	1,241,935,000	0.96	15.64	1.60	6.50
1999	1,252,735,000	0.87	14.64	1.60	6.46

Use this table for the next two questions

Year	Population growth (annual %)	Year	Population growth (annual %)	Year	Population growth (annual %)	Year	Population growth (annual %)	Year	Population growth (annual %)	Year	Population growth (annual %)
1960	1.83	1970	2.76	1980	1.47	1990	1.25	2000	0.79	2010	0.48
1961	-1.02	1971	2.75	1981	1.36	1991	1.28	2001	0.73	2011	0.48
1962	0.82	1972	2.46	1982	1.23	1992	1.47	2002	0.67	2012	0.49
1963	2.46	1973	2.28	1983	1.15	1993	1.44	2003	0.62	2013	0.49
1964	2.32	1974	2.07	1984	1.13	1994	1.31	2004	0.59	2014	0.51
1965	2.38	1975	1.77	1985	1.09	1995	1.36	2005	0.59	2015	0.51
1966	2.79	1976	1.55	1986	1.05	1996	1.49	2006	0.56	2016	0.54
1967	2.57	1977	1.36	1987	1.02	1997	1.60	2007	0.52	2017	0.56
1968	2.61	1978	1.34	1988	0.96	1998	161	2008	0.51	2018	0.46
1969	2.74	1979	1.33	1989	0.87	1999	1.53	2009	0.51		

15. How close was your prediction in #11 based on the 1978-data-informed model? What does this tell you about the average population growth rate between 1978 and the year in which the population reached 1.2 billion? Confirm this using the data from the table above.

16. China's population growth rate is in decline.

    a) Using "year" as the x-value and "population growth" as the y-value, create a linear function to model the population growth rate. You will need to use an external tool (Excel, Desmos, graphing calculator, etc.) to find a line of best fit to use for the linear model.

    b) Using this model, estimate the year in which China's growth rate will reach 0%.

17. From what you have learned, did the one-child policy significantly limit the growth of Chinese population? Why or why not? You may use the table below to inform your response.

Year	Population (total)	Population growth (annual %)	Birth rate, crude (per 1,000 people)	Fertility rate, total (births per woman)	Death rate, crude (per 1,000 people)
1960	667,070,000	1.83	20.86	5.76	25.43
1965	715,185,000	2.38	37.88	6.39	9.50
1970	818,315,000	2.76	33.43	5.73	7.60
1975	916,395,000	1.77	23.01	3.56	7.32
1980	981,235,000	1.25	18.21	2.61	6.34
1985	1,051,040,000	1.36	21.04	2.65	6.78
1990	1,135,185,000	1.47	21.06	2.31	6.67
1995	1,204,855,000	1.09	17.12	1.66	6.57
2000	1,262,645,000	0.79	14.03	1.60	6.45
2005	1,303,720,000	0.59	12.40	1.61	6.51
2010	1,337,705,000	0.48	11.90	1.63	7.11
2015	1,371,220,000	0.51	12.07	1.67	7.11

Write a paragraph in response to this question: From a perspective informed by Catholic Church teachings, what was morally problematic about the one-child policy and/or the measures taken to uphold the policy? As you write your response, you may consider quotes discussed in class and found in your packet.

Summative Task

Explain the following to someone who is not familiar with China's one-child policy.

- What the one-child policy was
- When and why the one-child policy was instituted (including the mathematical models)
- Why from a moral standpoint the one-child policy was highly problematic

Your creative explanation should take one of the following formats:

- Newspaper article
- Video of a "news report"
- A short podcast episode or YouTube video
- Any other format approved by your teacher

This summative task is worth 30 points and will be graded as follows:

	Excellent	Good	Average	Poor	Missing	Total
Explanation	The explanation and historical context of the policy were accurately and clearly stated.	The explanation and historical context of the policy were accurate but not clearly stated.		The explanation and historical context of the policy were incorrectly stated.	The explanation and historical context of the policy were not addressed.	/2
Mathematics	The description of the mathematical models… • demonstrated an understanding of the exponential model for population growth • demonstrated an understanding of the relevant charts and tables • was clearly stated • was clearly explained All four of these were met.	The description of the mathematical models… • demonstrated an understanding of the exponential model for population growth • demonstrated an understanding of the relevant charts and tables • was clearly stated • was clearly explained Three of these four were met.	The description of the mathematical models… • demonstrated an understanding of the exponential model for population growth • demonstrated an understanding of the relevant charts and tables • was clearly stated • was clearly explained Two of these four were met.	The description of the mathematical models… • demonstrated an understanding of the exponential model for population growth • demonstrated an understanding of the relevant charts and tables • was clearly stated • was clearly explained One of these four was met.	No description of the relevant mathematical models was present.	/20
Theology	The description of the morally problematic nature of the one-child policy was… • clearly stated • accurate • informed by Catholic Church teaching All three of these were met.	The description of the morally problematic nature of the one-child policy was… • clearly stated • accurate • informed by Catholic Church teaching Two of these three were met.	The description of the morally problematic nature of the one-child policy was… • clearly stated • accurate • informed by Catholic Church teaching One of these three was met.	The description of the morally problematic nature of the one-child policy was… • clearly stated • accurate • informed by Catholic Church teaching None of these three were met.	This submission did not address the morally problematic nature of the one-child policy.	/5
Presentation	The submission was a polished final product that utilized one of the creative formats and avoided significant grammatical errors.	The submission utilized one of the creative formats and avoided significant grammatical errors.	The submission utilized one of the creative formats but contained some significant grammatical errors.	The submission did not utilize one of the creative formats but avoided significant grammatical errors.	The submission did not utilize one of the creative formats and contained significant grammatical errors.	/3
						/30