AUTHENTIC APPLIED PROBLEMS: LIKE STORY PROBLEMS, ONLY LESS STUPID

DAWN ARCHEY

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MATHFEST-COLUMBUS, OHIO

STORY PROBLEMS VS AAPs

- Billy and Suzie are building a snowman. After 5 minutes of work they have a snowball with diameter 12 inches. Two minutes later, the snowball has diameter 16 inches. What % has the volume changed?

Answer the question posed in @MathInTheNews 's tweet from July 14, 2015:

- New Horizons says Pluto's diameter is 1473mi, 50mi larger than believed. What % does that change its volume estimate?

Story Problems	AAPs
Toy Scenario	Realistic Scenario
No one wants to know the answer	Scientists or politicians or homeowners want to know the answer
Uses material from the section	Uses material from the section and other material
May be an easier way to obtain the answer (ex measure directly)	Hard/impossible to find answer without doing math
	Ideally, only about 10% harder

zzzzz!

ANOTHER EXAMPLE AAP

On April 20, 2010 the Deepwater Horizon drilling rig exploded initiating the worst oil spill in US history. It was important to estimate the volume of oil spewing out each day, but it is hard to measure such high volume flow directly. Suppose that the spilled oil is cylindrical in shape and a uniform thickness of 1mm [AMSA]. On day 9 of the spill the area of the spill was 13,000 km^2 [TIME] and the radius of the spill was increasing at a rate of 743 meters per day[NBC].

a) At what rate was the volume of the spill increasing on the 9th day?

b) How quickly was the oil spewing out on the 9th day?

c) BP's official estimates of the flow rate were 160 to 790 m^3/day [WIKI], how accurate were their estimates?

WHY GIVE AAPS

- **Students hate story problems but want to know “when will I ever use this?”**
- **Employers want these skills (and when you tell students that it motivates them).**
- **Doing authentic problems also improves skill in rote problems [BOA]**
- **Fun for you**
- **For new faculty-its an innovation you can do whenever you have time, no big upfront commitment.**

CAUTIONS ABOUT AAPS

- Students get frustrated, but are satisfied afterward.
- Can take a long time to make (1-4 hours for one worksheet problem)
- Making them can be addictive
- If you want to make a problem about a certain type of function, say quadratic its hard to find data that has the right shape.
- Don’t forget to cite your sources—set a good example.

REFERENCES

- [AMSA] http://www.amsa.gov.au/Marine_Environment_Protection/Educational_resources_and_information/Teachers/Classroom_Projects/Mathematics_and_Oil_Spills.asp
- [BOA] Boaler, J. ``Open and closed mathematics: Student experiences and understandings.'' *Journal for Research in Mathematics Education*, 29 (1998), p 41-62.
- [CIA] https://www.cia.gov/library/publications/the-world-factbook/geos/kn.html accessed 12/2/2014
- [CL] Ben Crow and Suresh K. Lodha *The Atlas of Global Inequalities*. 2011.
- [NBC] http://www.nbcnews.com/id/37717335/\#slice-2
- [TIME] http://www.time.com/time/interactive/0,31813,2006455,00.html
- [WHO] http://apps.who.int/gho/data/node.main.688?lang=en accessed 12/2/2014
- [WIKI] http://en.wikipedia.org/wiki/Deepwater_Horizon_oil_spill
- [WRI] http://www.wri.org/resources/data-sets/cait-country-greenhouse-gas-emissions-data accessed on 12/2/2014

SOURCES OF AAPS AND OTHER GOOD PROBLEMS

- **My blog: http://blogs.udmercy.edu/archeyde/**
- ***Mathematics and Social Justice: Modules for the Classroom*** **(Eds. Karaali, Gizem and Khadjavi, Lily) to appear from MAA press.**
- **Nasa http://www.nasa.gov/audience/foreducators/index.html**

WHERE TO FIND IDEAS FOR AAPS

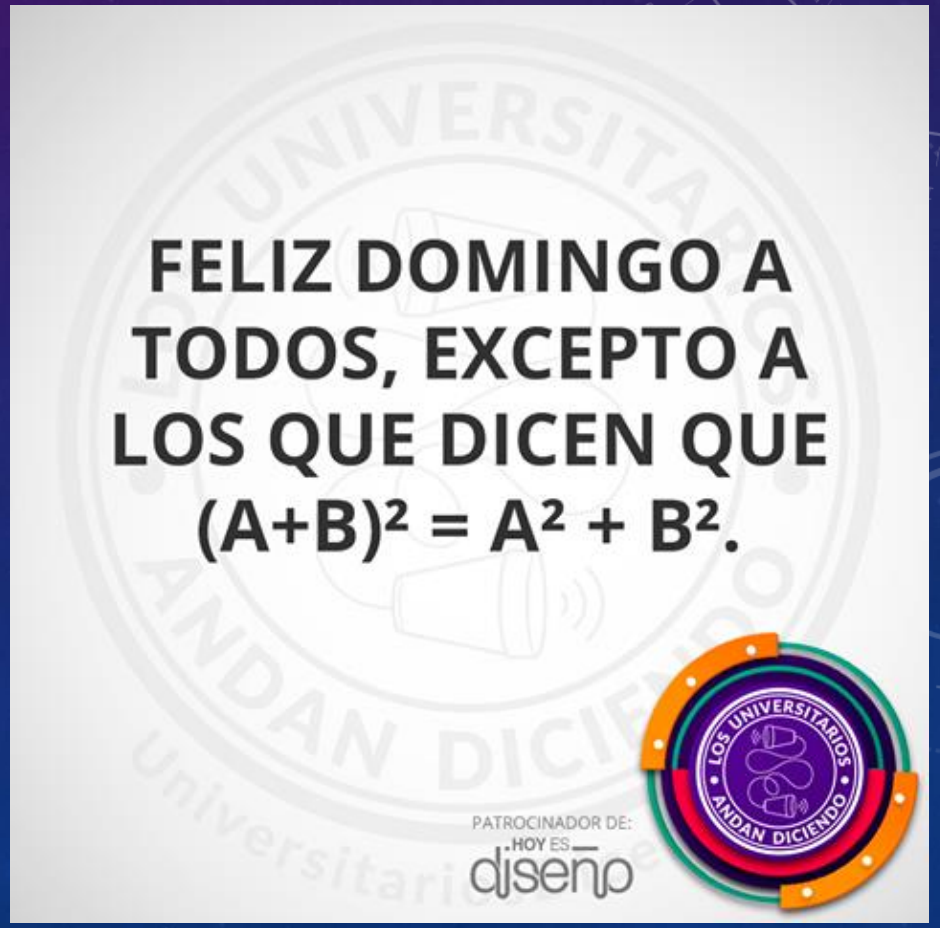
- News
- Social media
- Adjust text book problems
- Data sets or graphs
- Articles on things that interest you
- Non fiction books
- Talk to people in other fields

WHERE TO PUBLISH AAPS

- I don’t know, suggestions welcome
- I got two in as book chapters
- I put mine on my blog http://blogs.udmercy.edu/archeyde/
- I’m thinking about writing a book, if you’d like to contribute let me know

AAPs CAN BE VERY SIMPLE

- **This appeared on my Facebook wall. What does it say? What's the point?**

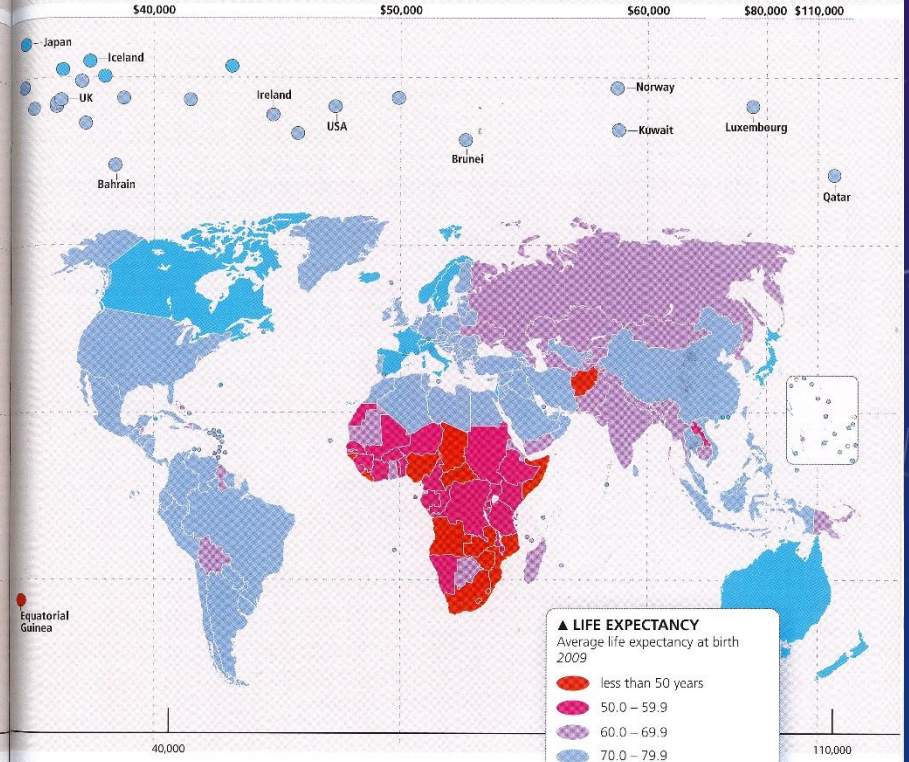


ANOTHER EXAMPLE

Life Expectancy

Societies with higher GDP tend to have higher life expectancy. At all levels of GDP, however, societies with greater equality achieve longer life spans than more unequal societies.

◄ **RELATIONSHIP BETWEEN INCOME AND LIFE EXPECTANCY**
GDP per capita, PPP$ *2008*
Life expectancy at birth *2000–05*



A child born in central Africa is likely to live only **half as long** *as one born in western Europe*

► Life expectancy at birth is a measure of the number of years a newborn is expected to live if current mortality rates continue to apply. It provides a robust measure of the health of a country's population, and also of the level of inequality within it.

Until the 1990s, life expectancy was steadily rising in almost all parts of the world. Then HIV/AIDS became a major cause of death in Sub-Saharan Africa, and the disruptions of economic transition in Eastern Europe brought life expectancy decline there, too. In some countries of southern Africa, such as Botswana, life expectancy declined by 10 years or more during the 1990s as a result of AIDS deaths. In Russia it declined from 69 to 64 in the five years after 1989.

Longer life expectancy is associated with increased national income, reduced inequalities and government programs that improve education and health, in particular for the poor. That is why people in Sri Lanka, Cuba and Costa Rica have high life expectancy compared with other countries of a similar income level. By contrast, people in South Africa and Brazil have lower average life expectancy than other societies of a similar income level because their histories are characterized by marked inequality and neglect of the needs of the poor.

The influence of social and economic change on life expectancy is also illustrated by the example of the industrializing countries of Europe from the 18th to 20th centuries, where dramatic increases in life expectancy pre-dated advances in curative medicine such as antibiotics.

Life expectancy in Africa: **54 years**
in North America: **79 years**

ANOTHER EXAMPLE

The function $f(x) = 4.5242ln(x) + 33.774$ can be used to predict the life expectancy at birth $f(x)$ in a country where the GDP per capita is x US dollars. (Data from [WRI] and [WHO])

a) Use the model above to predict the life expectancy at birth in a country where the GDP per capita is $40, 000.

b) North Korea does not publish the information which is usually used to determine GDP [CIA]. However, in North Korea, life expectancy at birth is 63.8 years[CL]. According to the model, what is the likely GDP per capita of North Korea?

QUESTIONS OR ANSWERS

- Where can I publish AAPs?
- Where can I find AAPs?
- Do you want to contribute to my book of AAPs?
- Any suggestions for AAPs on?
  - Graph Transformations
  - Trig graphs
  - Parallel and perpendicular lines
  - Piecewise functions