

Possible Topics for Research Paper

1. The German astronomer Johann Bode discovered a pattern in the distances of the planets from the sun. Research Johann Bode and his pattern. How could you use this research in an elementary class studying the solar system? A possible project is a model of the solar system or a way to show students how large the distances actually are with a model.
2. Research how to estimate the number of people in a crowd -- one way is through the amount of trash they leave behind. How can this be used to estimate the number of beans in a jar – a typical problem for a contest or for an elementary school class? A possible project might be to run a contest about estimating the number of beans or candies in a jar with other students in class – a raffle of some sort.
3. George Cantor was one of the first mathematicians to answer questions concerning infinite sets. Research George Cantor and his work on infinite sets. You could include in your research information about Cantor’s professor who was one of his most acerbic critics and information about paradoxes. A possible project could be bringing in several paradoxes to the class and discuss them with the class.
4. Catherine the Great once asked for Euler’s help to quiet the famous French philosopher Diderot, who was attempting to convert her subjects to atheism. One day in the court, Diderot was informed that someone had a mathematical proof of the existence of God. Research as many different proofs as to the existence of God that you can find.
5. Research “controversial Venn diagrams” on the Web. How can you use Venn diagrams to teach English, history, etc. A possible project could be a book of possible topics that can be used in an elementary school classroom. Venn diagrams are attributed to John Venn. What is the name of the work in which Venn diagrams were first used? What is another name for Venn diagrams?
6. Is infinity a number? How big is infinity? What is infinity plus one? What about infinity plus infinity? Consider Infinity Hotel or the Hilbert Hotel created by mathematician David Hilbert. Mary Pat Campbell has written a song about a hotel with an infinite number of rooms titled *Hotel Aleph Null—yeah* which is sung to the tune of *Hotel California* by the Eagles. How can you use this in the classroom?

7. Find out what Boolean algebra is and how it relates to logic. Research George Boole – recount the tragic circumstances of his death (*Lectures on Ten British Mathematicians of the Nineteenth Century* by A. Macfarlane).
8. There is a type of logic, called *fuzzy logic*. What is *fuzzy logic*? Look up applications of fuzzy logic. What is a fuzzy set?
9. Explore the contributions made by Indian mathematicians, such as Brahmagupta (seventh century), Mahavira (ninth century), and Bhaskara (twelfth century).
10. Research other numeration systems such as
  - a) Egyptian numeration system – how did they handle fractions?
  - b) Babylonian system with special emphasis on the base used.
  - c) Sumerian numeration system.
  - d) Mayan calendar
  - e) Gregorian calendar
  - f) Ionic Greek numeration system
11. Research fractions and decimals.
  - a) Who invented the horizontal bar to write the common fractions, and who was the first European mathematician to use the horizontal fraction bar?
  - b) Who were the first users of the diagonal fraction bar? From what did the diagonal bar evolve?
  - c) What symbols were used to write the decimal point and by whom?
  - d) Who invented the percent symbol and when?
12. The word algebra is the European derivation of *al-jabr*, part of the title of al-Khwarizmi's treatise *Hisab al-jabr w'al muqabalah*, "The Science of Reunion and Reduction." Research the beginnings of algebra. Al-Khwarizmi noted six types of equations that can be written using squares, square roots, and constants? What were the six types of equations? What inspired al-Khwarizmi to write the book? In the first decade of the eleventh century, a major work dealing with algebra, entitled *The Marvelous*, was written. Who was the author of this book, what was its original title, and what topics were covered in this book? Find out what techniques the Babylonians used to solve quadratic equations. What method was used by Euclid to solve quadratics? How did the Hindu mathematician Brahmagupta solve quadratics?
13. Research linear programming. What is it? How is it used? Who invented it? When was it first used?
14. Was algebra invented before geometry? When was Euclid born? Where? What did his book *The Elements* contain? Book 1 of *The Elements* contains five important postulates used in what is now called Euclidean geometry? What are these five postulates? What other types of geometries are there? What is non-

Euclidean geometry? Who is the author of the phrase “There is no royal road to geometry?” and what are that person’s other contributions to geometry? What are Thales of Miletus contributions to geometry?

15. Pythagoras is such an important part of mathematical lore and history that many pages and effort have been devoted to the study of his life and achievements. Here are some topics to ponder.

a) Many scholars ascribe the Pythagorean theorem to, surprise, Pythagoras! However, other versions of the theorem like the following exist:

The ancient Chinese proof  
Euclid’s proof  
Pappus’ generalization

Bhaskara’s proof  
Garfield’s proof

- b) There are different versions of Pythagoras’s death.
- c) Pythagorean triples
- d) Pythagorean’s theory of music
- e) Pythagorean’s theory of astronomy

16. In 1637, Pierre de Fermat scribbled a note proposing that there are no positive integers  $a$ ,  $b$ , and  $c$  such that  $a^n + b^n = c^n, n > 2$ . Write a report on Fermat’s last theorem and the false proof the theorem offered in March 1988. Has the theorem been proved?

17. Write a report about chaos. Who discovered it, when, and what are some of its applications? Get a copy of the book *Jurassic Park* and discuss its interpretation of chaos and how this subject applies to the plot in the book. Find the fractal curves mentioned in the book and how do you think these fractals are constructed.

18. Write a short history of game theory stating the main contributors as well as their contributions. What is the Prisoner’s Dilemma, who discovered it, and what is its importance. State different versions and solutions to the problem.

19. What is clock and modular arithmetic? Research the origins of both types. How are they used? What about the Chinese Zodiac? What are congruences and how can we use them to solve problems?

20. This man rediscovered Euclid’s 32<sup>nd</sup> proposition, invented the first calculating machine at age of 18, and, inspired by a persistent toothache became a successful researcher of the properties of the cycloid (a geometric curve). Find out who this mathematician was and write a paper detailing the events mentioned.

21. Write a report about Antoine Gombaud, the Chevalier de Mere, and the gambling problem he proposed to Pascal. Look at the correspondence between Pascal and Fermat and its influence in the development of the theory of probability. Find the name, author, and year of publication of the first work on the mathematical treatment of probability. The theory of probability was studied by the Russian mathematicians P. I. Chebyshev, A. A. Markov, and Andrei Nikolaevich Kolmogorov. What are their contributions to probability?
22. Write a paper on how Gregor Mendel, Sir Francis Galton, and Florence Nightingale used statistics in their work. What fields use statistics? How are statistics used in medicine, psychology, and business? How will statistics be used in your future career? Why is it so easy to abuse statistics? Talk about some of the abuses of statistics? Discuss the Harris and Gallup polls and the techniques used in their surveys?
23. The Game of Life was invented by the mathematician John H. Conway in 1970. Research the Game of Life and its inventor. Many websites have applets that allow you to play the Game of Life. Try playing the game.
24. Research the Monty Hall problem that is discussed at the beginning of Chapter 1. Do several simulations of the game.
25. Research the Tower of Hanoi puzzle invented by Edouard Lucas in 1883. Play with the puzzle.
26. Research one of the unsolved problems in mathematics.
  - a) One famous unsolved problem is known as the *Collatz problem* or the  $3n + 1$  problem. This problem was created by L. Collatz in 1937.
  - b) Another famous unsolved problem is the Traveling Salesman problem.
  - c) The 4-color map problem was recently solved.
  - d) Trisecting an angle is another one.
27. Explore Pascal's Triangle – its history and use. There are lots of secrets in the triangle.
28. Raymond Smullyan is a logician, a philosopher, a professor, and an author of many books on logic and puzzles. Some of his fans rate his puzzle books as the best ever written. Research his life and his work in the area of logic. Try some of his puzzles.
29. Research switching networks. For a project, you could actually build one or two different networks. How can this be used in a classroom for elementary school children? Science fair projects?

30. Research the life and writings of Lewis Carroll. Play particular interest in puzzles. Find some that you think are interesting and write about them. He also devised a bilateral diagram (two-part board) to analyze syllogism that has some advantages over Euler's diagrams and Venn diagrams.
31. Report on fallacies – there are a lot of them out there (ad hominem, ad populum, ad baculum, ad vercundiam, non sequitur, fallacy of false cause, pluriam interrogationem are just a few). How are these fallacies used every day? Give examples.
32. Explore number theory – perfect numbers, abundant numbers, semi-perfect numbers, weird numbers, etc.
33. John Quincy Adams, the sixth president of the United States, proposed an apportionment method. Research this method, which is known as the Adams method of apportionment. Explain how this method works. Also indicate whether it satisfies the quota rule and whether it is susceptible to any paradoxes. Also look at the Hamilton method, the Jefferson method, the Webster method, and the Huntington-Hill methods. Do any of them break the quota rule? Are any of them susceptible to any paradoxes? You might do a simulation with some population figures to dramatize the difference between the methods.
34. Research weighted voting systems. Look at the Borda Count Method of voting, plurality with elimination, Cordorcet criterion, Fairness Criteria, Arrow's Impossibility Theorem, the Electoral College, the United Nations Security Council, and the European Union.
35. Simpson's math – look at the long-running comedy series and how math has been used in the program. There are many websites on this topic.
36. Math in the media – cartoons, movies, TV shows, music. There are many websites talking about how math and mathematicians are viewed in the media. A possible project is a video or DVD or CD with clips from different shows showing how math is portrayed.
37. Math in other cultures – Egyptian math, Babylonian math, Mayan math, Indian math, ancient Chinese math, math used by the native people in America, etc.
38. Pyramids – There are pyramids found all over the world. Research these – what type of math was needed and used. What do these have in common? What about Stonehenge?
39. Calculating devices – abacus, early computers, knots used by the Aztecs, Napier's Bones, etc.
40. Research the role of women and minorities in mathematics.

41. Research some of the myths and tales about mathematicians and math history.
42. Research math anxiety and ways of coping with this anxiety. There are many websites about this topic. If you are going to be a teacher, this is an important topic for you. What can you do? What kind of help is out there for students?
43. Research innovative ways of teaching children their basic math such as Touch Math
44. Math in art – symmetry, the golden ratio.
45. M. C. Escher
46. Math in literature