

Teacher's Preparatory Guide

R.A.N.-Reading and Analyzing Nanotechnology

Purpose

A focus of the National Science Standards and the Georgia Performance Standards is that students are provided opportunities to read and analyze science outside of their textbooks. This lesson will allow reading across the curriculum by providing students the opportunity to read about nanotechnology. In addition this will open up an opportunity to engage students in discourse about a significant technology that will allow them to analyze and reflect on its implications and significance for the future.

Time required:

Total time: Five 50 minute class periods

Three 50 minute class periods for part 1

One 50 minute class period for students to plan booklets for part 2

One 50 minute class period for students to share booklets for part 2

For part 2 of project students should be given at least four weeks to read fiction book and write and illustrate booklets.

Level:

Middle or high school. The age level of the students would determine the non fiction book selected and the list of fiction books that students could select from.

Teacher Background

As stated by the National Science Education Standards, science influences society through its knowledge and world views. The effect of science on society is neither entirely beneficial nor entirely detrimental because technology influences society through its products and processes. These technological changes are often accompanied by social, political, and economic changes that can be beneficial or detrimental to individuals and to society. Social needs, attitudes, and values influence the direction of technological development.

Nanotechnology is an exciting area of science and engineering that occurs at the atomic, molecular level. It is the science and technology of small things. There are many different views of precisely what is included in nanotechnology. In general, however, most agree that three things are important.

1. Small size, measured between 1 to 100 nanometers.
2. Unique properties because of the small size. Nano size properties of materials like conductivity, hardness, or melting point meet the more exotic properties of the atomic and molecular world such as wave-particle duality and quantum effects.
3. Control the structure and composition on the nm scale in order to control the properties.

Materials

Class room set of non fiction book selected.

Copies of R.A.N. Literature Student Worksheet and Student Assignment Sheet for each student.

Advance Preparation

1. Select non-fiction book on nanotechnology and obtain a classroom set. Resource list of both fiction and nonfiction books is attached. **(Funding ideas for obtaining books may include local groups such as PTA or grants.)**
2. Prepare worksheet by listing chapter assignment and group assignment. Number of groups and group sizes will be determined by class size and length of book selected. Typical number of pages for

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a class of 28 high school students is 12 to 14 pages.

3. Contact feeder or cluster elementary schools to make arrangements for constructed booklets to be given to teachers or media center. (It might be possible to make arrangements that some students will go with booklets to read a few to students.)

Safety Information

Have selected nonfiction book and fiction book list approved by your school's media committee.

Directions for the Activity

Part 1: (Day 1)

1. Distribute selected nonfiction books to students and student worksheet. Students are to complete Section 1 on student worksheet. (Copy of R.A.N. Literature Student Worksheet is attached)
2. Students will read pages assigned on their worksheet. Number of pages will be determined by number of students in each group and number of pages of the selected book.
3. Have students complete section 2 on student worksheet.

(Day 2)

4. Place students into assigned groups and have each student share with the group what their section of the book was about. At least 30 minutes.
5. Have whole class discussion of book with each group being asked to contribute a statement about some portion of the book.
6. Have students complete section 3 on student worksheet.
7. Collect student worksheets.

Part 2: (Day 3)

8. Distribute Reading Assignment Instruction Sheet that includes a list of Nanotechnology connected fiction books. Explain to the students that they are to select a book off the list. (You may want to limit the list to books that are available in the school or local libraries.) (Copy of Reading Assignment Instruction sheet is attached)
 9. Review instruction sheet with students. Set up a day for students to work with their partners to plan booklets together.
- (4-6 weeks later)
10. Have students share booklets with their class before turning in to be taken to elementary school.

Procedure (from Student Activity Guide)

(Copies of both the R.A.N. Literature Student Worksheet and the Reading Assignment Instruction sheet are attached.)

Cleanup:

Have an area set up for students to turn in the nonfiction book that they read and the booklets that they will turn in at the end of the project.

Procedure (from Student Activity Guide)

(Worksheet with answers is attached.)

Worksheet (with answers)

(Worksheet with answers is attached.)

Assessment

Students will be graded using rubric. Rubric will include worksheet points, children's booklet points, and bonus points. (Copy of rubric is attached.)

Resources:

To learn more about nanotechnology, here are some web sites with educational resources:

To find a list of books on nanotechnology Google for books on nanotechnology or go to Amazon and ask for books on nanotechnology.

National Science Education Standards

Science in Personal and Social Perspectives:

1. Environmental quality
2. Science and technology in local, national, and global challenges

History and Nature of Science:

1. Science as a human endeavor
2. Nature of scientific knowledge
3. Historical perspective

Georgia Performance Standards Addressed:

SCSh 1. Students will evaluate the importance of curiosity, honesty, openness, and skepticism in science.

SCSh 2. Students will communicate scientific investigations and information clearly.

SCSh 7 Students will analyze how scientific knowledge is developed.

SCSh 9 Students will enhance reading in all curriculum areas.

List of Books

Non-fiction: (Examples of books to be used for classroom groups and classroom discussion.)

1. Nanotechnology-A Gentle Introduction to the Next Big Idea by Mark Ratner and Daniel Ratner. (Book is designed to introduce you to nanoscience and nanotechnology. The book also gives examples of why these areas are two of the hottest fields in science, business, and the news today.)
2. Engines of Creation-The Coming Era of Nanotechnology by K.Eric Drexler. (Book about the consequences of a new technology such as nanotechnology.)
3. Muscle Wire Project Book by Roger G. Gilbertson (A hands-on guide to amazing robotic muscles that shorten when electrically powered and projects to do with these wires.)
4. Nanotechnology and Homeland Security by Daniel Ratner and Mark A. Ratner (Nanotechnology offers immense potential for fighting terrorism without sacrificing our open, free, and democratic society. Book covers ways nanotechnology can be used.)
5. NanoFuture-what's next for nanotechnology by J. Starrs Hall (Describes nanotechnology so that everyone can understand what it is, its possibilities and its limitations)
6. Nano-Hype-the Truth Behind the nanotechnology Buzz by David M. Berube (Review of the literature about nanotechnology which looks at both the positive and negative information about nanotechnology)
7. Nanotalk by Rosalyn W. Berne (Conversations with scientists and engineers about ethics, meaning, and belief in the development of nanotechnology)
8. Nanotechnology-Science, Innovation, and Opportunity by Lynn E. Foster (Offers up-to-the-minute briefing on where the industry stands now, how it will unfold over the coming decade, and how it will impact you)
9. Nanotechnology-basic science and emerging technologies by Mick Wilson, Kamali Kannangaro, Geoff Smith, Michelle Simmons, and Burkhard Raguse (Discusses nanotechnology by trying to bridge the gap between highly detailed specialist and basic science)
10. Understanding Nanotechnology by Editors of Scientific American (Presents the cutting edge of a new technology that will find usage in medicine, space exploration, communication, manufacturing and almost every other aspect of modern society)
11. The Dance of Molecules by Ted Sargent (Brings readers into the lab and reveals how all disciplines of science from medicine to microchips, are converging to create practical solutions to our biggest problems and revolutionizing the way we live, work, and play.
12. Gecko's Foot by Peter Forbes (discusses how scientist and engineers are using the kind of "wet"

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self-assembly techniques that nature has perfected to build intricate structures with surprising new properties.)

13. *Nanotechnology for Dummies* by Richard Booker and Earl Boysen (A book designed to help the general public comprehend the basic concepts of nanotechnology, discover what nanotechnologists are making happen today, and get a look at the groundwork for tomorrows nano-applications)

14. *Nanotechnology Demystified* by Linda Williams and Dr. Wade Adams (For anyone interested in the nanoscale world who wants to learn more about this exciting new area.)

Fiction: (Examples of books that could be chosen by students for individual reading.)

1. *Nanotech Chronicles* by Michael Flynn.
2. *The Diamond Age* by Neal Stephenson
3. *A Fire Upon the Deep* by Vernor Vinge
4. *A Deepness in the Sky* by Vernor Vinge
5. *Prey* by Michael Crichton
6. *Nanotech* by Jack Dann
7. *Queen City Jazz* by Kathleen Ann Goonan
8. *Bloom* by Will McCarthy
9. *Ventus* by Karl Schroeder
10. *Singularity Sky* by Charles Stross
11. *Moonwar* by Ben Bova
12. *The First Immortal: A Novel of the Future* by James L Halperin
13. *Nano* by John Robert Marlow
14. *Blood Music* by Greg Bear
15. *Wellstone* by Wil McCarthy
16. *The Collapsium* by Wil Carthy
17. *Metaplanetary* by Tony Daniel
18. *The Free Lunch* by Spider Robinson
19. *Snow Crash* by Neal Stephenson
20. *Forge of Heaven* by C.J. Cherryh
21. *Hammerfall* by C.J. Cherryh
22. *Diaspora* by Greg Egan
23. *Permutation City* by Greg Egan
24. *I Dora* by William Gibson
25. *Limit of Vision* by Linda Nagata
26. *Vast* by Linda Nagata
27. *Deception Well* by Linda Nagata
28. *Tech Heaven* by Linda Nagata
29. *Bohr maker* by Linda Nagata
30. *Factoring Humanity* by Robert J. Sawyer
31. *Acts of the Apostles* by John F.X. Sundman
32. *Mississippi Blues* by Kathleen Ann Goonan
33. *Crescent City Rhapsody* by Kathleen Ann Coonan
34. *Light Music* by Kathleen Ann Goonan
35. *The Nano Flower* by Peter F. Hamilton
36. *Technogenesis* by Syne Mitchell
37. *Viral Intelligence* by Don De Brandt
38. *Slant* by Greg Bear
39. *The Forge of God* by Greg Bear
40. *Anvil of Stars* by Greg Bear
41. *Queen of Angels* by Greg Bear
42. *Blood Music* by Greg Bear
43. *Moonseed* by Stephen Baxter
44. *Moonrise* by Ben Bova
45. *Dead Girls, Bead Boys, Bead Things* by Richard Calder
46. *The Fortunate Fall* by Raphael Carter
47. *Immortals* by Jack Dann
48. *Camelot 30K* by Robert L. Forward
49. *Moving Mars* by Greg Bear

R.A.N Literature Student Worksheet

Pages assigned to read _____

Assigned Group _____

Members _____

Part 1

Section 1: Answer before reading assigned pages.

Read the following statements and put a check in the appropriate box.

	Agree	Disagree
1. Most companies currently pursuing nanotechnology initiatives are involved in pure research and development.		
2. The process of nanofabrication in making gold nanodots is a new process showing up in industry.		
3. Biotechnology and pharmaceuticals are two segments of industry that stand to gain a great deal from nanotechnology.		
4. A speech by Nobel Prize winning physicist Richard Feynman in 1960 is commonly considered to have launched nanotechnology.		
5. A "smart" material is one that incorporates in its design a capability to perform several specific tasks and in nanotechnology that process is done at the molecular level.		

6. Write below two questions that you have about the assigned book
A.

B

7. Predict what you think the book will focus on in relationship to nanotechnology.

Read your assigned pages.

Section 2:

1. Summarize and write below at least four important statements that come from the assigned reading.

A.

B.

C.

D.

2. When instructed to do so by your teacher, find the other members of your group. Share with the group what your section of the book was about and the four important statements from your reading.

3. List each member of your group and a one sentence summary of their section of the book.

Student	Summary

Section 3:

Read the following statements and put a check in the appropriate box.

	Agree	Disagree
1. Most companies currently pursuing nanotechnology initiatives are involved in pure research and development.		
2. The process of nanofabrication in making gold nanodots is a new process showing up in industry.		
3. Biotechnology and pharmaceuticals are two segments of industry that stand to gain a great deal from nanotechnology.		
4. A speech by Nobel Prize winning physicist Richard Feynman in 1960 is commonly considered to have launched nanotechnology.		
5. A "smart" material is one that incorporates in its design a capability to perform several specific tasks and in nanotechnology that process is done at the molecular level.		

Write a statement below that summarizes your initial predictions to questions 6 and 7 in section 1. Explain how your predictions agree or disagree with your understanding of the book now.

R.A.N Literature Student Worksheet

Pages assigned to read _____ (This will be determined by book and number of students in groups)_____

Assigned Group Members _____ (List all students in a group here)_____

Part 1

Section 1: Answer before reading assigned pages.

Read the following statements and put a check in the appropriate box.

<i>(These questions came from the book "Nanotechnology: A Gentle Introduction to the Next Big Idea" by Mark and Daniel Ratner. Your questions will depend on the book selected)</i>	Agree	Disagree
1. Most companies currently pursuing nanotechnology initiatives are involved in pure research and development.	X	
2. The process of nanofabrication in making gold nanodots is a new process showing up in industry.		X First were medieval glass makers
3. Biotechnology and pharmaceuticals are two segments of industry that stand to gain a great deal from nanotechnology.	X	
4. A speech by Nobel Prize winning physicist Richard Feynman in 1960 is commonly considered to have launched nanotechnology.	X	
5. A "smart" material is one that incorporates in its design a capability to perform several specific tasks and in nanotechnology that process is done at the molecular level.	X	

6. Write below two questions that you have about the assigned book

A. (Questions will depend on student and the book selected)

B

7. Predict what you think the book will focus on in relationship to nanotechnology.

(Answers will depend on student)

Read your assigned pages.

Section 2:

1. Summarize and write below at least four important statements that come from the assigned reading.

A. (Answers will vary depending on what section a student read)

B.

C.

D.

2. When instructed to do so by your teacher, find the other members of your group. Share with the group what your section of the book was about and the four important statements from your reading.

3. List each member of your group and a one sentence summary of their section of the book.

Student	Summary

Section 3:

Read the following statements and put a check in the appropriate box.

(These answers may change for students depending on what they originally put)	Agree	Disagree
1. Most companies currently pursuing nanotechnology initiatives are involved in pure research and development.		
2. The process of nanofabrication in making gold nanodots is a new process showing up in industry.		
3. Biotechnology and pharmaceuticals are two segments of industry that stand to gain a great deal from nanotechnology.		
4. A speech by Nobel Prize winning physicist Richard Feynman in 1960 is commonly considered to have launched nanotechnology.		
5. A "smart" material is one that incorporates in its design a capability to perform several specific tasks and in nanotechnology that process is done at the		

molecular level.		
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Write a statement below that summarizes your initial predictions to questions 6 and 7 in section 1. Explain how your predictions agree or disagree with your understanding of the book now.

Student Reading Assignment Instruction Sheet

Goal: A focus of the National Science Education Standards is that students are provided opportunities to read and analyze science outside of their textbooks. This project will provide you the opportunity to read about nanotechnology and will allow you time to analyze and reflect on its implications and significance for the future.

R.A.N. Part 2 Reading Assignment Instruction Sheet

1. Off of the list of fiction books you must select and read one of the books.
2. You are to complete the following questions about the book you read and turn in with the booklet described below.

Questions:

1. What was the book title and author that you read?
 2. Summarize in one paragraph what your book was about.
 3. Explain the connection to nanotechnology in the book.
 4. Based on what you have read do you think nanotechnology was based on "real" science. Why or why not?
 5. What was your favorite thing about the book?
 6. What was your least favorite thing about the book?
 7. Would you recommend this book to others? Why or why not?
-
4. You and your assigned partner are to **write and illustrate** a booklet about how you think nanotechnology will impact society in the next 20 years. The book must be at least 10 pages not including the cover and should be written and illustrated for either ages 5-7 or for ages 8-12. The booklets must be bound by the media center and you must make arrangements with them for getting it done.
 5. You and your partner will be given at least one class period to discuss and plan the booklet but all other work must be done outside of class.
 6. Booklets and answers to questions above are **due**_____.

List of Books to choose from. Check with your school's media center or the local public library system.

Fiction:

1. Nanotech Chronicles by Michael Flynn.
2. The Diamond Age by Neal Stephenson
3. A Fire Upon the Deep by Vernor Vinge
4. A Deepness in the Sky by Vernor Vinge
5. Prey by Michael Crichton
6. Nanotech by Jack Dann
7. Queen City Jazz by Kathleen Ann Goonan
8. Bloom by Wil McCarthy
9. Ventus by Karl Schroeder
10. Singularity Sky by Charles Stross
11. Moonwar by Ben Bova
12. The First Immortal: A Novel of the Future by James Halperin
13. Nano by John Robert Marlow
14. Blood Music by Greg Bear
15. Wellstone by Wil McCarthy
16. The Collapsium by Wil Carthy
17. Metaplanetary by Tony Daniel
18. The Free Lunch by Spider Robinson
19. Snow Crash by Neal Stephenson
20. Forge of Heaven by C.J. Cherryh
21. Hammerfall by C.J. Cherryh
22. Diaspora by Greg Egan
23. Permutation City by Greg Egan
24. I Dora by William Gibson

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25. Limit of Vision by Linda Nagata
26. Vast by Linda Nagata
27. Deception Well by Linda Nagata
28. Tech Heaven by Linda Nagata
29. Bohr maker by Linda Nagata
30. Factoring Humanity by Robert J. Sawyer
31. Acts of the Apostles by John F.X. Sundman
32. Mississippi Blues by Kathleen Ann Goonan
33. Crescent City Rhapsody by Kathleen Ann Coonan
34. Light Music by Kathleen Ann Goonan
35. The Naro Flower by Peter F. Hamilton
36. Technogenesis by Syne Mitchell
37. Viral Intelligence by Don De Brandt
38. Slant by Greg Bear
39. The Forge of God by Greg Bear
40. Anvil of Stars by Greg Bear
41. Queen of Angels by Greg Bear
42. Blood Music by Greg Bear
43. Moonseed by Stephen Baxter
44. Moonrise by Ben Bova
45. Dead Girls, Bead Boys, Bead Things by Richard Calder
46. The Fortunate Fall by Raphael Carter
47. Immortals by Jack Dann
48. Camelot 30K by Robert L. Forward
49. Moving Mars by Greg Bear
50. I Robot by Isaac Asminov

R.A.N. Rubric

Item	Points each	Maximum points	Points Awarded	Comments
Worksheet				
Section 1 completed	2 points	2 points		
4 statements listed on Section 2 #1	2 points each	8 points		
Each member of group listed and a summary statement given for each	2 points deducted for each missing member	10 points		
Summary statement at the bottom of worksheet	2 points	2 points		
Fiction Book Info				
Title and Author given	2 points	2 points		
Summary paragraph of book	2 points	2 points		
Nanotechnology connection given	2 points	2 points		
Favorite thing about book	2 points	2 points		
Least favorite thing about book	2 points	2 points		
Booklet				
Booklet bound	2 points	2 points		
Authors of booklet indicated on back cover	2 points	2 points		
10 pages not counting cover	2 points	2 points		
Recommended age of readers indicated	2 points	2 points		
Definition of nanotechnology somehow included	5 points	5 points		
Illustrations suitable for subject matter and age level	5 points	5 points		
At least 5 examples of how nanotechnology will impact society	10 points each	50 points total		
Bonus Points				
		Total Points		

Bonus Points-Determined by elementary students: ages 5-7 or 8-12
 Most realistic booklet-5 points
 Most creative booklet-5 points
 Best illustrated-5 points