



Why is Kettle Corn Cooked in Copper Pots?

A Lesson on Specific Heat

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Lesson #17

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Note: The activities that follow are DRAFT activities and have not yet been peer reviewed for content accuracy or pedagogy. The lesson plans and opinions in this report are those of the authors and do not necessarily reflect the opinions of any of the supporting institutions or the editors.

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2011 Works in Progress

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References

National Research Council (NRC). (1996). *National Science Education Standards*. Washington, DC: National Academy Press.

Alignment and references to state science education standards as of 2010 are cited by the authors.

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Teacher Section

PURPOSE	To understand that as a substance absorbs heat, the temperature change depends on the nature of the substance and the amount of heat that is being added.
OBJECTIVES	Upon completion of this activity, students will be able to: <i>Content Objectives:</i> • define specific heat. • understand how specific heat specifications relate to their everyday lives and activities. For example, the specific heat is used to determine which pot and pans we use in our kitchen. • understand what specific heat means in the mathematical equation (heat (J)= mass x specific heat [J/kgxC] x change in temperature).
GRADE LEVEL	This unit is designed for middle school classroom. However, it can be adapted both to high school and upper elementary.
PRIOR KNOWLEDGE	• Students should be familiar with conduction, radiation, and convection. • Students should understand the terms heat, temperature, joules, Kelvin. • Students should understand that energy moves from objects at higher temperature to objects at lower temperatures.
TIME REQUIRED	Two to four class periods. This includes in-school use of Internet (Internet activities could be done as homework).
INCLUDING ALL STUDENTS	This lesson uses multiple modalities to engage students in activities as well as in the assessment. <i>During the Lesson:</i> Audio-Visual: The students are asked to create pictures, posters, listen to listen to descriptions. Group Learning: creating skits together, class discussions, fishbowl discussions team brainstorm sessions. <i>Assessment:</i> Assessment projects include the following types of learning styles: logical-mathematical, verbal/linguistic, bodily/kinesthetic, visual/spatial, interpersonal, intrapersonal, musical.
QUESTIONS TO ASK ALONG THE WAY	• Why is copper used to make kettle corn? • How does the bimetal rod work? • Where do you see evidence of different specific heat examples in the kitchen and around the house? • Do engineers and architects take specific heat into consideration when building bridges and houses?
NATIONAL SCIENCE EDUCATION STANDARDS	Physical Science 3a: Energy is the property of many substances and is associated with heat, light electricity, mechanical motion, sound, nuclei, and the nature of a chemical. Energy is transferred in many ways. Physical Science 3B: Heat moves in predictable ways, flowing from the warmer objects to cooler ones. Until both reach the same temperature.

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- WASHINGTON STATE SCIENCE EDUCATION STANDARDS**
- 6-8 INQA: *Question*: Scientific inquiry involves asking and answering questions and comparing the answer with what scientists already know about the world.
- 6-8 INQA: *Inquiry*: Plan and conduct a scientific investigation (e.g., field study, systematic observation, controlled experiment, model, or simulation) that is appropriate for the question being asked.
- 6-8 PS3B: *Physical Science*: Heat (thermal energy) flows from warmer to cooler objects until both reach the same temperature. Conduction, radiation, and convection, or mechanical mixing, are means of energy transfer.
- 6-8 PS3A: *Physical Science*: Energy exists in many forms which include: heat, light, chemical, electrical, motion of objects, and sound. Energy can be transformed from one form to another and transferred from one place to another.

MATERIALS

Demonstration

- bimetallic strip-(one side is made with aluminum and the other side is made of iron (Carolina Biological))
- hand held lighter

Explore Section

- poster of specific heat temperatures (see attachment at end of teacher section)
- student notebooks

Explain Section

- student notebook
- student worksheet for internet activities
- lab materials- have available for students
- butcher paper
- wax blocks
- blocks (or shots) of aluminum, wood, copper, silver (Wards Science or Carolina Biological)
- various pots and pans available: copper, aluminum, stainless steel, cast iron (purchased at thrift stores)
- ring stands
- water source
- beakers
- flame source
- hot pads

SAFETY

- aprons and goggles must be worn during lab times
- tongs are required at each lab table
- teacher must approve each experiment before students can begin
- caution students to use hot pads and tongs
- safety rules are reviewed before every lesson

**PREPARATION
AND
PROCEDURE**

INFORMATION: Unlike a temperature reading, energy transferred between objects can not be measured directly; it must be calculated. When calculating energy transferred between objects, the definition of heat can be used as the amount of energy that is transferred between objects that are at different temperatures. Heat can then be expressed in Joules (J). When you are trying to figure out how much energy it takes to heat a pot of water on the stove, you have to consider the water's mass, its change in temperature and its specific heat. With this information, you can calculate heat. (heat (J)= mass x specific heat [J/kgxC] x change in temperature). This 5E lesson is designed to help middle school students understand the specific heat segment of this equation. This unit does not involve mathematical equations but it is a natural follow up to this lesson.

START: Have students fill in the K section of the KWL chart- what do you know about the heat capacity of various objects (the teacher is purposefully not using the term specific heat at this point as later in this unit, the students will be creating their own definition).

ENGAGE: Bimetallic strip (aluminum on one side, iron on the other)

1. Arrange students around your demonstration table.
2. Hand out Engage student worksheet- "What is Going On?"
3. Pass around the bimetallic strip. Ask students to draw the instrument in their notebooks and on the worksheet.
4. Class- discussion- what did you notice (strip is made of two different metals)
5. Ask students to predict what will happen when strip is heated. Have students record predictions with pictures.
6. Heat the bimetal strip by holding it over the lighter (or flame of burner)
7. Students write down observations as the strip cools.
8. Reheat the strip on the other side.
9. Have students write observations on the worksheet and in their notebooks.
It is important for the students to note that the strip bends in only one direction and returns to its original shape when it cools. The students should use the words expansion and contraction.
10. Have students write down and then make a class list of further questions about this strip (*keep this list for the end of the unit*).

EXPLORE: Students create their own definition for specific heat

1. Ask students to first listen to this scenario and then draw the following picture in their notebook. The picture will need labels. (By listening to this description rather than just looking at a picture of this scenario, the students are required to create a mental image in their mind thus helping them to process the information)

Picture in your mind identical blocks of copper, wood and marble. Each block has a hole drilled into it. A thermometer is placed in the hole to determine the temperature of the block. Each block is heated for five minutes in boiling water. Temperatures are recorded. The copper has the highest and the wood has the lowest temperature.

**PREPARATION
AND
PROCEDURE**

2. Ask students to interpret this data and write this interpretation in their notebooks (*copper absorbs thermal energy most easily and wood absorbs thermal energy the least*).
3. See if the students can create a *class definition* for how various substances absorb energy differently. Write this class definition on the board. Can they think a term that would explain this? What word or words would best describe this concept?
4. Ask what about marble? Ask if they have ever seen a marble slat in their kitchen. What is it used for?
5. Show the students the poster (or PowerPoint slide) the Specific Heats of Several substances (*attached at the end of Teacher Section- the last three rows are intentionally left blank. As the students research and learn more about specific heat of substances, have them fill in the numbers*). The students will see the term *specific heat*. Ask them if this term makes sense in comparison to their class definition. Ask them look at the right side column, What do they think J/kg .K means? At this time, you will *define* specific heat (*the amount of energy required to raise the temperature of 1 kilogram of a material 1 degree Kelvin*).
6. Discuss with the class when they have seen these substances in use (*notice wood's specific heat- why do doctors use wood sticks to pull down your tongue when inspecting your throat during exams instead of a metal rod? Notice the specific heat of water: how can a pool of water be cooler than the cement surrounding a pool?*)

EXPLAIN PART 1: Reading about specific heat in the kitchen.

1. The students will need access to the Internet.
2. Hand out Internet Treasure Hunt worksheets.
3. The student will be playing an Internet game to help reinforce the concept of specific heat of various metals.
4. Students should visit the site: <http://www.absorblearning.com/>
5. Type in "conduction" in the search box.
6. Students will be doing two sections- Testing materials for conduction and Question #2.
7. Students should write a summary of what they learned in their notebook and on the worksheet.

EXPLAIN PART 2: Students design and conduct own experiment to answer question.

1. Review the concepts the students have learned so far.
2. Tell the students that they are to design an experiment to show how *two substances can have the same temperature but different amounts of heat energy*. Write this statement on the board.
3. Have the lab teams (two to four per lab team) brainstorm about ways to show this and have each team come up to the front table and peruse the choices of materials.
4. Have each lab team describe their plan on a large butcher paper and display the finished poster in front of the room. Their plan should include a question, hypothesis, procedures, materials, and a data table.

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PREPARATION AND PROCEDURE

5. Have a science seminar (class discussion) about the experiment. As a class, go over each lab proposal (*Ask: Does it prove the statement? Is it safe? Are there unwanted variables? Remind them that each substance must have the same mass*)
6. Hand out Investigation Guidelines (see Student Section).
7. Give students time to design their experiment, question, hypothesis, procedure, materials and safety cautions. The students will also need to design their data table (an example of their proposed data table could be a homework assignment)
8. The teacher should be looking for safety cautions and unwanted variables.
9. Give time for the students to revise their lab procedures.
10. Conduct the labs watching for safety issues and unwanted variables
11. When labs are complete, before the students write their summaries, have a class “fishbowl” discussion (i.e., one lab team sits in middle of room and discusses the lab question, results, and error analysis).
12. Students write their lab summaries.
13. Students write list of further questions they have about specific heat.
14. Students will also write about how this relates to their own lives.

ELABORATE: Seeing specific heat in their own kitchen

1. Students will read two articles about cookware in relation to specific heat.
<http://www.retinning.com/importance.html>
<http://whatscookingamerica.net/Information/ChoosingCookware.html>
2. Feel free to find your own. One suggestion is below:
http://en.wikibooks.org/wiki/Cookbook:Pots_and_Pans
Describes the components of various cooking materials
3. Students will follow directions relating to this article: writing a letter to the owner of restaurant requesting specific pots and pans to use
4. Students will read and discuss article about a chocolate teapot
<http://www.thenakedscientists.com/HTML/content/kitchenscience/exp/how-useless-is-a-chocolate-teapot/>

EVALUATE: Now you are the expert.

Assessment, Part 1: Hand out the multiple intelligences assessment choices.

Students must select and complete one of the nine options (see attachment at end of Teacher Section, rubric is included in Student Section).

Assessment, Part 2: Have students answer the assessment questions (Student Section). They will need to use their science vocabulary and knowledge that they have gained to answer these questions.

FINAL STEP: Return to the KWL chart.

Have students fill in the L section of this chart

WHERE TO GO FROM HERE

- With the knowledge of specific heat of metals, the teacher can lead the students to an introduction of element placement on the periodic table.
- The students can learn how the mathematical calculations of the specific heat of a substance.
- Students can learn about the heat energy calculations of food energy.
- Students can work with calorimeters.
- Students can learn about heat technology and the teacher can invite professional in to talk about heat technology.

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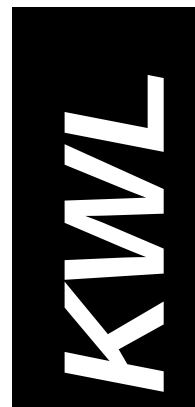
SUGGESTIONS FOR ASSESSMENT The students will demonstrate their knowledge of specific heat by completing an assessment project of their choice and completing an essay question quiz.

REFERENCES AND RESOURCES

1. D.C. Heath and Company (1991) *Physical Science: The Challenge of Discovery*. Lexington, Massachusetts; Heath Publication, pages 156-158
2. Glencoe/McGraw-Hill (2002) *Glencoe Science- Physical Science*. Columbus, Ohio: page 161.
3. *Naked Scientist*
<http://www.thenakedscientists.com/HTML/content/kitchenscience/exp/how-useless-is-a-chocolate-teapot/>
This short article describes a teapot made out of chocolate and how it withstands boiling a pot of tea. Accessed on December 12, 2010.
4. *Properties of Matter*
http://www.stcms.si.edu/pom/pom_student.htm
STC/MS Program, National Science Resource Center, Smithsonian Institution, Washington D.C. Accessed March 28, 2011.
5. *Retinning Company: The Value of Copper*
<http://www.retinning.com/importance.html>
Article about the value of copper as a cooking instrument. Accessed December 12, 2010.
6. *Rubristar*
www.rubristar.com
Website that helps teachers create rubric
7. *What is Cooking*
<http://whatscookingamerica.net/Information/ChoosingCookware.html>
An article describing the metal properties of various cooking pots. Accessed on December 12, 2010.
8. *Wikibooks* (suggested, but not used)
http://en.wikibooks.org/wiki/Cookbook:Pots_and_Pans
Article detailing the properties of various pots and pans. Accessed December 12, 2010.

*Create as a poster for student to view.
This data can be used for assessment activities.*

Specific Heat of Common Materials	
Substance	Specific Heat J/kg • K
Water	4180
Wood	1,760
Metal of seat belt	500
Cloth of seat belt	1340
Carbon (graphite)	710
Air	1000
Alcohol	2460
Glass	664
Iron	450
Paraffin	2900
Ice	2090
Marble	880
Copper	390
Mercury	140
Oxygen	910
Nitrogen	1040
Aluminum	899
Gold	129
Lead	128



What I Know
What I Want to Know
What I Learned

Name _____
 Date _____
 Period _____

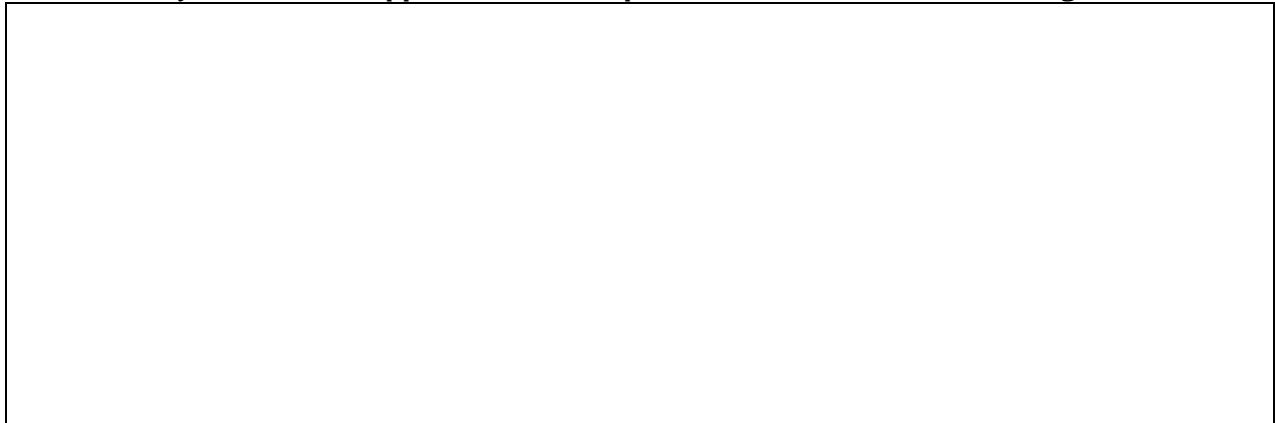
Topic of Discussion: How do organisms survive from one biome to another?		
What I <i>Know</i> about this topic/question	What I <i>Want</i> to know about this topic/question	What I <i>Learned</i> about this topic/question

ENGAGE WORKSHEET: WHAT IS GOING ON?

Draw a picture of the bimetallic strip that your teacher showed you.



Predict what you think will happen when the strip is heated. Use words and drawings.



Write down your observations of what happened to the bimetallic strip when it was HEATED.

Write down your observations of what happened to the bimetallic strip when it was COOLED.

What happened when the strip was REHEATED?

What further questions do you have about this strip or what you saw?

INTERNET ACTIVITY: Testing Materials for Conduction

Directions:

1. Go to this website: <http://www.absorblearning.com/>
2. Click on Absorb Physics
3. Scroll down and find the Free Resources section. Click on the highlighted word, “here”
4. Scroll down and click on the number 2 to get to the second page.
5. Find the activity titled, “Testing materials for conduction”
6. Click “view online”
7. Fill out “Internet Treasure Hunt” sheet

Assignment: Here you will see a burner. When you click on Apply Heat, you will see that the nail, attached to the rod with a ball of wax, will eventually fall off the rod as the wax heats up and melts. The timer keeps track on how long the nail stays attached.

In a written summary, describe how long the nail stays attached to the glass rod, the copper rod, the aluminum rod and the steel rod. In your own words, explain the reason for the different times of each rod using the word specific heat in your explanation.

Summary:

INTERNET READING ASSIGNMENT: Two Reading Assignments

Part 1 Directions:

1. Go to this website- <http://www.retinning.com/importance.html>
2. Read this article keeping in mind the title of this unit: Why is kettle corn cooked in copper pots?
3. Assume you have been hired as a manager of a brand new café. Write a letter to the owner describing what pots and pans you would like to buy and the reasons why.

Part 2 Directions

1. Go to this website:
<http://www.thenakedscientists.com/HTML/content/kitchenscience/exp/how-useless-is-a-chocolate-teapot/>
2. Summarize this article and its surprising results.

Summary

INVESTIGATION GUIDELINES

Use complete sentences. Write answers on Worksheet for Investigation.

Question

Write a question that clearly identifies what you will investigate. Your question should be measureable, comparable, and testable.

Hypothesis

If...then...statement.

Listing the Variables:

Dependent Variable: *The factor that you want to investigate, what you will be measuring?*

Independent Variable: *What factor will you intentionally change every trial?*

Variable held Constant: *What did not change?*

Safety Reflection

Describe the safety equipment that you will be using. What are your safety features? From a safety standpoint, describe what the teacher will see (and not see) when walking past your lab table.

Data/Observations

You will be creating your own data table. Think first about what needs to be included in the data table? What is the best way to demonstrate the data? Describe your plan for collecting data and observations.

Teamwork

Describe what you contributed to your lab team and how your lab team helped you.

Summary

After the lab, you will be asked to summarize your results. Remember to discuss the hypothesis, evaluate the relationship between the independent and dependent variable, write up the error analysis, and discuss what you would do next time or further questions you might have.

WORKSHEET FOR INVESTIGATION

Question

Hypothesis

Variables

Dependent Variable:

Independent Variable:

Variable held Constant:

Safety

Data Table

Teamwork

Summary

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Student Section

Internet Treasure Hunt

Name: _____ Date: _____

This web information search will help you find information about the specific heat of various metals and products. You will be looking at pre-selected web sites to answer each question. It is important to use the information on the site. While you are using the site for research consider; who wrote the site, what their purpose is in writing it, and how credible (accurate) you think the information is.

Question 1: How much heat is required to heat the metal rod in order for the wax to melt?		
Website Title URL	Site 1 <i>Absorb Learning</i> http://www.absorblearning.com/	Site 2 <i>Retinning</i> http://www.retinning.com/importance.html
Who created this web site (organization, etc.)?		
Why did they create it? (check all that apply)	☐ To provide factual information ☐ To influence the reader's opinion ☐ To sell a product or service ☐ I'm not sure	☐ To provide factual information ☐ To influence the reader's opinion ☐ To sell a product or service ☐ I'm not sure
How credible (accurate) do you think the info is?	☐ Very accurate ☐ Somewhat accurate ☐ Not very accurate ☐ I'm not sure	☐ Very accurate ☐ Somewhat accurate ☐ Not very accurate ☐ I'm not sure
What did you learn?		

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Student Section

Internet Treasure Hunt

Name: _____ Date: _____

This web information search will help you find information about the specific heat of various metals and products. You will be looking at pre-selected web sites to answer each question. It is important to use the information on the site. While you are using the site for research consider; who wrote the site, what their purpose is in writing it, and how credible (accurate) you think the information is.

Question 2: How do you choose the right pot for the food that we cook based on specific heat?		
Website Title URL	Site 1 <i>What is Cooking</i> http://whatscookingamerica.net/Information/ChoosingCookware.htm	Site 2 <i>Retinning</i> http://www.retinning.com/importance.html
Who created this web site (organization, etc.)?		
Why did they create it? (check all that apply)	☐ To provide factual information ☐ To influence the reader's opinion ☐ To sell a product or service ☐ I'm not sure	☐ To provide factual information ☐ To influence the reader's opinion ☐ To sell a product or service ☐ I'm not sure
How credible (accurate) do you think the info is?	☐ Very accurate ☐ Somewhat accurate ☐ Not very accurate ☐ I'm not sure	☐ Very accurate ☐ Somewhat accurate ☐ Not very accurate ☐ I'm not sure
What did you learn?		

ASSESSMENT CHOICES

Choose an activity that demonstrates what you know about specific heat.

LOGICAL/MATHEMATICAL Construct a graph or chart that explains the definition of specific heat. Use objects that you found on the poster in class. Research to find the specific heat of objects not listed on the poster. Minimum of 15 objects to be included on graph or chart. Cite your sources.	VERBAL/LINGUISTIC Create a Public Service Announcement commercial about the safety issues of specific heat and metals on the rides at the amusement park in the summer. Cite your sources.	BODILY/KINESTHETIC Imagine a swimming pool during midday in July with temperatures of 100 degrees F. Think about the water in the pool, the metal rods of the ladder, the cement under your feet, etc. (use poster for data). Create a skit demonstrating to the class how specific heat plays a role in how hot some of these objects are and how some of objects mentioned are much cooler. Be sure and explain the reasons why for each material. Cite your sources.
VISUAL/SPATIAL Draw a cartoon that describes a car sitting in the summer sun for an extended period of time-Think about the handles on the doors, the steering wheel, the windshield, the metal on the seat belt, the cloth on the seat belt. Explain your reasoning. Cite your sources.	INTERPERSONAL Interview a cook and ask which pot or pan he or she uses for the following items-steaks, caramel, popcorn, rice, steaks, candy, chocolate, pasta. Explain why these specific pots or pans were chosen (look at the bottom of each pan). Feel free to ask about other food products. Cite your sources.	INTRAPERSONAL Read about the use of marble with chocolate and other candies. Why do they use this? What does it have to do with specific heat? How can chocolate be shipped all over the world without melting? Cite your sources.
MUSICAL Write a song about specific heat for younger students. The younger students should be able to understand what specific heat means and how it can relate to their lives. Cite your sources.	NATURALISTIC Create a photo essay of 10 items outside of the classroom that demonstrate specific heats of metals and other objects. Label and explain each picture. Cite your sources.	BE CREATIVE You can design your own assessment but be sure and get the teachers approval first and cite your sources.

RUBRIC FOR ASSESSMENT

Multimedia Project: Multi-Learning Styles Assessment Process

CATEGORY	4	3	2	1
Sources	Source information collected for all graphics, facts and quotes. All documented in desired format.	Source information collected for all graphics, facts and quotes. Most documented in desired format.	Source information collected for graphics, facts and quotes, but not documented in desired format.	Very little or no source information was collected.
Attractiveness	Makes excellent use of font, color, graphics, effects, etc. to enhance the presentation.	Makes good use of font, color, graphics, effects, etc. to enhance to presentation.	Makes use of font, color, graphics, effects, etc. but occasionally these detract from the presentation content.	Use of font, color, graphics, effects etc. but these often distract from the presentation content.
Mechanics	No misspellings or grammatical errors.	Three or fewer misspellings and/or mechanical errors.	Four misspellings and/or grammatical errors.	More than 4 errors in spelling or grammar.
Content	Covers topic in-depth with details and examples. Subject knowledge is excellent.	Includes essential knowledge about the topic. Subject knowledge appears to be good.	Includes essential information about the topic but there are 1-2 factual errors.	Content is minimal OR there are several factual errors.
Organization	Content is well organized using headings or bulleted lists to group related material.	Uses headings or bulleted lists to organize, but the overall organization of topics appears flawed.	Content is logically organized for the most part.	There was no clear or logical organizational structure, just lots of facts.
Originality	Product shows a large amount of original thought. Ideas are creative and inventive.	Product shows some original thought. Work shows new ideas and insights.	Uses other people's ideas (giving them credit), but there is little evidence of original thinking.	Uses other people's ideas, but does not give them credit.