CONTROVERSIAL TOPICS IN THE CLASSROOM: AN INVESTIGATION OF TEACHING STRATEGIES AND INSTRUCTIONAL ENVIRONMENTS FOR PROMOTING CRITICAL THINKING IN A MIDDLE SCHOOL EARTH SCIENCE CURRICULUM.

By
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A report submitted in partial fulfillment of the requirements for the degree of
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This report, "Controversial topics in the classroom: An investigation of teaching strategies and instructional environments for promoting critical thinking in a middle school earth science curriculum," is hereby approved in partial fulfillment of the requirements for the Degree of MASTER OF SCIENCE IN APPLIED SCIENCE EDUCATION

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Abstract

Controversial topics in the classroom: An investigation of teaching strategies and instructional environments for promoting critical thinking in a middle school earth science curriculum.

By

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The National Research Council (NRC) promotes argumentation as a part of the National Science Standards. (NRC, 2000) Students can learn decision-making skills through the practice of controlled arguments. Using controversy promotes critical thinking skills that are required to make valid and unbiased decisions. Earth System Science is an important area of science that has issues that students and members of the community work on daily to explain through the reconciliation of fact and fiction. The issue considered in this study involved a projected mine development in a rural northern portion of Marquette County Michigan. The decision would allow the building of the mine, or not, and it would have environmental and economic impacts on the region and the citizens of the area.

The goal of this study was to determine if students could form unbiased scientifically supported opinions, in particular, opinions regarding the Kennecott Eagle Mining Project. Students started the unit by taking a Likert-like pretest...
survey. The unit began using specific teaching model strategies in conflict resolution and determining values, plus, a lesson to recognizing bias. Throughout the unit, these same strategies helped the students see the relevance of mining to their lives. At the end of the unit, the students completed the same survey as a posttest, and as a final assessment wrote a conclusion delineating their reasons agreeing or disagreeing with the implementation of the mine.

The collected data supported the hypothesis that if students could define bias and find relevance about a controversial topic involving a Marquette County mining project, they would formulate an unbiased scientifically supported opinion. The data collected from the attitudinal surveys and from student assessments supported this premise. The number of students who viewed the mine as a positive endeavor changed substantially after comparing three years of the pilot study, student-compiled, final conclusions to those compiled in year four. The formal research in year four included the implementation of educational models to resolve conflicts and determine values with modification of full inquiry to partial inquiry. Explicit teaching of specific concepts in the areas of bias and relevance was key to targeting learning outcomes.
Acknowledgments

I would like to thank my family for their encouragement and support; for not minding that I was gone for weeks every summer and that the laptop went everywhere I did for the last year. Secondly, a thank you also goes to my advisor Dr. Kedmon Hungwe who was supportive and gave much needed positive feedback when I became frustrated and overwhelmed. This paper could not have happened without him. Dr. Theodore Bornhorst, my co-advisor, provided the motivation and fire that got this study off the ground. Thank you for being a part of the Teacher’s Earth Science Institute that supplied the ways and means to get me excited about the geology of the area and ultimately about mining. A salute also goes to all the Newberry middle school students and staff who surrounded me with an energetic atmosphere in which to work and provided the reasons that this research was important. A final thank you goes to Michigan Technological University and the National Science Foundation for the funding that supported many of the classes needed to fulfill this degree. They supplied a solid base from which to work.
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Chapter 1 - Statement of Problem

The National Research Council (NRC) promotes argumentation as a part of the National Science Standards. (NRC, 2000) Students can learn decision-making skills through the practice of controlled arguments. Using controversy promotes critical thinking skills that are required to make valid and unbiased decisions. Earth System Science is an important area of science that has issues that students and members of the community work on daily to explain through the reconciliation of fact and fiction. There are issues of global warming, climate change, fossil fuels and evolution. There are also issues that are regional in scope, such as, hydrology, pollution, and flood control and mining.

The use of controversial issues in the classroom provides a means for the students to experience or immerses themselves in a topic that has real-world application without leaving the classroom. The benefits of promoting controversial issues are that students learn decision-making skills ultimately leading to social responsibility (Geddis 1991; Aikenhead, 1985). However, a student must personally see the relevance of the issues presented. According to Kolsto (2000), relevance is a key issue when dealing with socio-scientific controversial issues.

Students are exposed to controversial topics throughout their lives. How they form a decision on these topics is important to society in general and their own
lives specifically. Often, students feel cut-off or distanced from scientific controversy, due to ignorance, geographical distance, or personal bias. It is my belief that the science classroom is a logical place to implement teaching strategies and learning skills to enhance a student’s ability to make educated, unbiased decisions.

I chose to have my students research a mining project that has local populations debating environmental and economic factors. The instructional goals for this project focus on students being able to determine bias from the different media sources that are for or against implementing the mine, and how relevance plays a role in the formation of students’ opinions. The first goal, determining bias, has its roots in numerous related media sources that students may view or read during any given week. The newspapers in the area regularly carry articles about the mining project. There are television ads and billboards both in support of the mine and against the mine, as well as internet information. It is my intention that students think about how each source has its own agenda. After researching a variety of sources both for and against the mine, they will use that information to make their own decisions about the impact of the mine on the economy and environment.

My concern as a teacher is how to provide a learning environment that will promote relevance to the students in controversial science topics so that they will
be able to make educated decisions when presented with these topics into adulthood. Many important decisions made in life are the result of taking a stand on a topic based on personal values. Knowing how to systematically eliminate bias, see the relevance and come to a defendable consensus is a notable advantage.

**Focus Question:**

The purpose of this research was to address the following question:

Which teaching strategies and instructional environments fostered the ability of students to develop unbiased scientifically supported opinions in Earth Science?

**Background to the study**

Four years ago, I introduced a controversial topic to my middle school science students. The topic was about a mining project being planned in Marquette County, Michigan to remove nickel sulfide ore from the Yellow Dog Plains. I had just finished a second summer at the Teachers’ Earth Science Institute (TESI) where mining was a focus and was very interested in bringing the information I learned to my students. My only goal that first year was to have the students learn something about mining and expose them to real world applications that involved learning about jobs needed to operate a mine and answer the question, “Is this mine a good thing for Marquette County?” The culminating activity was to be a debate. The surprise came when the unit was finished there was no one to debate
the topic. All but one student viewed the mine as a negative venture for the area. With a year to think about the lesson, I presented it again. I had modified it minimally from the first year and the views remained the same. No one wanted the mine. The views both years revolved around environmental impacts. Now I was intrigued.

The third year of the unit I pretested and post-tested the students to see if views changed, if the students were given a reason to have this issue relevant to them. During the previous two years, I had not made the topic relevant to the students. They had no personal stake in the nickel and other minerals removed from the mine. A short scenario, after the unit was finished, gave the students information telling them that they would not have nickel for rechargeable batteries or stainless steel and then asked them to share their views. Students did change their views to some degree. At least, a small number of students were in favor of the mine.

The unit was presented to students for a fourth year. This time, after a year of research and with some strategies in mind, I taught the unit more explicitly and with relevance to the students in mind. That lesson will be the primary focus discussed in this project.
Connection to standards:

This work connects to Michigan Standards and Benchmarks (2008) in the following strands:

E.E.S.M.4 – Human Consequences – Human activities have changed the land, oceans, and atmosphere of the Earth resulting in the reduction of the number and variety of wild plants and animals sometimes causing extinction of species.

E.E.S.07.41 Explain how human activities (surface mining, deforestation, overpopulation, construction and urban development, farming, dams, landfills and restoring natural areas) change the surface of the Earth and affect the survival of organisms.

E.E.S.07.42 Describe the origins of pollution in the atmosphere, geosphere, and hydrosphere, (car exhaust, industrial emissions, acid rain, and natural sources), and how pollution impacts habitats, climatic change, threatens or endangers species.

Additional Michigan standards and benchmarks (2008) addressed are under the categories of Inquiry Process, Inquiry Analysis and Communication, and Reflection and Social Implications. The following benchmarks are impacted the most in this unit, on the students’ abilities to generate new knowledge through critical thinking and then reflect upon that knowledge and make a decision.

S.IP.0711 Generate scientific questions about fluid earth systems and human activities based on observations, investigation, and research.

S.IA.07.11 Analyze information from data tables and graphs to answer scientific question concerning earth systems and human activities.

S.IA.07.12 Evaluate data, claims, and personal knowledge through collaborative science discourse on earth systems and human activities

S.IA.07.13 Communicate and defend findings of observations and investigations dealing with earth systems and human activities.

S.IA.07.15 Use multiple sources of information on earth systems and human activities to evaluate strengths and weaknesses of claims, arguments, or data.
S.RS.07.11 Evaluate the strengths and weaknesses of claims, arguments, and data regarding earth systems and human activities.

S.RS.07.13 Identify the need for evidence in making scientific decisions about earth systems and human activities.

Inquiry education has three essential features that support using controversy in the classroom (NRC, 2000). These mesh with the National Science Education Standards set forth by the National Research Council (2000). These features are as follows: learner gives priority to evidence in responding to questions, learner formulates explanation from evidence, learner communicates and justifies explanations (NRC 2000, pg 29). The Michigan standards and benchmarks break down these three features into very specific benchmarks listed previously.

When learners give *priority to evidence*, they are searching for evidence, putting aside personal biases, and constructing and reflecting on new knowledge. From this new knowledge, learners are *formulating an explanation* that is *communicated and justified* to an audience comprised of their classmates and teacher.
Chapter 2 - Literature Review

Controversial issues are strategically introduced to promote critical thinking in the classroom. Critical thinking is a process necessary to reach the higher order thinking skills as promoted by Bloom’s Taxonomy (Dalton, 1986) in the areas of evaluation, synthesis, and analysis. When students access higher-order thinking skills they are better able to make connections to the material. With greater connections to the topics, (Kolsto, 2000) students will make better-informed decisions in the social arena (Aikenhead, 1985) and from a teacher’s point of view, better decisions on assessments.

Students are exposed daily to controversial topics as technology and the media infiltrate their lives enabling them to observe and experience what is happening around them. Students need skills to figure out what to believe and how to communicate their feelings and views in ways that are effective. These skills, ultimately, lead to responsible citizens, therefore decision-making is vital to social responsibility (Aikenhead, 1985). A plan or model to implement strategies that a student can use to form valid, supportable opinions in the educational setting is imperative. Students must be able to understand the social implications of the issues at stake, and decide if the evidence is based on objective views. (Aikenhead, 1985) Students must also be aware of the stakeholders and how their views and expectations are affected by the information they receive. (Geddis, 1991)
Without a plan, attempting to resolve a conflict or reach a conclusion on a controversial topic would be difficult to achieve. It is important to look to instructional models that provide the ways and means for teachers to direct students in their development of unbiased, scientifically supported opinions in science. Gunter, Estes, and Schwab (2003) have developed educational models, for use in the classroom. This review will focus on similarly adopted versions of ‘The Resolution of Conflict Model’ and ‘The Values Development Model’ (Gunter Estes, and Schwab, 2003). These models are adaptable across curricula and grade levels.

The relevance of the resolution of conflict model to the current educational atmosphere is that conflict resolution can help students learn to become skilled critical thinkers, increasing their understanding of the topic at hand. The resolution of conflict model brings into focus the idea that students need to have a personal connection with the topic. Gunter, Estes, & Schwab, term this the student’s “private core where feelings merge to dictate behavior”. (Gunter, Estes, and Schwab, 2003, p. 228) If a student does not care or like a topic, their behavior may be to disrupt the class or otherwise not be engaged in the learning process.

The steps of the resolution of conflict model provide direction for students as they develop argumentation skills. These steps provide a model of explicit instruction
that is necessary for successful argumentation and conflict resolution. (Osborne, Erduran, and Simon, 2004) To support the use of this model in the classroom I reviewed other literature that supported the use of controversy in the classroom. Glen S. Aikenhead’s work on “Collective Decision Making in the Social Context of Science” provided valuable insights into how decision-making evolves, and why it is important to a science curriculum. (Aikenhead, 1985) Without purposeful and legitimate skills and guidelines decision-making can be confusing. This is especially true when done in the group setting, or collectively (Aikenhead, 1985). It is important to note that the resolution of conflict model is further titled, “reaching solutions through shared perspectives”. (Gunter, Estes, and Schwab, 2003). It is a dialogue between persons.

The resolution of conflict model can be further explained through the definition of the word argumentation as “the coordination of evidence and theory to support or refute an explanatory conclusion, model, or prediction.” (Osborne, Erduran, and Simon, 2004) Conflict resolution by its nature uses the argumentation process. Argumentation provides an avenue for students to do the learning of science, and at the same time, develops the format for assessment through discourse. (Osborne, Erduran, and Simon, 2004) Argumentation is a critical thinking process. When students argue they are learning to find the strengths and limitations of their arguments. (Osborne, Erduran, & Simon, 2004) This helps them to make connections to the topic that will last. Research shows that only about 2% of
lessons in middle school use this form of discussion. (Osborne, Erduran, & Simon, 2004).

Arthur Geddis’ research on controversial issues and classroom discourse also provides insights into decision making in the classroom. (Geddis, 1991) As students advance through the science educational process, decision-making is one of the most important critical skills that should be integral throughout the curriculum. “The wise use of knowledge enables students to assume social responsibilities of attentive citizens or key decisions makers.” (Aikenhead, 1985).

Values play an important role in conflict resolution. Values evoke emotions and those emotions color the views a person has of the issue. Emotions or feelings tend to result in biases that affect the resolution of the conflict. Since feelings are results of inherent values another model proposed by Gunter, Estes, and Schwab, (2003), that is necessary to resolution of conflict, is the values development model, which compliments the resolution of conflict model. Conflict arises when the parties involved have different values on the same issue. There are two types of values that make up the components of decision-making. (Aikenhead, 1981) Using Longino’s (1983) research, these values are defined as constitutive and contextual values. Constitutive values are unique to the discipline. The values that one has on a subject are clear and direct. Contextual values reflect the ethics, ideology, and culture of the researcher (Longino, 1983). When the science topic
is not black and white, contextual values have greater influence and invoke emotion. This becomes very important in the school setting where students do not yet have well developed constitutive values because they do not yet possess the knowledge to have synthesized a clear-cut solution, if there is one. Contextual values, on the other hand are from home and the cultural and ethnic background of the family. These values have a direct impact on how students and teachers feel about a conflict. Teachers’ constitutive values may be more concrete due to greater knowledge but their contextual values will still reflect bias due to cultural and ethnical backgrounds. (Longino, 1983) All of these different values held by the stakeholders in the conflict are in play and will have a part in the resolution.

“Learning to think is learning to argue.” (Osborne, Erduran, and Simon, 2004) The explicitly taught use of argumentation, using models, will give students skills that will ultimately improve their test scores and their ability to be successful in school and society. (Osborne, Erduran, and Simon, 2004) By using these models, students begin to understand that many topics have been a source of conflict at some point in their history (Gunter, Estes, and Schwab, 2003). Therefore, to help them see the “big picture”, as Gunter, Estes, and Schwab (2003) proposed, students need to research facts and find materials to support their views and reflect on their values. From this vantage point, the teacher and students will begin to connect the information to real-world applications encompassing other
disciplines. They may need to look at the social and political components for feelings and actions and consequences.

The meshing of these two models will be conducive to the best use of teaching strategies and class time to resolve the conflict in lessons of a controversial nature. (See Table 1). If students do not see any value in what they have discovered they will determine that it has no personal relevance and the learning will stop, therefore “beliefs influence behaviors” (Hogan, 1999) If students do not see any values inherent in a controversial topic, the need to resolve it will be lacking, leading to less specific knowledge retention. This in turn could be projected into lower test scores, as educational standards become more rigorous or less input into social decision-making.
Table 1: Key learning objectives as related to teaching models used in lesson.

<table>
<thead>
<tr>
<th>Learning Objectives</th>
<th>A model to resolve conflicting opinions</th>
<th>Determining what is of value</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><em>(Gunter, Estes, &amp; Schwab, 2003)</em></td>
<td><em>(Gunter, Estes, &amp; Schwab, 2003)</em></td>
</tr>
</tbody>
</table>
| Determine, using facts, scientifically supported reasons and feelings that influence how you feel about this mine. | Find Facts  
Why do you feel this way?  
What are your other options?  
How do feelings change as a result of new facts?  
What do you think will happen?  
Teacher evaluation | Supplemental resources,  
Provide relevance to students  
Cross-curricular connections |
| Write a paragraph analyzing how human activities have affected the implementation of the Eagle project. | Finding facts,  
Why do you feel this way?  
What are your other options?  
How do feelings change as a result of new facts?  
What do you think will now happen?  
Teacher evaluation | What is the theme of the unit?  
What is the big question?  
Supplemental resources |
| Write a paragraph summarizing the views of the group and analyze how human activities influence the decision that will determine if the Eagle project is a viable endeavor. | Find facts  
What are other options and how can they be implemented?  
Teacher evaluation | The theme of the unit  
The big question to answer |
Chapter 3: Methods

Background

The goal of this unit was to improve my students’ ability to think critically about a controversial issue. The focus issue was the impact nickel sulfide ore mining would have on the Yellow Dog Plains in Marquette County, Michigan. Students investigated the relevance the mining project could have on their lives. A key component of the unit was to determine the bias of information sources. Websites and newspaper articles were used as research material to highlight the biases reflected in values and feelings that stakeholders used to formulate their opinions. Students worked to reach consensus on issues and to consider their biases and those of others when making a decision.

Context of Study

The study took place in Newberry Middle School, in the village of Newberry, located in the Upper Peninsula of Michigan. Newberry is part of Luce County and is rural. The county population was 6,7614 in 2008. (U.S. Census Bureau) Newberry Middle School is part of the Tahquamenon Area School District, which is one of the largest school districts, geographically speaking, in the eastern United States. The school district data indicates that 43% of the students are considered educationally disadvantaged.
The median income of the county in 2007 was $37,718, $10,000 (U.S. Census Bureau) below the state average. Forty-six percent of the students live in an urban setting and 54 percent are rural residents. Unless students live in smaller outlying communities, their usual contact with peers is in a school setting. About 12 percent of the adult population has bachelor degrees and 77 percent of the population has high school diplomas. (U.S. Census Bureau) This demographic data led me to believe that many students live in isolation within the county, and may be lacking in opportunities or exposure to science topics upon which to think critically.

Towns that have some influence on the education and culture of Newberry are some distance away and have limited influence on the community. There is a local TV station, but many students have limited access to it. A local newspaper is available, but is not read by many students. I have found that students are not always aware of controversial issues close to where they live due to the isolation and the social culture that has developed. One of the primary intents of the unit was to get students to think about issues happening beyond the county boundaries, but still within a reasonable geographic area.

The focus of the unit was mining, using a controversial mining topic pertinent to Marquette, Michigan. Marquette is a cultural and economically important area 100 miles from Newberry. The topic provided a means to expose students to
issues that could have relevance to their lives. Although Newberry does not have a mine, the impact that the mine could have on the environment was something to which the students could relate. Both the Newberry and Marquette areas have a large concentration of state-owned land and the environment is important. Newberry is in part, supported economically by outdoor recreational activities. Marquette County also hosts a variety of outdoor recreation opportunities and is not unlike the geographical area around Newberry in its remoteness. It was hoped that the students could make the connection between Marquette County’s mining issues and similar scenarios that may one-day impact the environment around Newberry.

**Organization of Study**

This study took place in three different science class sections, in each of four years, starting with the spring of 2006 and ending in the spring of 2009. The first year of the study, the students were eighth graders. In the spring of 2007, the students were seventh graders due to a teaching assignment change. In the spring of 2008, the unit was presented to seventh graders. A follow-up survey was done with the previous year’s seventh graders, now eighth graders. In 2009, the final year of the research, seventh grade students participated. The units, presented in the spring, at the end of the school year, were as a culminating activity to the Earth Science Unit. Due to time constraints, the students had one week of class time to complete the unit each year. (See Table 2).
Table 2: Summarization of the organization of the study.

<table>
<thead>
<tr>
<th>Cohort &amp; year when study conducted</th>
<th>Spring 2006</th>
<th>Spring 2007</th>
<th>Spring 2008</th>
<th>Spring 2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration of study</td>
<td>5 – 45 minute periods</td>
<td>5 – 60 minute periods</td>
<td>5 – 60 minute periods</td>
<td>5 – 60 minute periods</td>
</tr>
<tr>
<td>Grade level</td>
<td>8</td>
<td>7</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Number of students</td>
<td>81</td>
<td>62</td>
<td>70</td>
<td>72</td>
</tr>
<tr>
<td>Date of follow-up</td>
<td>NONE</td>
<td>Spring 2008</td>
<td>NONE</td>
<td>NONE</td>
</tr>
</tbody>
</table>

In the final year of the study, an inclusion teacher was in the classroom during one section when the numbers of learning disabled students represented eleven of the 22 students. The inclusion teacher acted as a facilitator and was able to help students during guided study times outside of regular science class.

The study occurred in two parts, the first part being in 2006 and 2007, as an exploratory concept that evolved in my classroom prior to engaging in graduate research. The second part of the study evolved in 2008 and 2009 with a view to submitting this work for graduate credit.
Section 1: Exploratory Studies in 2006 and 2007
Activities and Objectives

Spring 2006

Materials

Folders to hold notes and articles
Lined paper for note taking
Three *Detroit Free Press* articles on Kennecott Minerals, Inc., Eagle Project (McDiarmid, 2003) (This article is no longer accessible, but others of the same nature may be substituted).
*Marquette Mining Journal* article on Kennecott Minerals, Inc. Eagle Projector (Flesscher, 2006) (This article is no longer accessible, but others of the same nature may be substituted).

Computers
Websites
Rubric

Lessons

*Day One*

The students in this class were eighth graders in an Earth Science curriculum.
Students worked in groups of three or four as designated by the teacher. Teacher observations of personalities and work abilities throughout the year preceded student assignment to groups. In addition, each group named their company to promote ownership of the project and unity of the group.
Students received instructions on the first day and received a rubric with checklists for each required activity and its possible points. A fifteen-minute lecture about Kennecott Minerals Inc., detailing their interest in Marquette County’s nickel-sulfide ore deposit preceded the start of the unit. This lecture consisted of a brief history of the company and the location of the mineral deposit in Marquette County.

Each member in the group picked a job from a list of pre-determined options. These options were geologist, economist, mining engineer, and environmental scientist. These jobs most closely related areas that would represent all sides of a professional mining project. Students then spent 10-15 minutes researching their job descriptions. From this point on the students would view the project from the perspective of the job. Limited help was given to students who were unclear about what their job description meant or who had trouble accessing the information on the computer.

Students began the unit reading the newspaper articles and taking notes on the paper provided in the folders or in a word document saved on the computer. Notes were kept in the folder and the folder kept in the classroom for easy access to members of the group. Due to technical difficulties, some students lost information on the computer and had to do the notes again.
The teaching strategy intent of this unit was inquiry. For most of the project students worked with little direction from the teacher. The only assistance given was in the area of technology troubleshooting. If students had questions, the teacher would rephrase it and lead the students to an acceptable answer. Students, although familiar with technology, rarely used computers for a whole project. They were required to do word processing and internet searches to find information. Some required much more technical assistance than others did. This was a new teaching strategy and had an impact on the time spent on fact-finding.

*Day Two*

Students continued to do research and take notes about Kennecott Eagle Mineral Project, and Marquette County, all from the perspective of their jobs. This was difficult for many of the students. They had to put themselves into a job that they had no experience in and try to look at it from the eyes of an eighth grader. As long as there was positive progress this part of the unit was a success.

Students needed to find information about the geology of the area. They used Kennecott’s website, the Michigan Department of Environmental Quality’s (DEQ) website, and websites advocating for and against the environment. Students needed to find a topographical map of the area and record geographical features important to the project, such as wetland, streams, high and low
elevations and anything else that they felt might prove important. Students looked at the land use or plant cover. The intent was to use a soil conservation survey but that document was not yet completed for Marquette County. Looking at geographical features led students to consider how the environment would be impacted by the construction and implementation of the mine. Students searched for economic information about Marquette County. This was probably the most difficult task. It required search skills beyond that of the students. Kennecott and DEQ provided data that the students could use once it was located. This required pre-reading by the teacher and then directions to the pages, due to the size of the documents.

The newspaper sites and environmental advocacy sites provided students with emotional reasons for or against the mine. Many students spent time on these sites gathering information on the environmental impact of the mine and geographical information. The emotional voice of the information easily caught the students’ attention and remained with them.

*Day Three*

Students met with other members of each group having the same job to compare notes and fill in any gaps in information. This activity was meant to mimic what real companies did when they attended conferences. Group work ended and individuals typed or hand wrote their paragraphs summarizing what they learned.
about the mine and whether it should operate. Writing continued on day four. Some students were still scrambling to get enough information and many were slow typists.

Day Four

The groups put all their paragraphs together into one paper. Many completed this on the computer. Others just stapled all the papers from each individual together. One student acted as recorder and collected the paragraphs into one document file. In this final document, students had to conclude whether this mine was a good thing for Marquette County and support their answers with evidence they had found from their research. There was not much teacher interaction with the students on this day of the project as students finished up their writing. The teacher’s role continued to be one of crowd control and facilitator.

Day Five

The final assessment was a debate. The students were unfamiliar with debate format and the result was very simplistic in nature. Some students took sides of the debate that they had not intended so there would be pros and cons to argue. Participation and appropriate behavior during the debate was essential to a passing this portion of the assessment. Three students at a time stood for or against the mine and argued their points with facts they had found in their research. Some students, as mentioned, had to take a side and argue contrary to what they felt. These students liked to argue for the sake of arguing most days.
Students not involved directly in the debate could send questions or factual supporting materials to the debaters through the intermediary, the teacher.

The final assessment grade was very subjective in nature as all facets of the project were taken into account from staying on task, to writing paragraphs, to formalizing a conclusion. In the end, the assessment did not count in a final marking period grade but the process itself was a positive learning and teaching experience.

**Assessment**

The assessment rubric was lengthy with many areas for students to receive points, both individually, and as a group. There were positives and negatives to this. They had numerous components to focus on, but many of the areas proved to be too difficult to achieve due to time considerations, student abilities and technology. It was my belief that the grade was not the ultimate purpose of this unit activity. It was to work in a group, use technology, and do critical thinking to make a judgment on a social problem in a community close to home.

This was the first time this unit was done. There were many difficulties with technology and expectations, which became obvious over the course of the five days. The final assessments were based on work ethic and supporting of details about the implementation of the Eagle Project.
Spring 2007

This year the students were seventh graders due to a different teaching assignment. The students were assigned to one of three different class hours in the day. The focus of science in 7th grade is primarily life and environmental so this unit’s content appeared in the environmental portion of the curriculum. This unit was presented to three different classes every day through the course of the lesson.

The exact format mentioned for Spring 2006 was followed with no changes other than students and some improved technical skills by both the teacher and the students. No changes occurred in the lesson rubrics or expectations. This was a new group of students and it seemed likely, at the time, that any variations were a result of different students’ behaviors and abilities.

Assessment

The assessments were based on class participation, group work, ability to stay on task and final paragraphs with support for their view about the mine. An added assessment tool consisted of a running tally of participation points for the week. The points ranged from 1-5, with 5 being actively participating and staying on task and 1 being off task often with teacher interventions reminding students to get to work or seek assistance. At least one hour was an especially behaviorally challenging class necessitating the need for additional supports in terms of
behavior rewards. Daily formative assessments were done as the teacher walked around and heard what the students were discussing and accomplishing.

The rubric (Appendix C) showed other content assessed, with tasks checked off when completed. As in the previous year a grade was given, generous in nature, if a student worked to ability, stayed on task and was able to have an opinion with some basis of fact to back it up. Similar results, compared to 2006, occurred when students answered the question “Is this mine a good thing?”

In the summer following this unit, after discussions with a Michigan Technological University professor, Dr. Ted Bornhorst, and a presentation to teachers in the Teacher’s Earth Science Institute, a research project evolved that appeared to have merit to the teaching community. More attention to details and data in the next two years became an important priority. The driving force behind the research was the choice of opinion about the Eagle Project that the majority of the students held at the end of the unit and why.
Section: Phase 2 of Study in 2008 and 2009
Activities and Objective

Spring 2008

Materials

Folders to hold notes and articles

Lined paper for note taking

*Detroit Free Press* articles on Kennecott Eagle Minerals Project (McDiarmid, 2003) (This article is no longer applicable due to more current articles available. Others of the same nature may be substituted.)

*Marquette Mining Journal* articles on Kennecott Eagle Minerals Project (Flesscher, 2006) (This article is no longer applicable due to more current articles available. Others of the same nature may be substituted.)

Teacher webpage

Website links

Computers and a projector

Pre-test/Post-test

Survey for previous year’s students

Rubric
Lessons

Day One

The same basic daily format was followed for this year’s project as in the past two years. There were some modifications due to new ideas about inquiry and assessment. These are addressed below in the lesson details.

Students received instructions on the first day and received a rubric with checklists for each required activity and its possible points. The rubric was modified into a simpler format with less total points. In the interim between spring 2007 and 2008 teacher assessment training occurred and it became evident that the previous rubric was obsolete and needed to be overhauled. The new rubric was more specific in its requirements and easier to follow. Some topics in the rubric were no longer relevant, such as the use of technology. Other material that had consistently been difficult for students to locate was removed, if it did not impact the overall learning outcomes of the unit. Other material, provided by the teacher, was in the form of hard copy job descriptions and maps of the area.

A pretest was added to the unit this year. Students responded to questions demonstrating mineral knowledge and views on mining and the environment. The students took the pretest a few weeks before as the unit on minerals and rocks was introduced. This unit on mining was a culminating activity using knowledge acquired about rocks, minerals and mining. A pretest was a modification intended
to measure progress in learning. Use of pretesting was a research-based strategy that helped the students and teacher focus on specific learning goals.

A lecture about Kennecott Eagle Minerals Company detailing their interest in Marquette County’s nickel-sulfide ore deposit started the unit. This lecture consisted of a brief history of the company and the location of the mineral deposit in Marquette County. Students were able to ask questions. Also included in the discussion was accessing websites for information, but not in clearly stated terms that would focus on bias. Also viewed were the types of jobs and their descriptions that could be pertinent in a mining venture. This year more explicit teaching was done based on reoccurring problematic areas of the previous two years – finding topographic maps and soil surveys.

Now, in the third year, computer use was the norm, not the exception. Students quickly opted to go to the internet for information as opposed to reading articles. There were exceptions. Some had a hard time reading a computer screen and others were banned from internet use. Cautioned not to print too much material or to be careful what they were printing meant they had to have permission before printing. The Kennecott document was many pages long and only a few pages were needed, as was information from the Department of Environmental Quality in Michigan.
From this point on students worked with little direction from the teacher. The only assistance given was in the area of computer or technology troubleshooting. If students had questions, the teacher would rephrase them and lead the students to figure it out on their own. The intent was to foster an inquiry based learning environment whereby students came to their own conclusions based on their own research.

*Day Two*

Students continued to do research and take notes about Kennecott Eagle Minerals Project, and Marquette County, all from the perspective of their jobs, as in past years.

*Day Three*

Students met with other members of each group having the same job to compare notes and fill in any gaps in information. Group work ended and individuals typed or wrote their paragraphs. This continued on day four. Some students were still scrambling to get enough information and many were slow typists.

The teacher’s role at this time was as facilitator and crowd control. Group work in the middle school setting can be easily taken off task and loud. The generated excitement, as information was found, was rewarding and drove the students to go further in their investigations.
Day Four

The groups put all their paragraphs together into one paper. The continuity or flow from one paragraph to the next was faulted but was not the focus at this time. Some were able to complete this on the computer; others just stapled all the papers from each individual together. One student acted as recorder and collected the paragraphs into one document file. In this final document, students had to conclude whether this mine was a good thing for Marquette County and support their answer with evidence they had found from their research. There was not much teacher interaction with the students on this day of the project as students finished up their projects. The teacher’s role continued to be one of crowd control and facilitator.

Day Five

The final assessment was a debate as is discussed in the Exploratory Studies.

Assessments

The final assessment grade was very subjective in nature as all facets of the project were taken into account from staying on task, to writing paragraphs, to formalizing a conclusion. In addition, informal formative assessments occurred daily. Students were assessed points based on behavior during the hour. Their behavior included staying on task and working to ability. The students could earn points from 1-5, with 5 being excellent and 1 being off task and a distraction to
others. This type of assessment seemed to work well for most students and each day the points earned were added to the rubrics in the folders each group was keeping.

A post-test was given to see if students’ opinions would change about mining and the environment when given a scenario that might prove more personally relevant to each of them. This post-test was given to the current years 7th graders and also as many as possible of last years’ 8th graders. This required the cooperation of the 8th grade teachers and time and effort on the part of those students. About three quarters of the students responded in the 8th grade. The post-test was not a graded assessment but a survey of attitudes with the explicit purpose to see if opinions changed over time. The students were aware of the nature of the survey (post-test) when given. Post testing was part of a research based teaching strategy and part of informal research parameters designed to see growth in learning from the beginning of the project to the end. The scenario looked to see if students, when personally affected by mineral production, opted for personal gain or the environment. This became the basis of research for the next year’s study.
Spring 2009

Materials

Folders to hold notes and articles and lined paper for folder

_Detroit Free Press_ articles on Kennecott Eagle Minerals Project (McDiarmid, 2003) (This article is no longer applicable due to more current articles available. Others of the same nature may be substituted.)

_Marquette Mining Journal_ articles on Kennecott Eagle Minerals Project (Flesscher, 2004) (This article is no longer applicable due to more current articles available. Others of the same nature may be substituted)

Teacher webpage with website links

Computers and projector

Pre-test/Post-test

Writing and project rubrics

Lessons

This was the final year of this project. I wanted to see if research-based teaching strategies showed whether or not bias and relevance played a role in how students reached a conclusion about a controversial topic. These teaching strategies helped students determine bias so that they understood the views represented in the materials that they used in their research. New strategies also helped students focus on finding relevance to the topic and were part of this modified lesson.
Day One

The students were given a pretest consisting of ten questions about their views on mining, the environment and of bias. This pretest was a baseline from which to compare changes in attitudes about mining and the environment. Students started the unit with little knowledge about mining and its impact on the economy and environment. Throughout the unit, specific content was taught that would help students see the bias in the topics they were researching.

The first topic discussed as the unit began was bias. The students defined the word bias using a dictionary. The teacher and students discussed examples of biases using examples from the media and looked at how it helped form their views and those of others. Specific examples of websites relevant to the unit were shown to the students and they were asked whose views were represented by each example. They looked at sites and reasoned out whose opinion might be dominant at each site. They would use this strategy when researching materials for the mining unit. At the completion of the lecture, students filled out a worksheet about bias assessing their understanding before continuing the unit on mining. (Appendix B)

Students were put into groups as designated by the teacher. There were some changes to how the groups were organized compared to past years. As before, group work accomplished many things. It was easier to mimic a company,
supplies shared and students could help each other in the learning process. The groups were a mix of students with similar abilities, in most cases. To accommodate special needs, some groups were designed so that they could continue to work together in a special education guided-study class during a different hour. A couple of groups were put together for the sole purpose of alleviating behaviors that would adversely affect the other groups, if those students were in their group. At least six students were chronically absent or tardy and they were added to groups as extras so as not to affect the overall performance of the rest. These students had jobs as “the public” and needed to look at the mining project from that perspective.

Once the groups were assigned, each job (geologist, mining engineer, economist and environmental scientist) that would be required of group members was viewed on-line at a site designated by the teacher. The work descriptions were studied as well as salary and education. Unlike previous years, this portion of the unit was an explicitly taught component using a computer, specific web addresses and a projector. The students then picked their job within the context of the group and the process of research began.

After three years, the availability of information about Kennecott Minerals, their Eagle Project, opinions and views from a wide variety of sources on-line had grown dramatically. To reduce the time spent surfing and not accomplishing
much, specific sites were given to the students in a document posted on the teacher’s webpage. These sites were a starting point for basic information. They represented both sides of the issue. The students needed to research at least three sites from two different views.

As in the past, much of the work was done independently with limited input from the teacher. The basic format of an inquiry lesson was still an underlying strategy and to that purpose teacher intervention was minimal. The rubric, the lesson and sites were all available to the students from a web page document that they had access to in school and at home. If new sites were located and found to be useful, the students were encouraged to share by adding them to a list on the board, which was incorporated into the webpage by the teacher.

**Day Two and Three**

Research continued, interspersed with short discussions held daily about nickel sulfide ore, uses of minerals in general and how mining affects the environment. These discussions were in the form of conversations amongst classmates or with a teacher and small groups of students. Also discussed was the idea of life without minerals, and what mineral-based items we viewed as important to our lives. This was a strategy to establish relevance and was new to the unit this year.
Students did not go their own way as they had been in the past. Their ability to research was still encouraged but kept to the topic at hand by daily lessons refocusing them on mining, the environment and their own personal stake in this mine. They were questioned about the stakeholders, and who benefited most from the mine. This represented a new look to inquiry-based learning. Full inquiry was not the best strategy given the timeframe or the maturity of the students. Partial inquiry allowed some freedom while providing a framework to keep the students focused on the learning goals.

*Day Four*

Very briefly, (10 minutes) students met with others having the same job descriptions to compare notes. Due to the more explicit nature of the teaching strategies, this was not as an important a component as it had been in the past. Students used the rest of the time to compile their information into paragraphs, always with the thought about the importance of this mine to the area. One person in the group compiled the paragraph information into a final document answering the question, “Is this mine a positive venture for Marquette County?” once the individual paragraphs were finished.

The paragraph writing was held to certain standards. There needed to be an opening statement, three supporting details and a concluding statement. This was true of each individual student’s paragraph and for the group summary and
conclusion. The writing component in science was a weak area on the standardized test for our school district so the addition of a rubric assessing writing was a positive offshoot of this project.

Day Five

In the past, there had been a debate about the validity of the mine project. This year all the group members had their turn to speak about the mine and its positive and negative sides. There was no debate. It was stressed that it might be necessary to state an opinion different from the group. That could happen in a real-world company setting. In all cases there had to be supporting details. The teacher completed a short assessment based on the rubric as each group presented. Students responded to clarifying questions and individual knowledge was assessed as needed.

Assessments

A posttest checked whether values or opinions changed, from the pretest once the students understood bias, and relevance to the topic established. The addition of different teaching strategies, after the first three years of this lesson, provided the means necessary to solidify the students’ views. The posttest was not part of a final grade, but a part of the research for this paper. The results will be discussed in the next chapter.
A short summative assessment followed as each group presented their findings. The short assessment looked for facts to support the opinions that each group held, in terms of the Eagle Project. This supported the resolution of conflict model. Clarifying questions were asked and individual knowledge was assessed as needed. The assessment of the completed folders proceeded according to the rubric guidelines.

**Summary**

The first three years of the study was exploratory. The experience from the first three years provided feedback formalizing the study as a research project. Formal assessments were developed and implemented. Greater structure and guidance provided for improved student inquiry. The resolution of conflict model and values development model provided the structure and guidance. The next chapter will present data and analysis from the project focusing on the final year of the project in 2009.
Chapter 4 – Data Collection

Results

The purpose of this study was to research the effects specific teaching strategies and instructional environments had on the ability of students to develop unbiased, scientifically supported opinions in Earth Science. The implementation of two teaching models, specifically the resolution of conflict model and the values development model, (Gunter, Estes, and Schwab, 2003) guided students as they considered bias and personal relevance in their research of Kennecott Eagle Mining Company’s nickel sulfide ore deposit and proposed mine in Marquette County Michigan.

I implemented the mining unit lesson in the spring of 2006 as a pilot study providing feedback defining the final research project. The results reported in this chapter are for the spring 2009, including comparisons to the pilot study from units done in the springs of 2006 to 2008. The spring 2009 study applied a pre/post test survey design with an intervention, and no control group. Students were pretested using a survey of attitudes and background knowledge. Instruction and post testing followed. The data from pretesting and post testing were two primary sources of data for this study. Additional findings will be analyzed using project assessments and teacher observations.
The survey was comprised of fourteen items, organized in two parts. Ten Likert-type questions formed Part A. Six of the ten questions measured bias and possible changes in bias after intervention. The other four measured relevance to the topic. Part B questions were binary true/false questions designed to measure content knowledge. Questions can be found in Appendix C.

**Data Analysis Procedures**

The data analysis from the surveys is in two parts. Analyzed first is the Likert-type questions that measured attitudinal changes in bias and relevance. The analysis of the content type items follow. The scale used in the survey was based on a number scale from 1 to 5 with 1 meaning strongly disagree, 3 being undecided and 5 being strongly agree. A correlation between the scale values was determined with 1 through 5, showing bias and not showing bias, respectively, and not relevant and relevant, respectively.

**Attitude survey analysis**

To analyze the attitude survey, I compiled the total number of answers the students gave per question and analyzed how those counts varied between the pretest and posttest surveys. The sample numbers between the two surveys were different due to fewer students completing the post survey and thus affecting the totals. To compensate for this difference I converted the actual numbers into percents of the total. The percents are shown in tables with each question and corresponding data discussed.
Questions 1, 2, 3, 5, 6 and 9 surveyed bias and will be discussed in the following pages. Questions 4, 7, 8 and 10 surveyed attitudes regarding relevance and will follow the discussions on bias. (See Appendix C for questions)

Questions #1 and #9 asked students to reflect on their *personal* opinions to determine whether those opinions were based on facts about that topic or opinions they heard from others. I wanted to see if students felt that they based their opinions on what others told them, believing it to be fact. In the pretest, the data from question #1 (Table 3) showed that students believed their opinions to be factual. Over half of the students agreed with the statement. After presenting the lesson, the posttest data showed a shift toward disagreeing, with an increased number of students now undecided. This showed that students questioned how or why they believed in what they observed as fact. Three percent strongly disagreed that their opinions were based on facts compared to zero in the pre-test survey.

**Table 3: Question 1** – My opinion about a topic that is controversial is based on facts about that topic and not on opinions that I have heard from others. (*pretest n=72, posttest n=68*)

<table>
<thead>
<tr>
<th>Choice</th>
<th>Percent of each value chosen on the pretest</th>
<th>Percent of each value chosen on the posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly agree - 5</td>
<td>11</td>
<td>9</td>
</tr>
<tr>
<td>Agree – 4</td>
<td>51</td>
<td>39</td>
</tr>
<tr>
<td>Undecided – 3</td>
<td>26</td>
<td>35</td>
</tr>
<tr>
<td>Disagree – 2</td>
<td>11</td>
<td>14</td>
</tr>
<tr>
<td>Strongly disagree - 1</td>
<td>0</td>
<td>3</td>
</tr>
</tbody>
</table>
Question #9 was more general in nature. I wanted to see if students understood that bias came from a variety of sources. Half of the students were undecided in the pretest survey with 32% disagreeing with the statement (Table 4). In the posttest, the student responses shifted to 42% disagreeing, with less than half of the students undecided. An optional space was left for comments, but no student left comments to help clarify any changes in their views. I believe there were too many options such as home, church, school and friends. They are all very different environments and if the question had been worded so that each location could be assessed individually, there might have been sufficient data to make an interpretation.

Table 4: **Question 9** – A biased opinion is formed from information a person hears at home, church, school, and with friends. (*pretest n=72, posttest n=68*)

<table>
<thead>
<tr>
<th></th>
<th>Percent of each value chosen on the pretest</th>
<th>Percent of each value chosen on the posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly agree - 5</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Agree - 4</td>
<td>14</td>
<td>12</td>
</tr>
<tr>
<td>Undecided – 3</td>
<td>50</td>
<td>41</td>
</tr>
<tr>
<td>Disagree - 2</td>
<td>22</td>
<td>39</td>
</tr>
<tr>
<td>Strongly disagree - 1</td>
<td>10</td>
<td>3</td>
</tr>
</tbody>
</table>

Question #2 (Table 5) looked at student views on the reliability of article or website sources. In the pretest 38% of the students were undecided. That number dropped to 25% after the lesson. In the pretest 28% of the students agreed with the statement trusting a source to be reliable and that number increased to 41% after the presentation of the lesson. I believe this shows that the students felt
more confident in assessing websites and articles once they learned specific skills. There was no change in the percent of students disagreeing that sources were reliable, but that was offset by the fact that fewer students strongly disagreed. I feel the overall trend was toward more confidence in ability. Question #2 supports the conflict of resolution model (Gunter, Estes, and Schwab, 2004) whereby students would need to find facts to resolve their conflict, in this case, the mining issue.

**Table 5: Question 2** – When I find a written article or website on a topic that I am researching, I trust that the source is reliable. *(pretest n=72, posttest n=68)*

<table>
<thead>
<tr>
<th>Percent of each value chosen on the pretest</th>
<th>Percent of each value chosen on the posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly agree - 5</td>
<td>4</td>
</tr>
<tr>
<td>Agree - 4</td>
<td>28</td>
</tr>
<tr>
<td>Undecided – 3</td>
<td>38</td>
</tr>
<tr>
<td>Disagree - 2</td>
<td>24</td>
</tr>
<tr>
<td>Strongly disagree - 1</td>
<td>7</td>
</tr>
</tbody>
</table>

Question #3 (Table 6) surveyed how a student’s opinion formed in relation to agreeing or disagreeing with the teacher’s view. The following table shows that over half of the students disagreed with the statement in the pretest. The undecided vote remained the same and there was a shift to show more students now disagreeing with the statement.
Table 6: Question 3 – When I am doing a project for a class that requires me to form an opinion I like to find information that I think will agree with the teacher’s point of view. (pretest n=72, posttest n=68)

<table>
<thead>
<tr>
<th></th>
<th>Percent of each value chosen on the pretest</th>
<th>Percent of each value chosen on the posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly agree</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Agree</td>
<td>22</td>
<td>15</td>
</tr>
<tr>
<td>Undecided</td>
<td>22</td>
<td>22</td>
</tr>
<tr>
<td>Disagree</td>
<td>39</td>
<td>45</td>
</tr>
<tr>
<td>Strongly disagree</td>
<td>13</td>
<td>9</td>
</tr>
</tbody>
</table>

Interestingly, the number of students who strongly agreed with the statement doubled while those strongly disagreeing dropped by 4%. The reason for the change could be related to the explicit teaching of some content and strategies. The students may have viewed this type of teaching as the teacher’s expectation of specific answers.

Question #5 (Table 7) asked students to agree or disagree with the statement that they would choose the environment over “toys” to protect the environment from the effects of mining. This question looked at both bias, when thinking about mining, and relevance. In the pretest, the highest percentage of the students were undecided. The percentage of those who disagreed and agreed were about evenly split. The posttest showed there were fewer undecided, and an increase to 43% of those who disagreed with the statement. The undecided votes surfaced in the agree category.
Table 7: Question 5 – If I had to choose between protecting the environment and giving up items… I would choose to protect the environment most of the time. (pretest n=72, posttest n=68)

<table>
<thead>
<tr>
<th></th>
<th>Percent of each value chosen on the pretest</th>
<th>Percent of each value chosen on the posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly agree - 5</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td>Agree - 4</td>
<td>22</td>
<td>24</td>
</tr>
<tr>
<td>Undecided – 3</td>
<td>29</td>
<td>21</td>
</tr>
<tr>
<td>Disagree - 2</td>
<td>19</td>
<td>23</td>
</tr>
<tr>
<td>Strongly disagree - 1</td>
<td>17</td>
<td>20</td>
</tr>
</tbody>
</table>

Question 6 (Table 8) asked how students viewed mining and its impact on the environment. By agreeing, they said that mining does more harm than society benefits. Forty-seven percent of the class, in the pretest, was undecided. This dropped to 34% in the posttest. The greatest change was in those who agreed with the statement. In the pretest 33% agreed and after the lesson 40% now agreed. Question #6 followed one of the steps of the values development model (Gunter, Estes, and Schwab, 2004) that required students find relevance to a topic.

Table 8: Question 6 – I feel that overall the mining of minerals does more harm to the environment than the benefits it can provide to society. (pretest n=72, posttest n=68)

<table>
<thead>
<tr>
<th></th>
<th>Percent of each value chosen on the pretest</th>
<th>Percent of each value chosen on the posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly agree - 5</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>Agree - 4</td>
<td>33</td>
<td>40</td>
</tr>
<tr>
<td>Undecided – 3</td>
<td>47</td>
<td>34</td>
</tr>
<tr>
<td>Disagree - 2</td>
<td>11</td>
<td>7</td>
</tr>
<tr>
<td>Strongly disagree - 1</td>
<td>3</td>
<td>7</td>
</tr>
</tbody>
</table>

The aforementioned bias questions reflected personal, interpersonal and public interpretations of biased opinions. The shifts in perspectives from the pretest to
the final assessment were not large when taken as a whole. (See Figure 1) The students felt relatively safe in voicing their opinions, so it is my belief that they answered as best they could on both the pre- and post-test surveys.

![Bias](image)

**Figure 1: A graph of data from bias related questions from the pre- and post- surveys.**

A summary of survey questions about bias from the pre/post survey.

1. Opinion is based on facts not others’ opinions.
2. I trust that articles and websites are trustworthy
3. I find information that agrees with the teacher’s view.
4. I chose to protect the environment over personal “toys”.
5. Mining of minerals harms the environment more that it benefits society.
6. A biased opinion formed from information a person hears at home, church, school and friends.

Another important aspect of this study was to see if relevance to the topic played a role in student-formulated opinions. Finding relevance was one of the steps in the values development model (Gunter, Estes, and Schwab, 2004). Questions #7
and #8 surveyed the students’ attitudes regarding their views of mining and its impact on their lives. Question #4 surveyed if the students formed opinions based on a controversial topics’ affect on their lives. Question #10 asked students how safe they felt voicing their opinions in the classroom. Questions #7 and #8 showed the biggest shift in the pretest and posttest attitudes and those questions will be discussed in the following paragraphs.

![Relevance graph](image)

**Figure 2: A summary of data from the pre- and post- test surveys**

A summary of relevance questions from the survey.

4. My opinion about a controversial topic is influenced by how it will affect me.
7. I am not directly affected by the mining of minerals
8. I can name many things that I own that have come from mined materials.
10. I feel safe in voicing my opinion in the classroom

Question #7 (Table 9) asked the students if they felt they were not affected by mining and 35/34% were undecided in the pre/post tests, respectively. In the pre-
test, 46% of the total agreed that they were not directly affected by mining. After participating in the lessons, this value dropped by 11%. Total percentages of students disagreeing with the statement rose from 15% to 29% in the pre- and post- comparisons. These data show that after students participated in discussions about mining, they learned how they benefited and/or were negatively impacted by mining, and saw the relevance personally, using the values development model (Gunter, Estes and Schwab, 2004). Ultimately, this affected their conclusions about the mine in the final unit assessment component.

**Table 9: Question 7 – I am not directly affected by the mining of minerals.**

*(pretest n=72, posttest n=68)*

<table>
<thead>
<tr>
<th></th>
<th>Percent of each value chosen on the pretest</th>
<th>Percent of each value chosen on the posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly agree - 5</td>
<td>11</td>
<td>9</td>
</tr>
<tr>
<td>Agree - 4</td>
<td>35</td>
<td>28</td>
</tr>
<tr>
<td>Undecided – 3</td>
<td>35</td>
<td>34</td>
</tr>
<tr>
<td>Disagree - 2</td>
<td>11</td>
<td>22</td>
</tr>
<tr>
<td>Strongly disagree - 1</td>
<td>4</td>
<td>7</td>
</tr>
</tbody>
</table>

Question #8 (Table 10) asked if students knew what materials came from mining. It could also reflect content knowledge. This question showed relevance because if students do not know that minerals come from a mine and we have products made from them there is no connection to the mine project and the lesson will not be relevant. This question reflected good prior knowledge about mining and that products are made from mined minerals. After the lesson, the percentage of students agreeing with the statement increased from 47% to 55%. There were 10% fewer students strongly disagreeing and an increase of 6% strongly agreeing.
Overall, a significant number of students agreed in the posttest to understanding they owned materials that started out in the mine. This question also showed fewer students undecided when compared to other questions. (See Table 10).

Table 10: Question 8 – I can name many things that I won that have come form materials that have been mined. (pretest n=72, posttest n=68)

<table>
<thead>
<tr>
<th>Percent of each value chosen on the pretest</th>
<th>Percent of each value chosen on the posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly agree - 5</td>
<td>7</td>
</tr>
<tr>
<td>Agree - 4</td>
<td>47</td>
</tr>
<tr>
<td>Undecided – 3</td>
<td>22</td>
</tr>
<tr>
<td>Disagree - 2</td>
<td>18</td>
</tr>
<tr>
<td>Strongly disagree - 1</td>
<td>6</td>
</tr>
</tbody>
</table>

I looked at how students, as a group, shifted survey responses from the pretest to the posttest. Thirty five percent of the answers in the pretest occurred around the undecided value. In the posttest, the percentage of students selecting an undecided response dropped to 29%. The strongly held views were about the same and did not shift in focus significantly, although the posttest did show a 2% increase in the number.
Figure 3: Changes in attitudes of pre and posttest survey questions of whole group.

Other types of data will be further discussed that show the teaching models helped students to construct unbiased, scientifically sound conclusions about nickel sulfide ore mining in Marquette County Michigan. Statistical data alone do not support the focus question.

**Project Assessment Data**

Another indicator in this study were the final assessment paragraphs written by the students summarizing their research. The final assessment required each group of students to reach a consensus, if possible, about the viability of the mine and answer the question “Is this mine a positive venture for Marquette County?” In the first three years of the pilot study, the students almost unanimously decided against Kennecott Eagle Mining Company and decided in favor of the environment. Students’ summaries focused on the environment and the impact
the sulfide ore could have on the animals and plants, and subsequently, the watersheds. Students were able to use past Kennecott mining projects as an argument against the Marquette County mining project.

After implementing specific strategies that helped the students define bias, understand the relevance of the mine to them personally, and think about what they valued, through large group and small group discourse, the conclusions’ focuses changed. Thirty out of sixty-two students decided the mine was a good idea. The rest were still concerned about the environment. The graph (Figure 4) shows how views changed over time with the greatest change happening in the final year of the project. The variables that changed in the final year of the project, besides the students themselves, were the teaching strategies. All other variables remained the same.

![Graph](image)

**Figure 4:** The data in this graph represents views held for and against the mine before and after the implementation of specific teaching models on conflict resolution and the development of values.
The Chi square statistic compares the tallies or counts of categorical responses between two (or more) groups. The data from the study can be represented using a 2 x 2 contingency table (see table 11). In table 11, a, b, c and d represent the frequencies for each of the categories of subjects.

**Table 11: 2x2 contingency table**

<table>
<thead>
<tr>
<th></th>
<th>Pretest</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of students For</td>
<td>a</td>
<td>b</td>
</tr>
<tr>
<td>Number of students Against</td>
<td>c</td>
<td>d</td>
</tr>
</tbody>
</table>

For the 2x2 table (table 11), the value of Chi square is given by:

\[
\chi^2 = \frac{(ad - bc)^2(a + b + c + d)}{(a + b)(c + d)(b + d)(a + c)}
\]

The students were pre and post tested on the question “Is the Kennecott Eagle Mine Project a positive venture for Marquette County?”

---

1 Chi Square computation [http://math.hws.edu/javamath/ryan/ChiSquare.html](http://math.hws.edu/javamath/ryan/ChiSquare.html) (November 23, 2009) This page was created as part of the Mathbeans Project. The java applets were created by David Eck and modified by Jim Ryan. The Mathbeans Project is funded by a grant from the National Science Foundation DUE-9950473
Table 12: contingency table created from the data

<table>
<thead>
<tr>
<th></th>
<th>Pretest</th>
<th>Posttest</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of students for the mine</td>
<td>10</td>
<td>30</td>
<td>40</td>
</tr>
<tr>
<td>Number Of students against the mine</td>
<td>62</td>
<td>32</td>
<td>94</td>
</tr>
<tr>
<td>Total</td>
<td>72</td>
<td>62</td>
<td>134</td>
</tr>
</tbody>
</table>

Applying the equation for a 2x2 indicated above, the value of Chi square is $\chi^2 = 18.9$. The value is interpreted using 2x2 table Chi square tables and the number of degrees of freedom is 1. The critical value of Chi square for a 2x2 table is 3.84, for a $p$ value of 0.05. Any value that equals or exceeds 3.84 indicates statistically significant changes, and the $p$ value of 0.05. The computed value indicates that the data were statistically significant. The results therefore indicate a significant shift in attitude between the pre- and posttest results.

**Teacher Observations**

During the pilot study, seventh grade students in Newberry, when participating in full inquiry, did not know how to focus their thoughts and behaviors to achieve a credible final goal. The students poorly understood bias and relevance. Many worked hard at the tasks but did not have enough direction to be successful. In 2009, after implementing the models-approach teaching strategies students used
partial inquiry-based learning, and explicitly taught lessons on bias, and informal conversations about minerals and mining to lead to the establishment of relevance to the topic. The students began to exhibit a better work ethic and were able to organize their research and construct meaningful arguments for and against the mine. As a teacher, I was able to provide direction through informal questioning and redirect to research sites that were relevant to the topic. Their writing in most cases was more logical and ideas and thoughts more clearly expressed.
Chapter 5 – Conclusion

Successes

Taken together, as a whole unit of research, the hypothesis that students would be able to construct unbiased, scientifically supported opinions was defended. The attitudinal survey’s statistical data alone did not support the idea that students met my expectations. When the data were interpreted question by question, and the degree of change in the final assessment responses were tallied and statistically analyzed using the Chi square, I felt confident that the students answered the question about the positive or negative nature of the mine in a thoughtful and reasoned manner that reflected implementation of the teaching models.

The models on which I based my teaching strategies were easily incorporated into the lesson. The model (see Table 1) aiding in conflict resolution promoted fact-finding, but also required students to use reasoning skills and ultimately look at solutions or consequences. The data from the pre/post tests supported the change in attitude. These new adapted strategies helped the students focus their attention on the concepts that I viewed as important. They were better able to understand how bias affected their decisions and once we discussed the location of the mine project, and related it to our geographical area, they were able to see the relevance of this controversial topic.
Another model instrumental to the lesson and my research was based on
determining values, and provided the key concept of relevance. Relevance was a
key factor in decision-making. There was greater teacher/student interaction with
the implemented teaching models fostering dialogues between the students and
myself, and between students. Part of the development of relevance dealt with
making connections. I feel a large part of the success of this unit was due to
students being able to look at the whole picture and discussing how they were part
of it. This was crucial to resolving any conflicts that occurred with group
members or personally in regards to the topic.

Many students gave “undecided” as an answer choice in the pretest. Fewer
students were “undecided” in the posttest. This showed that the students were
thinking about their choices, and, as a result of the teaching models now had some
skills upon which to scaffold new learning and make supported claims regarding
the mine. An undecided selection was a safe selection if the students felt lacking
in background information and had unclear expectations.

The most positive result was the final assessments where the students told their
views of the Eagle Project. This was the first time in four years that a majority of
students could articulate the negative and positive aspects of the mine. It was not
an all or nothing mentality as in previous years. Moreover, they backed up their
views with solid facts. The number of positive responses was significantly higher than in any other year that students completed this unit.

Problems with the Research

I found that presenting this unit during the last full week of school had its own problems with attention and behavior. Although most of the students did very well, there were some who were ready to be done and gone, plus many students were worried about other classes and materials that had to be finished. There were also students who were absent. When I repeat this unit again I will try to start earlier in the semester.

I would also look closely at how the pretests and posttests were constructed. The assessment and question may be improved. I would also encouraged students to make comments on the test/surveys. This would have been valuable when looking at the change in attitudes.

Implications for Teaching

This research has given me new strategies to use in the classroom. It will be valuable in many areas not just Earth Science. The need to determine bias is especially important if students are to make good decisions in the future about stem cells research, global warming, the environment, and mining, to name just a
few. Other teachers can learn from this research and implement similar strategies in cross-curricular content in social studies and language arts.

I know that the concepts inherent in the teaching models will become an integral part of my curriculum and are already becoming a tool that is often used to encourage students to think about real world problems and determine who is benefitting and who is not. As teachers we know what we believe, but students do not have very well-formed skills to assure that they can critically think an issue through to a logical, unbiased opinion.

In conclusion, having young adults that are able to understand bias and are interested enough in a topic to find it relevant will go one-step further in their thinking. These will be the people leading us in the future. It is in our best interest and that of the world to support their learning any way we can. This is one way, through the research I have completed, that I hope to have an impact on future generations of decision-makers. Using teaching models in the classroom that promote conflict resolution and help students determine what they value are two extremely important skills that we can teach our students.

The idea that inquiry based learning cannot be directed and focused hindered my ability as a teacher to provide a best-case-scenario teaching atmosphere. It was necessary to assess the cognitive abilities of the students, their maturity level to
work independently and their prior knowledge. Given the grade-level of the students, full inquiry was not the best option and the use of the teaching models allowed for partial inquiry while meeting the objectives of the lessons.
References


APPENDIX A: RESOURCE MATERIALS

Research articles for mining unit:

McDiarmid, H. Jr., “Mining Anxiety: Environmentalists, officials concerned about U. P. drilling plans.” Detroit Free Press 23 December 2003. (This article appears to no longer be available on-line but others of the same nature may be substituted.)

Flessher, J., DEQ delays Kennecott decision. Marquette Mining Journal, 16, November 2006. ) (This article appears to no longer be available on-line but others of the same nature may be substituted.)

Websites used for student research. These links were available at the time of the research. I hold no such claim at present. They are a mix of for and against.

http://www.epa.gov/r5water/uic/kennecott

http://citizensforresponsiblemining.org

http://www.greatlakeswiki.org/index.php/Yellow_Dog_Plains


http://Kennecottminerals.org

http://mediamouse.org search Kennecott
## Writing Rubric

<table>
<thead>
<tr>
<th></th>
<th>Not proficient 1</th>
<th>Basic Skills 2</th>
<th>Proficient 3</th>
<th>Advanced 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Paragraphs</strong></td>
<td>Paragraph does not meet any of the criteria.</td>
<td>Topic sentence and some details. No conclusion.</td>
<td>Topic sentence, simple details, and concluding statement.</td>
<td>Clear topic sentence, clear and concise details with above average conclusion.</td>
</tr>
<tr>
<td><strong>Group summary</strong></td>
<td>Only individual summaries</td>
<td>One or two sentence introduction, some supporting material from group members. Not a clear conclusion.</td>
<td>Introduction, supporting material from all members of group, and logical conclusion.</td>
<td>Clear introduction, well-supported details from all group members, Conclusion accounts for all members’ views.</td>
</tr>
</tbody>
</table>
APPENDIX B: LESSON PLANS AND WORKSHEETS

Lesson Plans

Day 1

Instructional objective
Students will evaluate multi-media sources for bias.
*S.RS.07.11 Evaluate the strengths and weaknesses of claims, arguments, and data regarding earth systems and human activities*

Instruction: 45 minutes
The teacher facilitates a discussion on the definition of bias.
The students receive sample articles to read to determine bias.
The teacher will present selected websites to the students using a computer and projector. Students should infer from their names what side of the issue they favor. Additional sites can also be found using a search engine for “eagle project Marquette County”.

- [www.savethewild.org](http://www.savethewild.org)
- [www.michigan.gov/deq](http://www.michigan.gov/deq)
- [www.responsiblemining.org](http://www.responsiblemining.org)
- [www.kennecottminerals.com](http://www.kennecottminerals.com)
- [www.miningjournal.com](http://www.miningjournal.com) search Kennecott or Eagle Project
- [www.freep.net](http://www.freep.net) search Kennecott or Eagle Project

Students will complete a worksheet on determining bias. (Appendix B)

Materials
Bias worksheet (Appendix B)
Websites showing bias on mining, both pro and cons (Appendix B)
Projector
Folders
Assessment
Assessment
The assessment consists of five selected response items to determine the
students’ ability to evaluate bias. (Appendix C)

Day 2

Instructional objective:
Students will conduct research and analyze data and claims to formulate
knowledge using written media and web-based media.

E.ES.07.41 Explain how human activities (surface mining,
  deforestation, overpopulation, construction and urban development,
  farming, dams, landfills and restoring natural areas) change the surface
  of the Earth and affect the survival of organisms.

E.ES.07.42 Describe the origins of pollution in the atmosphere,
  geosphere, and hydrosphere, (car exhaust, industrial emissions, acid
  rain, and natural sources), and how pollution impacts habitats, climatic
  change, threatens or endangers species

S.IP.0711 Generate scientific questions about earth systems and
  human activities based on observations, investigation, and research.

S.IA.07.11 Analyze information from data tables and graphs to answer
  scientific question concerning earth systems and human activities.

S.IA.07.12 Evaluate data, claims, and personal knowledge through
  collaborative science discourse on earth systems and human activities.

Materials:
Group assignments
Folders
Computers
Job description articles and on-line web sources
Articles on Kennecott Minerals, Inc and the Eagle Project
Websites about Kennecott Minerals, Inc. and the Eagle Project, or mining in
general.
Instruction: 45-60 minutes
Students assigned to a group by the teacher.
The students will select the “career/job” from the following list: economist, environmental scientist, geologist, or mining engineer.

Each group receives a folder to keep the information in, and they are required to name their company. It is not an assessment condition. Naming options and suggestions can be provided by the teacher, to hurry the process along, when needed. The folder will hold material that will be part of the final assessment.

Students research their job descriptions. For students without internet privileges give copies of the job descriptions.

Websites linking to newspaper articles are provided as starting points. (See Appendix A) (I copied and laminated articles. Teachers can use the sites ahead of time and copy and laminate their own, if desired. This is helpful if there are limited amounts of computers for student use.)

Students then proceed to evaluate information from the point of view of what job they have. The students are to read, and thinking in terms of their jobs, find fact to support the feasibility of the nickel-sulfide ore mine in Marquette County.

Assessment
Students will be evaluated on group participation and staying on task each day of the project. This rating will be from 1-5. 5 being full participation, working to best ability.
Day 3

Instructional Objectives:
Students will conduct research, analyze data and evaluate claims to formulate knowledge using written (hard copy) media and web-based media.

   E.ES.07.41 Explain how human activities (surface mining, deforestation, overpopulation, construction and urban development, farming, dams, landfills and restoring natural areas) change the surface of the Earth and affect the survival of organisms.

   E.ES.07.42 Describe the origins of pollution in the atmosphere, geosphere, and hydrosphere, (car exhaust, industrial emissions, acid rain, and natural sources), and how pollution impacts habitats, climatic change, threatens or endangers species

   S.IA.07.15 Use multiple sources of information on earth systems and human activities to evaluate strengths and weaknesses of claims, arguments, or data.

   S.RS.07.13 Identify the need for evidence in making scientific decisions about earth systems and human activities.

   S.RS.07.18 Describe what science and technology can and cannot reasonably contribute to society when dealing with earth systems.

Materials
Research information
Computers
Determining Relevance and Values handout (Appendix B)

Instruction: 45-60 minutes
The teacher will lead a discussion on the information found so far about mining and connect it to the bias work done earlier in the unit.

The teacher will then provide the students with a handout titled ‘Determining Relevance and Values’ (Appendix B) to use as they continue their research. This handout will help the students focus their critical thinking skills and reflect on their values about this mine as they come to a consensus on the Eagle Project unit.

Students will research, analyze data and evaluate the information they have read.
Students will fill out a Determining Relevance and Values worksheet to help them come to a consensus on a controversial topic. (Appendix B)

Assessment – Day 3
Students will be evaluated, daily, on group participation, working collaboratively, and staying on task. This rating will be from 1-5, 5 being full participation and working to best ability.

Day 4

Instructional objectives
Students will conduct research, analyze data and evaluate claims to formulate knowledge using written (hard copy) media and web-based media.

E.E.S.07.41 Explain how human activities (surface mining, deforestation, overpopulation, construction and urban development, farming, dams, landfills and restoring natural areas) change the surface of the Earth and affect the survival of organisms.

E.E.S.07.42 Describe the origins of pollution in the atmosphere, geosphere, and hydrosphere, (car exhaust, industrial emissions, acid rain, and natural sources), and how pollution impacts habitats, climatic change, threatens or endangers species.

S.I.A.07.15 Use multiple sources of information on earth systems and human activities to evaluate strengths and weaknesses of claims, arguments, or data.

S.R.S.07.13 Identify the need for evidence in making scientific decisions about earth systems and human activities.

S.R.S.07.18 Describe what science and technology can and cannot reasonably contribute to society when dealing with earth systems.
**Materials**
Research information
Computers
Determining Relevance and Values handout (Appendix B)

**Instruction – 45-60 minutes**
Students will attend a “conference” where they meet with other students having the same job description. This is to mimic what real professionals do. The students then meet back with their “mining company” and share any new information.

Students will discuss new information with their “company”, finish their research and start to evaluate what they have learned using the ‘Controversial Topic’ handout. (Appendix B)

The students will write a paragraph summarizing the evidence for or against this mining project; based on the “job” they hold in the “company”. (Writing Rubric – Appendix A or C)

**Assessment**
Teachers will evaluate students on group participation, working collaboratively, and staying on task. This rating will be from 1-5, with five being full participation and working to best ability.

Students will write a paragraph or more evaluating data, summarizing and evaluating information they have researched from multiple sources, thereby identifying evidence showing how humans influence decision-making in regards to the Earth’s surface.

**Day 5**

**Instructional objectives**
Students will conduct research and analyze data and claims to formulate knowledge using written media and web-based media. Students will summarize evidence, formulate a decision about the Eagle Project, and communicate and defend their findings.

S.RS.07.13 Identify the need for evidence in making scientific decisions about earth systems and human activities.

S.RS.07.18 Describe what science and technology can and cannot reasonably contribute to society when dealing with earth systems.
S.IA.07.13 Communicate and defend findings of observations and investigations dealing with earth systems and human activities

**Materials**
Computer
Rubrics for writing (Appendix B and D)

**Instructional time - 45- 60 minutes**

Each group “company” will work as a group and write a conclusion about the Eagle Project, supporting their findings with details from their research. One student must act as recorder and compile the answer in a word document.

The conclusion must answer the question: Is this mining project a good thing for the area.

List of questions to be debated:

- Is this mining project a good thing for the area?
- How will it affect the environment?
- How will it affect the economy of the area?

Students will volunteer to act as representatives of their groups, a take a stand on the issue of the mine and support their groups view using facts they have investigated and evaluated.
Assessment
The students will communicate and defend their stand on the mining project by writing a summarizing essay, to include supporting details from each member of the group and in the conclusion respond to the question: “Is the Eagle Project a positive or negative mining venture for Marquette County?” (Writing rubric for essay – Appendix C)
Not all persons have to agree on the final point, but again, they have to support their reasoning with evidence.

The final component is a debate about the issue.

S.IA.07.13 Communicate and defend findings of observations and investigations dealing with earth systems and human activities.
S.RS.07.13 Identify the need for evidence in making scientific decisions about earth systems and human activities.
S.RS.07.18 Describe what science and technology can and cannot reasonably contribute to society when dealing with earth systems.
Determining Relevance and Values

Answer the following questions on a separate sheet of paper.

Theme: Nickel Sulfide Ore Mining

Big Question: Is this mine a positive venture for Marquette County?

A. Why do people want this mine?

B. Why do people NOT want this mine?

C. What agencies or people have the power to make decisions about the mine Project?

D. Proposed solutions to the conflict regarding the mine.
   1.
   2.
   3.

E. Short-term consequences of each choice
   1a.
   1b.
   2a.
   2b.
   3a.
   3b.

F. Long-term consequences of each choice
   1a.
   1b.
   2a.
   2b.
   3a.
   3b.

G. List some values that you feel are most important to this mining issue.

Contextual – (Examples would be ethnic, religious, cultural, political, and economic) example: Mining in this area is a part of the history

Constitutive – (These values are part of the science involved in mining, minerals) example: Nickel is a metal needed for many products
H. Now weigh the evidence for and against mining.

What are the pros and cons?

<table>
<thead>
<tr>
<th>Pros</th>
<th>CONS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

I. After determining the consequences and thinking about your values, what do you feel should happen with the Eagle Project? Should the mine open? This will be your final paragraph for the assessment. Check your rubric.

J. Alternative solutions – Do you have other ideas about this mining issue?

K. What other subjects in school could provide information to help you resolve this conflict?
Determining Bias Worksheet

What does the word bias mean to you?
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

What is the definition of the word bias?
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

Read the next two paragraphs. Which one shows bias? Explain on a separate sheet of paper using examples from the writings.

Minerals, Inc. located an ore body containing copper. They have determined that the top of the ore body is 5 meters deep and stretches 750 meters wide, through core sampling. The market value is about 10 million dollars and is located on private property. The projected contribution to the economy in the area is approximately 50 million dollars in wages and benefits to area workers and businesses. Mining is scheduled to begin in 12 months. The first steps to opening the mine will be to obtain the correct permits from the state mining commission.

Minerals, Inc. owner and multi-millionaire has found copper on recently purchased local property. The ore body is 5 meters below the surface and 750 meters wide on this heavily forested acreage, formerly property of the county. The market value of the copper is about 10 million dollars, adding to his already wealthy bank account. Local area businesses are hoping for a cut of the 50 million dollars of wages and benefits that this copper mine could bring to a struggling economy. Without the auto plants, that have recently closed, many people are looking to the owner to provide much needed jobs in the area with the hiring of local workers. When asked if local workers would be trained to work in the mine, the owner did not commit.
Site addresses to use that are examples in determining bias. These can also be used for research.

www.savethewild.org

www.kennecottminerals.com/Eagle-Project

www.responsiblemining.org

www.mediamouse.

www.michigan.gov/deq
APPENDIX C: ASSESSMENTS, RUBRICS

Pre-test/Post test

Read the following statements and respond by circling the number that reflects how you feel about that statement. 5 is strongly agree (SA), 4 is agree (A), 3 is undecided (UND), 2 is disagree (DA), and 1 is strongly disagree (SDA).

Use the comment line if you have more to add to your answer.

1. My opinion about a topic that is controversial (one that is argued) is based on facts about that topic and not on opinions that I have heard from others.
   5  4  3  2  1
   SA  A  UND  DA  SDA
   Comments :
   ___________________________________________________________________
   ___________________________________________________________________

2. When I find a written article or website on a topic that I am researching, I trust that the source is reliable.
   5  4  3  2  1
   SA  A  UND  DA  SDA
   Comments :
   ___________________________________________________________________
   ___________________________________________________________________
3. When I am doing a project for a class that requires me to form an opinion, I like to find information that I think will agree with the teacher’s point of view.

5 4 3 2 1
SA A UND DA SDA

Comments:

__________________________________________________________________
__________________________________________________________________

4. When I form an opinion about a controversial topic, it makes a difference in my decision if it will directly affect my life in some way.

5 4 3 2 1
SA A UND DA SDA

Comments:

__________________________________________________________________
__________________________________________________________________

5. If I had to choose between protecting the environment and giving up items such as mp3 players, computers, video games, or rechargeable batteries, etc. that require mined minerals in their construction I would choose to protect the environment most of the time.

5 4 3 2 1
SA A UND DA SDA

Comments:
6. I feel that overall the mining of minerals does more harm to the environment than the benefits it can provide to society.

5 4 3 2 1

SA A UND DA SDA

Comments:

__________________________________________________________________
__________________________________________________________________

7. I am not directly affected by the mining of minerals.

5 4 3 2 1

SA A UND DA SDA

Comments:

__________________________________________________________________
__________________________________________________________________

8. I can name many things that I own that have come from materials that have been mined.

5 4 3 2 1

SA A UND DA SDA

Comments:

__________________________________________________________________
__________________________________________________________________

__________________________________________________________________
9. A biased opinion is formed from information a person hears at home, church, school, and with friends.

5 4 3 2 1
SA  A  UND  DA  SDA

Comments:
__________________________________________________________________
__________________________________________________________________

10. I feel safe in voicing my opinion in the classroom.

5 4 3 2 1
SA  A  UND  DA  SDA

Comments:
__________________________________________________________________
__________________________________________________________________

Circle T for true and F for false for each of the statements.

11. T or F Mining is the removal of minerals from ores that are found in the ground.

12. T or F If we did not have mining then we would not have many of the things that we now use and enjoy.

13. T or F Mining is done only underground in deep shafts.

14. T or F Once a mining company leaves an area it is up to the citizens to restore the area back to its natural state.
## Writing Rubric

<table>
<thead>
<tr>
<th>Category</th>
<th>Not proficient 1</th>
<th>Basic Skills 2</th>
<th>Proficient 3</th>
<th>Advanced 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paragraphs</td>
<td>Paragraph does not meet any of the criteria.</td>
<td>Topic sentence and some details. No conclusion.</td>
<td>Topic sentence, simple details, and concluding statement</td>
<td>Clear topic sentence, clear and concise details with above average conclusion.</td>
</tr>
<tr>
<td>Group summary</td>
<td>Only individual summaries</td>
<td>One or two sentence introduction, some supporting material from group members. Not a clear conclusion</td>
<td>Introduction, supporting material from all members of group, and logical conclusion.</td>
<td>Clear introduction, well-supported details from all group members, Conclusion accounts for all members’ views.</td>
</tr>
</tbody>
</table>
Rubric for Mining Project 2004 - Original

Your conclusion must answer the question:
Was or is this mine a positive or negative influence for the area it was in?

- Name of mine – 5 pts
- Mineral(s) mine produced and why are they important – 10 pts.
- Location of mine – city, county, state - 10 pts.
- Coordinates – latitude and longitude - 5 pts.
- Earth processes that would result in the minerals being there. – 20 pts
- Impact on community when fully operational. Was it good, provide jobs, bring in people. – 20 pts
- Impact on community when mine closed – If it has. How has it affected the people and economy of the area? – 20 pts
- Type of mining process that removed the minerals – shaft, open pit, etc. Explain or describe.- 15 pts
- Model of some type showing information – paper, book, game, model, PowerPoint, etc – 40 pts.
- Conclusion – a written paragraph or more with evidence to support your answer. – 20 pts.
- References All the internet sites, book, or materials that you used to find your information. – 10 pts

Total 75 pts.

As you complete each area check it off and include with your final project. Also keep all the notes you take and sources of information that you print off. You will need to keep this in the file folders that are provided.
Rubric and assessment for 2009

☐ Bias Assessment 5 points
☐ Job description and note handout 5 points
☐ Paragraph or two about the mining project from the view of the job. 10 pts
☐ Daily participation - doing your work, staying on task 5 pts/day -25 total
  o Day 1
  o Day 2
  o Day 3
  o Day 4
  o Day 5
☐ Concluding paper with contributions from all members. 25 pts.
  o Introduction
  o 4 – 5 supporting paragraphs (one from each group member)
  o Conclusion (Answer the question –“Is the Eagle Project a good thing Marquette County?”) See writing rubric.
☐ Class presentation on last day of project 10 points
  o All members present their part of the project.

Total Points ______________

Letter Grade ______________

Comments:

__________________________________________________________________
__________________________________________________________________
__________________________________________________________________
__________________________________________________________________
__________________________________________________________________