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THE USE OF A THEMATIC UNIT BASED ON FORENSIC SCIENCE TO ENHANCE LEARNING OF GENERAL HIGH SCHOOL SCIENCE

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THE USE OF A THEMATIC UNIT BASED ON FORENSIC SCINECE TO ENHANCE LEARNING OF GENRERAL HIGH SCHOOL SCIENCE

By

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ABSTRACT

THE USE OF A THEMATIC UNIT BASED ON FORENSIC SCINECE TO ENHANCE THE LEARNING OF GENERAL HIGH SCHOOL CHEMISTRY

By

Peter H. Peterson

For this thesis, I have developed and evaluated a thematic unit based on forensic science. The unit incorporates many science disciplines in exploring forensic science, which include chemistry, physics, biology, and earth science. The unit also draws from computer technology, creative writing and mathematics. This unit was organized and taught around the theory of multiple intelligences and hands-on/ minds-on instructional techniques. Over the past four years, the students participating in this study have shown improvement in learning and understanding as measured by four different evaluation instruments.

DEDICATION

This thesis is dedicated to my wife, Jennifer, for all her patience and understanding. And also to my sons, Evan and Logan; may they grow up to be "science guys."

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I would like to recognize Dr. Merle Heidemann and Dr. Jay Siegel for their assistance with this project. I would also like to thank Mrs. Jane Glerum for her help in preparing this thesis for presentation.

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INTRODUCTION

Background Information

My rationale for developing a unit on forensic science stems from my desire to make learning relevant for my students. I believe that my teaching philosophy, in general, can be best summed up in the following quotes taken from the American Association for the Advancement of Science's Project 2061: "Science is for all students. Learning science is an active process…Students should develop an understanding of what science is, what science is not, what science can and cannot do, and how science contributes to culture"(1990).

Teachers often struggle to answer the students'age-old question, "When are we ever going to use this?" This unit gave me the opportunity to show my students some of the practical uses for the material they were learning. It also afforded me a chance to show them that individual subject knowledge does not exist in a vacuum. The sciences, as well as most other fields, are related and do not exist as separate entities. This unit developed around the idea of an integrated unit that would encompass many different science fields as well as other academic areas. The integration of this unit also lent itself to exploring

the concept of teaching for multiple intelligences. This theory states that intelligence is made up of seven different realms of knowing. Current trends in educational research show that "...an integrated approach (to teaching) is supported by research on how the brain works and how human beings learn"(Hurley, 1997).

Comparison old vs. new approach

Traditionally, I am a follower of the chemistry text. Lectures, reading, note taking and text-related laboratory activities are the "norm." However, I do pride myself in keeping up with new findings from research and using new or innovative approaches to teaching. I try to use these to supplement my traditional methods. One theory that I have been exploring to help me improve my teaching is Howard Gardner's Theory of Multiple Intelligence.

A teacher does not have to look far to see examples of multiple intelligences. In the classroom, we see students with a wide array of talents and skills. We see students who are gifted in the areas of the visual arts and spatial relationships, for example. I have tried to address these differences in small but meaningful activities such as having my chemistry students create posters for elements

and molecules. I will admit that I have not fully explored every possible avenue of incorporating learning for multiple intelligence, but I do try to offer a unique experience for both the traditional and non-traditional learner in my classes.

This forensic science unit gave me the opportunity to develop an almost totally laboratory-based, integrated unit which lends itself nicely to the concept of multiple intelligences. For this unit, I chose to eliminate long lectures. I replaced them with short (five to ten minute) discussions before students engaged in lab activities. The purpose of these discussions was to help the students activate previous knowledge and offer hints or suggestions on how to best approach the activity. Additionally, in the development of this unit, I was able to explore a new way to lecture that involved the use of computer technology. I presented the early history of forensic science with a 20-minute presentation done using Microsoft PowerPoint. PowerPoint incorporates computer generated visual images and sound effects to produce presentations that rival music videos. This not only livens up a lecture, but also provides an avenue to reach the visual and spatial learner.

For most of the unit, I acted as a guide or coach to help students find the best way to approach activities and

help them create meaningful knowledge since "we need to encourage students to construct knowledge, rather than receive it" (Stephen, et al., 1995). Most students enjoyed this less stressful, work-at-your-own-pace environment.

The forensic unit replaced the last section I teach in my Chemistry I classes: Gas Laws and Gas Properties. Initially, I was concerned that replacing this unit would somehow short-change my students. However, I found that by including the forensic science unit, I presented more of the recommended topics presented in the Project 2061 literature (1990), the National Science Education Standards (1996), as well as, the Michigan Essential Goals and Objectives for Science Education K-12 (MEGOSE)(1991).

Through the implementation of this unit, I was also able to touch upon objectives that I traditionally ignored in the MEGOSE recommendations. This unit effectively emphasized the reflecting and constructing of scientific knowledge objectives set forth by MEGOSE. These objectives include: designing and conducting scientific investigations, explaining how math, science and technology can be applied in a real-world context and discussing the historical development of key scientific concepts.

The forensic unit also acted as an effective review for the final exam. In addition, it gave me the

opportunity to demonstrate the everyday practicality of chemistry and illustrate the many different disciplines related to it. This provided the students with an opportunity to see that "some of the best and most interesting advances occur at the interfaces among the disciplines (biochemistry, biophysics) and between broad subject areas (history of science, mathematics of music)"(Rankow et al., 1998).

In setting up this forensic science unit, I researched Gardner's Theory of Multiple Intelligences as well as integrated thematic instruction. I also examined and extracted information from literature, video, workshops and personal interviews to develop the science contents of the unit.

Pedagogical Literature Review

The following review deals with both Gardner's Theory of Multiple Intelligence and the concept of thematic instruction. To understand Gardner's theory, we need to look at what learning is. According to Kandel and Hawkins, "Learning is the process by which we acquire new knowledge, and memory is the process by which we retain that knowledge over time"(1992).

As teachers, we are all aware that different students have different strengths when it comes to learning. Some students are adept at manipulating objects, others at visualizing numbers. Gardner's Theory of Multiple Intelligences is based on these differences. Even though the idea of multiple intelligence seems simple, it is a quantum leap from where psychology started! Early psychologists struggled to explain simple behaviors and encountered tremendous difficulty answering the question, "How do we learn?" Current research in the field of neuro-biology has made huge strides in our understanding of the exact physiological changes that occur within the brain as it develops and "learns" information. Psychologists are examining current brain research in order to determine the best methods for combining it with existing cognitive and behavioral learning theories.

Jean Piaget introduced the idea that for learning to take place, the brain must make some sort of connection between the new information and the existing information. He called the creation of these frameworks "schemata" (Slavin, 1988). Rebecca Jones and Sharon Begley state that current brain research suggests that this is indeed true. By using MRI, PET and other sophisticated machinery, researchers have been able to localize the area where

different types of knowledge are stored in the brain. They have found that these sites in the brain are very specific. For instance, one particular site has the ability to recognize verbs; a completely different area is used to store nouns (Jones, 1995; Begley, 1997). Research suggests that "our school system must change to reflect what we now know about teaching, learning, mind and brain"(Bruer, 1999). It only makes sense for us as teachers to try to make connections between as many different areas in the brain as possible. It is our aim as teachers to reach all student and "if all students are to learn the curriculum, then all need the opportunity to be taught in ways that enrich their learning"(Bellanca, 1998). I believe this is the strength of multiple intelligence learning and is, therefore, along with thematic instruction the basis of this thesis.

Gardner's Theory of Multiple Intelligences states that intelligence is made up of seven different realms of knowing: verbal (linguistic), visual (spatial), mathematical (logical), musical, kinesthetic (bodily), interpersonal and intrapersonal. Verbal intelligence is the intelligence involved in writing, reading and story-telling. Visual intelligence deals with the ability to create drawings, paintings, and the ability to work with

one's hands. Mathematical skill is the ability to reason, deduct and see relationship among objects and ideas. Musically gifted students are those who can create and reproduce music. Bodily or kinesthetic intelligent learners are skilled at whole body coordination and have a sense of timing. Interpersonal intelligence involves the ability to "read" people and empathize with others' feelings. Finally, intrapersonal intelligence is an awareness of oneself. Students with this capability are skilled at knowing their own strengths and weaknesses. (Gardner, 1993)

Traditionally, most teachers teach to only a few of the intelligences. Verbal and mathematical intelligences are the focus of most science teacher's lesson plans. This is evident in examining the types of students who take elective science courses. The non-traditional students, who are dominated by visual, kinesthetic, intrapersonal and interpersonal intelligences, are under represented.

We, as teachers, must realize that most students possess a combination of two or more of these intelligences. A teacher needs look no further than his/her classroom to find examples of students that are dominated by one or more of the seven types of intelligences. In order for teachers to facilitate student

learning, they need to provide a variety of activities, which will encompass all the different types of intelligences. (Hurley et al., 1997; Forgarty, 1998)

How does the notion of multiple intelligences fit with the idea of thematic instruction? Thematic instruction is the building of a unit around a central theme, topic or idea. Thematic instruction works best if it is integrated across the curriculum. (Peters et al., 1995; Koerner, 1995; Shanahan et al., 1995) In the case reported here, the unit was built around forensic science. I included all science subject areas: biology, chemistry, physics and earth science, as well as writing, reading, art, mathematics and technology into the unit.

Thematic instruction is very compatible with current learning research:

> A thematic approach also reflects the most current research on how the brain comes to *know*. There are two ways we remember new information. The traditional classroom emphasizes one method, which is memorization of isolated facts and concepts... A second method... is based on the theory that our minds organize pieces of related information into complex webs, called schemata. New information becomes meaningful when it is

> integrated into our existing schemata. In this way, knowledge builds on itself, and the schemata grow exponentially. A thematic approach takes advantage of this process by having all the subjects revolve around a central theme, thus enabling students to develop complex webs of interconnected information. (Peters et al., 1995)

Thematic instruction greatly enhances learning because it integrates different intelligences and subject matter into a single lesson that effectively mirrors how students actually learn. I feel that thematic instruction also offers the students a chance to explore their intelligences in the "real world." An example of this occurs during the unit when students role-play the job of a forensic scientist. First, they spend twenty minutes working on sketching the crime scene (visual and spatial intelligence); then, they go into the crime scene to collect evidence (bodily and visual intelligence). This method gives "the major advantage in thematic instruction...replacing coverage with depth so that higher-order thinking skills can be developed and integrated in learning"(Koerner, 1995).

In summary, employing thematic instruction and addressing multiple intelligence shows promise in improving

student learning. "When students express something that they know in more than one form, they reinforce and deepen their knowledge of the subject"(Forgerty, 1994).

The History and Evolution of Forensic Science

Most of us are familiar with Hardy Boys, Nancy Drew or Sherlock Holmes mystery books. Many of us have tried to out-guess "Quincy" or "Matlock" in order to be the first to solve the "crime." Most people are fascinated with "whodunits." This fact is evident in the media coverage given to some of the more infamous criminal trials like O.J. Simpson's. In developing this forensic unit, I hoped to play on students' natural excitement involving investigation and their fascination with the weird and macabre.

For us to explore forensic science, we need to look at what forensic science is and what a forensic scientist does. Forensic science deals with recognition, identification, individualization and evaluation of evidence. Recognition is the gathering of any evidence that may be important. It is always better to gather evidence and throw it out later than to not collect the evidence and lose it forever. Identification involves the

placing of evidence into general categories; for example, "Evidence A" is hair. Individualization takes identification a step further into describing the color, texture, chemical make-up, etc. of the evidence. For example, "Evidence A" is brown hair, which is human and has been chemically treated. The better that the evidence can be described, the more valuable it becomes. Finally, evaluating the evidence involves determining whether the evidence gathered will help solve the crime. (Osterburg, 1992)

The main duties of a forensic scientist are to collect and identify physical evidence using scientific techniques. A forensic scientist may also be asked to provide expert testimony in court, which may corroborate or disprove alibis. (Osterburg, 1992)

History of Forensic Science

In the early to mid 1800's, most criminal investigations centered on interviewing victims and solving crimes based on deductive reasoning. The biggest obstacle facing detectives was the lack of a reliable method to identify criminals. Most police stations did keep records, but with no fingerprints or photographs it was difficult to

identify repeat offenders. Many criminals were smart enough to move around frequently and use an alias to conceal their true identities. It wasn't until about the late 1800's, that detectives started using physical evidence to identify criminals and to solve crimes. (Saferstein, 1990; Zonderman, 1990)

Early pioneers in the field included men such as Alphonse Bertillon, Francis Galton and Hans Gross. Bertillon developed a method to identify people based on certain body measurements. He measured height, ear length, length of feet and the circumference of the head and chest. He named this science Anthropomotery. Bertillon's method, however, soon lost favor after the introduction of fingerprinting. Francis Galton was the chief driving force behind the use of fingerprints for identification. He worked out a system for classifying fingerprints and published the first book on how to use fingerprints. Finally, Hans Gross wrote a book detailing how current scientific knowledge could be used in investigating and solving crimes. He predicted that the use of fingerprints, ballistics, serology, toxicology and microscopic examination would change the face of investigation forever. (Saferstein, 1990)

Even with considerable growth in the field of physical evidence, it wasn't until 1910, in Lyons, France, that the first crime lab was set up to analyze physical evidence. Edmond Locard set up his laboratory to analyze dust and soil after being inspired by Sir Arthur Conan Doyle's "Sherlock Holmes." He is also famous for his "Exchange Principle." Locard stated that whenever two objects come into contact with each other, they would leave traces of their contact on one another. This evidence, if found, could link the criminal to the crime scene. Locard's Exchange Principle is the foundation of forensic science. (Saferstein, 1990)

Over the next twenty years, techniques and procedures improved dramatically. In 1932, J. Edgar Hoover of the Federal Bureau of Investigation set up the first United States crime lab. In its first week of operation, it handled 20 cases. Today, the lab handles thousands of pieces of evidence a week. (Saferstein 1990)

Over the last fifty years, forensics has become such a broad field that scientists have had to specialize in certain fields of evidence analysis. Today, there are scientists who do nothing but investigate and analyze trace evidence (fibers and hairs), serology (blood and its components), toxicology (drugs and poisons), fingerprints,

DNA, soils, botany (plant pollen and seeds) or ballistics. Forensics is truly an integrated endeavor. Zonderman (1990) states:

> Although there were great strides before 1960 in science as it relates to criminal investigation, it is in the past 30 years that science and, especially, technology have made quantum leaps. The scientific criminal investigator can gather and analyze more information about physical-and even behavioral-evidence that appears at a crime scene than many authors of the 1960s dreamed possible.

Recent advancements in scientific knowledge and technology have found their way into crime labs. Today, research relies heavily on high-speed computers for everything from fingerprint analysis to enhancement and enlargement of photographs and video. Improvements in laser, microscope, and chemical instrumentation have also improved the accuracy and precision of forensic analysis. There is no telling how good the analysis of evidence will get in the future. (Zonderman, 1990)

Forensic science is a truly integrated discipline. It incorporates knowledge and techniques from every field of science, as well as many other related disciplines.

Forensics is such a broad field that I cannot do each individual field justice in the scope of this thesis. In the Implementation and Appendixes section of this thesis, you will find laboratory exercises and additional information that will provide you with a rudimentary knowledge of each field presented. This, along with the brief historical perspective of forensics, should provide you with a point to start your own investigation of forensic science.

Demographics of the Classroom

Shelby Public School district is a rural, agricultural-based district. The population of the district is approximately 12,000 people, over half of which are employed in agricultural or related work. The two top employers in Shelby are both canning companies (U.S. Census Bureau, 1999; Michigan School Report, 1998).

The average income in the Township of Shelby is $17,740 per family. This ranks Shelby 57th out of 83 Michigan counties per capita. The population is about 89% white to 11% Hispanic. In 1998, it was estimated that approximately 18% of the families living in Oceana County were living below poverty level. Most of this is due to a

large Hispanic migrant population that travels here in the spring and stays through the fall to help with farming (U.S. Census Bureau, 1999; 1998 Michigan School Report).

The school district educates approximately 1800 students per year in grades K-12. The high school contains 550 of these students. Shelby High School teaches in a block system of instructional time. Each class is eighty-five minutes long and there are four blocks a day. Students have four block classes each semester.

Shelby students are required to take three science classes (Freshman Science, Advanced Science and Biology) in order to graduate. Chemistry I and II, Biology II and Physics are offered as elective science classes. I usually teach two Chemistry I classes, one Chemistry II class, one to three Freshman Science Classes, and one to three biology classes a year. My average class size is around 20 students. The average student in my chemistry classroom would be a white, eleventh grade student from a middle income family. Sadly, traditionally, Hispanic students do not enroll in the more advanced science classes. Of the students in my chemistry class, most would attend some form of higher education after high school (44% four-year college and 37% two-year college)(Shelby High School Guidance Office, 1999).

Considering the backgrounds that most Shelby students come from, I felt that any method of teaching (such as multiple intelligences and thematic instruction) which could help more students learn was worth investigating. The choice of forensic science as the theme for this unit was also carefully planned. Because of the gore involved, forensic science offered an interesting topic that I thought most students would enjoy exploring.

IMPLEMENTATION OF UNIT

The development and implementation of this forensic science unit has progressed throughout the last four years. The preliminary groundwork was laid during my 1995 summer coursework at Michigan State University with the development of a fingerprinting lab and a paper chromatography lab. Over the next four years, I have added to and revised the unit.

The original intent of my thesis project was to produce a series of laboratory activities to supplement my existing curriculum. I thought this project would also give my students the chance to see *science in action!* The first year I piloted the unit (1995), it consisted of five labs: fingerprinting, paper chromatography, soil/sand analysis, blood analysis and handwriting/paper analysis; video segments taped from The Discovery Channel's "The New Detectives" series and a guest speaker from the Michigan State Police were also included. I thought that this would be a exciting introduction to the interesting, science-based career of forensic science. I planned these activities to be interspersed year-long throughout my Chemistry I class.

The second year I taught the labs, my students wanted to do more than the original five labs. They also did not

want to wait to do each lab separately as the text was dictating. Therefore, I modified the unit to produce a short two-week unit that culminated in a final crime that the students could solve based on their knowledge. The unit went over surprisingly well. The students suggested that I add more labs and make the unit longer. They also suggested that the final crime should be more challenging.

Over the next two years, I modified the unit to take into account multiple intelligences and hands-on learning. At the same time, I improved upon and threw out labs or activities that just did not work well or fit into the unit effectively.

As this unit has grown so has the class time I have had to commit to it. The first three years (1995-1998), the unit lasted for an average of about two weeks. The time was primarily spent on performing the labs with the hopes of gathering data on how to improve them. This year (1999), I spent almost four and one half weeks teaching this forensic science unit. A majority of the time was spent showing the integration of forensic science in relation to other disciplines. I was also able to collect and analyze data from the unit to evaluate its effectiveness.

In the following section, I will outline and describe the forensic science unit and discuss how and why each activity is scientifically meaningful. The Appendixes contain the complete lab write-ups for all work mentioned in this thesis.

Outline of the Unit

As I have stated earlier, I teach in an eighty-five minute block. This gives me and my students plenty of time to work and explore the science behind forensic science. The students work in a group of two to three persons. This year, I tried to avoid lecturing about the labs to my students; instead, I led a brief discussion to help activate the students' existing science knowledge and to provide some hints or suggestions on how to best approach the labs. Using the lab instructions and their previous knowledge, the students had no problem performing the labs or interpreting the results. Most students enjoyed working at their own pace. I usually assigned one or two new labs each day. However, I did find that I had to leave supplies out for each lab at least a week. I also had to provide a "catch-up" day so all groups could finish every lab.

Below is a rough outline of how the unit progressed from start to finish.

Forensic Science Unit 1998-1999

The following symbols, given in parenthesis, are used to represent which intelligence is addressed in each activity: Vb = verbal, Vs = visual, K = Kinesthetic, Mt = mathematical, Ms = musical, Ia = intrapersonal and Ie = interpersonal.

Day One

- Guest speaker: Crime Scene Technician from Michigan State Police.
- Question and Answer Session.
- Pre-test and survey over forensic science knowledge. (Used as an evaluation instrument)

Day Two

- Overview of forensic science unit and what I expect from the students, including a file folder that contains all of the group's work from this unit.
- Microsoft PowerPoint presentation on "The History of Forensic Science." (Vb and Vs)
- Lab activity: Anthropometry. (Vs, K and Mt)
- Lab activity: Powers of Observation (cartoon before/after crime scene). (Vs, K and Ie)

Day Three

- No class- Community Clean-up Day.

Day Four

- Video segment on fingerprinting.
- Discussion of fingerprinting.
- Lab activity: Direct Fingerprints. (Vs, Ve, Mt and K)
- Lab activity: Developing Latent Fingerprints. (Vs, Ve, Mt and K)
- Lab activity: Using Fingerprints to Solve a Crime. (Vs, Ve, Mt and K)

Day Five

- Continuation of Day Four lab activities.

Day Six

- Conclusion of Day Four lab activities.
- Handwriting analysis introduction.
- Handwriting "fun" quiz. (Vb, Vs and Ia)
- Assignment: Locate or produce two one-page handwriting samples for Day Eight lab.

Day Seven

- Oral quiz over the early history of forensic science and fingerprinting.
- Video segment on fields of forensic science.
- Discussion on fields of forensic science.

- Assignment: Read article on forensic entomology and answer assigned questions. (Ve, Vs and K)
- Assignment: Solve "Taking Clues from Fly-Witnesses."

Day Eight

- Go through prepared overheads on the basics of handwriting analysis.
- Lab activity: Analyzing Handwriting. (Vb, Vs and Ia)
- Turn in homework from Day Seven.

Day Nine

- Discussion on serial number restoration.
- Lab activity: Serial Number Restoration. (K and Vs)

Day Ten

- Discussion on Forensic Anthropology.
- Assignment: Read forensic anthropology article and prepare one page written summary. (Ve, Vs and K)
- Review of procedures for collecting evidence at a crime scene.
- Lab activity: Powers of Observation. Draw and label mock crime scene. (Vs, K and Ie)

Day Eleven

- Turn in article review on forensic anthropology.
- Discussion of serology (blood, blood typing, and blood splatter).

- Lab activity: Blood Typing. (Vb, Vs and K)
- Lab activity: Using Blood Typing to Solve a Crime. (Vb, Vs and K)
- Lab activity: Blood Splatter. (Vb, Vs, K and Mt)

Day Twelve

- Video segment on blood splatter evidence.
- Continue Day Eleven lab activities.

Day Thirteen

- Completion of Day Eleven and Day Twelve labs.
- Lab activity: Powers of Observation. Re-examining the mock crime scene for signs of tampering. (Vs, K and Ie)

Day Fourteen

- Video segment on facial reconstruction and forensic anthropology.

Day Fifteen

- Discussion of trace evidence (fiber, hair, pollen and sand).
- Review on how to use a microscope.
- Lab activity: Soil Analysis. (Vb, Vs and K)
- Lab activity: Solving a crime using soil evidence. (Vs and K)
- Lab Activity: Hair Analysis. (Vb, Vs and K)

- Lab activity: Solving a crime using hair evidence. (Vs and K)
- Lab Activity: Fiber Analysis. (Vb, Vs and K)

Day Sixteen

- Continuation of Day Fifteen labs.
- Oral quiz over trace evidence, serology and forensic anthropology.

Day Seventeen

- Completion of Day Fifteen labs.
- Video segment on trace evidence.

Day Eighteen

- Discussion of chromatography.
- Lab Activity: Paper chromatography. (Vb, Vs, Mt and K)
- Lab Activity: Use of paper chromatography to solve a crime. (Vs, Mt and K)

Day Nineteen

- Lab Activity: Thin Layer Chromatography. (Vb, Vs, Mt and K)
- Lab Activity: Solving a crime using TLC. (Vs, Mt and K)

Day Twenty

- Assignment: Read article and answer questions on DNA analysis. (Ve, Vs and K)

- Lab activity: Interpreting DNA Fingerprints. (Vb, Vs and K)
- Discussion on glass and its properties.
- Lab activity: "Density is a Crime--Glass Analysis." (Vb, Vs, Mt and K)

Day Twenty-One

- Unit test "Forensic Science."
- Finish and turn in completed team case file folder.

Day Twenty Two-and Twenty-Three

- Final Crime Scene (Vb, Vs, Mt, K, Ia and Ie)
  1. Draw crime scene.
  2. Process all interviews and suspects.
  3. Analyze evidence and report findings.
  4. Prepare written statement on who the killer was using evidence collected and analyzed.
  5. Prepare one to two page explanation on how the murder took place, based on the evidence, and what the killer's motive was.
  6. Complete post-test and survey. (Used as evaluation instruments)

This unit relies heavily on audio-visual aids. In addition to the overhead presentation for handwriting analysis, this year I added a multi-media presentation into

the unit. The unit also contains video segments from the Discovery Channel's "The New Detectives." I try to show only twenty to thirty minute segments at a time. Students seem to really enjoy the video segments, and they usually want to see the complete one-hour video instead of just segments. Eventually, some students will start watching the Discovery Channel to see the whole episode themselves. A complete list of the videos that I have used is included in the RESOURCES CITED section of the thesis. Every year, I re-evaluate which video should be added or removed from the video portion of this unit. I am very selective to make sure that what I am showing is teaching them something, as well as entertaining them.

In the following pages, I will summarize each lab or activity that has been presented in the outline. It should be noted that this is a summary of the labs and will only provide a rudimentary knowledge of each subject. Complete lab write-ups and evaluation instruments are included in the Appendices.

Summary of Labs and Activities

Guest Speaker

Every year, I start my forensic science unit with guest speaker Bill Burd, Crime Scene Technician, from the Michigan State Police. Bill covers the basic duties of the technician including how to develop and lift fingerprints. He also provides information on how evidence is collected and identified. For the last twenty minutes of the presentation, students are encouraged to ask questions about forensics. Students seem to enjoy Mr. Burd's interesting sense of humor and his gruesome stories from the "field." This really gets the students excited about the upcoming unit.

History of Forensic Science

This year, 1998-1999, I changed how this section was taught. Instead of a traditional lecture, I presented the material via a Microsoft PowerPoint presentation. Most of the information presented to the students is covered on pages 10 through 14 of this thesis in the INTRODUCTION section. The novelty of this technology seems to keep the students very attentive. This presentation gives the

students a chance to see the historical development of forensic science and how advances in forensic science were tied to advances made in scientific knowledge and equipment. The PowerPoint presentation also stimulates the visual and verbal intelligent students through its colorful graphics and effects.

Anthropometry Lab

In this activity (see Appendix A I), students use the fields of biology, mathematics and measurement to identify a criminal. Students start the class by recording their own body measurements on an index card; they include the following measurements: head circumference, right wrist circumference, left foot length and right ear length. On the index card, the students choose and write an alias and turn in their card. This information is then compiled into a suspect list. Two students are then chosen from the class to be the "criminals." I measure these students and record their measurements on the chalkboard. During the hour, students take turns sorting and evaluating the card data to determine the true identity of the criminal. I usually record the measurements as decimals instead of fractions to make the identification harder. At the end of the activity, we discuss why biologically some measurements

are better to use. We also discuss why scientists need uniform standards when recording data. The process of measuring, converting fractions and categorizing the measurements is geared toward the verbal, kinesthetic and mathematical intelligences.

Power of Observation Activities

I use two different activities to stimulate those who are visually and mathematically intelligent (see Appendix A II). The first is taken from page 169 of The Crime Laboratory. It is a before and after cartoon picture of a crime scene. The students use comparison skills to find fifteen differences.

In the second activity, I section off the back corner of my room with yellow plastic caution tape and set up a mock crime scene. This year, I set up a table with a variety of everyday items (pens, pencils, a bottle of glue, paper clips, various coins, my gradebook, a calendar, etc.). Students were sent to the crime scene with tape measures and told to draw the crime scene. A few days later, the students were sent back to the crime scene to determine twenty ways in which the scene had been tampered with or changed. Students learned quickly that they needed to be very precise with their observations. This activity

shows the integration between art and mathematics because it requires the production of a detailed and measured sketch of the crime scene. It is also great for the interpersonal and kinesthetic learners because the students needed to work in pairs to complete the work. Usually, one student drew the scene and the other used the tape measure to gather measurements.

Fingerprinting Labs

I have developed three fingerprint labs (see Appendix A III), which require students to use knowledge from both chemistry and biology. The first lab involves taking direct inked prints. The students use these prints to learn the skill of finding landmarks, which can be used to help categorize the fingerprints for identification purposes. The second lab involves the development of latent (hidden) prints on surfaces. Students learn how to "dust" and lift prints with powder. They also "develop" prints using ninhydrin, superglue and iodine fuming. The chemical basis for each developing technique is discussed, as well as the difference between qualitative and quantitative tests. The final lab activity involves the use of both inked and dusted prints to identify a criminal. This shows the real life connection between fingerprints

and forensic science. These labs involve the ability to match and compare information (spatial and mathematical intelligences), read lab directions (verbal intelligence) and physically manipulate lab equipment (kinesthetic intelligence).

Assigned Readings

For the sake of time, availability of labs and wanting to reach every mode of learner, I have added readings with directed assignments to broaden the number of fields of forensics that can be discussed and taught in this unit (see Appendix A IV). I have students read articles on forensic entomology, forensic anthropology and DNA analysis. I try to update the articles yearly to keep them as current as possible. Due to expense and/or moral issues, I cannot do an actual DNA analysis lab or allow a corpse to rot on school property to study insect succession. However, I do show two video segments that accurately depict the fields of facial reconstruction, insect succession and bone evidence so that students do get additional exposure to these fields. These assigned readings and videos cover a wide variety of topics including sculpture, insect growth, skeletal growth, the chemistry of DNA, cell growth and development and the

relationship between cause and effect. These readings show the connection between biology, art and language arts. It also allows the verbally, visually and bodily intelligent learners a chance to excel.

Handwriting Analysis Lab

This lab is among the students' favorite (see Table 2 and Appendix A V). They analyze two pieces of handwriting via an overhead presentation based on the basics of handwriting analysis taken from Handwriting Analysis: Putting It To Work For You by McNichol and Nelson. The lab shows the relationship between how a person's mental state influences his physical ability to function (cause and effect). This lab works well for the visual, verbal and interpersonally intelligent students because it deals with analyzing written language and emotional states. It also shows the integration of science, psychology and the language arts.

Serial Number Restoration

Students perform a chemical etching to the surface of an aluminum bar (1/4" x 1" x 3") which has been stamped with a serial number then ground away (see Appendix A VI). The acid mixture reacts preferentially with stressed areas

of the original stamp, causing the serial number to re-appear. This is an excellent opportunity to talk about the nature of chemical bond (ionic, covalent and metallic), types of chemical reactions and the process of etching. Manipulating the lab equipment and examining the bar for signs of the serial number is well suited for kinesthetic and visual learners.

Serology

This is one of the larger sections and involves a wide array of biology, physics and chemistry concepts that are presented in three labs (see Appendix A VII). The first lab involves using simulated blood to determine blood type. Concepts which can be taught include antigen-antibody reactions, the chemical make-up of blood and qualitative vs. quantitative testing. The second lab, concerned with blood splatter, involves a mock crime scene of an assault with a baseball bat. I paper an entire corner of my room, including the ceiling and floor, then take a baseball bat soaked in red paint that I use to bludgeon a tackling dummy. Various patterns can be obtained by changing the force or angle at which the dummy is struck. The students use mathematics, physics and creative writing to determine and report the angle of attack and direction of blood

splatter at a mock crime scene. They get an understanding of the concepts of force, basic trigonometry, point of origin determination, cause and effect and deductive reasoning. The actual measurement of the blood patterns and calculation of angles is geared toward the visual, kinesthetic and mathematical learners. The verbal learners enjoy the opportunity to create a story describing the event.

Trace Evidence Labs

This section of four labs includes hair, fiber, sand and glass analysis (see Appendix A VIII). It covers topics from biology, earth science and chemistry. Most of the work in these labs involves the use of microscopic investigation, dichotomous keying, as well as performing simple physical tests like calculating density. The soil lab includes gross and microscopic inspection and simple chemical tests for potassium, calcium, phosphates, pH and alkalinity. The students learn many concepts in these labs: classification skills; chemical make-up of hair, fiber, sand and glass; use of density; chemical reactions involved in creating polymer fibers; qualitative tests to identify traces of chemicals and the use of physical properties to identify substances. These labs benefit the

visual and kinesthetic learners because of the required acts of visual discrimination of objects and the hands-on nature of the labs.

Chromatography

This section consists of two labs: paper and thin layer chromatography (see Appendix A IX). Visual, kinesthetic and mathematical learners excel at these labs because they involve measurement, manual dexterity and discrimination of patterns and colors. Chromatography teaches solution chemistry, molecular size, and how mathematics can be used to quantify substances. This lab combines the fields of mathematics and chemistry.

Final Crime Activity

The final lab activity in this unit involves the use of all the above-learned skills to solve a mock murder (see Appendix A X). The students are presented with the murder of an unknown man and evaluated on how well they can apply the forensic techniques taught previously in the unit to solve the crime. Usually, the crime involves analyzing blood, blood splatter, hair, fingerprints, and ink evidence. It also involves reading and analyzing police interviews and determining motive. I have created a crime

grid to provide each team with its own unique killer from a pool of sixteen suspects. The students list this activity as one of their favorites.

This is a unique assessment technique in that it is a practical and totally lab-based exercise. It also integrates most of the subject areas of science with art, mathematics and language arts. I count this final crime activity as approximately thirty percent of the unit grade.

Students are evaluated in almost every lab through a hands-on evaluation that involves solving a crime using the new skill or knowledge learned. The crimes are either stand alone labs or extensions presented at the end of the lab activities. Other evaluation techniques for this unit include oral quizzes, a unit test, a pre- and post-test (five essay questions dealing with specific topics of forensic science), student assessed survey of learning covering 21 different forensic topics, student interviews and the solving of the final crime. These evaluation instruments and rubrics are included in Appendices B and C.

EVALUATION

To evaluate this unit, I expanded on the traditional methods used to measure student learning. In addition to the use of quizzes and a unit test, I added lab practicals, student-produced work (techniques, drawings and artwork), a student assessed learning survey, written evaluation of the unit by students, pre- and post-tests and a final project. I used a combination of old and new methods because I wanted to keep the students comfortable with the unit, but I also wanted it to be challenging. I found that my students were hesitant about getting away from the traditional evaluation technique of test taking. In the end, however, I did give my students a unit test (see Appendix B IV) over the forensic science unit to ease their tensions. As expected, the students performed at the level they normally did (89%) on written tests.

Teaching to multiple intelligences and using integrated units require different evaluation methods. In this unit, many labs involved the ability to perform special lab techniques and interpret the results. I chose to grade the students on the products they produced in the lab, such as inked fingerprints. Most of my non-traditional learners (those dominated by visual, kinesthetic, intra or interpersonal intelligences) responded well to being graded

on something other than the ability to memorize material. I also found that these students performed slightly better overall than their traditionally-minded peers (verbal or mathematically intelligent). This unit gave these students a chance to perform activities which demonstrated their intelligences.

For the evaluation of this unit for the 1998-1999 school year, I chose to use four different measurement instruments: an average percentage grade, a pre- and post-test of five specific subject area questions, a student-assessed learning survey and written student evaluations (see Appendix B).

In compiling and analyzing the students' average percentage grades over the last three years of this study, I have found that students gained about a five percent increase in their average grade (see Figure 1). The average grade over the last three years using non-thematic teaching methods was 87%. During the thematic teaching portion of the class (forensic science unit), the average grade rose to 92%. This is an increase equivalent to 1/3 of a letter grade (B+ to A-). I have also analyzed the data from the 1998-1999 school year individually and found a similar trend (see Figure 2).

Pecentage Grade Comparison of Thematic vs. Non-Thematic Instruction
(1996 - 1999)

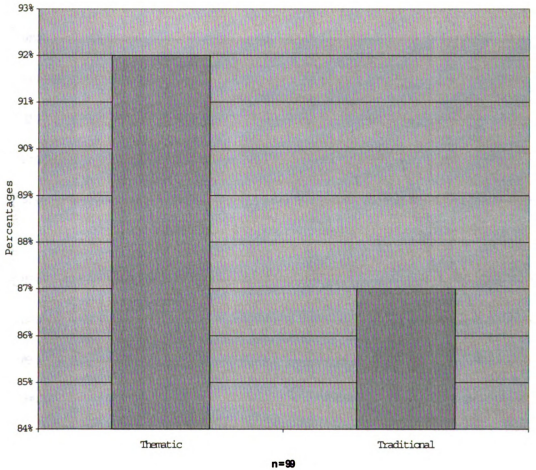


FIGURE 1

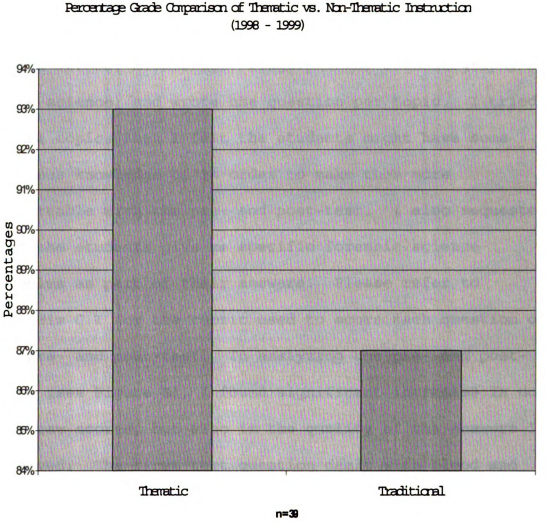

Percentage Grade Comparison of Thematic vs. Non-Thematic Instruction
(1998 - 1999)
94%
93%
92%
91%
90%
89%
88%
87%
86%
85%
84%
Percentages
Thematic
Traditional
n=38

FIGURE 2

The second instrument used to measure student learning was a five-question pre- and post-test (see Appendix B I). I created the test after consulting Dr. Joyce Parker, education professor, on the best way to measure students' achievement. She suggested that I come up with a short, "meaty," essay response-type test. I chose five forensic topics (blood, microscope, fingerprints, chromatography and crime science) and wrote one question per topic. I tried to use topics that I felt the students might have some previous knowledge of in order to make them more comfortable with the pre- and post-test. I also requested that the students give me specific forensic science examples as part of their answers. Please refer to Appendix C I for the rubric used to score each question of the pre- and post-test. In analyzing the pre- and post-tests (see Figure 3), I found significant increases in not only raw scores, but also in the quality of the answers I received. The first test question dealt with blood and blood testing. I found that, on average, students' knowledge rose from a 1.7 to a 3.8 (out of 6 possible points). On the use of the microscope, the students averaged 1.9 before the unit and 3.3 after (out of 5 points possible). Fingerprint knowledge went from a 2.0 to a 4.1 (out of 7 points possible). Knowledge of chromatography

Comparison of Pre-Test and Post-Test Learning of the Forensic Sciences Unit (1998 - 1999)

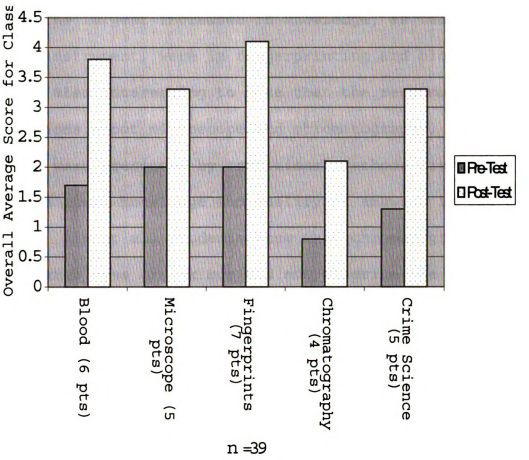


Figure 3

rose from 0.8 to 2.1 (out of 4 points possible). Finally, the question dealing with crime science went from a 1.3 to a 3.3 (out of 5 points possible).

The largest increases in knowledge, as measured by this instrument, were in fingerprinting and blood analysis. It is also interesting to note that the responses to questions about microscope and chromatography, both of which were presented by traditional methods previously, showed lower knowledge and quality of answers in the pre-test. Almost all students knew that chromatography separates dyes or ink but did not describe the process. The same was true of the microscope question. The students understood that a microscope enlarges objects for easier viewing, but most did not explain how it does this. It is unknown whether the students assume that everyone knows how the microscopes and chromatography work or if it is a lack of true understanding of the processes.

As I have stated earlier, the pre- and post-test showed that subject knowledge did improve after the unit. The quality of the answers, as well as, the use of specific examples also indicated this.

In order to illustrate the effectiveness of the pre- and post-test evaluation, the following is a sample pre- and post-test response taken from the same student. The

student is answering the question which deals with blood.

Pre-test response:

"There are different types of blood, much blood typing is genetic. A, B, AB and O and there is a + and - thing that indicates the presence of some 'thingy.' People with positive blood can't give blood to a negative person. Blood is made up of red cells, plasma, white cells and platelets. O is the universal donor."

Post-test response:

"Blood is made up of many things, plasma, white and red blood cells and platelets. The white cells have DNA in their nucleuses which can be used to identify a criminal. Blood cells also contain antibodies which can be used to type blood into one of the four blood types (A, B, AB or O). Blood type is passed on genetically from the parents to the child so it could be used to determine paternity by doing a Punnett Square."

As you can see the unit did improve this student's understanding of blood components, blood typing and practical uses of blood evidence.

On the third instrument, the Forensic Science Self-Evaluation of Knowledge Survey (see Table 1 and Appendix B II), the students assessed their own knowledge of twenty-one topics on a scale of one to five, some specifically

TABLE 1

Average Score on Survey Before and After Unit

TOPIC	Overall Class Average	
	Before Unit	After Unit
Using Microscope	3.9	4.3
DNA	3.2	3.6
Using DNA to Solve Crimes	2.1	3.9
Blood Typing	2.1	4.3
Use of Blood Evidence	2.0	4.4
Fingerprinting	2.8	4.6
Use of Fingerprinting to Solve Crime	2.6	4.6
Footwear Impressions	2.2	2.9
Paper Chromatography	1.9	4.4
Ink Analysis	1.6	4.3
Thin Layer Chromatography	1.2	3.2
Crime Scene Procedures	1.8	4.1
Fiber Analysis	1.5	3.8
Handwriting Analysis	2.0	3.8
Qualitative vs. Quantitative Labs	2.0	3.8
Document Analysis	1.8	3.5
Entomology	2.0	3.4
Rocks and Minerals	2.6	3.3
Trigonometry	3.4	3.7
Density	3.3	4.0
Basic Chemistry Techniques	3.7	4.5
Average of All Topics	2.4	3.9

about forensic science and others about general science knowledge. A "one" rating indicated "no knowledge of subject" and a "five" rating meant "understood well." Initially, students averaged a 2.4 in their self-reported knowledge of all subject areas. After the unit, the average rose to 3.9. The largest increases were in the areas of blood, DNA, chromatography, crime scene procedures and fiber analysis. The smallest increases were in the use of microscopes and trigonometry. The small increases may be due to previous exposure to both microscopes and trigonometry in math and biology classes. According to the overall data, student knowledge increased from "less than average understanding" to "good understanding" of the topics (see Figure 4).

The last and most subjective measurement of knowledge was my observations of the students and written student evaluations of the unit (see Table 2 and Appendix B III). During the unit, I observed that most students were eager to find out what the next topic would be. They were so eager during the labs that if I did not come over to answer questions immediately they became agitated. They could hardly wait to see if they had performed a technique

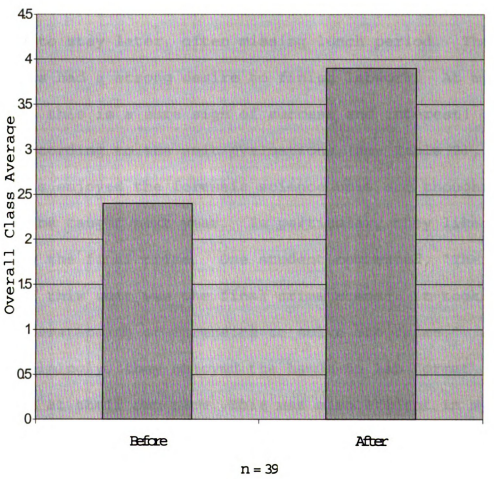

Average of Student Assessed Survey of Learning (1998-1999)
Overall Class Average
45
4
35
3
25
2
15
1
05
0
Before
After
n = 39

Figure 4

correctly or solved the crime accurately. They also seemed genuinely enthusiastic about doing the labs, and I would consider most of them proficient at performing new techniques. Most students came to class early to secure lab supplies or get started on the new labs. They also wanted to stay later, often missing lunch period. The students had a strong desire to finish labwork. At my school, this is a sure sign of success and interest!

According to the unit evaluations (see Table 2), most students enjoyed the forensic science unit and thought it should be taught next year. In particular, they liked solving the final crime. One student commented, "The best part of this unit was the final crime scene. It took all our understanding of forensics to solve the crime." Overwhelmingly, they enjoyed the hands-on lab format and working at their own pace. This was also evident in my observations. Many commented on how much they liked learning when it was active and performance-based rather than passive, i.e. reading the text. Another student commented, "I like how we incorporated lab skills into real life situations. Lots of people always ask 'When are we going to use this stuff?' This stuff can actually be used on a job or to successfully commit a crime and get away with it!"

Results of Student Evaluation of Forensic Science Unit (1998-1999)		
1. Which lab did you like best?		
	Top 3 Choices	
Lab	# of students	% of students
Final Crime	18	46
Blood Splatter Lab	6	15
Handwriting Analysis	5	13

2. Which lab did you like the least?		
	Top 3 Choices	
Lab	# of students	% of students
Hair Analysis	20	51
Fiber Analysis	4	10
Thin Layer Chromatography	3	8

3. Which lab was the most confusing?		
	Top 3 Choices	
Lab	# of students	% of students
Hair Analysis	23	59
Fiber Analysis	3	8
Thin Layer Chromatography	2	5

4. What improvements could be made?		
	Top Choices	
	# of students	% of students
Better explanations of labs activities	11	28
No changes	11	28
Spend more time on unit	10	26
Better equipment	8	21
n = 39		

Table 2

DISCUSSION AND CONCLUSIONS

Overall, I am very pleased with the results of this unit. I feel that the students enjoyed the change of pace offered by thematic teaching and hands-on learning. Like everything, though, there is always room for improvement. My observations and the collected data (see Figures 1-4) support the fact that the unit was effective in teaching forensic science knowledge. I believe this was due to the all-encompassing nature of the integrated theme-based teaching. It demonstrated to the students that no discipline exists in a vacuum; for a person to excel in life he or she must be capable of integrating many subject areas. The use of activities tied to multiple intelligence learning also provided students with a chance to explore different avenues of learning. It showed them that every person is unique in how they learn or acquire knowledge.

One change I will implement is to make my students more aware of the concept of multiple intelligences and put this knowledge to use. During labs, I will point out when and what intelligences are being targeted. This may help them to be more aware of their own and their peers' personal learning styles and to become more efficient workers, both individually and in group settings.

On the basis of the students' comments from the follow-up questionnaire and my own personal observations; I would like to point out the strengths and weaknesses of the individual labs and activities in this unit and suggest the changes listed below.

The most popular lab and the most difficult to set-up was the final crime (see Table 2). Over 46% of the students listed this activity as the best lab. This year, 15 out of 16 groups were able to analyze their evidence successfully and identify their "killer." The group that was unsuccessful missed on the processing of only one clue: the fingerprints. The only problem with the final crime activity is that it relies heavily on every other lab in the unit. For it to work well, teachers should use only the lab activities from early in the unit which the students understand well and can perform with little chance of failure. Students have a tendency to be shortsighted when it comes to matching <u>all</u> the evidence with their criminal. They are easily sidetracked if one piece of evidence shows a result which is inconsistent with the killer they have chosen. Every year at least one group complains that the evidence doesn't fit the crime scene. Of course, they would never fault themselves for sloppy lab work. A word of warning when setting up the final crime,

be aware of which labs are working well and which are not. Every year the 'hardest' lab varies, so try not to use it as the main identifying piece of evidence. This year, my students had difficulty with hair and fiber analysis so these labs were not included in the final crime.

According to student opinions, the blood splatter lab and handwriting analysis lab (see Table 2) were the two best individual labs. Students also liked the serial number restoration, chromatography, sand analysis, blood typing and fingerprinting labs. I find that the students like the labs that produce consistent results which are easy to interpret.

The blood splatter lab was improved from last year. Originally, I used 2-foot by 4-foot pieces of posterboard splattered with red paint as the evidence. The students complained that they were too hard to interpret. I had almost decided not to use blood splatter evidence this year until I discovered videotape on blood splatter that gave me some inspiration. I realized that it would be better to show the blood splatter on a larger scale; using a football dummy and paint covered baseball bat, I created life-sized blood splatters. Not only could the students see the direction of the strokes, but they could count approximately how many times the body had been hit. The

"blood" drops produced also gave excellent results for angle and point of origin determination. Students really enjoyed the use of trigonometry to determine angles and point of origin.

The handwriting analysis is also a yearly favorite. The students enjoy seeing what "secrets" are in their friends' and relatives' handwriting. One note of caution, however: be sure the students understand that you are not a handwriting expert and the interpretations are very subjective. Every year, I have students who are worried that their handwriting shows some terrible character flaw.

The fingerprint, chromatography, sand analysis, blood typing and serial number restoration labs are also considered "good" labs. These labs have reached a point where they only require minor modifications to produce consistent results. The more times a lab is used, the easier is it to predict what its weaknesses are and how to modify it to make it more student-friendly. For example, the students seemed to have trouble getting uniform results from the chromatography lab. The problem was caused by a lack of uniformity of test tubes. This year, I set-up ten identical kits for the lab and the results were much better.

The lab that the students thought was the most confusing and difficult was the hair lab (see Table 2). I feel this had more to do with an equipment problem than with the lab itself. Most of the microscopes could not focus down far enough on the hair to see the details necessary for identification. Other labs which students deemed as "losers" were the fabric lab and the thin layer chromatography of lipstick lab. Both of these labs had problems with equipment and samples. Nothing kills the excitement of labwork quicker than faulty lab equipment or poorly written directions. I would caution against adding labs that are not thoroughly tested, because if the quality of the lab suffers, so do your students. I often like to use my teacher's aide or Chemistry II students as guinea pigs for testing new labs that I want to introduce for the following year. The students enjoy this and like to offer suggestions on how to improve them.

I am currently looking at revising the existing labs in this unit and perhaps adding three new ones. I would like to find a way to either simulate DNA testing or find a quick and inexpensive way to teach it. I would also like to explore forensic anthropology using the biology department skeleton. The students could learn to determine height based on femur length, for example. Finally, I

would like to develop an insect succession lab. Perhaps, I could put a freshly road-killed animal out in the school wood lot to study insect succession. I may need to cover the animal with a wire mesh cage to keep it from being dragged away by larger animals, but it might work!

One of the benefits of doing an interesting thematic unit is that it can spark interest outside of class. Students, other teachers and parents may send articles, video and books that can supplement your theme. This is an excellent way to keep your videotapes and articles up-to-date. I am sure I am not alone in showing what I thought was a really interesting science video, only to have the students spend more time laughing at the actors' clothing or speech rather than paying attention to the message of the video.

One of the biggest problems I am struggling with is the length of time spent vs. what is gained. I will have to consider cutting down the scope of some labs or eliminating topics all together in order to ensure that class time is used productively. The students want the unit to last longer, but I cannot justify its length when it is so close to the maximum allowance. I am also struggling with whether or not I should provide more instruction (walk them though the labs). From the survey

(see Table 2) there was a 50/50 split between those who liked to work on their own and those who wanted more instruction.

For any teacher who would like to try this forensic unit, I would suggest starting small (two or three labs) and staying close to your field of expertise. Secondly, make sure that the students have the resources and time needed to do the labs right. Use or modify the resources at hand; it is not necessary to buy new equipment. Lastly, I would encourage others to try new things or change what is shown here to suit their needs.

Overall, I feel that this forensic science unit works well because it is unique. I do not plan to teach any other chemistry unit thematically because I believe it would lessen the novelty of the forensic unit. I will, however, consider using thematic teaching in my other classes if I can find a suitable theme that will generate excitement and teach quality science. Based on this study, I know that I will incorporate more activities that work with multiple intelligence activities into my other classes and units so I can reach more learners. This theory has definitely caused me to consider the relevance of what I teach and how I present it.

Over the past four years, this forensic science unit has evolved and changed to become what it is today. I am sure it will continue to "evolve" in other interesting and new directions. The unit has gotten so popular that it has taken on a life of its own. I have students sign up for Chemistry I simply because of the forensic science unit. I also have more than enough former students willing to help set-up or donate specimens, body outlines or fingerprints needed to create each lab. The most rewarding outcome of this unit is that two former students are pursuing careers in forensic science because they were so intrigued by this unit.

In conclusion, I feel that this unit accomplished what I intended it to do. First, it provided students with a unique learning experience involving many different intelligences. Secondly, it demonstrated how science is integrated and related to other disciplines. Last, and most importantly, it enhanced their learning of science.

APPENDICES

APPENDIX A

Appendix A I

Anthropometry

Anthropometry is the use of body measurements to identify a person. Alphonse Bertillon purposed this method of identification in the late 1870's as a means to identify and keep track of criminals. Bertillon's method was the preferred way to identify criminals until the introduction of fingerprinting in the early 1900's.

Anthropometry Activity

This is a simple lab to show the students how anthropometry is done and that it is an effective means of identification.

Crime Scene

The FBI has notified the school that there are two foreign agents posing as high school students to gather information about the upcoming Asparagus Festival. From an intercepted message, the FBI knows that the spies are enrolled in Mr. Peterson's Chemistry I class. They have also gathered information about the spies' body measurements. It is your job to match and identify the spies based on the compiled anthropometric data collected from the class.

Materials:
5 cloth tape measures
24 (3"x5") index cards

Procedures:
1. On an index card, record your name and any aliases. Next, measure and record the following: length of left foot, length of right ear, circumference of head and right wrist circumference.
2. Turn in your card to the teacher.
3. Using the body measurements of the spies given on the chalkboard, sort through the cards until you find probable matches.
4. On a separate sheet of paper, list your matches and then answer the following questions:

1. Did all your numbers match exactly? If not, explain why?
2. Why don't we use body measurements, such as circumference around the waist?
3. Why do scientists need to use standard units of measurement, such as centimeters?

Developed by Pete Peterson, Shelby High School, 1997.

Teacher Notes

This activity ties in well following a discussion of the history of forensic science. The students should understand the difficulty scientists had in finding a reliable method of identifying criminals before fingerprinting and photography were developed.

Begin this activity by having the students do the actual body measurements before talking about anthropometry. This will allow students more time to take accurate measurements. Collect all the cards and compile them to create a suspect card pile. From the cards, select two students' data cards to serve as the "spies" body measurements. Be sure to choose students who can handle being the "spies." To make the activity more challenging change the "spies" measurements from fraction to percent form and change one of the measurements so students don't get an exact match. After the presentation of the history of forensic science, write the "spies'" body measurement data on the board and place the card back into the card pile. In groups of two, students can take turns sorting through all the cards to find the suspects. Combine this with another activity to keep the students busy while they wait for their turn to look at the cards.

Appendix A II

Powers of Observation Activities

I use two different activities to show the students the importance of good observation and note taking. The first activity is taken from page 169 of The Crime Laboratory by Osterburg. It is a *before* and *after* picture of a crime scene. The students have to identify 10 ways in which the picture has changed. Any *before* and *after* picture taken from the comics section of a newspaper would work well, also.

The second activity is a bit more involved. I section off a corner of my room with yellow plastic caution tape and set up a mock crime scene. I usually set up a table with various common items (pens, pencils, a bottle of glue, various coins, etc.) I have the students draw, measure and note the exact location of all the items in the crime scene on a piece of graph paper. After every group has had a chance to draw the scene, I make about twenty-five changes to the locations or positions of the evidence. Make some changes very obvious and others very subtle. The groups are then sent back to re-measure and analyze the crime scene to see if they can find at least 15 changes. Most groups find about twenty.

Created by Pete Peterson, Shelby High School, 1996.

Resources:

Burd, Bill. Michigan State Police: Crime Scene Technician. Hart, MI 1996.

Osterburg, James. The Crime Laboratory: Case Studies of Scientific Criminal Investigation. New York: Clark Boardman Company, Ltd., 1992.

Appendix A III

Fingerprinting Lab

Fingerprints are the preferred means used by law enforcement in identifying criminals. Fingerprints are an excellent method of identifying people because no two sets of fingerprints are exactly identical (not even in identical twins) and because fingerprints do not change with age.

The use of high-speed computers, optical scanning technology and special software has allowed the FBI to create an Automated Fingerprint Identification System (AFIS). Using AFIS, the FBI is able to search and match a print against all 175 million fingerprints stored in their database in a matter of minutes. This technology has made the use of fingerprints an invaluable tool in the investigation of crime.

There are two main types of fingerprints that are used to identify suspects. The first is called *direct prints* which are inked impressions of the ridge patterns of a persons fingers. The second is called *latent (hidden) prints*. Latent prints are invisible traces of perspiration, salts and oils left by the finger ridges when they contact a surface. It is possible to react these trace compounds with a special chemical (iodine, ninhydrin or superglue fumes) to make them visible. Some latent prints can also be made visible by using very fine powders to "dust" the print. The dust adheres to the oils left by the finger ridges. After the latent prints have been developed, by chemicals or dusting, they can be "lifted" or photographed for comparison to stored prints in hopes of a match.

Direct and Latent Fingerprinting Lab

Direct Fingerprinting

Materials:

1 ink pad
2 index cards
1 sheet of white paper

Procedure:

1. Obtain the necessary lab materials from the main lab table.

2. To transfer a good print, roll your finger from one edge of your fingernail to the other. Do not over-ink your fingertips. Use the plain white paper to do a few trials. Once you feel confident that you can produce good quality prints (have the teacher check your work if you are in doubt), place your inked prints of all ten fingers on one index card.
3. On the other card, place only your right thumbprint.
4. Make sure to identify each finger and hand; also, include your name on the cards.
5. Using your right thumbprint, follow the steps below to mark your print for later comparison.

Comparing Prints:

The FBI classifies fingerprints into 3 main categories (see below).

Whorls Arches Loops

The FBI also uses other special landmarks and features to identify and distinguish fingerprints (see below)

1. Ending ridge
2. Fork
3. Island ridge
4. Dot
5. Bridge
6. Spur
7. Eye
8. Double bifurcation
9. Delta
10. Trifurcation

How to mark a print:

Using your right inked thumbprint, mark 10-12 identifying landmarks of your print.

Latent Fingerprints

There are four methods of developing latent fingerprints. Three of the methods involve the use of chemicals which react with the oils and perspiration left by the finger when it contacts a surface. The fourth method, which is the simplest, is dusting the print with powder.

Dusting Fingerprints

Method: The oils and perspiration from the fingerprint will attract and hold very fine powder, producing a visible fingerprint.

Materials:
2 index cards
1 clean 250 ml beaker
1 vial of dusting powder
1 brush
1 roll of tape

Procedure:
*Be careful when handling items so that you don't leave any extra, unwanted fingerprints.
1. Obtain a clean 250-ml beaker.

2. Roll your right thumbprint onto the beaker. (You may want to wipe your thumb across your forehead to add extra oil for a better print).
3. Using the brush, dust and tap a small amount of powder over the fingerprinted area. Do not brush the print too hard or you will destroy it.
4. Carefully blow off any extra dust.
5. Once the print is well developed, place a piece of tape over the dusted print and smooth out any wrinkles.
6. Remove the tape and place onto an index card.
7. If you cannot see a print, repeat steps 1-6.
8. Put your name on your print and turn it in to the teacher.

Crime Scenario:

An angry waiter leaves a dirty glass filled with toilet water at his manager's private table. See if you can figure out who left the glass at his table.

Teacher Notes:

Arrange the students in groups of four. Have one student from each group place a right thumbprint on a clean beaker. Have each group exchange their inked right thumbprints taken from the previous lab and the newly printed beaker with another group. Have students in each group work together to lift the thumbprint off the beaker and try to match it to one of the four inked prints. The students should find and mark at least 10 points of similarity between the inked and lifted print.

Chemically Developed Prints

There are three methods which can be used to chemically develop latent fingerprints. In the following two labs you will experiment with iodine fuming and ninhydrin developing. The third method, Superglue fuming, will be done as a teacher demonstration.

Iodine Fuming

Method: Latent fingerprints contain fatty oils which may react with the iodine vapors to form purple-brown visible print. The exact chemistry behind iodine fumed prints is still not fully understood.

Materials:

1 forceps
1 iodine fuming jar (baby food jar)
5-8 iodine crystals (do not handle with your hands)
2 1"x1" squares of plain white paper
1 roll of clear tape
2 index cards
1 spray bottle containing a 1% starch solution

Procedures:

1. Place 5 to 8 crystals of iodine into the jar and replace cap. Do not handle the iodine directly or inhale vapors.
2. Carefully roll your right thumbprint onto one of the 1"x1" squares. You may need to rub your thumb against your forehead to add additional oil to your thumb.
3. Uncap the jar and place printed square into jar. Reseal.
4. Observe the paper in the jar. You should start to see the purplish outline of the fingerprint form within 30 seconds. If not, hold the jar in your hand to warm the iodine so it will sublime faster.
5. Once you have a good fingerprint, carefully remove the paper square from jar and tape it onto an index card.
6. To preserve the print, you can spray it with a 1% starch solution before taping to the card.
7. Write your name on the back of the card and turn in to the teacher.

Ninhydrin Developing:

Method: Ninhydrin (triketohydrindene hydrate) is made into a solution by dissolving it in ethanol. This solution is sprayed onto a latent fingerprint and reacts with the amino acids in the perspiration of the latent print. The ninhydrin solution reacts with these amino acids to form hydrindantin which is pink- or purple-colored and thus, renders the print visible.

Materials:
2 1"x1" plain white paper squares
1 spray bottle ninhydrin solution (2 grams of ninhydrin per 100ml of acetone)
1 forceps
Steam iron
2 index cards

1 roll of clear tape

*Handle ninhydrin only with gloves or a forceps. The ninhydrin will react with the amino acids in your skin turning it blue!

Procedures:

1. Place a right thumbprint onto a 1"x1" paper square.
2. Using gloves and forceps, carefully take the print over to the fume hood and spray it with the ninhydrin solution. The paper should be wet.
3. Place the wet paper square between two paper towels and heat with the iron (1 to 2 minutes). You should see a faint purplish-brown developed print, if not repeat the lab. It may take a few trials to produce a "good" print.
4. Let the print fully dry and examine it.
5. Tape print onto an index card and put your name on the back. Turn in to your teacher.

Superglue Fuming:

This lab is best done as a teacher demonstration under a fume hood. Place a fingerprint on 1"x1" piece of plastic cut from a 20 ounce pop bottle. Place 5 to 6 drops of Superglue on a metal pop cap or similar metal item. Next, tape the plastic square to the inside of a large inverted beaker or other suitable glass container near the top. The Superglue fumes will coat the inside of the beaker so use one that is expendable. Place the inverted beaker over the Superglue-filled pop cap and place on a hot plate. Slowly heat the Superglue until it starts to fume; turn off the heat. The beaker should fill with white, smoky-looking fumes. Do not breathe these vapors! After the Superglue has stopped fuming, remove the beaker and retrieve the plastic square. You should have a perfectly preserved, white raised fingerprint. This can be done with larger items in a fish tank, but be sure the lab is well ventilated. The exact mechanism of why the Superglue polymers choose to form on the ridges of the latent prints is unknown.

Resources:

Peterson, Pete. Thesis research project. Michigan State University. SS 1995.

Chemistry and Crime Solving: Analysis of Fingerprints. Kemtec Educational Corp. 1991.

Miller, Larry. Criminal Evidence Laboratory Manual: An Introduction to Forensic Science. Glencoe Publishing Co., 1990.

Appendix A IV

Assigned Readings

For this forensic unit, I have chosen to supplement some of the more difficult to perform labs (cost or moral issues) with assigned reading from current periodicals. I try to keep the readings as up-to-date and as reader-friendly as possible. The topics may also change from year to year depending on current events (the O.J. Simpson Trial) and student interest. Listed below are the articles and assignments for the 1998-1999 school year.

1. Forensic Anthropology: The students read the three page article and wrote a one page summary of what information could be gathered by examining skeletal remains.

"Tales Bones Tell." AnthroNotes. National Museum of Natural History Bulletin for Teachers. Vol.15 No.1, Winter 1993.

2. Forensic Entomology: The students read the article and answered the questions at the end of the article and solved the animal poaching case study.

"Nature's Detectives." Current Science. Weekly Reader Corporation. Vol.83 No.12, 1998.

3. DNA Analysis: The students read the article and answered the questions at the end of the article.

Science Kit and Boreal Laboratories. "DNA Fingerprinting." New York.

Appendix A V

Handwriting Analysis

This section of the forensic science unit is one of my students' favorites. A day or two before we start this section, I have the students obtain two one-page handwritten letters. I usually start the unit with two or three "fun quizzes" taken from Handwriting Analysis: Putting It to Work for You. Next, we use the two handwriting samples to practice analyzing handwriting. I have created a series of overheads which I use to summarize the basics of handwriting analysis. I let my students' interest guide the overhead analysis session, and I do not try to cover every aspect of handwriting analysis. It is important to remind your students that this is a very subjective practice, and we are merely amateurs. The students are graded on how thoroughly they analyzed the writing samples based on the presentation. In order for you to gain a better understanding of what a broad topic handwriting analysis is, you will need to research this topic for yourself. Due to space and copyright considerations, I did not include my overhead summaries.

Resources:

Amend, Karen and Mary Ruiz. Handwriting Analysis: The Complete Basic Book. North Hollywood, CA: Newcastle Publishing Co., Inc., 1980.

McNichol, Andrea and Jeffrey Nelson. Handwriting Analysis: Putting It to Work for You. Chicago, IL: Contemporary Books, 1991.

Appendix A VI

Restoring Serial Numbers

Most items of value are coded or stamped with a set of digits (serial numbers) which is unique to that item. Most criminals know that if an item's number can be removed or rendered unreadable, the identity of the item cannot be proved.

The basis of serial number restoration is that the molecules or crystals under the stamped number have been disturbed by the stamping and are under stress as compared to the surrounding areas. This stress causes them to react faster with a reagent than the non-stressed areas. The process of reacting a reagent solution with a destroyed serial number on metal is called etching. An acid/metal solution is used to electrochemically react with the stressed metal to redevelop the serial number. An example of the electrochemical etching reaction is given below. It is simply a single replacement reaction with an acid catalyst.

$$Al + Fe^{+3} \rightarrow Al^{+3} + Fe$$

Materials:
1 Aluminum bar with serial number removed
Modeling clay
Ringstand and utility clamp
Safety glasses
250 ml beaker
Q-tips
Etching solution for aluminum (mix 25 g of Iron (III) Chloride, 25 ml of concentrated HCl and 100 ml of distilled water)
Acetone

Basic technique for serial number restoration:

1. Get a metal sample with the serial number removed.
2. Clean the metal surface using acetone to remove grease.
3. Set up a ringstand, clamp, metal sample and beaker as shown on the board.
4. Build up a clay dam around the ground serial number.
5. Soak a Q-tip in the acid/metal solution and apply it to the disturbed area.

6. Carefully watch the site and record any developments. Lines may appear and disappear as the process unfolds. Be careful not to breathe the fumes from the reaction.
7. Apply fresh solution every 2 or 3 minutes.
8. Be patient, record everything. You only have one chance.

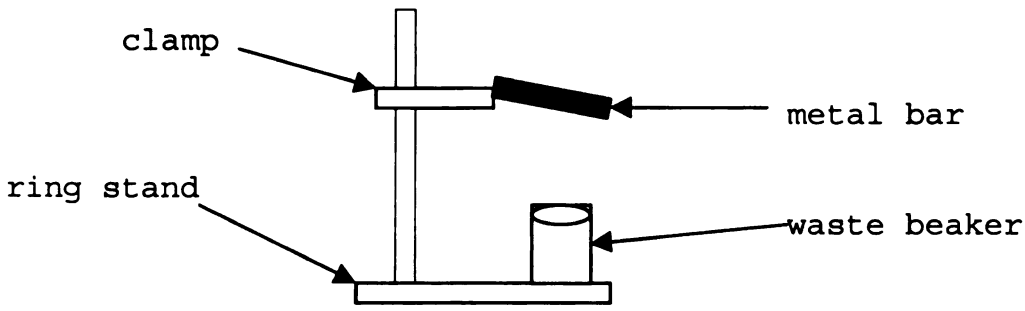
Modified by Pete Peterson, 1998.

Resources:

Adapted from Thornton, J.I. and P.J. Cashman. "The Mechanism of the Restoration of Obliterated Serial Numbers by Acid Etching." J. Forensic Science V.16, 1976.

Teacher Notes:

The set-up for this lab is illustrated below. It is important to make up fresh solutions for this lab. To create the samples, I use a metal die stamp to impress two numbers onto the surface of a 1"x 2" X ¼" slug of aluminum metal. I also code the piece with a letter in permanent marker on the back. I use the letter code to keep track of what numbers are on the piece. Using a grinder, carefully grind down the serial numbers until they just disappear. If you grind too hard you will not be able to re-develop the number later. If you are uncomfortable with using this type of equipment, have the shop teacher or a sheet metal worker help you. I have also found that the thicker pieces of metal (1/4") work better because it prevents the stamp marks from going through the metal. You can also restore numbers on wood, plastic, steel or silver, if you use the correct reagent (see reference above for more information). The students are graded on whether or not they could correctly restore and report the original serial number. This lab works well for the students. Over 95% of my groups are able to restore the serial numbers.



Appendix A VII

Serology

The study of blood and its components is called serology. Blood is made up of red blood cells, white blood cells, platelets and plasma. In the following two labs, you will learn how to type blood and analyze blood splatter. You will use these techniques to help you solve two mock crimes.

Blood Typing

Objective: The purpose of this experiment is to do a simulation of the blood typing process used to determine an individual's blood type. You will then identify the blood type of an unknown sample of blood and use that information to solve a crime.

Background: Blood is classified according to the antigens located on the surface of the red blood cells. A person may have antigen A, antigen B, both A and B antigens or no antigen at all. We can type blood based on how the antigens on the surface of the red blood cells react with special antibodies (Anti A and Anti B). For example, if a red blood cell with antigen A on its surface is reacted with anti A antibodies, the reaction will cause the blood cells to clump or coagulate. If the same blood is treated with Anti B antibodies, there is no effect. Since the blood only reacted with the Anti A antibodies the blood is typed as A. In the following lab exercise, you will determine blood type by comparing which antibodies cause the simulated blood samples to coagulate.

Materials:

Type A blood	(.20M Lead Nitrate)
Type B blood	(.20M Barium Chloride)
Type AB blood	(Equal amounts of A and B from above)
Type O blood	(Distilled water)
Anti-A sera	(.20M Sodium Iodide)
Anti-B sera	(.20M Silver Nitrate)
Droppers	
Spot plate	

Procedures I:

1. Place 5 drops of the simulated Type A blood into two wells on the spot plate.

2. In the first well, put 2 drops of Anti-A sera. Observe and record your results in a table.
3. In the second well, repeat the procedure from above using Anti- B sera. Observe and record your results.
4. Repeat steps 1-3 with Type B, Type AB and Type O blood. Observe and record your results.
5. After you have completed the table, show your results to your teacher for approval.

Procedure II:

1. Obtain the unknown blood sample from your teacher. Record the sample number and then test to determine the type of the unknown sample.
2. A sample of AB blood is collected at the scene of a rape. If the unknown sample of blood you typed came from one of the suspects could this person have committed the rape?

Suspect blood	Evidence	Victim's blood
???	AB	O

Additional Questions:

1. A woman claims Elvis fathered her son. Her blood type is AO. The king's blood type is AB. Show all the possible blood types this cross could have produced using a Punnett square. If the boy is type O blood, is he the son of the king—Elvis?

2. A very wealthy man dies. A woman comes to the will reading claiming to be the illegitimate daughter of the deceased. His blood type is AB++. She is tested and found to be BB++. What genotype must her mother be in order for her to have a legitimate claim to the man's estate? (Use two different squares--one for type and one for Rh).

Modified by Pete Peterson, Shelby High School, 1997.

Resources:

Saferstein, Richard. Criminalistics: An Introduction to Forensic Science Laboratory Manual. Englewood Cliffs, New Jersey: Prentice Hall, 1990.

Blood Typing Kit, Kemtec Educational Corporation, 1996.

Name _____

Blood Typing Lab

	Results of combining with	
Blood Type	Anti A	Anti B
A		
B		
AB		
O		
Unknown # _____		

Teacher Notes:

I do not use real blood for this activity. There are too many problems associated with handling real blood (AIDS, Hepatitis, etc.). This lab was original from a blood simulation kit I purchased from Kemtec. It is fairly simple to mix up my own "blood." Mix the solution according to the following proportions.

	Chemical	Amount of water
Anti-A	3 g Sodium Iodide	100 ml of distilled
Anti-B	3.4 g of Silver Nitrate	100 ml of distilled
Type A	6.6 g of Lead Nitrate	100 ml of distilled
Type B	4.2 g of Barium Chloride	100 ml of distilled
Type AB	Equal amounts of Type A and B	100 ml of distilled
Type O	Distilled water	100 ml of distilled

You can add red food coloring to the solution to get a more realistic-looking blood; it will not interfere with the blood typing. I put the anti A and anti B into dropper bottles and the different types of blood in larger stock bottles. When I get ready to set up the lab, I transfer about 2 ml of each blood type into small labeled test tubes for the students to use. This gives the students the impression that it is real blood. For the unknown blood samples, I use the prepared solution and put it into a test tube labeled with a letter. I usually make up 26 unknown test tubes marked with letters A - Z. Be sure you keep track of which blood type is in which test tube. The students are graded on identifying the unknown blood sample, successfully completing the lab table and answering the questions. You may need to review Punnett squares and traits with your students.

Blood Splatter Analysis

For this section, I use "Mathematics of Bloodstain Pattern Interpretation," taken from Pamela Tejkl's Michigan State University Master's Thesis,"Forensic Unit: Application of Science and Mathematics in the Junior Year." The six-page lab exercise does an excellent job of taking students through how to analyze blood patterns to determine point of origin, point of impact and direction. To fully

use all the activities described in the lab, I set up a mock crime scene by papering one corner of a room and then bludgeoning a tackling dummy with a red, paint-soaked baseball bat. Make sure that you do not raise the bat overhead, when you are hitting the dummy or you may have to clean your ceiling tiles. Below is the activity I have developed to go along Tejkl's lab.

Blood Stain Evidence

A body is found which has been bludgeoned to death. The weapon was found at the crime scene- a Louisville slugger. It is your job to determine the approximate location that the victim and perpetrator were standing, the number of times the body was struck, and the angles at which it was hit. You should make a rough sketch of the crime area and also identify the angles of the 20 marked points. Lastly, write a short paragraph describing how you think the beating took place.

Resources:

Tejkl, Pamela. "Forensic Unit: Application of Science and Mathematics in the Junior Year." Master's Thesis Michigan State University, 1997.

Saferstein, Richard. Criminalistics: An Introduction to Forensic Science Laboratory Manual. Englewood Cliffs, New Jersey: Prentice Hall, 1990.

Appendix A VIII

Trace Evidence

Trace evidence is a term used to describe evidence which is found in very small amounts (traces) and which does not fit into any other forensic evidence category. In the following four labs, you will be examining sand, glass, fabric and hair. You will rely on both chemical tests and physical examination to compare and categorize the evidence.

Forensic Sand Examination

Sand is the result of erosion and weathering of rocks and minerals. Sand varies greatly in size, shape, color and mineral composition. Since sand exhibits such great variety, it is possible to use sand as evidence to link a suspect to a crime scene. In this lab, you will examine three samples of sand to determine mineral composition, size, sortedness and angularity. You will then use this information to solve "Murder in Mears".

Materials:
Dissecting microscope
Hand lens
Sand samples
8 Index cards
Scissors
Wide, clear tape
3 Keys to Identifying Sand

Procedures:
Preparing a sand slide:
1. Cut a 1" x 3" rectangle in the center of each index card.
2. Cut and apply a piece of tape over the rectangular hole.
3. Using one card per sand sample, sprinkle the sand onto the sticky side of the tape. Label each sand slide.

Observing sand slides:
1. Using the hand lens, examine slide #1. Note the color of the sand grains.
2. Using the Key to Identifying Sand, try to identify the mineral that makes up your sand sample. Report this on the lab sheet.
3. Use the sizing chart to determine if your sand is 0.25mm or 2 mm. Report this on the lab sheet.

4. Using a microscope and the sorting and angularity keys, determine the sortedness and angularity of slide #1 and report it on the lab sheet.
5. Repeat steps 1-4 for the remaining two sand slides.

When you are finished, show your teacher your lab sheet and then proceed onto the "Murder in Mears."

Sand Lab

Sand Sample	#1	#2	#3
Mineral Composition			
Size			
Sortedness			
Angularity			

Common Mineral Found in Sand

Sand Color	Mineral/Rock
Clear or transparent	Quartz
Pink, tan, peach	K-Feldspar
Thin, shiny sheets	Mica
Black, prism-shaped	Hornblende
Dull black or dark gray	Basalt
Multi-colored grains varying from pink, gray, white and black	Granite
Black and magnetic	Magnetite

Biogenic Sand

(fragments of once-living sea life)

Appearance	Source
Fragments of clams, mussel and oyster shells in a variety of colors	Mollusks
Fragments identified by many rounded holes (usually found in tropical sands)	Coral
Rod-shaped or tubular spines in a variety of colors	Sea urchin spines

Key to Identifying Sand

1. Grain is shell material (**Calcite**).
   Grain is NOT shell material. Go to #2

2. Grain is gray or black. Go to #3
   Grain is NOT gray or black. Go to #5

3. Grain is attracted to a magnet. The mineral is **Magnetite**.
   Grain is NOT attracted to a magnet. Go to #4

4. Grain is black. The mineral is **Hornblende**.
   Grain is speckled gray-black to gray-pink. The rock is **Granite**.

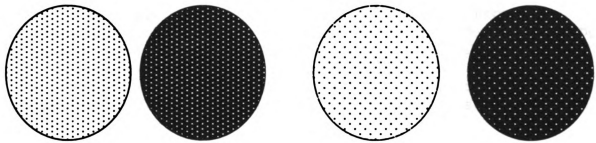
5. Grain is flat, paper-like and shiny silver or black. The mineral is **Mica**.
   Grain is NOT flat, thin sheets. Go to #6

6. Grain is clear or white and glassy. The mineral is **Quartz**.
   Grain is NOT clear or glassy. Go to #7

7. Grain is pink, tan or light brown. The mineral is **Feldspar**.
   Grain is NOT pink, tan or light brown. Go to #8

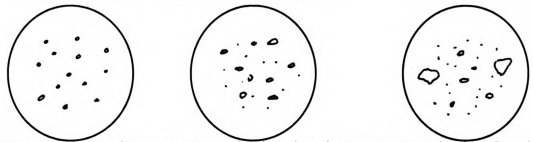
8. Grain is a mineral or rock source other than those listed above. Label as **Other**.

Sizing Chart



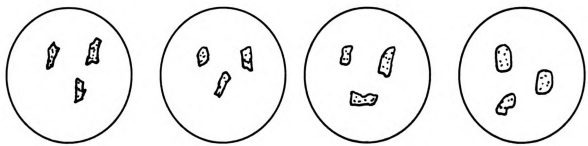
.25mm .25mm 2mm 2mm

Sortedness Chart



mostly the same size some variation in size great variation in size

Angularity Chart



Murder in Mears

A murder has occurred at a beach house in Mears. Three samples of sand evidence were collected from the crime scene. A drifter from Florida is picked up wandering in the nearby woods. He claims he was searching for morel mushrooms and doesn't know anything about the murder. Two sand samples were taken from the suspect's shoes and pockets. Compare the samples from the crime scene and the suspect.

Sand Sample	Evidence #1	Evidence #2	Evidence #3	Suspect's Shoes	Suspect's Pockets
Mineral Composition					
Size					
Sortedness					
Angularity					

Can the police hold the suspect for further questioning based on the evidence?

Teacher Notes: The sand lab works well provided that you have good equipment. You will also need to obtain different types of sand. I would recommend contacting the Michigan Earth Science Teachers Association or visiting their booth at a MSTA conference to get sand samples.

Modified by Pete Peterson and Kathy Lound, Shelby High School, 1999.

Resources:

Wiltse, Linda. "Simply Sand?" Michigan Science Teachers Association Spring Convention, 1998.

Murray, Raymond and John Tedrow. Forensic Geology. New York: Prentice Hall, 1992.

Density is a Crime–The Glass Lab

Glass is an amorphous material made up of silica fused with borates and phosphates. Glass occurs naturally, obsidian, or can be man-made. In this laboratory activity, you will use the physical properties of glass (density, thickness, color and fracture) to classify various types of glass. Once you are proficient at classifying, you will be asked to solve "Density is a Crime!"

Materials:
Glass samples
Ruler
Electronic balance
Hand lens
Microscope

Procedures:
1. Obtain a glass sample from the front table.
2. Using a hand lens and microscope, examine the glass sample and note its color and fracture pattern on the lab sheet. Fracture patterns are described as smooth, uneven or jagged.
3. Using a ruler, measure the thickness of the glass along three different edges. Record the average thickness on your lab sheet.
4. Using the electronic balance, mass the glass sample to the nearest 0.1 of a gram.
5. Using a graduated cylinder, take the glass sample and calculate its volume using water displacement.
6. Calculate the density of the glass by dividing the mass by the volume. Record this on the data sheet.
7. Have your teacher check your results before you proceed with the next lab.

Glass Lab Data Sheet

Type of Glass	Window	Automobile front windshield	Headlight	Beaker	Automobile side window
Color					
Fracture					
Thickness					
Density					

Density is a Crime!

A bicyclist is the victim of a hit and run accident as he crosses M-20 on the rail trail just south of Shelby. Glass fragments are collected at the scene of the crime. Over the following week, police have tracked down four different cars which have come into the local repair shop for new headlights. It is your job to analyze the headlight glass from the scene and the cars to see if you can find a match and catch the guilty motorist.

Data Sheet

Type of Glass	Crime Scene	Car #1	Car #2	Car #3	Car #4
Color					
Fracture					
Thickness					
Density					

Based on your analysis, who should be brought in for questioning?

Teacher Notes:

This is an easy and inexpensive forensic lab to set up. I would suggest that you go to a junkyard for the headlight and windshield glass. They will usually give it to you for free. I spend about 5 to 10 minutes with my students before the lab discussing why glass is not an ordinary "solid."

Created by Pete Peterson, Shelby High School, 1998.

Resources:

Barry, Keith. "Focus on Forensic Experiments." Journal of Chemical Education Dec. 1985.

Fabric Lab

The basic element of any fabric is the fiber. Fibers can be natural (wool, cotton, silk and linen) or man-made (nylon, polyester, acetate and rayon). Natural fibers tend to be made of fibrous proteins. These fibers are typically very short and fine and must be further processed before they can be used to make fabric. Natural fibers are twisted into long, continuous threads or yarns, which are then used to make fabrics. Man-made fibers, on the other hand, are produced from chemicals which are polymerized into long chains. Man-made fibers can be produced in any length. These fibers can be directly manufactured into fabric.

In this lab, you will analyze four different fabric samples using microscopic examination, burning, a protein test and solubility. You will then solve a simple crime using your newly acquired analytical skills.

Materials:

Fabric samples: wool, cotton, acetate and polyester
Scissors
Microscope
Bunsen burner
Forceps
Biurets solution
Watch glass
4 test tubes
Acetone

Procedures:

1. Obtain four 2"x2" squares of the fabric samples. Cut each square into ½" x 2" strips
2. Using a microscope, examine and draw the appearance of each fabric.
3. Burn test: Hold a fabric strip in the flame of a Bunsen burner until it ignites. Remove the strip and record the results of the test. Note the smell and length of time the strip continued to burn. Repeat for remaining three fabrics. (Use the Fiber Burning Key)
4. Protein Test: Place a small piece of the fabric strip in a watch glass and cover with about 10 drops of Biurets solution. This is an indicator for the presence of proteins. Observe and record any color change of the liquid. Repeat for remaining samples.
5. Solubility Test: Place 2 ml of acetone into each test tube. Put each fabric sample into its own test tube and record the results after 1 minute. Remember that "like dissolves like" so the acetone will only dissolve acetate.
6. Once you have completed these tests, show your results to your teacher for approval then proceed to "The Mystery Fiber."

Data Table

Fabric	Wool	Cotton	Acetate	Polyester
Microscopic Examination				
Burn Test				
Protein Test				
Solubility in acetone				

Burning Fibers Key

In flame	Burns and Chars		Melts and Burns	
Out of the flame	Stops burning	Keeps burning	Stops burning	Keeps burning
Residue	Crushable bead	Ash	Plastic bead	Plastic bead
Odor	Burning hair	Burning paper	Acrid/ Chemical	Acrid/ Chemical
Fiber Identity	Silk or Wool	Cotton	Nylon or Polyester	Acetate

The Mystery Fiber

One hundred rolls of toilet paper have been stolen from the janitor's closet. The only clue that police could find was a single white fiber. Before school ended for the day, the four most likely suspects were rounded up and fiber samples were taken from their clothes. Examine the fibers and make a recommendation on whose car and locker should be searched.

Data Table

Fabric	Evidence #1	Suspect #1	Suspect #2	Suspect #3	Suspect #4
Microscopic Examination					
Burn Test					
Protein Test					
Solubility in acetone					

Which suspect's car and locker should be searched?

Teacher Notes:

I have revised this lab so that it will work better. I took out some of the more difficult and ambiguous tests and added a new crime. This is an inexpensive and simple lab to do. Fabric samples can be obtained for very little money from a fabric store (Ben Franklin's). The biurets solution and 95% acetone can be borrowed from the chemistry or biology teacher.

Revised by Pete Peterson, Shelby High School, June 1999.

Resources:

Flachskam, Robert. "Textile Fiber Examination." Journal of Chemical Education Dec. 1991.

Fiber Analysis Kit. Kemtec Educational Corporation, 1996.

Hair Analysis Lab

Human hair is one of the most frequently found items at a crime scene. Hair is valuable evidence because it does not break down as rapidly as most other human tissue or body fluids. Hair covers a majority of the human body. At any given time, we are shedding some of these hairs.

Hair consists of two main parts, the shaft and the root. The root or follicle is the living part of the hair which is embedded in the scalp. The shaft of the hair is the portion of the hair which projects out from the root. The root of human hair is similar in appearance to a flower bulb. A cat's roots appear slightly larger than the shaft and have frayed looking edge. A dog's roots are diamond shaped.

The shaft of the hair is made up of three distinct areas: the cuticle, medulla and cortex. The cuticle is the outmost covering of the shaft. In humans it has a scale like appearance. The medulla is the middle layer of the hair and is not useful for identification. The inner most layer of the shaft is the cortex. This is the area where color pigment granules are stored. The cortex can be useful for identification. The color of the hair, as well as the distribution of the pigment granules, is unique to each race.

In the following activity, you will examine three hair samples with the microscope. You will examine and record

the appearance of the three layers of the shaft and the root.

Materials:
Hair samples (human, dog and cat)
Microscope
Slide and coverslip
Forceps

Procedures:
1. Cut the hair so that it fits onto the slide. You may need to make more than one slide so you can examine the entire length of the hair.
2. Using the microscope, record the general appearance of the hair.
3. Focus on the root and draw it on your lab sheet. Hair that has been torn from the scalp will contain bits of tissue. Hair that has been cut off will show a clean edge.
4. Focus on the shaft of the hair. Describe and draw the cuticle layer.
5. Refocus the microscope on the cortex. Draw and describe the distribution of the pigment grains.
6. Repeat these procedures with the other two hair samples.
7. Have your teacher check your results, then obtain a mystery hair sample. Try to determine the origin of the hair. Is it human?

Hair Analysis Data Sheet

Species	Root Shape	Cuticle	Cortex	General Appearance
Human				
Cat				
Dog				
???				

Modified by Pete Peterson, Shelby High School, June 1999.

References:

Saferstein, Richard. Criminalistics: An Introduction to Forensic Science Laboratory Manual. Englewood Cliffs, New Jersey: Prentice Hall, 1990.

Teacher Notes:

This lab has been revised but has not been tested. My students had difficulty getting the microscopes to focus down far enough to see in good detail. I think the changes I have made will improve the results. When you are collecting hair samples, make sure you pull the hair out so that the root stays attached. Students will be more than happy to give you samples for a little extra credit. You may also want volunteers to bring in some more exotic pet hairs to examine and compare.

Appendix A IX

Chromatography Labs

Chromatography is a process by which a mixture or solution can be separated into its components. The general process for performing chromatography is to place a drop of a mixture onto special paper which is then allowed to dry. The paper is put in contact with a solvent which carries the components of the mixture up the paper by capillary action. The components of the mixture will separate based on their charge (polarity) and the size of the molecules. The lighter the molecules and greater the charge attraction for the solvent, the further and quicker they will travel up the paper. For inks, chromatography produces a strip of paper that looks like a rainbow. Each type of ink has its own banding pattern which can be used to identify it. In today's labs, you will be performing paper and thin layer chromatography. Thin layer chromatography works the same as paper, except the mixture is placed on a special powder coated plastic strip.

Paper Chromatography

Materials:

3 different black water soluble markers
7 strips of chromatography paper
4 test tubes
Test tube rack
14 ml of distilled water
Plastic wrap

Procedures:

1. Obtain the lab materials from the main table.
2. Measure out 2 ml of distilled water and put into test tubes.
3. Take a paper strip and make a heavy black do about 2 cm from the bottom. Repeat this with other two markers.
4. Place each strip into a separate test tube. Make sure that the dot is above the level of the solvent.
5. Put plastic wrap over each test tube.
6. It will take about 5 minutes for the dyes to separate.
7. Remove the strips when the solvent line has reached about 1 cm from the top of the test tube.
8. Set the strips aside to dry.
9. Compare the color bands. What similarity do you see? Are the patterns different?

The Threatening Letter

Mr. Peterson has received a letter threatening to steal his pet snake if he doesn't stop feeding it live mice. The letter is evidently from an over-zealous vegetarian student concerned about cruelty to animals. Three students who fit the profile have been searched and black soluble markers have been confiscated from each. It is your job to determine who wrote the letter.

Procedure:

1. This lab proceeds exactly like the last one.
2. Run each of the suspects' markers. Keep track of which marker belongs to which suspect.
3. To run the ink from the letter, cut a small piece from the letter. Make sure you take a sample with a lot of ink. Take the piece and staple it face down onto the chromatography strip.
4. Run the strips.
5. Staple your results to the table below.

Marker	Chromatography Strips
Letter	
Suspect 1	
Suspect 2	
Suspect 3	

Which suspect wrote the letter?

Teacher Notes:

Use different markers for the first lab and the forensic lab. You can also use permanent markers if you switch to an alcohol solvent. You will want to create your own scenario for the crime note. I write the note on chromatography or filter paper so the ink will run better.

Modified by Pete Peterson, Shelby High School, 1996.

References:

Peterson, Pete. Thesis research project. Michigan State University. SS 1995.

Saferstein, Richard. Criminalistics: An Introduction to Forensic Science. Englewood Cliffs, New Jersey: Prentice Hall, 1990.

Thin Layer Chromatography

I use Kemtec's Thin Layer Chromatography kit for this lab. I have tried it on my own but the results are not as reliable.

References:

Thin Layer Chromatography. Kemtec Educational Corporation, 1996.

Appendix A X

Final Crime

This activity is the culmination of the forensic science unit. It provides the students with a chance to use what they have learned in the previous labs. One of the first considerations when setting up your crime is what scenario you are going to use. Is the final crime a murder, a robbery or some other type of crime? Use your imagination to develop a storyline which will be unique to your school or area. I find that leaving the story a bit sketchy makes it easier for the students to create the motive for the killer and to describe how the crime took place. Next, take into consideration what type of evidence you want to use. Use the lab activities which the students enjoyed earlier in the unit and choose evidence which will give consistent results. After you have decided on the scenario and the type of evidence, create a crime grid.

Originally, when I first started teaching this unit, the final crime would have eight suspects and one killer. Each group would receive the same evidence and eventually come to the same conclusions. In the hope of creating something a bit more challenging, I expanded the suspect pool to sixteen of which any of the sixteen could be the killer. This allowed each group to have its own unique killer and solution. A sample grid is set up below. Every suspect in the first column has blood type A (suspect 1, 5,9, and 13). Every suspect in the first row (suspect 1, 2, 3 and 4) has the same type of marker (Sharpie). No two suspects, though, have exactly the same blood type and marker. Setting up the evidence like this makes it easier to keep track of and also allows you to use fewer samples.

This year, I set up a grid which used four different pieces of evidence: fingerprint on a beaker, marker, hair and blood type (See the Crime Grid for 1998-1999). Suspect #1 has type A blood, black hair, prints #1 and is carrying a sharpie pen. He is the only suspect which matches these four pieces of evidence.

Sample Crime Grid

		Blood Type			
		Type A	Type B	Type AB	Type O
Type of ink pen or marker	Sharpie	Suspect #1	Suspect #2	Suspect #3	Suspect #4
	Overhead	Suspect #5	Suspect #6	Suspect #7	Suspect #8
	Permanent	Suspect #9	Suspect #10	Suspect #11	Suspect #12
	Bic	Suspect #13	Suspect #14	Suspect #15	Suspect #16

Crime Grid (1998-1999)

		Blood Type					
		Type A	Type B	Type AB	Type O		
Ink Pen or marker	Sharpie	Suspect #1	Suspect #2	Suspect #3	Suspect #4	Black	Hair color
	Overhead	Suspect #5	Suspect #6	Suspect #7	Suspect #8	Brown	
	Permanent	Suspect #9	Suspect #10	Suspect #11	Suspect #12	Red	
	Bic	Suspect #13	Suspect #14	Suspect #15	Suspect #16	Blonde	
		Print 1	Print 2	Print 3	Print 4		
		Fingerprints					

To make the crime interesting for the students, I loosely base the suspects on teachers or adults at the school. I provide the students with the crime scene, a handout which describes the contents of the victim's pocket (see Contents of Joe Smith's Wallet), pages from his day planner and an autopsy report (see Autopsy Results of Joe Smith). From this information my students are able to piece together that a man named Joe Smith was bludgeoned to death with a baseball bat in the back corner of my classroom. The students also determine that Joe was a photographer and a softball umpire and was at the school to deliver pictures and watch the softball game. The handouts also provide information about Joe's education and family.

Once the students determine what crime was committed, I provide them with a packet of suspects' information (see Suspect Profile and Interview) which includes a photo, blood type, height, weight, fingerprints and an interview of the suspects. The interviews provide clues as to which suspects had contact with Joe and to their possible motives. In the suspect profile of Bruce Dimmer, students could figure out that Joe's father and Joe, both umpires, had caused Dimmer to lose important softball games. Dimmer also had opportunity to kill Joe before he went out to coach his game.

After the students have read through the interviews, I let them examine and draw the crime scene. I place labeled cards on the floor to act as marker for the evidence. I then assign each group a number which corresponds to a certain suspect. Do not show the murder grid to the students. Group #1 is given evidence which will correspond to Suspect #1's evidence. Each group has its own unique killer. This year, there were five pieces of evidence. (victim blood, suspect blood found on a pair of scissors, hair, a note and fingerprints left on a beaker). Students then come to me to request specific pieces of evidence. Using the information they have collected in their file folder during the labs earlier in the unit, the students then work on analyzing each piece of evidence. Students then solve the crime based on their evidence. The students are graded on how well they perform the following items:

- Drawing the crime scene.
- Processing the autopsy, interviews, wallet contents and day planner information. They keep notes on everything they find as they go through the crime (see Evidence Notes).
- Preparing a written statement on who the killer was based on their evidence.

- Writing a two-page narrative on how they think the murder happened and what the killer's motive was (see Murder Notes).

This year every group except for one successfully solved the crime. The students really enjoy this activity and it serves as a good wrap up to the unit.

Created by Pete Peterson, Shelby High School, 1997.

Week of May 23, 1999

Sunday 23	Photo-11:00am-JuJu Harry Photo-1:00pm-Zelda Bullrush Softball vs. End Zone 6:00pm
Monday 24	Photo: Kelly VanDoggan 11:00am Photo: Cat Bound 3:oopm Umpire: ***Mont*** vs. Shelby 4:30 pm shelby
Tuesday 25	Job interview- Montague HS at 11:00 Job interview- Big Rapids HS at 2:00 Date 8pm Kelly
Wednesday 26	Interview-Shelby 2 pm Drop off pictures at HS
Thursday 27	Umpire-***Shelby*** vs. Oakridge4:30 at shelby Date-CB 9pm Date-Kelly 11pm
Friday 28	Meeting with D at 4pm Get passport
Saturday 29	camping/fishing trip with the boys

Contents of Joe Smith's Wallet

Michigan Driver's License

Joe D. Smith
235 Colby St.
Whitehall, MI 49437
DOB 1/28/67
Hair Brown Eyes: Blue

Blue Cross/Blue Shield
345-980-888-09

Name	DOB
Joseph D. Smith	1/28/67
Mary C. Smith	12/2/65
Sally R. Smith	1/10/85
William J. Smith	3/9/89

LOTTO
5/23/99
$1 Insta pick
11 17 27 32 39 47
Agent # 345-679-009

Wallet contained $250 cash (2-$100, 2-$20, 1$10)

Shelby State Bank ATM

5/23/99
Withdrawal

$350

Whitehall Realty

Mary C. Smith

MHSAA
Certified Referee
Joe Smith
Softball/ BaseBall
1999-2000

Whitehall Public Library
Joe Smith
#345-721
Please present this cards when checking out books.

New York College of Arts
Alumni Association

Joe Smith
Degree: Business1985

Sally Struthers' Mail Order Education Services

Joe Smith- 1994-996Degrees:
TV/VCRRepair,
Computer/Industrial Art
Teaching
Locksmith,Photography

Football Coaching Card
Joe Smith
Montague H.S.

1997-1998

Shelby Bakery

$25.00 paid on account

J.S. Glamour Shots
Photographs that show the real you!
Joe Smith
894-0000

Autopsy Results of Joe Smith

Age: 29 Ht. 6'1" Wt. 190 Hair: brown eyes: blue

Cause of Death: Blunt trauma to the back of neck and skull

Examination of Body:
Serology: Blood type: AB-
No evidence of chemical or poison

General Health: Excellent

Distinguishing marks: Tattoo on right bicep "mom"

Injuries: Two bruises on right arm, small abrasion on right shin, broken nose, fractured 3 and 4 cervical vertebrate in neck, fracture of occipital region of skull (1" wide x 6" long)

Injuries consistent with long, cylindrical object (bat?)

Suspect Profile of Robert Bruce Dimmer

Name: Robert Bruce Dimmer
Aliases: Big Bob
DOB: 10/10/52
Occupation: Science Teacher, Softball Coach, and Professional Bowler
Criminal Record: 1965 Armed Robbery-served 3 months, 1972 Assault-charges were dropped, 1984 Arrested for fighting at bowling tourney, 1992 Arrested and released for fighting at high school softball finals, 1998 assaulting an umpire-served 10 hours community service.

Robert Bruce Dimmer's Fingerprints

Rt. Thumb	Rt. Index	Rt. Middle	Rt. Ring	Rt. Pinkie

Interview of Robert Dimmer

Profile:

Ht.	Wt.	Age	Eye	Hair	Blood Type
5"9"	254Lb.	46	Hazel	Brown	O+

? Where were you between 3p.m.and 7:30p.m.on Wednesday, May 26, 1999?

A. I was working in my classroom until about 3:35p.m.then I went out to get ready for the district championship game. I was back in the building at 4:15 p.m. to change into my coaching clothes.

? Did you know Joe Smith?

A. Yes, Him and I had a few run-ins.

? When was the last time you saw Joe Smith?

A. I ran into Joe about 3:10 p.m. in the three hundred hallway. He knew better than to talk to me.

? Sounds like you and Joe didn't get along very well?

A. Well, I know peoples been talkin' about the game fixin' situation. Let me tell you the whole story. Joe used to hang around with us softball/baseball coaches. He was on our bowling and summer softball team and we used to play cards. We knew that he was into some really shady stuff. We had heard that before he came back from New York that he was accused to fixing a softball game. Well, Joe was a big gambler so I wouldn't put it past him. A guy could make a couple hundred dollars on a big game. Recently, Joe has been trying to get into the teaching game. I guess he got some degree from a mail order place to teach computers and shop class. He was sniffing around Montague looking for a job. Last year, I was playing against Montague and Joe was

umpiring. Joe proceeds to call 23 walks, which sent me ballistic. I charged the plate, and we got into a pretty good tussle. I beat him like a red headed stepchild. Tying with Montague caused us to tie for the conference title. I also found out later that the A.D. and Joe both had $25 riding on the game. It was bad enough that Joe's dad cost me the Class C title in 1992 calling that final strike, but I wasn't going to let his boy cost me another shot at a title.

? What happened after that game?
A. The Umpiring Officials review the case and kicked Joe out of the MHSSA. They let the game stand since it didn't effect the playoffs.

? Did you kill Joe Smith?
A. I would have had to stand in line. They are too many people who dislike that man. He cost Gregory and Clean their umpiring jobs. Those guys are probably still celebrating Smith's death.

Evidence Notes

(The following is taken directly from student work from the 1998-1999 school year.)

Evidence A-	Blood	Type O
Evidence B-	Blood	Type O
Evidence C-	Hair	Dark brown, straight, human

Evidence D- Wallet He has degrees in 5 different fields, he coached football at Montague High School. He has a Whitehall library card. ATM receipt from Shelby State Bank shows he withdraw $350 dollars on May 23, but he only has $250 left in cash. He lives in Whitehall, is married and has two kids. He is a certified referee and his wife is a realtor. He owns his own photography studio.

Evidence E- Note Written with black Crayola marker

Possible suspects: William Bullrush, Robert Dimmer, Brian Harry and Pete Peterson.

Evidence F- Fingerprints William Bullrush

Based on our analysis the killer is William Bullrush. His motive was anger at losing $200 in a card game.

Murder Notes

(This work is from the same students used above)

Motive: One week ago, Joe Smith and William Bullrush, friends since childhood, were playing a game of Jamaican Rummy (a card game) at Joe's house. This tropical game has the tendency to make people act violent at times, sometimes after playing this game it is necessary to visit a psychologist to relieve your anger. However, Joe and William remained calm throughout the game, placing bets. William ended up losing two hundred dollars in the course of one night of Jamaican Rummy. William left Joe's house faking a cheerful disposition, but was inwardly fuming over the loss of his hard-earned money. Checking the records, we find that William Bullrush never visited a psychologist after playing Jamaican Rummy to vent his strong feelings. William dragged himself to a new low in the days following his dreadful loss to Joe. He visited every bar between Montague and Shelby and drank himself to depression. He was kicked out of Paul's Tavern for public drunkenness and fighting. He felt at home in this tavern due to the lack of windows. Being kicked out of the tavern was the last straw for William. His anger needed to be released: He wanted revenge! He wanted his money back from Joe, and he didn't want to gamble for it. In a fit of rage, he began to plan his brutal actions. Luck was with William, however. The next day, while carrying out his custodial duties at school, he bumped into Joe (who was delivering pictures) by the school office (3:30 p.m.). Playing it cool, William returned to the 300 wing and waited, cleaning in the meantime. He saw Joe disappear into Mr. Peterson's classroom and quickly followed him inside.

How the killing occurred

Once inside, William slammed the door, screaming, "I want my money, Joe!" Joe, seeing William with a mop in his hands, dashed to the back of the room to escape. In his haste, he tripped over a stool, scraping his shin, landing with a THUD on his face. "Stop, William! Get away!" Joe screamed as blood flowed over his cut lip. Quickly, William seized a beaker of what he thought was acid but was really water and doused Joe with it while he remained lying in a crumpled heap on the floor. Seeing his mistake with the water, William placed the now empty beaker in the

counter and decided to take action with the mop handle. He hit Joe in the neck and head (two times each) with severe force. Seeing his job was done, William decided to place a note at the scene. Quickly scrawling a note: "You will never live to tell our secret," he made it a point to insinuate that the killer was one of the many women Joe had been having affairs with. Smiling at his work, he removed one hundred dollars from Joe's wallet. He was about to take more, but heard footsteps and so he returned the wallet, fleeing from the room. He then began mopping again.

Moral of the Story: People who are not Jamaican must take care when playing Jamaican Rummy.

APPENDIX B

Appendix B I

Forensic Science Pre- And Post-Test

Answer each of the following questions as completely as possible (use additional paper if necessary).

1. What do you know about blood and blood typing? How is it used to solve crimes (What makes up blood? How is blood type determined? How can blood type be used to prove paternity)?

2. How does a microscope work, and how is it useful to scientist?

3. How does fingerprinting work, and how is it useful for solving crimes (What limits are there to fingerprinting)?

4. What is chromatography and how can it be used to solve crimes?

5. Using what you know from television and the media, what do you know about crime science (be as specific as possible)?

Appendix B II

Forensic Science Self Evaluation of Knowledge Survey

Circle the number that most closely represents how much you know about the following topics:

1 no knowledge of subject
2 little knowledge of subject
3 average knowledge of subject
4 good understanding of subject
5 fully understand subject

Using a microscope	1	2	3	4	5
DNA	1	2	3	4	5
Using DNA to solve crime	1	2	3	4	5
Blood typing	1	2	3	4	5
Use of blood evidence to solve crimes	1	2	3	4	5
Fingerprinting	1	2	3	4	5
Fingerprinting to solve crimes	1	2	3	4	5
Footprint impressions	1	2	3	4	5
Paper chromatography	1	2	3	4	5
Ink Analysis	1	2	3	4	5
Thin layer chromatography	1	2	3	4	5
Crime scene procedures	1	2	3	4	5
Fiber analysis	1	2	3	4	5
Handwriting analysis	1	2	3	4	5
Qualitative/quantitative labs	1	2	3	4	5
Document analysis	1	2	3	4	5
Entomology	1	2	3	4	5
Rock and minerals	1	2	3	4	5
Trigonometry	1	2	3	4	5
Density	1	2	3	4	5
Basic chemistry lab techniques	1	2	3	4	5

Appendix B III

Student Evaluation of the Forensic Science Unit

Answer each question as completely as possible.

1. What did you like best about this unit? Why?

2. What did you like the least? Why?

3. What was the most confusing topic or lab? How could it be made better?

4. What improvements could be made to make this unit better?

Appendix B IV

Forensic Science Test

Directions: Place all answers on the provided answer sheet.

Multiple Choice:

1. Identification of evidence means?
a. Describing the characteristics of the evidence.
b. Placing the evidence into a category-blood, hair, etc.
c. Asking "is this something I should collect?"
d. Asking "will this help solve the case?"

2. The correct sequence of dealing with evidence is
a. Recognition, identification, individualization and evaluation.
b. Evaluation, recognition, identification, and individualization.
c. Recognition, evaluation, identification and individualization.
d. Identification, recognition, individualization and evaluation.

3. Forensic Scientists do which of the following?
a. Link crime scene to suspect
b. Disprove alibis
c. Provide expert testimony
d. All of the above

4. What are the main types of fingerprint patterns?
a. whorl, arch and wave
b. wave, arch, loop
c. wave, whorl, loop
d. loop, whorl, arch

5. The two main ways that fingerprints are obtained are
a. ink and direct.
b. direct and indirect.
c. direct and latent.
d. indirect and latent.

6. The first officer responding to a crime scene should
a. arrest the perpetrator.
b. rope off the area.
c. get medical attention for the injured.
d. remove all persons from crime area.

7. Recording data at the crime scene will include all the following except:
a. photographs/video.
b. sketches.
c. notes.
d. a,b,c are all correct.

8. Fingerprints that are hidden may be developed by which method?
a. Elmer's glue fuming
b. fuming with Iodine
c. tracing with clear plastic
d. none of the above

9. The height of a human body can be determined using
a. any long bone.
b. jawbone.
c. 3rd rib.
d. length of cervical vertebrates.

10. In determining age in skeletal remains, scientists would use all except
a. growth plates on long bones.
b. pelvis width.
c. amount of closure in skull sutures.
d. teeth development.

11. Skeletal remains may show which of the following evidence?
a. Overdevelopment of bone/muscle attachment due to occupation
b. Disease of internal organs
c. Skin disorders-leprosy
d. None of the above

12. Some evidence requires special packaging when collecting it. Which example is incorrect?
a. Arson evidence should be packaged in a nylon bags.
b. Blood stain clothes should be packaged in airtight bags.
c. Liquids should be collected in airtight container or vials.
d. All are correct.

13. Which of the following are methods for developing a latent print?
a. superglue fuming
b. ninhydrin staining
c. dusting with powder
d. All are correct.

14. Which type of information can be obtained from a blood splatter?
a. angle of attack
b. force of attack
c. origin or position of attacker
d. All are correct.

15. Which is the correct formula for determining angle?
a. cos =width/length
b. cos = length/width
c. sine = length/width
d. sine = width/length

16. Which type of testing is most common in forensics?
a. analytical
b. qualitative
c. quantitative
d. deductive

17. The Cuticle on the outside of hair is divided into 3 main scale types. Which of the following is not one of them?
a. coronal
b. spicuous
c. imbricated
d. spinous

18. Marijuana can be identified by all the following except
a. Duquenois test.
b. microscopic examination.
c. presence of small crystal of calcium carbonate.
d. fluorescence under UV light.

19. Which field of science is not used in forensic science?
a. Entomology
b. Botany
c. Anthropology
d. Mycology
e. all are used

20. The three main parts of a hair are
a. cuticle, cortex, scales
b. cortex, scales, medulla
c. scales, cuticle, medulla
d. cuticle, cortex, medulla
e. none of the above

True/False

21. Marijuana is the only mind-altering drug that contains nitrogen.
22. Heavy metal poisonings cause death because the heavy metals interfere with the binding of oxygen.
23. Ultraviolet light is useful when looking for hairs and fibers.
24. Hair and fiber evidence is the most commonly collected evidence.
25. The order and sequence of insects on a body can give a good estimate of the time of death.
26. DNA can be extracted from as few as 20 mature red blood cells.
27. Electrophoresis is used to cut DNA into pieces.
28. Blood type can be used to positively identify a suspect.
29. Fingerprints can be taken from the inside of rubber gloves.
30. For a fingerprint to be a match, it must contain a minimum of 25 points of similarity.
31. For evidence to be considered credible, it must have maintained a chain of custody.
32. Sex can be determined from skeletal remains by looking at the pelvis.
33. It is difficult to determine the race of a person based on skeletal remains.
34. Fabric/fiber evidence can be distinguished using simple microscopic and chemical testing.
35. The hair of an animal and human are very similar in structure.

Matching: Some answers may be used more than once.

36. FBI	a. Eugene Vidocq
37. Scotland Yards	b. Robert Peel
38. CID	c. Alphonse Bertillon
39. Bobbies	d. Francis Galton
40. Sherlock Holmes	e. Hans Gross
41. Exchange Principle	f. J. Edgar Hoover
42. Anthropometry	g. Arthur Conan Doyle
43. Secrete (Security)	h. Edmond Locard
44. Fingerprints	
45. Father of Forensics	
46. 1st crime lab	

Matching: Some may be used more than once.

47.	Fungi	a.	Botany
48.	Pollen	b.	Anthropology
49.	Insects	c.	Serology
50.	Poisons	d.	Entomology
51.	Blood	e.	Toxicology
52.	Mold	f.	Mycology
53.	DNA	g.	Ballistics
54.	Skeletal remains	h.	Trace evidence
55.	Drugs		
56.	Bullets		
57.	Hairs		
58.	Fibers		

Matching:

59.	Stiffing of the body after death	a.	Restriction
60.	Pooling of the blood after death	b.	Blow fly
61.	Stench given off by a dead body	c.	Weave/knit
62.	The sequence of insect on a body	d.	Blood type
63.	Enzyme used to cut DNA	e.	larva
64.	Method used to separate dyes	f.	UV
65.	Fabric patterns	g.	hair/fiber
66.	Antigen/antibody reaction	h.	livor mortis
67.	Stage of insect development	i.	Rigor mortis
68.	Type of light used in rape cases	j.	succession
69.	Staining technique for DNA	k.	putrescence
70.	Microscopic examination	l.	chromatography
71.	1st insect at the scene	m.	Southern blot
		n.	Gram stain
		o.	ambient light
		p.	RLFP

APPENDIX C

Appendix C I

Rubric For Scoring the Forensic Science Pre- And Post-Test

I assigned each question a point value based on specific information. Students received one point for including that specific piece of information in their answer. I scored both the pre- and post-test with this rubric.

1. What do you know about blood and blood typing? How is it used to solve crimes (What makes up blood? How is blood type determined? How can blood type be used to prove paternity?)?

Information	Pts.
Four blood types	1
Rh factors	1
Components of blood	1
How blood typing works?	1
How crimes can be solved using blood?	2
Total Points	7

2. How does a microscope work, and how is it useful to scientists?

Information	pts.
What does it do (magnifies)?	1
How does it magnify?	2
How is it useful to forensic science	2
Total Points	5

3. How does fingerprinting work, and how is it useful for solving crimes (What limits are there to fingerprinting)?

Information	pts.
What causes fingerprints?	1
What are the two main types?	1
How are they developed?	1
How are prints classified?	1
How are prints used to solve crime?	2
What are the limits to fingerprinting?	1
Total Points	7

4. What is chromatography, and how can it be used to solve crimes?

Information	pts.
How does it work?	1
Like dissolves like	1
How is it useful in solving crime	1
Two common methods	1
Total Points	4

5. Using what you know from television and the media, what do you know about crime science (be as specific as possible)?

Information	pts.
Any specific information relating to crime science	5
Total Points	5

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LITERATURE CITED

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