Genetics and Genetic Counseling

11th & 12th Grade students

7 student participants

Olivia Hazel and Caitlin Lachut

HOSA Cincinnati, Chapter #69215 (Post-Secondary)

University of Cincinnati

2600 Clifton Avenue

Cincinnati, OH 45220
Lesson Plan

Topic:

Genetics and Genetic Counseling

Aims of the lesson:

To give students a greater understanding of what genetics entails, and to better educate them about an often-misinterpreted field and job opportunity in genetic counseling, while also exposing them to various viewpoints regarding the utilization of genetic counseling.

Lesson objectives:

Students will be able to...

- understand and trace genetic combinations and possibilities resulting from dihybrid crosses (i.e., eye color)
- determine and understand possible genotypes where co-dominance occurs in the genes (i.e., ABO blood typing and Rh factor)
- identify and understand how sex-linked disorders are passed to offspring (i.e., hemophilia).
- understand various genetic tests available/when implemented, and be able to identify and argue the various viewpoints regarding genetic counseling
Genetics and Genetic Counseling

Assumed prior knowledge:

Students can understand the basics of DNA/inheritance and recall basic genetic tracing techniques (i.e., Punnett squares) learned from previous instruction (prerequisite high school Biology course requirement).

Resources:

Google Slides presentation, lab handout, debate note sheet, survey half sheet, online Kahoot quiz, students’ cell phones/internet capable devices.

Assessment (how learning will be recognized):

An interactive post-quiz in the form of a “Kahoot” was administered following the lesson for a way to recognize how well the students understood and retained information presented and discussed.

Differentiation (how various learning styles are addressed):

- VISUAL- PowerPoint presentation and lab handout.
- AUDITORY- listening to presentation and discussion amongst smaller table groups and an all-class discussion.
Data and Supporting Information

Familial Inheritance:

The traits that code for every cell in the human body are all found within our DNA. We inherit this DNA in halves: one half from each parent. Some of the most obvious things people inherit from their parents are things like hair and eye color, but many things we’re unable to see are inherited too. Often times we can inherit disorders or risks for disease from our parents as well. Several examples of the directly inheritable conditions are hemophilia, cystic fibrosis, and fragile x syndrome. Some things you can inherit risks for are cancer, heart disease, and depression.

Chromosomal division issues within your parent’s egg or sperm cells can also lead to inheritable disorders and diseases in their offspring. Some examples of these are trisomy 21, aka down syndrome, trisomy 13, and Turner’s syndrome.

Genetic Counselors:

- “Genetic counseling is the process of helping people understand and adapt to the medical, psychological and familial implications of genetic contributions to disease” (Resta, 2006).

- “Genetic counselors are professionals who have specialized education in genetics and counseling to provide personalized help patients may need as they make decisions about their genetic health” (“Who are Genetic Counselors,” 2018).

Genetic counselors have the important job of communicating with patients about testing options, results, and repercussions in relation to these inherited genetics. They’re a part of an up and coming field in the health industry which combines
knowledge of genetic based lab work and high people skills. They can often be employed in places like hospitals and maternity clinics, but specialists are also found in solo practices and pediatrics. Their job usually starts not with recommending tests, like many people assume, but with trying to create the best family tree for each individual’s possible problems. It’s then that they may recommend and send out for tests, which are then returned and analyzed by them with the patient. Figuring out the next step for the patient and their family—be that information or different tests—is a key part of the supportive role these healthcare professionals provide in post.

Types Of Testing:

Since the field of genetic counseling is very all encompassing, there are a myriad of tests people can have performed. Each specialty of genetic counseling has many kinds of tests, and more are being created every year. Some of the following are basic examples of what can be performed in each field.

- Prenatal diagnostic tests often consist of tests in regards to a fetus and seeing if it has any genetic disorders. Amniocentesis and CVS are the two main ways of doing this, as both are tests that allow cells from the fetus or placenta to be removed for genetic sequencing. Many disorders can be found via this method, it just depends on what the parents wish to look for. (“Prenatal Genetics” 2017)

- Pediatric tests are involved with developing conditions that were not obvious at birth. Things like connective tissue disorders and the possibility of a child being on the autism spectrum are often tested by genetic counselors in this field. Patients with positive test results often continue to consult with these counselors
as they grow, and the condition continues to affect their lives. ("Who are Genetic Counselors" 2018)

- General testing that's usually done on adults consists of cancer screening for things like the BRCA gene and things that can be detrimental in the near future of late aging, like early onset alzheimer's. Many tests found here are for risk assessment, as those with 'hereditary cancer' are at a much higher risk than the rest of the population. (Riley, 2011)

- Post mortem testing is often used in cases of sudden, unexpected death. Tissues samples are taken from the deceased family member and run through several tests in order for the remaining family to understand what might have happened to the deceased and what repercussions this could have on the rest of the family. Often this dredges up heart conditions and other unknown issues, and families must adjust accordingly. ("Who are Genetic Counselors" 2018)
Lesson Outline

12:40PM- Introduce ourselves to the class, pass out lab worksheet, explain lab scenario and that this is a "refresher" on what may or may not have been fully comprehended from previous instruction. Announce that students will have 10 minutes to complete lab.
12:50PM- Pass out debate handout, then begin PowerPoint instruction, overviewing genetics and what a genetic counselor is, various genetic tests that are available, etc.

1:00PM- Pause on "debate slide" and ask students to complete the debate sheet passed out earlier, noting pros and cons for arguments surrounding genetic counseling.
Genetics and Genetic Counseling

1:05PM- After allowing time to write down argument points, facilitate a mock debate, randomly assigning students to opposing viewpoints. Pass out survey half sheet to kids.

1:15PM- Continue with OUR pre-determined argument point supplement their previous discussions and introduce other points that they may have missed. Finish presentation.

Positives- Knowledge is Power
- Opt for early testing
- Future arrangements in case of health bills
- Decisions about children
- Family wide lifestyle changes
- Early education and Acceptance

Negatives- When Knowledge Can Make You Feel Powerless
- Rash decision-making based on "possibilities"
- Expensive
- Paranoia about possible outcomes
- Could end up showing no new information (inconclusive results, etc.)
- Familial Conflicts/Ideology

1:20PM- Have students fill out "exit ticket" post-instructional survey

To determine how well students retained/understood the information, we had their teacher administer a Kahoot quiz the next day (5 minutes).

True or False: Disorders like Fragile X are passed to offspring from parents

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Kahoot!

True

False
Writing Materials
Case File 311: Baby Boy Lohman

Mr. and Mrs. Lohman have recently been notified that due to a hospital error, their son may have been switched with another boy while in the nursery! This error happened over 25 years ago, but they wish to discover if in fact their biological son is out there! They determine that on the day Mrs. Lohman gave birth, there were five other baby boys born that day as well. Your job is to complete a series of genetic tests in order to help the Lohmans determine which man is their biological son.

PART ONE: Complete Dominance (Dihybrid)

Brown eyes are dominant over blue eyes, and detached earlobes are dominant over attached earlobes.

<table>
<thead>
<tr>
<th>Mr. Lohman</th>
<th>Heterozygous detached earlobes and dominant brown eyed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mrs. Lohman</td>
<td>Heterozygous detached earlobes and heterozygous for eye color</td>
</tr>
<tr>
<td>Carter</td>
<td>Attached earlobes and homozygous brown-eyed</td>
</tr>
<tr>
<td>Ryan</td>
<td>Homozygous detached earlobes and blue-eyed</td>
</tr>
<tr>
<td>Derek</td>
<td>Heterozygous detached earlobes and homozygous brown-eyed</td>
</tr>
<tr>
<td>Evan</td>
<td>Heterozygous detached earlobes and heterozygous brown-eyed</td>
</tr>
<tr>
<td>Ricky</td>
<td>Homozygous detached earlobes and blue-eyed</td>
</tr>
</tbody>
</table>

Write the genotypes for Mr. and Mrs. Lohman:

Mr. Lohman: **AaBB**

Mrs. Lohman: **AaBb**

What are the possible genotypes of their offspring?

- AABB
- AaBb
- AABb
- aaBB

Write each person’s genotypes in the chart below:

<table>
<thead>
<tr>
<th>Person</th>
<th>Genotype</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carter</td>
<td>aaBB</td>
</tr>
<tr>
<td>Ryan</td>
<td>AABb</td>
</tr>
<tr>
<td>Derek</td>
<td>AaBB</td>
</tr>
<tr>
<td>Evan</td>
<td>AaBb</td>
</tr>
<tr>
<td>Ricky</td>
<td>AAbb</td>
</tr>
</tbody>
</table>

Which men can be eliminated based on these traits? Please provide reasoning for each man.

Ricky and Ryan can both be eliminated because there is no possible way for there to be a son who is homozygous for blue eyes (bb).
Genetics and Genetic Counseling

PART TWO: Codominance and Incomplete Dominance

Type A and Type B blood are codominant over Type O blood. Rh+ blood is dominant over Rh- blood.

Hair texture exhibits incomplete dominance. Homozygous dominant have curly hair, while homozygous recessive have straight hair. Heterozygous have wavy hair.

| Mr. Lohman | Homozygous type A blood, heterozygous Rh+, straight hair |
| Mrs. Lohman | Heterozygous type B blood, homozygous Rh+, wavy hair |
| Carter   | Heterozygous type A blood, heterozygous Rh+, wavy hair |
| Ryan     | Type AB blood, homozygous Rh+, wavy hair |
| Derek    | Heterozygous type A blood, homozygous Rh+, wavy hair |
| Evan     | Type O blood, Rh-, straight hair |
| Ricky    | Homozygous type A blood, heterozygous Rh+, wavy hair |

What are the genotypes of Mr. and Mrs. Lohman?

AA/Rh+/Rh-/hh

BO/Rh+/Rh+/Hh

What are the possible genotypes of their offspring? (You may need to draw 3 separate Punnett squares)

<table>
<thead>
<tr>
<th>Blood</th>
<th>Hair</th>
</tr>
</thead>
<tbody>
<tr>
<td>AR</td>
<td>Hh</td>
</tr>
<tr>
<td>AO</td>
<td>hh</td>
</tr>
</tbody>
</table>

Write each person’s genotypes in the chart below:

<table>
<thead>
<tr>
<th>Person</th>
<th>Blood Type</th>
<th>Rh Type (+ or -)</th>
<th>Hair Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carter</td>
<td>AO</td>
<td>Rh+ Rh-</td>
<td>Hh</td>
</tr>
<tr>
<td>Ryan</td>
<td>AO</td>
<td>Rh+ Rh+</td>
<td>Hh</td>
</tr>
<tr>
<td>Derek</td>
<td>AO</td>
<td>Rh- Rh-</td>
<td>hh</td>
</tr>
<tr>
<td>Evan</td>
<td>OO</td>
<td>Rh+ Rh+</td>
<td>Hh</td>
</tr>
<tr>
<td>Ricky</td>
<td></td>
<td>Rh- Rh-</td>
<td>hh</td>
</tr>
</tbody>
</table>

Which men can be eliminated based on these traits? Please provide reasoning for each man.

Evan can be eliminated because it is not possible for the Lohmans to have a son with Type O blood.

At this point, you should have successfully narrowed your results down to two men, 

Carter & Derek

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Genetics and Genetic Counseling

In order to determine who the Lohmans’ son is, a more extensive medical background was ordered for the two remaining candidates and Mr. and Mrs. Lohman. It was determined that Mrs. Lohman and Mr. Lohman are both afflicted individuals. Sex-linked disorders are determined based upon an X chromosome. In males, one affected X chromosome is necessary for hemophilia to occur. Based on the Lohmans’ information, determine the genotypes for both Mr. and Mrs. Lohman using the provided table below:

<table>
<thead>
<tr>
<th>Normal male:</th>
<th>$XY = X^hY$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemophiliac male:</td>
<td>$X^hY = X^hY$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Normal female:</th>
<th>$XX = X^hH$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal female, carrier:</td>
<td>$XX^h = X^hX^h$</td>
</tr>
<tr>
<td>Hemophiliac female:</td>
<td>$X^hX^h = X^hX^h$</td>
</tr>
</tbody>
</table>

Mr. Lohman: $X^hY$  
Mrs. Lohman: $X^hX^h$

What percentage of chance would any offspring of theirs have at being afflicted with hemophilia?

There would be a 100% chance that their son would have hemophilia because Mrs. Lohman can only donate an affected X chromosome.

In order to determine once and for all who the Lohman’s son is, the following results were determined for both:

**Candidate A:** $XY$

**Candidate B:** $X^hY$

Please circle the candidate who you think is the Lohmans’ son and present it to an instructor.
Genetic Counseling: The Debate

There can be many sides to a debate! Like all things, genetic counseling has its positives and negatives associated with it. Take a few moments to brainstorm some of the positives and negatives that could be associated with having yourself and others go through the process of genetic counseling, and list them below. Please be ready to explain your reasoning!

**POSITIVES**

- Can help family determine if they are mentally, physically and financially ready to have a child
- When saying "playing God" saying everything natural is inherently good (religation to nature)

**NEGATIVES**

- Some people may not want to know how they could die or disappear
- Parents may see this as "playing God"
Genetic Counseling: A Job of Genes, History, and Tests

A Presentation by
Olivia Hazel and Caitlin Lachut

Concepts to Know

- **DNA (deoxyribonucleic acid)**
  - The code of life, and what determines the structure and function of living species
  - Passed down from parents to offspring

- **Inheritance of Genes**
  - Half of an offspring's genes come from each parent

- **Disorders**
  - Risks vs causation

Family is Important!

- Eye color and blood type isn't all that's passed down through genes
- Illnesses and Chronic conditions are as well
- Hemophilia
- Cystic fibrosis
- Muscular dystrophy
- Fragile X
- RISK for conditions such as...
  - Cancer
  - Heart Disease
  - Depression
Family is Important!

- Sometimes issues can come from chromosomal division problems
- These are often also the result of improper divisions within parents cells
- Down Syndrome
  Trisomy 21
- Edward's syndrome
  Trisomy 18
- Turner Syndrome
  XO females

"So what is a genetic counselor anyways? What does this have to do with them?"

Genetic Counseling

Genetic counselors have advanced training in medical genetics and counseling to interpret genetic test results, and to guide and support patients.

Genetic counseling is a process to evaluate and understand a family's risk of an inherited medical condition.

NSGC.org
Genetic Counseling

- Up and coming career field
- Has both lab and social aspects
- Order and interpret test results for family

- Can be found in places like...
  - Hospitals
  - Maternity clinics
  - Solo practices
  - Pediatric care
- Assess risk factors and advise future behavior

Family tree tracing hemophilia through 7 generations of European royal families

Types of Testing Often Performed

- Amniocentesis
- Chorionic villus sampling (CVS)
- Autism Spectrum
- Connective Tissue Disorders

- BRCA-I and BRCA-II tests
- Early Onset Alzheimer's Disease
- Post Mortem Sample testing
Positives - Knowledge is Power

- Opt for early testing
- Future arrangements in case of health bills
- Decisions about children
- Family wide lifestyle changes
- Early education and Acceptance

Negatives - When Knowledge Can Make You Feel Powerless

- Rash decision-making based on “possibilities”
- Expensive
- Paranoia about possible outcomes
- Could end up showing no new information (inconclusive results, etc.)
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Interested? Want to learn more?

- DNA Sample Day: Friday Aug. 10th, 2018
  - RSVP online!
- National Society of Genetic Counselors
  - [https://www.nsgc.org/](https://www.nsgc.org/)
- Cincinnati Children's
  - UC
Lesson
Evaluation
Tools & Feedback
<table>
<thead>
<tr>
<th>Rank</th>
<th>Players</th>
<th>Total Score (points)</th>
<th>Q1</th>
<th>True or False: Disorders like Fragile X are passed to offspring from parents</th>
<th>Q2</th>
<th>In reference to Rh incompatibility, which scenario could pose a potential threat?</th>
<th>Q3</th>
<th>The scientific name for Down Syndrome is what?</th>
<th>Q4</th>
<th>Genetic counselors can be located in which of the following medical practices?</th>
<th>Q5</th>
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<tbody>
<tr>
<td>1</td>
<td>Blair</td>
<td>13166</td>
<td>387</td>
<td>True</td>
<td>1075</td>
<td>Rh- mother and Rh+ second baby</td>
<td>1162</td>
<td>Trisomy 21</td>
<td>1275</td>
<td>all of the above</td>
<td>1387</td>
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<tr>
<td>2</td>
<td>ANYa</td>
<td>12931</td>
<td>338</td>
<td>True</td>
<td>1058</td>
<td>Rh- mother and Rh+ second baby</td>
<td>1169</td>
<td>Trisomy 21</td>
<td>1251</td>
<td>all of the above</td>
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<td>3</td>
<td>Nevaeh</td>
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<td>333</td>
<td>True</td>
<td>997</td>
<td>Rh- mother and Rh+ second baby</td>
<td>1157</td>
<td>Trisomy 21</td>
<td>1259</td>
<td>all of the above</td>
<td>1360</td>
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<td>4</td>
<td>Arhana</td>
<td>12454</td>
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<td>True</td>
<td>1064</td>
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<td>1155</td>
<td>Trisomy 21</td>
<td>1103</td>
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<td>5</td>
<td>Nikky</td>
<td>11531</td>
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<td>False</td>
<td>954</td>
<td>Rh- mother and Rh+ second baby</td>
<td>1050</td>
<td>Trisomy 21</td>
<td>1166</td>
<td>all of the above</td>
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<td>6</td>
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<td>974</td>
<td>True</td>
<td>1032</td>
<td>Rh- mother and Rh+ second baby</td>
<td>1166</td>
<td>Trisomy 21</td>
<td>1274</td>
<td>all of the above</td>
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<tr>
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<td>Ishani</td>
<td>9902</td>
<td>826</td>
<td>True</td>
<td>1037</td>
<td>Rh- mother and Rh+ second baby</td>
<td>1088</td>
<td>Trisomy 21</td>
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<tr>
<td>8</td>
<td>Kayla</td>
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<td>0</td>
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<td>347</td>
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<td>0</td>
<td>Rh+ mother and Rh- first baby</td>
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<td>913</td>
<td>Rh- mother and Rh+ second baby</td>
<td>0</td>
<td>Trisomy 13</td>
<td>721</td>
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<td>Q6</td>
<td>Q7</td>
<td>Q8</td>
<td>Q9</td>
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<td>Rh+ blood is dominant over Rh- blood</td>
<td>1482 XhXh</td>
<td>Evaluate/understand and familial risks inherited of conditions</td>
<td>1436 Early education and acceptance</td>
<td></td>
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<td>1453 XhXh</td>
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<td>1356 XhXh</td>
<td>Evaluate/understand and familial risks inherited of conditions</td>
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<tr>
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<td>Rh+ blood is dominant over Rh- blood</td>
<td>1446 XhXh</td>
<td>Evaluate/understand and familial risks inherited of conditions</td>
<td>1447 Early education and acceptance</td>
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<td>Rh+ blood is dominant over Rh- blood</td>
<td>1454 XhXh</td>
<td>Evaluate/understand and familial risks inherited of conditions</td>
<td>1433 Early education and acceptance</td>
<td></td>
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<tr>
<td>2 of the above</td>
<td>Rh- blood is dominant over Rh+ blood</td>
<td>913 XhXh</td>
<td>Evaluate/understand and familial risks inherited of conditions</td>
<td>1157 Early education and acceptance</td>
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</tr>
<tr>
<td>Chorioic villus sampling</td>
<td>Rh+ blood is dominant over Rh- blood</td>
<td>1068 XhXh</td>
<td>Evaluate/understand and familial risks inherited of conditions</td>
<td>1225 Early education and acceptance</td>
<td></td>
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<tr>
<td>2 of the above</td>
<td>Rh+ blood isn’t dominant over Rh- blood</td>
<td>0 XhX</td>
<td>Evaluate/understand and familial risks inherited of conditions</td>
<td>937 Early education and acceptance</td>
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<tr>
<td>Chorioic villus sampling</td>
<td>Rh+ blood is dominant over Rh- blood</td>
<td>946 XhXh</td>
<td>Having advanced training in genetics and counseling patients</td>
<td>910 Early education and acceptance</td>
<td></td>
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<td>0 XhX</td>
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<td></td>
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<td></td>
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</tr>
</tbody>
</table>
Post-Instructional Survey

Please answer the following questions on a 5 point scale, 1 being “Not at all” to 5 being “Absolutely”

I felt that Caitlin and Olivia were knowledgeable about the topic: 5

I felt like the information was presented in an engaging manner: 4

I felt like the information and activities were relevant to the topic “Genetic Counseling”: 5

I feel that Caitlin and Olivia’s use of time for components of the lesson was appropriate: 4

Please include any additional comments or critiques for us!
Post-Instructional Survey

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I feel that Caitlin and Olivia’s use of time for components of the lesson was appropriate: ____

Please include any additional comments or critiques for us!

I would do something like riddles which is a little more engaging or make time to go over the answers to the lab at the end.
Post-Instructional Survey

Please answer the following questions on a 5 point scale, 1 being "Not at all" to 5 being "Absolutely"

I felt that Caitlin and Olivia were knowledgeable about the topic: 5

I felt like the information was presented in an engaging manner: 4

I felt like the information and activities were relevant to the topic "Genetic Counseling": 5

I feel that Caitlin and Olivia's use of time for components of the lesson was appropriate: 5

Please include any additional comments or critiques for us!

I liked the information presented and felt it was very informational, but could be more engaging if possible.
Post-Instructional Survey

Please answer the following questions on a 5 point scale, 1 being “Not at all” to 5 being “Absolutely”

I felt that Caitlin and Olivia were knowledgeable about the topic: 5

I felt like the information was presented in an engaging manner: 2

I felt like the information and activities were relevant to the topic “Genetic Counseling”: 5

I feel that Caitlin and Olivia’s use of time for components of the lesson was appropriate: 5

Please include any additional comments or critiques for us!

Come back to the first casting to the everything everyone.
Genetics and Genetic Counseling

References

Hellenga, J (2008). Who gets the money? [Class Handout]. Biology, Bremen Community High School, Midlothian, IL.


