Additional Files

File Name: Additional file 1

Title of Data: "Graduate and Undergraduate Student Survey"

Description of Data: This file contains survey that was distributed to graduate and undergraduate students in the US.

Graduate and Undergraduate Students Survey

Start of Block: Consent

1 Implied Consent Title of the Research Study: Assessing Undergraduate, Graduate, and Medical School Students' Educational Genetics Training in the United States My name is Badí Israel Quinteros Espinoza. I am an undergraduate student at Brigham Young University, and I am conducting this research under the supervision of Professor Liz Bailey, from the Department of Biology at Brigham Young University. You are being invited to participate in this research study about genetics education in American undergraduate, graduate, and medical schools. I am interested to learn more about your understanding about genetics. Being in this study is completely optional, and you may remove yourself from the study at any time. If you choose to be in the study and proceed, you will be asked to complete a survey that should take less than 30 minutes of your time. You can skip questions that you do not want to answer or stop the survey at any time. The survey is anonymous, and no one will be able to link your answers back to you. Please do not include your name or other information that could be used to identify you in the survey responses. You will not be paid for being in this study. However, as a thank you for participating, after the survey concludes you will have the opportunity to complete a second survey to enter a drawing to receive one of **12 Amazon gift cards ($25 each)**. We anticipate the odds of winning a gift card will be about 1 in 24. You will enter an email address into this second survey, but it will not be linked to your responses in the main survey. Questions? Please contact Badí Quinteros at +1 908-414-5983 or biqe2@byu.edu. If you have questions or concerns about your rights as a research participant, you can call the BYU Human Research Protections Program at +1 801-422-1461 or BYU.HRPP@byu.edu. Please click on either “I consent to participate in the study” or “I do not wish my survey responses to be included in the research study” before continuing to the survey questions for course credit.

- ○ I consent to participate in the study (1)
- ○ I do not wish my survey responses to be included in the research study (2)

End of Block: Consent

Start of Block: Demographics

Q1: What is your gender?

- ○ Female (1)
- ○ Male (2)
- ○ Non-binary/third gender (3)
- ○ Prefer to self-describe (please specify) (4) _____
- ○ Prefer not to say (5)

Q2: How old are you?
Age (1)

▼ 15 (1) ... 100 (86)

Q3: What is your race/ethnicity (choose all that apply)

- ☐ White (1)
- ☐ Hispanic or Latino/a (2)
- ☐ Black or African American (3)
- ☐ Asian (4)
- ☐ Native American, American Indian, or Alaska Native (5)
- ☐ Native Hawaiian or Pacific Islander (6)
- ☐ Other (please specify) (7) _____

Page Break

Q4: Please select the one that is more applicable to you: I am a

- ○ Freshman (1)
- ○ Sophomore (2)
- ○ Junior (3)
- ○ Senior (4)
- ○ Master Student (5)
- ○ PhD student (6)

End of Block: Demographics

Start of Block: Knowledge Test

Question 1: What is the relationship among genes, DNA, and chromosomes?

- ○ Genes are composed of DNA and lie within chromosomes. (1)
- ○ Genes are separate entities from either DNA or chromosomes. (2)
- ○ Genes are found only in chromosomes and not DNA. (3)
- ○ Genes are found only in DNA and not chromosomes. (4)
- ○ Chromosomes are composed of genes but not DNA. (5)

Question 2: Adult height in humans is partially determined by our genes. When environmental conditions are held constant, humans have a wide variety of heights (not just short, medium, and tall). Height is probably influenced by:

- ○ one gene with two alleles. (1)
- ○ a single recessive gene. (2)
- ○ a single dominant gene. (3)
- ○ several genes. (4)
- ○ only paternal genes. (5)

Question 3: Our understanding of how genes function indicates that:

- ○ different species of organisms use different genetic mechanisms for producing individual traits. (1)
- ○ there are no interactions among genes in producing individual traits. (2)
- ○ gene products can be carbohydrates, fats, or proteins. (3)
- ○ genes do not produce specific products but code directly for individual traits. (4)
- ○ genes code for proteins, which in turn produce individual traits. (5)

Question 4: Molecular genetic engineering is possible

- ○ because all living organisms have the same DNA sequence. (1)
- ○ because all living organisms have DNA as their genetic material. (2)
- ○ because all living organisms have different but compatible structures of DNA. (3)
- ○ because different genetic materials other than DNA are made compatible by scientists. (4)
- ○ only among plant species or among animal species, but not between plants and animals. (5)

Question 5: Which of the following is INCORRECT regarding meiosis?

- ○ It occurs only in species of organism that have sexual reproduction. (1)
- ○ It halves the chromosome number in reproductive cells. (2)
- ○ It provides for genetic variation in the offspring. (3)
- ○ It occurs in most body cells at some time during the life of the individual. (4)
- ○ It keeps the chromosome number constant from generation to generation. (5)

Page Break

Question 6: Sometimes a trait seems to disappear in a family and then reappear in later generations. If neither parent has the trait, but some of the offspring do, what would you conclude about the inheritance of the trait?

- ○ Both parents are carriers of the recessive form of the gene. (1)
- ○ Only one parent has two copies of the recessive form of the gene. (2)
- ○ Only one of the parents has a dominant form of the gene. (3)
- ○ Only one parent has a copy of the recessive form of the gene. (4)
- ○ It is most likely the result of new mutations in each parent. (5)

Question 7: An individual is found to have a mutation in a gene associated with breast cancer. In which cells is this form of the gene located?

- ○ Only in cells of the breast where cancer occurred. (1)
- ○ Only in cells of both breasts. (2)
- ○ Only in those cells found in females. (3)
- ○ Only in the cells of the breast and ovaries. (4)
- ○ All the cells of the individual. (5)

Question 8: Mutations in DNA occur in the genomes of most organisms, including humans. What is the most important result of these mutations?

- ○ They produce new genes for the individual. (1)
- ○ They produce new enzymes for the individual. (2)
- ○ They provide a source of new cells for the individual. (3)
- ○ They provide a fundamental source of genetic variation for future generations. (4)
- ○ They produce new chromosomes for future generations. (5)

Question 9: Multiple genes are associated with complex diseases such as cancer and mental disorders. When an individual is tested for these genes, what do the results indicate?

- ○ Whether or not s/he has the disease or disorder. (1)
- ○ Whether or not s/he has an increased risk for developing the disease or disorder. (2)
- ○ Whether or not s/he will definitely develop the disease or disorder. (3)
- ○ Whether or not his/her children will definitely develop the disease or disorder. (4)
- ○ How severe the disease or disorder will be if the individual has the gene. (5)

Question 10: Which of the following is a current benefit of the application of genetics and genetic technology to health care?

- ○ The ability to significantly increase human life expectancy. (1)
- ○ The ability to eliminate complex diseases like cancer. (2)
- ○ The creation of inexpensive and easily administered drugs. (3)
- ○ The ability to identify individuals and groups who are at increased risk of disease. (4)
- ○ The ability to routinely use gene therapy to cure genetic diseases. (5)

Page Break

Question 11: A woman has been told she carries a mutation associated with breast cancer. How does this influence her likelihood of developing breast cancer?

- ○ Her risk will be no different from any other healthy woman. (1)
- ○ She will likely not get breast cancer. (2)
- ○ She is at an increased risk for breast cancer. (3)
- ○ She will definitely get breast cancer. (4)
- ○ She already has breast cancer since she carries the mutated gene. (5)

Question 12: Many geneticists study the genetic material of organisms such as mice, fruit flies, and yeast. They are able to apply what they learn from these organisms to humans because virtually all different types of organisms:

- ○ have DNA as their genetic material. (1)
- ○ have proteins as their genetic material. (2)
- ○ have the same amount of genetic material. (3)
- ○ produce proteins, fats, and carbohydrates from their genetic material. (4)
- ○ have RNA as their genetic material. (5)

Question 13: As HIV has spread around the world, we know some individuals are resistant to the effects of the virus even though they are HIV positive. Why?

- ○ They carry genetic differences that provide the resistance. (1)
- ○ Genetic changes that provide resistance are produced in response to infection by the virus. (2)
- ○ Natural selection causes genetic differences to be produced that result in resistance. (3)
- ○ The environment in which the individual lives determines resistance. (4)
- ○ Nutritional differences among individuals are known to determine resistance to the virus. (5)

Question 14: Which of the following is a characteristic of mutations in DNA?

- ○ They are usually expressed and result in positive changes for the individual. (1)
- ○ They are usually expressed and cause significant problems for the individual. (2)
- ○ Those that occur in the body cells of a parent are usually passed on to their children. (3)
- ○ They usually occur at very high rates in most genes. (4)
- ○ They result in different versions of a gene within the population. (5)

Question 15: What is the relationship between DNA and chromosomes in higher organisms?

- ○ Chromosomes are found within DNA. (1)
- ○ DNA is found within chromosomes. (2)
- ○ There is no difference between DNA and chromosomes. (3)
- ○ DNA and chromosomes are completely separate structures. (4)
- ○ Chromosomes produce DNA. (5)

Page Break

Question 16: Huntington's disease is a genetic disorder caused by a dominant gene. Symptoms begin in adulthood and the disease is ultimately fatal. What is an ethical dilemma presented by Huntington's disease when a parent is diagnosed with the disease?

- ○ Whether that parent should be tested for the gene. (1)
- ○ Whether the other parent should be tested for the gene. (2)
- ○ Whether and when any of the children should be tested for the gene. (3)
- ○ Whether the parent should be treated for the disease. (4)
- ○ Whether that parent should be told s/he has Huntington's disease. (5)

Question 17: Regarding complex traits such as IQ, lung cancer, prostate cancer, etc, how do geneticists describe the contributions of ones' genetic makeup and the environment?

- ○ The environment sets the potential for a trait; how much of that potential is realized depends upon the genetic make-up of the individual. (1)
- ○ Each person inherits a genetic potential; how much of that potential is realized depends upon the environment. (2)
- ○ Geneticists typically accept that most traits are determined heavily by genetics with the environment having little effect on complex traits. (3)
- ○ The environment plays a major role in determining complex traits, with genetics playing a relatively minor role. (4)
- ○ Genetic differences among humans are so minor that essentially all variations observed among individuals are due to the environment in which they were reared. (5)

Question 18: How is the expression of genes regulated or controlled?

- The expression of genes is not regulated or controlled. (1)
- Genes are turned on during development and stay on throughout one's life. (2)
- Genes are only turned on and off during development. (3)
- Genes are turned on and off at appropriate times throughout one's life. (4)
- The expression of genes is only controlled by external factors. (5)

Question 19: If an individual has a genetic test for a mutation causing a particular disease, and the result is positive, what will that most likely mean?

- The individual will definitely exhibit the disease, regardless of whether it is due to a dominant or recessive mutation. (1)
- The individual will definitely exhibit the disease only if it is due to a dominant mutation. (2)
- A positive test for the mutation indicates that the individual already has the disease. (3)
- It depends upon the disease involved, as testing positive for some mutations only show a higher risk for getting the disease. (4)
- The environment during the individual's development will be the primary determinant of whether the individual exhibits the disease. (5)

Question 20: What effect, if any, does an individual's environment have on the development of his or her traits?

- ○ It has little or no effect on most traits in an individual. (1)
- ○ It sets the potential for the development of most traits in an individual. (2)
- ○ It affects to varying degrees most traits in an individual. (3)
- ○ It is a dominant factor for determining most traits in an individual. (4)
- ○ It does not have any effect on an individual's traits, but can have an effect on the traits of an individual's offspring. (5)

Page Break

Question 21: Your muscle cells, nerve cells, and skin cells have different functions because each kind of cell:

- ○ contains different kinds of genes. (1)
- ○ is located in different areas of the body. (2)
- ○ activates different genes. (3)
- ○ contains different numbers of genes. (4)
- ○ has experienced different mutations. (5)

Question 22: At what times during an individual's life does the environment influence the expression of his or her genes?

- ○ Beginning at conception and lasting throughout life. (1)
- ○ Beginning at birth and lasting throughout life. (2)
- ○ Beginning at birth and lasting until adulthood. (3)
- ○ Occurring only during key stages of life such as puberty and menopause. (4)
- ○ Environment has little or no effect on how genes are expressed. (5)

Question 23: Which of the following is INCORRECT regarding the genetic differences among ethnic groups?

- There is much more genetic variation within ethnic groups than among them. (1)
- Differences in appearance represent only minor genetic differences among ethnic groups. (2)
- Genetic diseases, such as sickle cell disease, have an increased prevalence within certain ethnic groups. (3)
- The DNA sequence is more than 99% similar among all humans. (4)
- Genetic differences responsible for skin color represent a substantial portion of the human genome. (5)

Question 24: What is the relationship between genes and traits expressed in individuals?

- Genes code for DNA, which is responsible for individual traits. (1)
- Genes code for proteins, which are responsible for individual traits. (2)
- Genes code for chromosomes, which are responsible for individual traits. (3)
- Genes code for carbohydrates, which are responsible for individual traits. (4)
- The environment rather than genes is primarily responsible for individual traits. (5)

Question 25: Which of the following does NOT accurately reflect Charles Darwin's basic principles of evolution?

- ○ The capacity of biological species to reproduce is limited. (1)
- ○ The capacity of the earth to sustain continuous population growth is limited. (2)
- ○ Differences among individuals are transmitted from generation to generation. (3)
- ○ Some individuals are better equipped than others to survive changes in the environment. (4)
- ○ Natural selection is the driving force of evolution. (5)

Page Break

Question 26: Which of the following is NOT considered an ethical or legal concern?

- Allowing prenatal sex selection. (1)
- Counseling couples not to have babies with conditions that require costly care. (2)
- Utilizing embryonic stem cells for research. (3)
- Giving insurance companies the right to deny insurance to those individuals known to have a high risk or genetic disease. (4)
- Offering mothers 35 years of age or older the opportunity to have prenatal diagnosis for chromosome anomalies. (5)

Question 27: Cystic fibrosis (CF) is a recessive disorder, meaning that an individual must have two copies of an abnormal CF gene to be affected. What is the probability that a child of two individuals who each have one copy of the abnormal gene will be affected with CF?

- 0% (1)
- 25% (2)
- 50% (3)
- 66% (4)
- 75% (5)

Question 28: Which of the following is a correct statement about science and the scientific method?

- They are rarely able to provide explanations of the natural world. (1)
- They are able to provide explanations that include the supernatural world. (2)
- They are processes of inquiry which include repeatable observations and testable hypotheses. (3)
- They are unlikely to contribute significantly to improving the human condition. (4)
- Their conclusions are not open to question in the light of new data and observations. (5)

Question 29: The muscle cells of humans contain 46 chromosomes. How many chromosomes do unfertilized human egg cells contain?

- 11 (1)
- 22 (2)
- 23 (3)
- 46 (4)
- 92 (5)

Question 30: What is an example of an unexpected consequence when current genetic technologies are used?

- ○ Determining the genetic make-up of an early embryo through preimplantation genetic diagnosis. (1)
- ○ Determining the genetic make-up of a new baby through newborn genetic screening program. (2)
- ○ Learning about a different paternity of a child upon testing for a genetic disorder. (3)
- ○ Learning the carrier status of individuals who request adult genetic screening. (4)
- ○ Finding a chromosome abnormality in a fetus where the mother has sought prenatal diagnosis. (5)

End of Block: Knowledge Test

File Name: Additional file 2

Title of Data: "Medical School Students Survey – Spanish"

Description of Data: This file contains survey that was distributed to medical school students in Ecuador.

Medical School Students Survey - Spanish

Start of Block: Consent

Pre:
Consentimiento Implícito Título del Estudio de Investigación: Evaluación de la Instrucción Genética Educacional de los Estudiantes de la Facultad de Medicina y de Médicos en el Ecuador IRB ID#: IRB2022-233 Mi nombre es Badí Israel Quinteros Espinoza. Soy un estudiante universitario de la Universidad de Brigham Young y estoy realizando esta investigación bajo la supervisión del Departamento de Biología de la Universidad de Brigham Young. Usted ha sido invitado a participar en este estudio de investigación sobre la educación en temas de genética en escuelas de medicina en Ecuador. Estoy interesado en poder aprender más sobre su entendimiento de lo que es la genética en el área de medicina y sobre su perspectiva sobre la importancia de la educación sobre temas de genética en las escuelas de medicina. Participar en este estudio es completamente opcional, y usted puede dejar de participar en el estudio en cualquier momento. Si usted decide participar en el estudio y proceder, se le pedirá que complete una encuesta que debería tomar menos de 30 minutos de su tiempo. Usted puede saltarse preguntas que no desee responder o finalizar la encuesta en cualquier momento. La encuesta es anónima, y nadie podrá conectar sus respuestas con usted. Por favor no incluya su nombre o su información los cuales podrían ser usados para conectar sus respuestas a la encuesta con usted. Usted no recibirá una compensación económica. Sin embargo, como forma de mostrarle nuestro agradecimiento por su participación cuando la encuesta termine, usted tendrá la oportunidad de completar una segunda encuesta que le permitirá entrar en un sorteo para ganar una de doce tarjetas de regalo de Amazon ($25.00 cada una). Nosotros anticipamos que la posibilidad de ganar una tarjeta de regalo es de 1 en 24. Usted ingresará un correo electrónico en la segunda encuesta, pero su correo no será conectado con sus respuestas en la encuesta principal. Si tiene preguntas, por favor contactar a Badí Quinteros al +1 908 414 5983 o a biqe2@byu.edu. Si tiene cualquier pregunta sobre sus derechos como participante del estudio, usted puede llamar al Programa de Protección de Investigación Humana en BYU at +1 801-422-1461 o al correo BYU.HRPP@byu.edu. Si desea participar en el estudio, seleccione la opción "Comenzar" y dé click en la flecha que se encuentra en la parte inferior derecha para comenzar la encuesta

- ○ Comenzar (1)
- ○ No deseo participar (2)

Skip To: End of Survey If Consentimiento Implícito Título del Estudio de Investigación: Evaluación de la Instrucción Genéti... = No deseo participar

End of Block: Consent

Start of Block: Demografía

Pregunta 1: ¿Cuál es su género?

- ○ Mujer (1)
- ○ Hombre (2)
- ○ No binario/ tercer género (3)
- ○ Prefiere identificarse como (4) _____
- ○ Prefiere no decir (5)

Pregunta 2: ¿Cuántos años tiene?
Edades (1)

▼ 15 (1) ... 99 (85)

Pregunta 4: ¿Cuál es su etnicidad?

- ○ Mestizo (1)
- ○ Blanco (2)
- ○ Indigena (3)
- ○ Afroecuatoriano (4)
- ○ Montubio (5)
- ○ Otra (6) _____
- ○ Prefiero no decir (7)

Pregunta 6: ¿En qué semestre está?

- ○ 1ro (1)
- ○ 2do (2)
- ○ 3ro (3)
- ○ 4to (4)
- ○ 5to (5)
- ○ 6to (6)
- ○ 7mo (7)
- ○ 8vo (8)
- ○ 9no (9)
- ○ 10mo (10)
- ○ más de10 semestres (11)

End of Block: Demografía

Start of Block: Opinión

Pregunta 7: ¿Está de acuerdo con las siguientes declaraciones?

	Estoy firmemente en desacuerdo (1)	Estoy en desacuerdo (2)	Estoy un poco en desacuerdo (3)	Estoy un poco de acuerdo (4)	Estoy de acuerdo (5)	Estoy firmemente de acuerdo (6)
En la facultad de medicina, yo he aprendido sobre principios básicos de genética humana y patrones de herencia y variación (tanto en familias como en poblaciones) (1)	○	○	○	○	○	○
En la facultad de medicina, yo he aprendido sobre la importancia de la historia familiar de tres generaciones para evaluar la predisposición a la enfermedad. (2)	○	○	○	○	○	○
En la facultad de medicina, yo he aprendido sobre el rol de los factores genéticos en el mantenimiento de la salud y en la prevención de enfermedades (3)	○	○	○	○	○	○
En la facultad de medicina, yo he aprendido sobre la diferencia entre el diagnóstico clínico de enfermedades y la identificación de la predisposición genética de una enfermedad en individuos, familias y comunidades. (4)	○	○	○	○	○	○
En la facultad de medicina, yo he aprendido sobre el rol de los factores de comportamiento, factores sociales y factores del	○	○	○	○	○	○

medio ambiente que modifican o influencian la genética en la manifestación de enfermedades. (5)						
En la facultad de medicina, yo he aprendido sobre la influencia de la cultura, la influencia de los beneficios de salud relacionados y la influencia de los estatutos socioeconómicos en la determinación del acceso que tienen los pacientes a la información genética y a los servicios genéticos. (6)	○	○	○	○	○	○
En la facultad de medicina, yo he aprendido sobre la implementación de las guías relevantes en la práctica genética o sobre la implementación de las declaraciones de consenso. (7)	○	○	○	○	○	○
En la facultad de medicina, yo he aprendido sobre los varios enfoques genéticos para tratar enfermedades(incluyendo farmacogenómica y terapia génica) (8)	○	○	○	○	○	○
En la facultad de medicina, yo he aprendido sobre las indicaciones y recursos para realizar pruebas genéticas y referir a un especialista genético. (9)	○	○	○	○	○	○
En la facultad de medicina, yo he aprendido sobre la historia del uso	○	○	○	○	○	○

inadecuado de la información genética de los seres humanos. (por ejemplo eugenesia) (10)						
En la facultad de medicina, yo he aprendido sobre los problemas éticos, legales y sociales relacionados con las pruebas y el manejo de información genética. (11)	○	○	○	○	○	○

Page Break

Pregunta 8: ¿Está de acuerdo con las siguientes declaraciones?

	Estoy firmemente en desacuerdo (1)	Estoy en desacuerdo (2)	Estoy un poco en desacuerdo (3)	Estoy un poco de acuerdo (4)	Estoy de acuerdo (5)	Estoy firmemente de acuerdo (6)
Soy capaz de recolectar la historia familiar genética (incluyendo historia familiar de varias generaciones que sea apropiada) de los pacientes. (1)	○	○	○	○	○	○
Soy capaz de identificar pacientes a quienes les podría ser beneficioso tener una consulta genética. (2)	○	○	○	○	○	○
Soy capaz de explicar conceptos básicos de probabilidad, susceptibilidad a enfermedades, y la influencia de los genes y los factores sociales en el mantenimiento de la salud y el desarrollo de enfermedades. (3)	○	○	○	○	○	○
Soy capaz de apropiadamente buscar	○	○	○	○	○	○

asistencia y poder referir a expertos en genética y a recursos de apoyo a los pacientes. (4)						
Soy capaz de obtener información actualizada sobre los genes para mí mismo, pacientes, y colegas. (5)	○	○	○	○	○	○
Soy capaz de considerar la influencia genética en todos los posibles procesos de enfermedad que sean relevantes cuando se me presenten. (6)	○	○	○	○	○	○
Soy capaz de proveer información objetiva sobre los posibles riesgos, beneficios, y limitaciones de las pruebas genéticas. (7)	○	○	○	○	○	○
Soy capaz de educar a pacientes sobre las posibles emociones que ellos o sus familiares podrían experimentar como resultado de recibir	○	○	○	○	○	○

información genética. (8)						
Soy capaz de proteger la privacidad y confidencialidad de la información genética de los pacientes y advertirles de posibles limitaciones. (9)	○	○	○	○	○	○
Soy capaz de educar a pacientes sobre la disponibilidad de pruebas genéticas y/o de tratamientos para condiciones que se ven frecuentemente en pacientes. (10)	○	○	○	○	○	○
Soy capaz de proveer a los pacientes un proceso de consentimiento informado apropiado para facilitar la toma de decisiones relacionadas con las pruebas genéticas. (11)	○	○	○	○	○	○
Soy capaz de educar a pacientes sobre los riesgos y beneficios de las pruebas genéticas realizadas sin consulta médica. (12)	○	○	○	○	○	○

Soy capaz de realizar pruebas genéticas de diagnóstico emergentes - análisis del genoma completo (13)	○	○	○	○	○	○

End of Block: Opinión

Start of Block: Conocimiento

Pregunta 1: ¿Cuál es la relación entre genes, ADN y cromosomas?

- ○ Los genes están compuestos de ADN y se encuentran en los cromosomas (1)
- ○ Los genes son entidades diferentes que el ADN o los cromosomas (2)
- ○ Los genes se encuentran sólo en los cromosomas y no en el ADN (3)
- ○ Los genes se encuentran únicamente en el ADN pero no en los cromosomas (4)
- ○ Los cromosomas están compuestos de genes pero no de ADN (5)

Pregunta 2: La altura en un adulto está particularmente determinada por los genes.¿Cuando condiciones ambientales se mantienen constantes, los seres humanos tienen una mayor variedad de alturas (no solamente pequeño, mediano y alto) La altura probablemente es influenciada por :

- ○ Un gen y dos alelos (1)
- ○ Un solo gen recesivo (2)
- ○ Un solo gen dominante (3)
- ○ Varios genes (4)
- ○ Solamente genes paternos (5)

Pregunta 3: Nuestro entendimiento del funcionamiento de los genes indica que:

- ○ Diferentes especies de organismos usan diferentes mecanismos genéticos para producir rasgos específicos (1)
- ○ No existen interacciones entre genes y la producción de rasgos específicos (2)
- ○ Los productos de los genes pueden ser carbohidratos, grasas, o proteínas. (3)
- ○ Los genes no producen productos específicos pero codifican directamente rasgos específicos (4)
- ○ Los genes codifican proteínas, las cuales a su vez producen rasgos específicos. (5)

Pregunta 4: La ingeniería genética molecular es posible:

- ○ Porque todos los organismos vivientes tienen el mismo ADN (1)
- ○ Porque todos los organismos vivientes tienen ADN como su material genético (2)
- ○ Porque todos los organismos vivientes tienen diferentes pero compatibles estructuras en su ADN (3)
- ○ Porque differentes materiales genéticos que no son el ADN son modificados por científicos para que sean compatibles (4)
- ○ Sólo entre especies de plantas o entre especie animales independientemente, pero no entre animales y plantas (5)

Pregunta 5: ¿Cuál de las siguientes oraciones es INCORRECTA con respecto a la meiosis?

- ○ La meiosis ocurre solamente en especies de organismos que se reproducen sexualmente (1)
- ○ La meiosis reduce a la mitad el número de cromosomas en las células reproductoras. (2)
- ○ La meiosis permite la variación genética de la descendencia (3)
- ○ La meiosis ocurre en la mayoría de las células del cuerpo en algún momento durante la vida del individuo (4)
- ○ La meiosis mantiene el número de cromosomas constante de generación en generación. (5)

Pregunta 6: A veces un rasgo parece desaparecer en una familia y luego reaparece en generaciones posteriores. Si ninguno de los padres tiene el rasgo, pero algunos de sus descendientes lo tienen, ¿qué es lo que puede concluir con respecto a la posibilidad de que ese rasgo pueda ser heredado?

- ○ Ambos padres son portadores de una forma recesiva del gen (1)
- ○ Solamente un padre tiene dos copias de la forma recesiva del gen (2)
- ○ Solamente uno de los padres tiene la forma dominante del gen (3)
- ○ Solamente uno de los padres tiene una copia de la forma recesiva del gen (4)
- ○ Lo más probable es que sea el resultado de nuevas mutaciones en cada padre (5)

Page Break

Pregunta 7: A un individuo se le detectó una mutación en un gen relacionado al cáncer de seno. ¿En qué tipo de células estaría este tipo de gen localizado?

- ○ Solamente en las células del seno en donde ocurrió el cáncer. (1)
- ○ Solamente en las células de ambos senos (2)
- ○ Solamente en las células que se encuentran en mujeres (3)
- ○ Solamente en las células del seno y en los ovarios (4)
- ○ En todas las células del individuo (5)

Pregunta 8: Las mutaciones en el ADN ocurren en los genomas de la mayoría de los organismos, incluyendo en los humanos. ¿Cuál es el resultado más importante de estas mutaciones?

- ○ Estas producen nuevos genes para el individuo (1)
- ○ Estas producen nuevas enzimas para el individuo (2)
- ○ Estas proveen de una nueva fuente de células para el individuo (3)
- ○ Estas proveen una fuente fundamental de variación genética para las futuras generaciones (4)
- ○ Estas producen nuevos cromosomas para futuras generaciones (5)

Pregunta 9: Varios genes están relacionados con enfermedades que son complejas como por ejemplo el cáncer y los trastornos mentales. Cuando a un individuo se le evalúa para este tipo de genes, ¿qué es lo que los resultados indican?

- ○ Si él/ella tiene o no tiene la enfermedad (1)
- ○ Si él/ella tiene o no tiene una mayor posibilidad de desarrollar esa enfermedad o trastorno (2)
- ○ Si él/ella va o no va a definitivamente desarrollar esa enfermedad o trastorno. (3)
- ○ Si sus hijos/as definitivamente desarrollarán o no desarrollarán la enfermedad o trastorno (4)
- ○ Cuán severa será la enfermedad o trastorno en el individuo que tiene una mutación en el gen (5)

Pregunta 10: ¿Cúal de las siguientes opciones es un beneficio actual de la aplicación de la genética y la tecnología genética en la atención médica?

- ○ La habilidad de significativamente incrementar la esperanza de vida (1)
- ○ La habilidad de eliminar enfermedades complejas como el cáncer (2)
- ○ La creación de medicamentos baratos y de fácil administración (3)
- ○ La habilidad de identificar individuos o grupos que tienen mayor riesgo de desarrollar alguna enfermedad (4)
- ○ La habilidad de usar la terapia génica rutinariamente para curar enfermedades genéticas (5)

Pregunta 11: A una mujer se le indicó que ella es portadora de una mutación relacionada al cáncer de seno. ¿Cómo este diagnóstico afecta a la posibilidad de que ella desarrolle cáncer de seno?

- El riesgo es el mismo en una mujer que es sana y no tiene la mutación (1)
- Ella posiblemente no desarrollará cáncer de seno (2)
- Ella tiene un mayor riesgo de desarrollar cáncer de seno (3)
- Ella definitivamente va a desarrollar cáncer de seno (4)
- Ella ya tiene cáncer de seno debido a que es portadora de la mutación (5)

Pregunta 12: Muchos genetistas estudian el material genético de ratones, moscas de frutas, y levadura. Ellos son capaces de aplicar lo que aprenden de estos organismos en humanos porque prácticamente todos los diferentes tipos de organismos:

- Tienen ADN como su material genético (1)
- Tienen proteínas como su material genético (2)
- Tienen la misma cantidad de material genético (3)
- Producen proteínas, grasas, y carbohidratos de su material genético (4)
- Tienen ARN como su material genético (5)

Pregunta 13: Mientras que el SIDA se ha propagado por todo el mundo, existen algunos individuos que son resistentes a los efectos del virus a pesar de que tengan SIDA. ¿Por qué?

- ○ Ellos llevan diferencias genéticas que los hace resistentes (1)
- ○ Cambios genéticos que proveen de resistencia son producidos en respuesta a la infección con el virus. (2)
- ○ La selección natural provoca diferencias genéticas que resultan en la resistencia al virus (3)
- ○ El medio ambiente en el cual los individuos viven determina su resistencia (4)
- ○ Se dice que las diferencias nutricionales entre los individuos determina su resistencia al virus (5)

Pregunta 14: ¿Cuál de las siguientes oraciones es una característica de las mutaciones en ADN?

- ○ Las mutaciones son usualmente expresadas y resultan en cambios positivos para el individuo (1)
- ○ Las mutaciones son usualmente expresadas y producen problemas significativos al individuo (2)
- ○ Las mutaciones que ocurren en las células del cuerpo de uno de los padres son usualmente heredadas a sus hijos. (3)
- ○ Las mutaciones ocurren en alto porcentaje en la mayoría de los genes (4)
- ○ Las mutaciones resultan en diferentes versiones de un gen en una población (5)

Page Break

Pregunta 15: ¿Cuál es la relación entre el ADN y los cromosomas en organismos complejos?

- Los cromosomas se encuentran en el ADN (1)
- El ADN se encuentra en los cromosomas (2)
- No existe diferencia entre el ADN y los cromosomas (3)
- El ADN y los cromosomas son estructuras completamente diferentes (4)
- Los cromosomas producen ADN (5)

Pregunta 16: La enfermedad Huntington es un trastorno genético causado por un gen dominante. Los síntomas comienzan en la edad adulta y la enfermedad es mortal. ¿Cuál es el dilema ético presentado debido a la enfermedad de Huntington cuando uno de los padres es diagnosticado con dicha enfermedad?

- Si dicho padre/madre (el cual tiene el diagnóstico) debería hacerse pruebas (1)
- Si el otro padre/madre (no está afectado) debería hacerse pruebas (2)
- Si uno de los hijos debería hacerse pruebas y cuando (3)
- Si el padre/madre debería ser tratado para la enfermedad (4)
- Si se le debería decir al padre/madre que tienen la enfermedad de Huntington (5)

Pregunta 17: Cuando se habla de rasgos complicados como IQ, cáncer de pulmón, cáncer de próstata, etc, como los genetistas describen la contribución de los genes de la persona y el ambiente?

- ○ El ambiente genera el potencial para el rasgo; cuánto ese rasgo es expresado depende de la conformación genética del individuo (1)
- ○ Cada persona hereda un potencial genético; cuánto de ese potencial es expresado depende del ambiente (2)
- ○ Los genetistas típicamente aceptan que los rasgos mayoritariamente son determinados principalmente por los genes y el ambiente tiene muy poco efecto en la complejidad de los rasgos (3)
- ○ El ambiente juega un papel muy importante en la determinación de rasgos complejos, y los genes juegan un rol minoritario (4)
- ○ Las diferencias genéticas entre humanos es tan insignificante que esencialmente todas las variaciones observadas entre individuos son debidos al ambiente en el cual los individuos se desarrollan (5)

Pregunta 18: ¿Cómo se regula o controla la expresión de los genes?

- ○ La expresión de genes no es regulada ni controlada (1)
- ○ Los genes son activados durante el desarrollo y se mantienen activos durante toda la vida (2)
- ○ Los genes son activados y desactivados únicamente durante el desarrollo (3)
- ○ Los genes son activados y desactivados en ocasiones apropiadas durante la vida (4)
- ○ La expresión de genes es controlada por factores externos (5)

Pregunta 19: Si una persona tiene se hace una prueba genética para saber sobre una mutación que causa una enfermedad en particular, y los resultados son positivos, ¿qué es lo que probablemente signifiquen los resultados?

- ○ El individuo definitivamente mostrará síntomas de la enfermedad, independientemente si es debido a una mutación dominante o recesiva (1)
- ○ El individuo definitivamente va a desarrollar la enfermedad si la mutación es dominante (2)
- ○ Una prueba positiva de la mutación indica que el individuo ya tiene la enfermedad (3)
- ○ Depende del tipo de enfermedad ya que una prueba positiva para algunas mutaciones solamente muestran mayor riesgo de contraer la enfermedad (4)
- ○ El ambiente durante el desarrollo del individuo será el determinante primordial si el individuo desarrolla la enfermedad (5)

Page Break

Pregunta 20: ¿Qué efecto, si es que hay alguno, tiene el entorno de un individuo en el desarrollo de sus rasgos?

- ○ Tiene poco o ningún efecto en la mayoría de los rasgos en un individuo (1)
- ○ Establece el potencial de desarrollo de la mayoría de los rasgos de un individuo (2)
- ○ Afecta de diferentes maneras la mayoría de los rasgos del individuo (3)
- ○ Es un factor dominante para determinar la mayoría de los rasgos en el individuo (4)
- ○ No tiene ningún efecto sobre los rasgos de un individuo, pero puede tenerlo sobre los rasgos de su descendencia (5)

Pregunta 21: Las células de los músculos, las células de los nervios, y las células de la piel tiene diferentes funciones debido a que cada tipo de células:

- ○ Contienen diferentes tipos de genes (1)
- ○ Están localizadas en diferentes partes del cuerpo (2)
- ○ Activan diferentes genes (3)
- ○ Contiene diferentes números de genes (4)
- ○ Han experimentado diferentes mutaciones (5)

Pregunta 22: ¿Durante qué tiempo en el desarrollo de un individuo el medio ambiente influencia la expresión de genes?

- ○ Desde el principio de la concepción y dura toda la vida (1)
- ○ Desde el nacimiento y dura toda la vida (2)
- ○ Desde el nacimiento y dura hasta la edad adulta (3)
- ○ Ocurre solamente durante etapas específicas de la vida como la pubertad y la menopausia (4)
- ○ El ambiente tiene poco o ningún efecto en la expresión de genes (5)

Pregunta 23: ¿Cúal de las siguientes oraciones es INCORRECTA con respecto a la diferencia genética entre grupos étnicos?

- ○ Existe mayor variación genética en grupos étnicos que entre grupos étnicos (1)
- ○ Las diferencias en apariencias representan solamente pequeñas diferencias genéticas entre grupos étnicos (2)
- ○ Las enfermedades genéticas, como la anemia drepanocítica (anemia de células falciformes), tienen una mayor prevalencia en ciertos grupos étnicos (3)
- ○ La secuencia del ADN es 99% similar entre humanos (4)
- ○ Diferencias genéticas que son responsables del color de la piel representan una porción substancial de genoma humano (5)

Pregunta 24: ¿Cúal es la relación entre genes y los rasgos expresados en individuos?

- ○ Los genes codifican el ADN, los cuales son responsables de los rasgos del individuo (1)
- ○ Los genes codifican proteínas, las cuales son responsables de los rasgos del individuo (2)
- ○ Los genes codifican cromosomas, los cuales son responsables de los rasgos del individuo (3)
- ○ Los genes codifican carbohidratos, los cuales son responsables de los rasgos del individuo (4)
- ○ El medio ambiente y no los genes es principalmente responsable de los rasgos del individuo (5)

Pregunta 25: ¿Cúal de las siguientes oraciones NO refleja los principios básicos de la evolución dados por Charles Darwin?

- ○ La capacidad biológica de las especies de reproducirse es limitada (1)
- ○ La capacidad del planeta tierra de mantener el crecimiento de una población es limitada (2)
- ○ Las diferencias entre individuos son transmitidas de generación en generación (3)
- ○ Algunos individuos están mejor equipados que otros para sobrevivir los cambios ambientales (4)
- ○ La selección natural es la fuerza en la cual se basa la evolución (5)

Page Break

Pregunta 26: ¿Cuál de las siguientes no es considerada una preocupación ética o legal?

- ○ Permitir selección sexual prenatal (1)
- ○ Asesorar a parejas que no tengan hijos que tengan condiciones que requieran cuidados costosos (2)
- ○ Utilizar células madre embrionarias para realizar investigaciones (3)
- ○ Dar a las compañías de seguros el derecho de negar cobertura a aquellos individuos que sean de alto riesgo o con enfermedades genéticas (4)
- ○ Ofrecer a las madres de 35 años o más la oportunidad de someterse a un diagnóstico prenatal para detectar anomalías cromosómicas (5)

Pregunta 27: La fibrosis quística (FQ) es un trastorno recesivo, lo que significa que un individuo debe tener dos copias de un gen anormal de la FQ para estar afectado. ¿Cuál es la probabilidad de que un hijo de dos individuos que tienen cada uno una copia del gen anormal esté afectado por la FQ?

- ○ 0% (1)
- ○ 25% (2)
- ○ 50% (3)
- ○ 60% (4)
- ○ 75% (5)

Pregunta 28: ¿Cúal de las siguientes oraciones es correcta con respecto al método científico y a la ciencia en general?

- ○ Raramente estos pueden proveer de una explicación sobre el mundo natural (1)
- ○ Estos pueden proveer una explicación que incluye al mundo sobrenatural (2)
- ○ Estos son procesos de investigación los cuales incluyen observaciones que se pueden repetir e hipótesis que se pueden probar (3)
- ○ No es posible que estos puedan contribuir significativamente al mejoramiento de la condición humana (4)
- ○ Sus conclusiones no pueden ser cuestionadas a pesar de que se que exista nuevos datos y nuevas observaciones (5)

Pregunta 29: Las células de los músculos de los seres humanos contienen 46 cromosomas. ¿Cuántos cromosomas tiene un óvulo no fecundado?

- ○ 11 (1)
- ○ 22 (2)
- ○ 23 (3)
- ○ 46 (4)
- ○ 92 (5)

Pregunta 30: ¿Cúal es un ejemplo de una consecuencia inesperada cuando se usan tecnologías génicas?

- ○ Determinar la conformación genética de un embrión temprano por medio del diagnóstico genético preimplantacional (1)
- ○ Determinar la conformación genética de un bebe por medio de una evaluación genética del recién nacido (2)
- ○ Conocer sobre la paternidad diferente de un niño después de realizar una prueba de trastorno genético (3)
- ○ Conocer sobre el estado de portador de individuos que solicitan evaluaciones genéticas (4)
- ○ Encontrar un cromosoma anormal en el feto cuando la madre pide un diagnóstico prenatal (5)

End of Block: Conocimiento

File Name: Additional file 3

Title of Data: " Medical School Students Survey – US "

Description of Data: This file contains survey that was distributed to medical school students in the US.

Medical School Students Survey - English

Start of Block: Consent

Q55 Implied Consent Title of the Research Study: Assessing Undergraduate, Graduate, and Medical School Students' Educational Genetics Training in the United States My name is Badí Israel Quinteros Espinoza. I was an undergraduate student at Brigham Young University, and I am conducting this research under the supervision of Professor Liz Bailey, from the Department of Biology at Brigham Young University. You are being invited to participate in this research study about genetics education in American undergraduate, graduate, and medical schools. I am interested to learn more about your understanding about genetics in the medical field and about your perspective about the importance of genetics education in medical school. Being in this study is completely optional, and you may remove yourself from the study at any time. If you choose to be in the study and proceed, you will be asked to complete a survey that should take less than 30 minutes of your time. You can skip questions that you do not want to answer or stop the survey at any time. The survey is anonymous, and no one will be able to link your answers back to you. Please do not include your name or other information that could be used to identify you in the survey responses. You will not be paid for being in this study. However, as a thank you for participating, after the survey concludes you will have the opportunity to complete a second survey to enter a drawing to receive one of **12 Amazon gift cards ($25 each)**. We anticipate the odds of winning a gift card will be about 1 in 24. You will enter an email address into this second survey, but it will not be linked to your responses in the main survey. Questions? Please contact Badí Quinteros at +1 908-414-5983 or quinterosebi@vcu.edu. If you have questions or concerns about your rights as a research participant, you can call the BYU Human Research Protections Program at +1 801-422-1461 or BYU.HRPP@byu.edu. Please click on either “I consent to participate in the study” or “I do not wish my survey responses to be included in the research study” before continuing to the survey questions for course credit.

- ○ I consent to participate in the study (1)
- ○ I do not wish my survey responses to be included in the research study (2)

End of Block: Consent

Start of Block: Demographics

Q1: What is your gender?

- ○ Female (1)
- ○ Male (2)
- ○ Non-binary/third gender (3)
- ○ Prefer to self-describe (please specify) (4) _____
- ○ Prefer not to say (5)

Q2: How old are you?
Age (1)

▼ 15 (1) ... 100 (86)

Q3: What is your race/ethnicity (choose all that apply)

- ☐ White (1)
- ☐ Hispanic or Latino/a (2)
- ☐ Black or African American (3)
- ☐ Asian (4)
- ☐ Native American, American Indian, or Alaska Native (5)
- ☐ Native Hawaiian or Pacific Islander (6)
- ☐ Other (please specify) (7) _____

Page Break

Q4: In what semester are you currently enrolled?

- ○ 1st (1)
- ○ 2nd (2)
- ○ 3th (3)
- ○ 4th (4)
- ○ 5th (5)
- ○ 6th (6)
- ○ 7th (7)
- ○ 8th (8)
- ○ more than 8 (9)

End of Block: Demographics

Start of Block: Attitudinal

Q4: How much do you agree with the following statements?

	Strongly disagree (1)	Disagree (2)	Slightly disagree (3)	Slightly agree (4)	Agree (5)	Strongly agree (6)
In medical school, I have learned about basic human genetics principles and patterns of inheritance and variation (both within families and within populations). (1)	○	○	○	○	○	○
In medical school, I have learned about the importance of the three-generation family history in assessing predisposition to disease. (2)	○	○	○	○	○	○
In medical school, I have learned about the role of genetic factors in health maintenance and disease prevention. (3)	○	○	○	○	○	○
In medical school, I have learned about the difference between clinical diagnosis of disease and identification of genetic predisposition to disease for individuals, families, and communities. (4)	○	○	○	○	○	○
In medical school, I have learned about the role of behavioral, social, and environmental	○	○	○	○	○	○

factors that modify or influence genetics in the manifestation of disease. (5)						
In medical school, I have learned about the influence of culture, related health beliefs, and socioeconomic status in determining patient access to genetic information and services. (6)						
In medical school, I have learned about the implementation of relevant genetics practice guidelines or consensus statements. (7)						
In medical school, I have learned about the range of genetic approaches to treat disease (including pharmacogenomics and gene therapy). (8)						
In medical school, I have learned about the indications and resources for genetic testing and referral to genetic specialists. (9)						
In medical school, I have learned about the history of misuse of human genetic information (i.e., eugenics). (10)						

In medical school, I have learned about the ethical, legal, and social issues related to testing and recording of genetic information. (11)	○	○	○	○	○	○

End of Block: Attitudinal

Start of Block: Skills

Q5: How much do you agree with the following statements: (Strongly disagree; Disagree; Slightly disagree; Slightly agree; Agree; Strongly agree)

	Strongly disagree (1)	Disagree (2)	Slightly disagree (3)	Slightly agree (4)	Agree (5)	Strongly agree (6)
I am capable of gathering genetic family history information (including an appropriate multi-generational family history) from patients. (1)	○	○	○	○	○	○
I am capable of identifying patients who would benefit from genetic consultation (2)	○	○	○	○	○	○
I am capable of explaining basic concepts of probability, disease susceptibility, and the influence of genetic and social factors on maintenance of health and development of disease (3)	○	○	○	○	○	○
I am capable of appropriately seek assistance from and refer to	○	○	○	○	○	○

genetics' experts and peer support resources (4)						
I am capable of obtaining current information about genetics for self, patients, and colleagues (5)	○	○	○	○	○	○
I am capable of considering genetic influence on all potentially relevant disease processes encountered (6)	○	○	○	○	○	○
I am capable of providing unbiased information about the potential risks, benefits, and limitations of genetic testing (7)	○	○	○	○	○	○
I am capable of educating patients about the range of emotions they and/or family members may experience as a result of	○	○	○	○	○	○

receiving genetic information (8)						
I am capable of safeguarding the privacy and confidentiality of the genetic information of patients and warn of potential limitations (9)	○	○	○	○	○	○
I am capable of educating patients about the availability of genetic testing and/or treatment for conditions seen frequently in practice. (10)	○	○	○	○	○	○
I am capable of providing patients with an appropriate informed consent process to facilitate decision making related to genetic testing (11)	○	○	○	○	○	○
I am capable of educating patients about risks and benefits with direct-to-	○	○	○	○	○	○

consumer (DTC) genetic testing (12)						
I am capable of emerging diagnostic genetic testing – whole genome analysis (13)	○	○	○	○	○	○

End of Block: Skills

Start of Block: Knowledge Test

Question 1: What is the relationship among genes, DNA, and chromosomes?

- ○ Genes are composed of DNA and lie within chromosomes. (1)
- ○ Genes are separate entities from either DNA or chromosomes. (2)
- ○ Genes are found only in chromosomes and not DNA. (3)
- ○ Genes are found only in DNA and not chromosomes. (4)
- ○ Chromosomes are composed of genes but not DNA. (5)

Question 2: Adult height in humans is partially determined by our genes. When environmental conditions are held constant, humans have a wide variety of heights (not just short, medium, and tall). Height is probably influenced by:

- ○ one gene with two alleles. (1)
- ○ a single recessive gene. (2)
- ○ a single dominant gene. (3)
- ○ several genes. (4)
- ○ only paternal genes. (5)

Question 3: Our understanding of how genes function indicates that:

- ○ different species of organisms use different genetic mechanisms for producing individual traits. (1)
- ○ there are no interactions among genes in producing individual traits. (2)
- ○ gene products can be carbohydrates, fats, or proteins. (3)
- ○ genes do not produce specific products but code directly for individual traits. (4)
- ○ genes code for proteins, which in turn produce individual traits. (5)

Question 4: Molecular genetic engineering is possible

- ○ because all living organisms have the same DNA sequence. (1)
- ○ because all living organisms have DNA as their genetic material. (2)
- ○ because all living organisms have different but compatible structures of DNA. (3)
- ○ because different genetic materials other than DNA are made compatible by scientists. (4)
- ○ only among plant species or among animal species, but not between plants and animals. (5)

Question 5: Which of the following is INCORRECT regarding meiosis?

- ○ It occurs only in species of organism that have sexual reproduction. (1)
- ○ It halves the chromosome number in reproductive cells. (2)
- ○ It provides for genetic variation in the offspring. (3)
- ○ It occurs in most body cells at some time during the life of the individual. (4)
- ○ It keeps the chromosome number constant from generation to generation. (5)

Page Break

Question 6: Sometimes a trait seems to disappear in a family and then reappear in later generations. If neither parent has the trait, but some of the offspring do, what would you conclude about the inheritance of the trait?

- ○ Both parents are carriers of the recessive form of the gene. (1)
- ○ Only one parent has two copies of the recessive form of the gene. (2)
- ○ Only one of the parents has a dominant form of the gene. (3)
- ○ Only one parent has a copy of the recessive form of the gene. (4)
- ○ It is most likely the result of new mutations in each parent. (5)

Question 7: An individual is found to have a mutation in a gene associated with breast cancer. In which cells is this form of the gene located?

- ○ Only in cells of the breast where cancer occurred. (1)
- ○ Only in cells of both breasts. (2)
- ○ Only in those cells found in females. (3)
- ○ Only in the cells of the breast and ovaries. (4)
- ○ All the cells of the individual. (5)

Question 8: Mutations in DNA occur in the genomes of most organisms, including humans. What is the most important result of these mutations?

- ○ They produce new genes for the individual. (1)
- ○ They produce new enzymes for the individual. (2)
- ○ They provide a source of new cells for the individual. (3)
- ○ They provide a fundamental source of genetic variation for future generations. (4)
- ○ They produce new chromosomes for future generations. (5)

Question 9: Multiple genes are associated with complex diseases such as cancer and mental disorders. When an individual is tested for these genes, what do the results indicate?

- ○ Whether or not s/he has the disease or disorder. (1)
- ○ Whether or not s/he has an increased risk for developing the disease or disorder. (2)
- ○ Whether or not s/he will definitely develop the disease or disorder. (3)
- ○ Whether or not his/her children will definitely develop the disease or disorder. (4)
- ○ How severe the disease or disorder will be if the individual has the gene. (5)

Question 10: Which of the following is a current benefit of the application of genetics and genetic technology to health care?

- ○ The ability to significantly increase human life expectancy. (1)
- ○ The ability to eliminate complex diseases like cancer. (2)
- ○ The creation of inexpensive and easily administered drugs. (3)
- ○ The ability to identify individuals and groups who are at increased risk of disease. (4)
- ○ The ability to routinely use gene therapy to cure genetic diseases. (5)

Page Break

Question 11: A woman has been told she carries a mutation associated with breast cancer. How does this influence her likelihood of developing breast cancer?

- ○ Her risk will be no different from any other healthy woman. (1)
- ○ She will likely not get breast cancer. (2)
- ○ She is at an increased risk for breast cancer. (3)
- ○ She will definitely get breast cancer. (4)
- ○ She already has breast cancer since she carries the mutated gene. (5)

Question 12: Many geneticists study the genetic material of organisms such as mice, fruit flies, and yeast. They are able to apply what they learn from these organisms to humans because virtually all different types of organisms:

- ○ have DNA as their genetic material. (1)
- ○ have proteins as their genetic material. (2)
- ○ have the same amount of genetic material. (3)
- ○ produce proteins, fats, and carbohydrates from their genetic material. (4)
- ○ have RNA as their genetic material. (5)

Question 13: As HIV has spread around the world, we know some individuals are resistant to the effects of the virus even though they are HIV positive. Why?

- ○ They carry genetic differences that provide the resistance. (1)
- ○ Genetic changes that provide resistance are produced in response to infection by the virus. (2)
- ○ Natural selection causes genetic differences to be produced that result in resistance. (3)
- ○ The environment in which the individual lives determines resistance. (4)
- ○ Nutritional differences among individuals are known to determine resistance to the virus. (5)

Question 14: Which of the following is a characteristic of mutations in DNA?

- ○ They are usually expressed and result in positive changes for the individual. (1)
- ○ They are usually expressed and cause significant problems for the individual. (2)
- ○ Those that occur in the body cells of a parent are usually passed on to their children. (3)
- ○ They usually occur at very high rates in most genes. (4)
- ○ They result in different versions of a gene within the population. (5)

Question 15: What is the relationship between DNA and chromosomes in higher organisms?

- ○ Chromosomes are found within DNA. (1)
- ○ DNA is found within chromosomes. (2)
- ○ There is no difference between DNA and chromosomes. (3)
- ○ DNA and chromosomes are completely separate structures. (4)
- ○ Chromosomes produce DNA. (5)

Page Break

Question 16: Huntington's disease is a genetic disorder caused by a dominant gene. Symptoms begin in adulthood and the disease is ultimately fatal. What is an ethical dilemma presented by Huntington's disease when a parent is diagnosed with the disease?

- ○ Whether that parent should be tested for the gene. (1)
- ○ Whether the other parent should be tested for the gene. (2)
- ○ Whether and when any of the children should be tested for the gene. (3)
- ○ Whether the parent should be treated for the disease. (4)
- ○ Whether that parent should be told s/he has Huntington's disease. (5)

Question 17: Regarding complex traits such as IQ, lung cancer, prostate cancer, etc, how do geneticists describe the contributions of ones' genetic makeup and the environment?

- ○ The environment sets the potential for a trait; how much of that potential is realized depends upon the genetic make-up of the individual. (1)
- ○ Each person inherits a genetic potential; how much of that potential is realized depends upon the environment. (2)
- ○ Geneticists typically accept that most traits are determined heavily by genetics with the environment having little effect on complex traits. (3)
- ○ The environment plays a major role in determining complex traits, with genetics playing a relatively minor role. (4)
- ○ Genetic differences among humans are so minor that essentially all variations observed among individuals are due to the environment in which they were reared. (5)

Question 18: How is the expression of genes regulated or controlled?

- The expression of genes is not regulated or controlled. (1)
- Genes are turned on during development and stay on throughout one's life. (2)
- Genes are only turned on and off during development. (3)
- Genes are turned on and off at appropriate times throughout one's life. (4)
- The expression of genes is only controlled by external factors. (5)

Question 19: If an individual has a genetic test for a mutation causing a particular disease, and the result is positive, what will that most likely mean?

- The individual will definitely exhibit the disease, regardless of whether it is due to a dominant or recessive mutation. (1)
- The individual will definitely exhibit the disease only if it is due to a dominant mutation. (2)
- A positive test for the mutation indicates that the individual already has the disease. (3)
- It depends upon the disease involved, as testing positive for some mutations only show a higher risk for getting the disease. (4)
- The environment during the individual's development will be the primary determinant of whether the individual exhibits the disease. (5)

Question 20: What effect, if any, does an individual's environment have on the development of his or her traits?

- ○ It has little or no effect on most traits in an individual. (1)
- ○ It sets the potential for the development of most traits in an individual. (2)
- ○ It affects to varying degrees most traits in an individual. (3)
- ○ It is a dominant factor for determining most traits in an individual. (4)
- ○ It does not have any effect on an individual's traits, but can have an effect on the traits of an individual's offspring. (5)

Page Break

Question 21: Your muscle cells, nerve cells, and skin cells have different functions because each kind of cell:

- ○ contains different kinds of genes. (1)
- ○ is located in different areas of the body. (2)
- ○ activates different genes. (3)
- ○ contains different numbers of genes. (4)
- ○ has experienced different mutations. (5)

Question 22: At what times during an individual's life does the environment influence the expression of his or her genes?

- ○ Beginning at conception and lasting throughout life. (1)
- ○ Beginning at birth and lasting throughout life. (2)
- ○ Beginning at birth and lasting until adulthood. (3)
- ○ Occurring only during key stages of life such as puberty and menopause. (4)
- ○ Environment has little or no effect on how genes are expressed. (5)

Question 23: Which of the following is INCORRECT regarding the genetic differences among ethnic groups?

- There is much more genetic variation within ethnic groups than among them. (1)
- Differences in appearance represent only minor genetic differences among ethnic groups. (2)
- Genetic diseases, such as sickle cell disease, have an increased prevalence within certain ethnic groups. (3)
- The DNA sequence is more than 99% similar among all humans. (4)
- Genetic differences responsible for skin color represent a substantial portion of the human genome. (5)

Question 24: What is the relationship between genes and traits expressed in individuals?

- Genes code for DNA, which is responsible for individual traits. (1)
- Genes code for proteins, which are responsible for individual traits. (2)
- Genes code for chromosomes, which are responsible for individual traits. (3)
- Genes code for carbohydrates, which are responsible for individual traits. (4)
- The environment rather than genes is primarily responsible for individual traits. (5)

Question 25: Which of the following does NOT accurately reflect Charles Darwin's basic principles of evolution?

- ○ The capacity of biological species to reproduce is limited. (1)
- ○ The capacity of the earth to sustain continuous population growth is limited. (2)
- ○ Differences among individuals are transmitted from generation to generation. (3)
- ○ Some individuals are better equipped than others to survive changes in the environment. (4)
- ○ Natural selection is the driving force of evolution. (5)

Page Break

Question 26: Which of the following is NOT considered an ethical or legal concern?

- Allowing prenatal sex selection. (1)
- Counseling couples not to have babies with conditions that require costly care. (2)
- Utilizing embryonic stem cells for research. (3)
- Giving insurance companies the right to deny insurance to those individuals known to have a high risk or genetic disease. (4)
- Offering mothers 35 years of age or older the opportunity to have prenatal diagnosis for chromosome anomalies. (5)

Question 27: Cystic fibrosis (CF) is a recessive disorder, meaning that an individual must have two copies of an abnormal CF gene to be affected. What is the probability that a child of two individuals who each have one copy of the abnormal gene will be affected with CF?

- 0% (1)
- 25% (2)
- 50% (3)
- 66% (4)
- 75% (5)

Question 28: Which of the following is a correct statement about science and the scientific method?

- They are rarely able to provide explanations of the natural world. (1)
- They are able to provide explanations that include the supernatural world. (2)
- They are processes of inquiry which include repeatable observations and testable hypotheses. (3)
- They are unlikely to contribute significantly to improving the human condition. (4)
- Their conclusions are not open to question in the light of new data and observations. (5)

Question 29: The muscle cells of humans contain 46 chromosomes. How many chromosomes do unfertilized human egg cells contain?

- 11 (1)
- 22 (2)
- 23 (3)
- 46 (4)
- 92 (5)

Question 30: What is an example of an unexpected consequence when current genetic technologies are used?

- ○ Determining the genetic make-up of an early embryo through preimplantation genetic diagnosis. (1)
- ○ Determining the genetic make-up of a new baby through newborn genetic screening program. (2)
- ○ Learning about a different paternity of a child upon testing for a genetic disorder. (3)
- ○ Learning the carrier status of individuals who request adult genetic screening. (4)
- ○ Finding a chromosome abnormality in a fetus where the mother has sought prenatal diagnosis. (5)

End of Block: Knowledge Test

File Name: Additional file 4

Title of Data: "Experts List"

Description of Data: This file contains the list of experts who helped with the translation of the survey and verifying that the content is correct.

Expert Committee						
Name	**Role**	**Degree**	**Primary Language**	**Second Language**	**Phase Participation**	**Authorship**
Badí I. Quinteros Espinoza	Undergraduate Student	Working towards: Bachellors Genetics, Genomics and Biotechnology	Spanish	English	1,2,3,4	yes
Jeffrey B. Quinteros	Non-Expert	Masters in Strategic Management of Information Technologies	Spanish	NA	4	yes
Priscila D. Hodges	Genetic Counselor	Masters in Genetic Counseling	Spanish	English	2	yes
Verónica Abraham	Genetic Counselor/ Physician	Masters in Genetic Counseling/ Masters of Public Health/ Medical Doctor	Spanish	English	2	yes
Daniela Díaz Caro	Genetic Counselor	Masters in Genetic Counseling	Spanish	English	2	yes
Amanda de León	Genetic Counselor	Masters in Genetic Counseling	English	Spanish	2	no

María I. Espinoza	Linguist	Masters in English Language and Applied Linguistics/ Ph.D. in Higher Education Administration	Spanish	English	3	yes
Juan A. Arroyo	Professor	Ph.D. Molecular Biology, Microbiology and Biochemistry	Spanish	English	3	yes

File Name: Additional file 5

Title of Data: "Skills and Knowledge Short Definitions"

Description of Data: This file contains the complete skills and knowledge sentences use for the survey and the short versions used in the figures.

Question	Shortened Name on Figure	Full Item on Survey
Knowledge	Ethics	In medical school, I have learned about the ethical, legal, and social issues related to testing and recording of genetic information.
	Misuse	In medical school, I have learned about the history of misuse of human genetic information (i.e., eugenics).
	Resources	In medical school, I have learned about the indications and resources for genetic testing and referral to genetic specialists.
	Treatments	In medical school, I have learned about the range of genetic approaches to treat disease (including pharmacogenomics and gene therapy).
	Guidelines	In medical school, I have learned about the implementation of relevant genetics practice guidelines or consensus statements.
	Patient Access	In medical school, I have learned about the influence of culture, related health beliefs, and socioeconomic status in determining patient access to genetic information and services.
	Environment x Genetics	In medical school, I have learned about the role of behavioral, social, and environmental factors that modify or influence genetics in the manifestation of disease.
	Diagnosis vs Predisposition	In medical school, I have learned about the difference between clinical diagnosis of disease and identification of genetic predisposition to disease for individuals, families, and communities.
	Disease Prevention	In medical school, I have learned about the role of genetic factors in health maintenance and disease prevention.
	3-Generation History	In medical school, I have learned about the importance of the three-generation family history in assessing predisposition to disease.
	Inheritance	In medical school, I have learned about basic human genetics principles and patterns of inheritance and variation (both within families and within populations).

Question	Shortened Name on Figure	Full Item on Survey
Skills	Conduct WGA	I am capable of emerging diagnostic genetic testing – whole genome analysis
	Educate re: DTC testing	I am capable of educating patients about risks and benefits with direct-to-consumer (DTC) genetic testing
	Provide consent process	I am capable of providing patients with an appropriate informed consent process to facilitate decision making related to genetic testing
	Educate re: testing/treatment	I am capable of educating patients about the availability of genetic testing and/or treatment for conditions seen frequently in practice.
	Safeguard privacy	I am capable of safeguarding the privacy and confidentiality of the genetic information of patients and warn of potential limitations
	Educate re: emotions	I am capable of educating patients about the range of emotions they and/or family members may experience as a result of receiving genetic information
	Provide unbiased info	I am capable of providing unbiased information about the potential risks, benefits, and limitations of genetic testing
	Consider genetic influence	I am capable of considering genetic influence on all potentially relevant disease processes encountered
	Obtain current info	I am capable of obtaining current information about genetics for self, patients, and colleagues
	Refer	I am capable of appropriately seek assistance from and refer to genetics' experts and peer support resources
	Explain basic concepts	I am capable of explaining basic concepts of probability, disease susceptibility, and the influence of genetic and social factors on maintenance of health and development of disease
	Identify need for consultation	I am capable of identifying patients who would benefit from genetic consultation
	Gather history	I am capable of gathering genetic family history information (including an appropriate multi-generational family history) from patients.

File Name: Additional file 6

Title of Data: "GLAI Summary Test Scores "

Description of Data: This file contains the mean, standard deviation, CI lower and upper bound of the GLAI test scores divided by medical school students in Ecuador, and medical school, graduate and undergraduate students in the US.

Data Name	n	Mean	SD	CI_Lower	CI_Upper
Ecuadorian Medical School	173	47.75	18.21	45.01	50.48
U.S. Medical School	37	73.69	28.81	64.09	83.3
U.S. Graduate Students	11	85.45	15.37	75.13	95.78
U.S. Undergraduate Students	182	80.46	14.73	78.31	82.6

File Name: Additional file 7

Title of Data: "GLAI Anova Results by Group"

Description of Data: This file contains the full results of the Anova test done between each group using the GLAI test scores.

Term	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Data_Name	3	102239.4	34079.8	105.8601	< 0.0001
Residuals	400	128773	321.9325		

File Name: Additional file 8

Title of Data: "GLAI Tukey Results by Group"

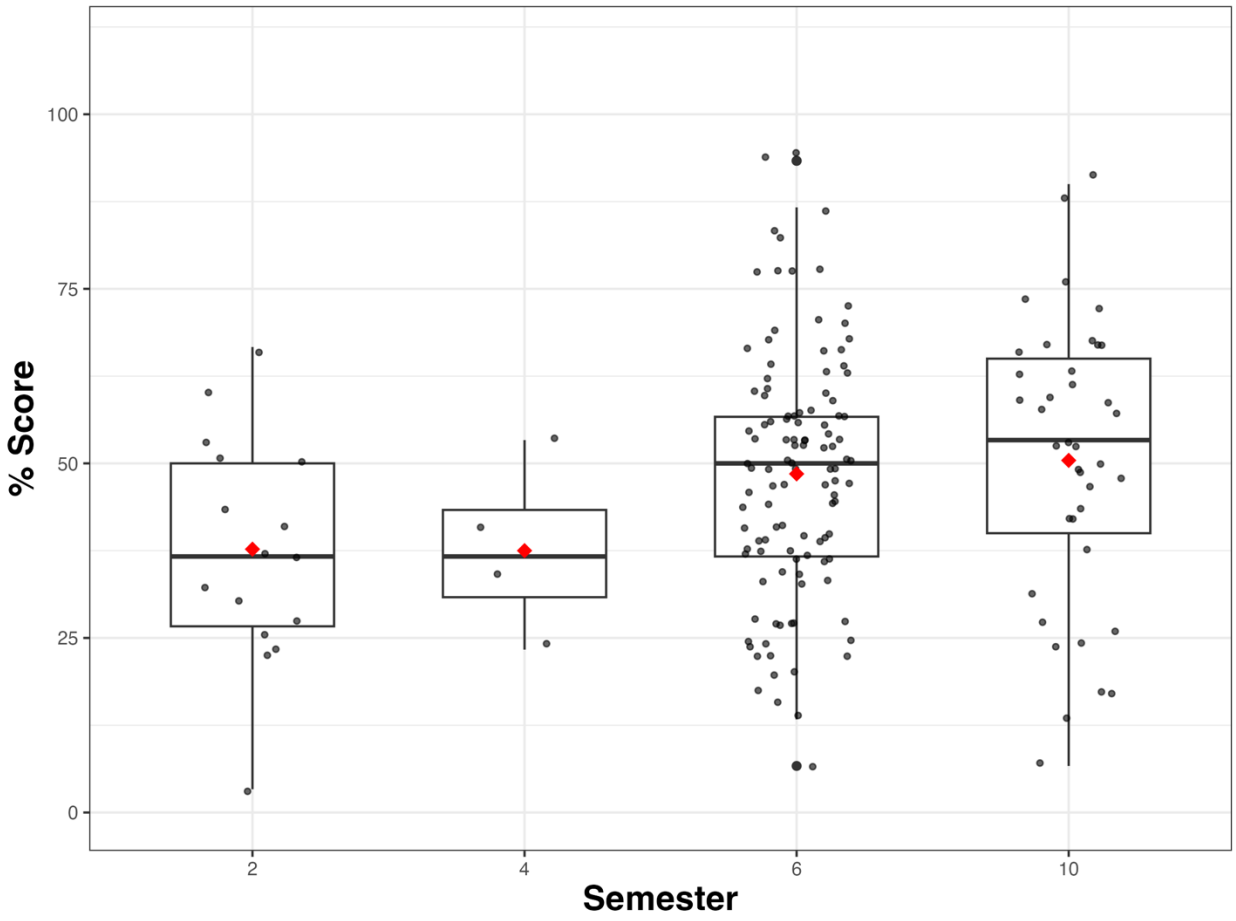
Description of Data: This file contains the full results of Tukey's HSD test done based on the results from Additional file 4.

Comparison	diff	lwr	upr	p adj
US_Grad-Ecu_Med_School	37.70888	23.31531	52.10245	< 0.0001
US_Med_School-Ecu_Med_School	25.94803	17.56377	34.33229	< 0.0001
US_Undergrad-Ecu_Med_School	32.70971	27.80113	37.61828	< 0.0001
US_Med_School-US_Grad	-11.7609	-27.6574	4.135683	0.226
US_Undergrad-US_Grad	-4.99917	-19.3692	9.37087	0.8061
US_Undergrad-US_Med_School	6.76168	-1.58212	15.10548	0.1579

File Name: Additional file 9

Title of Data: "Box Plot of Ecuadorian Medical School Student's GLAI Scores by Semester"

Description of Data: The y-axis shows % correct on the GLAI, an assessment of basic genetics knowledge. Groups are divided by semester including second (2; n=16), fourth (4; n=4), sixth (6; n=113), and tenth (10; n=39). Total of complete cases for this graph n=172. Each black dot is one student score, boxes show quartiles, and whiskers represent the data range within 1.5 times the interquartile range from the first and third quartiles, with points beyond this range shown as outliers. The red symbols represent group means.


100
75
50
25
0
% Score
2
4
6
10
Semester

File Name: Additional file 10

Title of Data: "GLAI Anova Results by Semester for Ecuadorian Samples"

Description of Data: This file contains the full results of the Anova test done between each semester group for the Ecuadorian samples based on their GLAI test scores.

Term	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Year	3	2375.003	791.6678	2.43961	0.0662
Residuals	168	54516.99	324.5059		

File Name: Additional file 11

Title of Data: "GLAI Anova Results by Semester/Year for US Samples"

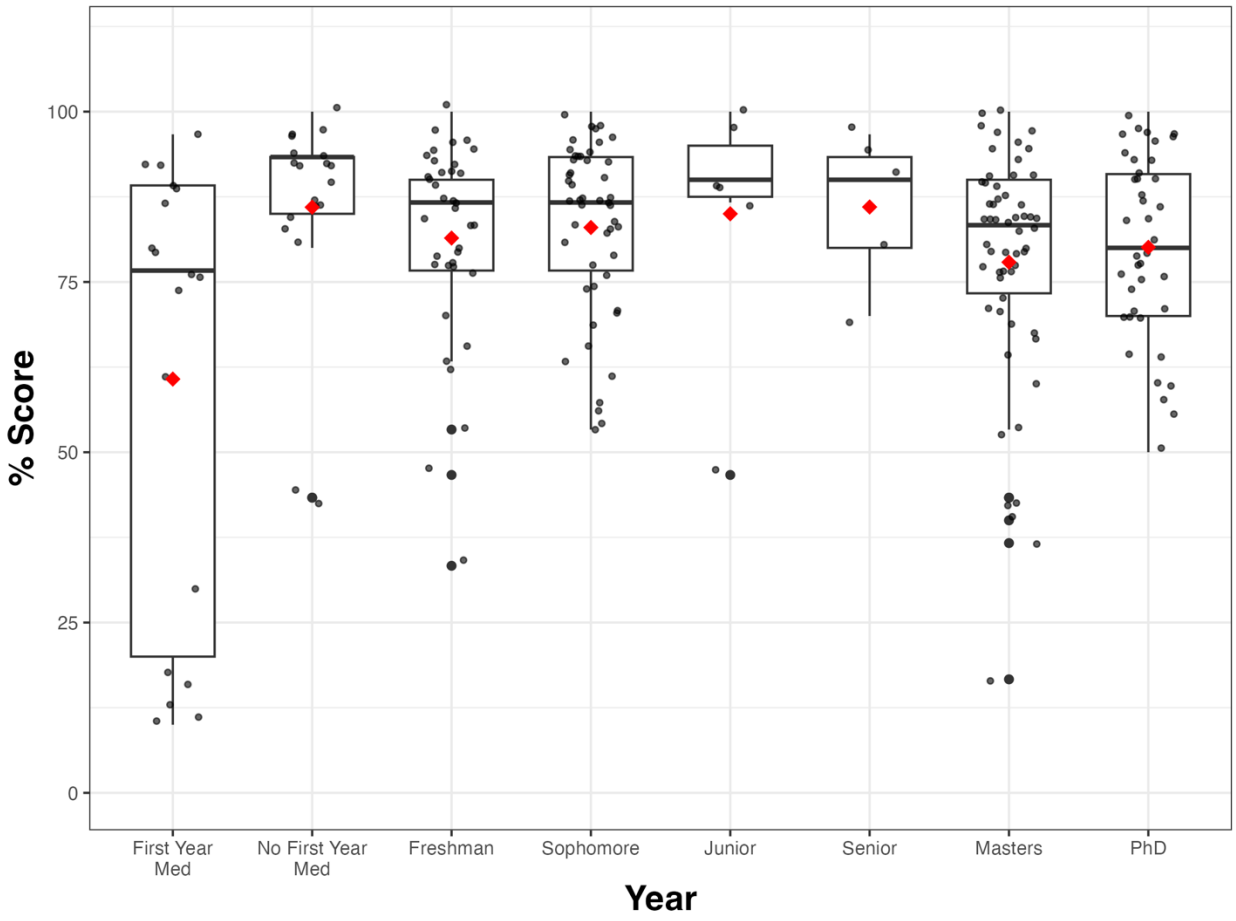
Description of Data: This file contains the full results of the Anova test done between each semester group for the US samples based on their GLAI test scores. The plots show the medical, graduate and undergraduate students separated into semester, year, or degree seeking.

Term	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Year	7	8416.29	1202.327	4.117602	0.0003
Residuals	223	65115.31	291.9969		

File Name: Additional file 12

Title of Data: "Box Plot of US Medical, Undergraduate, and Graduate Student's GLAI Scores by Semester"

Description of Data: This figure contains box plot showing the scores from the US medical, undergraduate, and graduate school students separated by semester. The scores are in percentage.


% Score
100
75
50
25
0
First Year Med
No First Year Med
Freshman
Sophomore
Junior
Senior
Masters
PhD
Year

File Name: Additional file 13

Title of Data: "GLAI Tukey Results by Semester for US Data"

Description of Data: This file contains the full results of Tukey's HSD test done based on the results from Additional file 8.

Comparison	diff	lwr	upr	p adj
Junior-First Year Med	22.25246	7.841061	36.66385	0.0001
No First Year Med-First Year Med	25.22417	8.025665	42.42268	0.0003
Freshman-First Year Med	20.7007	5.67457	35.72683	0.0009
Sophomore-First Year Med	19.34259	4.502019	34.18317	0.0023
Senior-First Year Med	17.154	3.016911	31.29108	0.0062

File Name: Additional file 14

Title of Data: "Wilcox Test Between Knowledge and Skill Questions"

Description of Data: This file contains the full results of the Wilcox test comparing the knowledge and skills attitudinal questions.

Variable	n	W	p_value
Knowledge Questions	236	6508.5	< 0.0001
Skills Questions	224	4309	0.0564