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Mystery Mutt: DNA Analysis With a Dog Named Charlie

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TLED 552 Developing Instructional Strategies

for Middle School Math and Science

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Abstract

This article provides an in-depth exploration of the design, execution, and outcomes of the "Mystery Mutt: DNA analysis with a dog named Charlie" lesson. Designed for seventh-grade life science students, the lesson focuses on unraveling the correlation between genotype and phenotype using authentic pet DNA test results. Grounded in real-life experiences and employing a multi-dimensional approach, the lesson successfully bridges the gap between theoretical genetic concepts and practical applications. The article discusses the lesson's alignment with academic standards, consideration of materials and safety, its unique classroom context, and the engaging phases of exploration, explanation, elaboration, evaluation, and closure. The emphasis on differentiation, professional learning, and supplementary materials underscores the lesson's adaptability and its lasting impact on students' understanding of complex genetic principles. This reflective exploration serves as a testament to the efficacy of innovative teaching strategies in making scientific concepts accessible and meaningful for diverse student populations.

Mystery Mutt: DNA analysis with a dog named Charlie

Introduction

Genetics, an intricate and integral component of life science education, often poses challenges for students due to its abstract nature. This genetics lesson plan was designed to address deficiencies in students' understanding of genotype-phenotype relationships. By grounding the lesson in authentic experiences, incorporating digital technology, and fostering hands-on activities, the aim is to bridge the gap between theoretical genetic concepts and practical applications, creating a more profound comprehension among students. The original creator of the lesson, Michelle Dashiell, designed the lesson out of an authentic experience of having her own pet dog, Charlie's, DNA tested. She found the report would make an interesting jumping point for a genetics lesson for her seventh grade life science class. This lesson has been adapted from her original lesson.

Concept Statement

The central concept of the lesson revolves around interpreting DNA test results to predict the physical traits of an organism – in this case, a mystery mutt named Charlie, the pet of the original lesson creator, Michelle Dashiell. The utilization of authentic pet DNA reports serves as a bridge between abstract genetic concepts and tangible outcomes. This approach aims to foster a context-rich environment that enhances students' comprehension of genotype-phenotype correlations, providing a solid

foundation for future genetic explorations. This lesson follows the five levels of design theory, (1) knowledge comprehension, (2) application, (3) analysis, (4) synthesis, and (5) evaluation (Li, 2019), but in a nonstandard order. By working backwards from the DNA makeup to find out what kind of dog we Charlie is, we are challenging the students to reverse their typical way of thinking.

Lesson Concept

The lesson objectives are designed to empower students to interpret DNA test data, apply percentage knowledge to predict breed makeup, and illustrate their predictions artistically. This multifaceted approach encourages students to synthesize genetic information, fostering a comprehensive understanding of the material. The emphasis on both theoretical understanding and practical application aligns with the broader goals of science education.

Alignment with Academic Standards

The lesson aligns seamlessly with Virginia Standards of Learning (SOL) objectives, particularly focusing on the role of DNA in determining organism traits. By addressing deficiencies highlighted in the spring 2023 Science SOL results, the lesson strategically targets core genetic principles. This alignment ensures that the lesson not only engages students but also meets the specific academic standard:

LS.10 The student will investigate and understand that organisms reproduce and transmit genetic information to new generations. Key ideas include:

a. DNA has a role in making proteins that determine organism traits

Materials and Safety Considerations

Careful consideration has been given to the selection of materials to ensure a blend of authenticity and safety. An authentic pet DNA report, Chromebooks for online research, and art supplies create a dynamic learning environment that caters to diverse learning styles. Digital safety measures, including a prior online safety lesson, mitigate potential risks associated with online research, ensuring a secure and controlled digital research environment.

Depending on the ability levels of your students, this lesson may take one or two 50 minute sessions.

Classroom Context

The genesis of the lesson from a real-life scenario, involving a fellow teacher's mystery mutt, creates a unique and enriching classroom context. Charlie's story, grounded in authenticity, establishes a tangible link between genetic concepts and students' everyday experiences. The lesson serves as a response to identified deficiencies in

genetics understanding, providing a relevant and engaging platform for exploration. This contextualization ensures that the lesson is not just an academic exercise but a meaningful journey for students.

Engagement

The engagement phase is strategically designed to tap into students' personal experiences with pets. The teacher will begin by asking about pets that the students may have at home. As any teacher knows, students love to talk about their pets. Probing questions about their own pets set a positive tone, fostering a connection between theoretical genetic concepts and students' lived experiences. The teacher then tells the students about a dog named Charlie, a mutt puppy whose lineage is unknown. The teacher tells the students that a DNA test has been performed to find out Charlie's genetic makeup, and which breeds makeup Charlie's lineage. The catch is that the teacher does not reveal what Charlie looks like. The relatability of the topic establishes a foundation for meaningful exploration, ensuring that students are emotionally invested in the learning process.

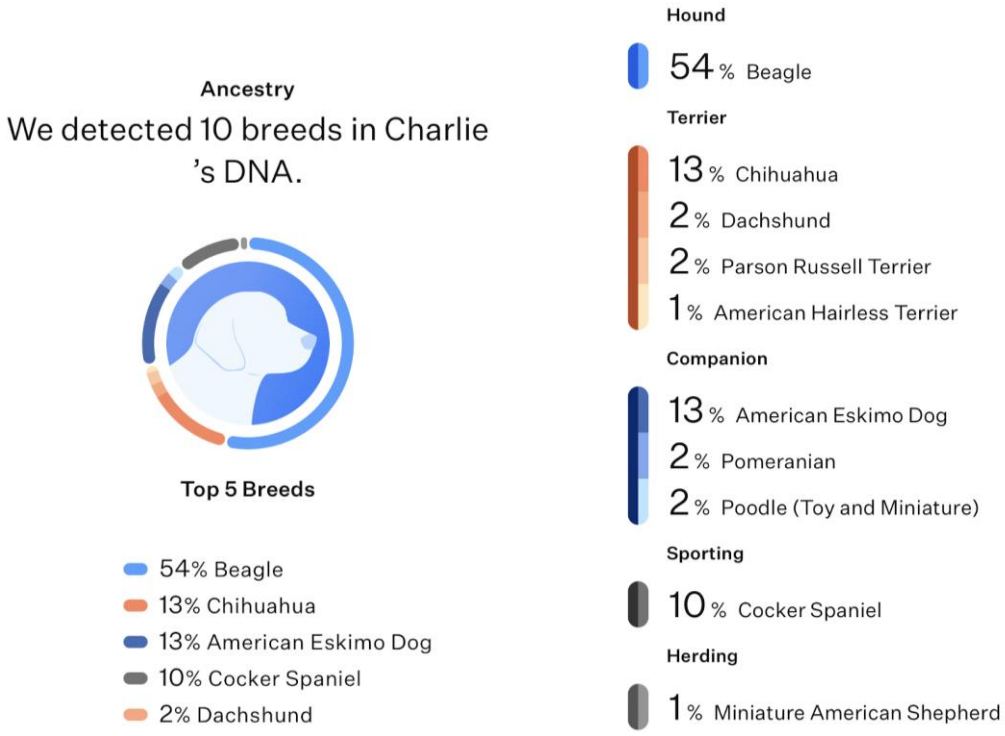
"Today, we are going to meet a very special mutt dog named Charlie. Only thing is, Charlie's owners did not know what type of dog he is. They know he is cute, and sweet, and fluffy, but they wanted to know how big Charlie might get, or if he might be predisposed to any types of diseases or health issues associated with certain breeds.

Charlie is a very special mutt. So special, that his family had a test done on Charlie to find out more about his dog family."

Exploration

The exploration phase unfolds through collaborative group activities, where students delve into DNA test results and conduct in-depth research on the dog breeds that appeared on Charlie's result report. The students are shown the DNA results report, including the percentage of breed breakdown. They then use their Chromebooks to research each of the listed breeds to find their main phenotypic traits. Using the percentages, they begin to form a guess as to what traits Charlie might exhibit. The groups then create drawings based on their findings of what they believe Charlie might look like. Be sure to point out that students may want to add more features from the breeds representing higher percentage matches in the report. Some students who were not strong artists utilized online videos with instructions for how to draw dogs. The teacher can model parts of the drawing on the classroom display- SMART board or Boxlight- drawing directly on the board or using a graphics tablet. The integration of technology enhances the exploration, providing students with a contemporary and interactive learning experience. By giving the students the freedom to research on their own, with minimal restriction, and allowing them the creativity to design their versions of the mystery pup we are using excellent project based learning practices. According to N. Santamaria-Cardaba (2019), "actively participating in the construction of

knowledge" rather than just listening to lectures can have a profound impact on student learning (p. 467–476). Observations of animated discussions and the eagerness to uncover Charlie's potential appearance highlight genuine interest, transforming the lesson into an active and participatory experience.



Explanation

As groups present their drawings, the explanation phase becomes a pivotal moment for articulating genetic principles. Discussions on commonalities, outliers, and an introduction to dominant and recessive genes deepen students' understanding. The

teacher-led discussion fosters an environment of collaborative learning, where students verbalize their thoughts and glean insights from their peers. This phase not only solidifies theoretical concepts but also encourages critical thinking and scientific discourse. English learner students may need assistance in the discussion part of this lesson. If you are able, you could ask for the student to provide a photo of any family pets they may have prior to this lesson, so that they have an image to share even if they are unable to come up with the English words. By connecting with our English learning students and helping them become part of classroom conversation we are implementing culturally sustaining pedagogy as part of this lesson (Jeong, 2021).

Elaboration

The elaboration phase seamlessly integrates technology, with groups capturing photos of their drawings using Chromebooks. This modern twist not only meets students at their comfort level but also sets the stage for the subsequent evaluation phase. The integration of technology adds a layer of sophistication to the learning process, preparing students for a technologically advanced academic landscape.

Evaluation

The evaluation phase unfolds with the comparison of student drawings to real photos of Charlie. This critical analysis prompts reflection and reinforces the connection between genotype and phenotype. The moment of revelation, as the real Charlie is unveiled, brings about a collective sense of accomplishment and understanding among the students. This phase not only assesses students' comprehension but also celebrates their achievements, fostering a positive and rewarding learning experience.

“Look how close your drawing looks to the real Charlie.” “Isn’t it amazing how much you were able to determine just by knowing the genetic makeup of this mystery mutt?”

Closure

The closure phase provides a thoughtful reflection on the broader implications of genetic knowledge. By relating the lesson back to students' personal pets, discussions on the usefulness of DNA testing prompt insightful reflections. The emphasis on practical applications for understanding and caring for pets elevates the closure, leaving students with a lasting appreciation for the relevance of genetics. This phase ensures that students leave the lesson with a sense of closure and a clear understanding of the broader significance of the genetic concepts explored.

"Would you like to have your own pet's DNA tested?"How would your pet's genetics report be useful to you and your family?"

Differentiation

The lesson's adaptability is showcased through differentiation strategies. Small group activities cater to diverse learning styles, allowing students to excel based on their strengths. Cultural differentiation is seamlessly integrated by tapping into students' experiences with various family pets, fostering a sense of inclusivity within the classroom. This emphasis on differentiation ensures that the lesson is accessible and beneficial for all students, regardless of their learning styles or backgrounds. If you have English Learner students, you may want to research the breed names in the student's native language, as breeds can be called by different names in different geographical regions and across cultures. Taking this extra step of viewing diverse cultures and languages as an asset for learning is important as part of culturally responsive teaching (Barrett-Zahn, 2021).

Professional Learning

This lesson works well in an in-person setting, especially if students are working in pairs or small groups. The assignment could be modified for long distance online learning by

having the students complete their drawing at home and submitting a photograph, or by having the students draw their versions of Charlie in a digital art application then submitting their drawing and any research requirements online. The lesson is easily adaptable and can be differentiated before posting online for students. When teaching this lesson through distance learning, a graphics tablet can be helpful for the teacher to model any of the drawing portions of the assignment.

Because the sharing portion of the lesson had such a positive impact on the students, I recommend adding a discussion portion where students can tell their peers all about their own pets and their backgrounds. Allowing students to upload photos of their pets would elevate the lesson.

S**upplementary Materials**

Supplementary materials, including images of DNA test results and photos of Charlie, serve as valuable visual aids. The inclusion of photos of drawings from Michelle Dashiell's original lesson provides additional context and inspiration, enriching the overall learning experience. These supplementary materials serve as a repository of visual information reinforcing key concepts. These images were pulled, with permission, from the original slideshow presentation created by Michelle Dashiell. The images of student artifacts were photographed by the author.

Conclusion

In conclusion, the "Mystery Mutt: DNA analysis with a dog named Charlie" lesson exemplifies a successful pedagogical approach to teaching genetics. By intertwining authentic experiences, technology integration, and hands-on activities, the lesson effectively addresses deficiencies in understanding genotype-phenotype relationships. Students were guided through the five E's to collectively contribute to a holistic learning experience. This lesson highlights the efficacy of innovative teaching strategies in making complex genetic concepts accessible and meaningful for students by touching on a subject that is universally interesting and fun. The students enjoy each aspect of the lesson, from the thrill of solving a mystery, to a chance to use their art skills, to the task of being able to talk and collaborate with their peers. It emphasizes the importance of context, engagement, and reflection in creating a transformative educational experience that extends beyond the confines of the classroom.

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