The Effect of Discovery Learning through Biotechnology on the Knowledge and Awareness of Type 2 Diabetes and its Genetics Affects on Lower Income Students in a Rural Community

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Abstract
The purpose of this proposal was to assess the effect of discovery learning through biotechnology on the knowledge and awareness of type 2 diabetes and its genetics affects on low income students in a rural community. New research has indicated there is a type 2 diabetes known as MODY that might be associated with heredity. Through the use of various genetic lab techniques, having students research articles from the NCBI website, and teaching students the main principle of genetics and how inheritance works, the final assessment included students formulating their own opinion on diabetes and genetics. Students used their knowledge to persuade their audience of their own belief on the science behind the integration of diabetes and genetics with the majority of students finding MODY to be influenced by environmental and genetic factors.

Rationale
Baker County High School is the only high school in very rural Baker County. Students attending the high school come from about a seventy mile radius including students coming from rural South Georgia. The majority of students live in a family house (a house that has been owned by the family for centuries) and their parents' main income is through their farmland. Similar to any rural area, there is a small population of students whose parents commute into neighboring Jacksonville and hold jobs as lawyers, businessmen, entrepreneurs, etc. The majority of the students who enter my classroom are of the lower economic bracket and these are the students who will be addressed in this research proposal.

In 2005, the Baker County Health Department released an article about the chronic health problems in Baker County and how it related to the rest of the counties throughout Florida. Baker County ranked in as:

- 1st for obstructive pulmonary disease
- 2nd for diabetes mellitus
- 3rd for cardiovascular disease
- 4th for stroke
- 10th for heart disease

Although many other diseases were listed on the health department's website, these main five can be attributed to high blood pressure and high cholesterol all stemming from obesity (Baker County Health Dept, 2002). In 2005, there were ninety million Americans that suffered from a chronic disease and nearly 70% resulted in death. In 1990, $655 billion were spent in medical expenditures to treat these chronic diseases. In 2010, the cost of treatment is at $1 trillion (Baker County Health Dept, 2011). Working in a county that has such high rates of chronic disease and working with low income students who are the most susceptible to these diseases, it is important for the students to have a growing knowledge on diabetes and how it can be controlled.

In 1999, the American Diabetes Association opened their newsletter stating, "this article considers the epidemiologic evidence of an ***increasing incidence of type 2 diabetes in youth***, the classification and diagnostic issues related to diabetes in young populations, pathophysiologic mechanisms relevant to the increasing incidence, the role of genetics and environment, and the community challenge for prevention and treatment" (Rosenbloom, 1999). The article continued

on that type 2 diabetes had reached a height in our youth due to our youth not facing the facts of diabetes and the treatments for the disease. The ADA placed a majority of blame on the education system and students not being taught the necessary precautions for prevention and treatment.

In 2003, the first survey was released in the United Kingdom relating to the idea of a "new" type of diabetes known as MODY – maturity onset diabetes of the young (Barrett, 2003). The purpose of their research was to find out if MODY (considered a type 2 diabetes) was more closely related to genetics or environmental factors. Since the work with MODY is still continuing, this is the main focus of the proposal. At this point in scientific research, it is known that type 1 diabetes is a genetic disease. Therefore, we can use our knowledge of type 1 diabetes, our understanding of its pathogenesis and affects, as a premise for relating MODY more closely to type 1 or type 2 (Atkinson, 2001).

Students engaged in various activities related to diabetes and genetics culminating in the students formulating their own hypothesis as to whether there is a genetic basis to type 2 diabetes or if it is purely environmental. Based on the collected data from student's attitude and knowledge of material, knowledge was retained better with the additional lab content then with the textbook information alone. Students generally had more interest in learning when they could interact with the material.

Action research intervention

In order to understand diabetes and how it relates to genetics, there are essentially two separate entities that need to be addressed. The students that were addressed throughout this proposal are students who have come face-to-face with diabetes, either a family member has it or they, themselves, have it. These are my lower income students from the rural community. For the purpose of this proposal, instruction began with understanding the foundation of genetics. Inheritance bingo, the textbook, concept maps, and supplemental activities with Punnett Squares, served as the preliminary activities for teaching students the premise of genetics. Students were assessed with a "typical" unit exam on the material resulting in a 73% proficiency of the material. After students had a grasp on what genetics is and that almost everything has some mode of heredity, we then indulged in diabetes. The textbook, minilabs, and a full lab determining the modes of inheritance for a strain of diabetes, guided the students to a greater knowledge on diabetes. Students were instructed to keep lab notebooks in which they documented all their findings. The last seven minutes of each class period, students wrote reflections on the class period as far as what they enjoyed, what they were confused about, and what they learned. This information allowed me to assess the students' attitudes toward the lab and their further understanding of the material. Finally, we combined genetics and diabetes. This combination resulted in the students looking through the NCBI website to formulate their own hypothesis as to whether there is a genetic basis for MODY which is considered to be type 2 diabetes, or if it is strictly based on environmental factors. Students reviewed each others materials, critiquing their resources and providing opposing views to aid in students creating presentations that directly reflected their knowledge on the material. Students created a document persuading their audience to see their points of view. From the learning and understanding of basic genetics, then incorporating diabetes, to the integration of the two, this intervention took six weeks to complete. This intervention began the last two weeks of

December prior to winter break and resumed at the start of the new semester, culminating the Thursday prior to the symposium. I teach six classes of regular Biology, including two classes of alternative students, a class of students who did not have a high enough GPA to enter directly into the health academy, and two E.S.E. classes. I used this intervention in all my classes with my primary focus being on my students who are interested in eventually being a part of the health academy. Four of the girls in my health academy related class attended the symposium with me, presenting their findings to other students from across the state of Florida. *[Attached is the lesson plan with more in depth activities that was implemented in the classroom.]*

Connections to Bench to Bedside summer institute
Listed below are the specific items I used that were provided through Bench to Bedside:

- Inheritance bingo
  - A bingo game that can be used for students to see common genetic traits.
- Pipetting by design
  - A lab used to get students acquainted with the pipet.
- What you should know about diabetes
  - A lab used for understanding the differences in type 1 and type 2 diabetes.
- Determining modes of inheritance for a strain of diabetes
  - A lab used to trace a strain of diabetes (will be made similar to the B2B lab project).
- NCBI website
  - Students will use this website in order to find research articles to build their final paper in order to persuade their audience as to whether type 2 diabetes has a genetic basis.

Data collection and analysis
With the genetics portion prior to the lab, the data collection included:

- A pre-test in which students were provided a ten question quiz on genetics. Five questions related to content and five questions were linked to their attitude on the subject matter. Students were later given the same assignment as a post-test. The assessment is attached.
- Assignments
  - Vocabulary assignments including Frayer models, word walls, games with the student response system (on clickers), and concept maps.
  - Punnett square assignments in which students were provided word problems and had to find the genotypes and phenotypes of the first filial generations. Punnett square assessment is attached.
- Quiz
  - Pre-test average on content: 60%
  - Post-test average on content: 100%
  - Pre-test average on attitude: most students were interested in understanding genetics and felt like they knew a majority of information relating to genetics and heredity

    - Post-test average on attitude: for the most part the numbers stayed the same; in the blank at the bottom where I allowed the students to write freely, most of them expressed how much they had learned. The most meaningful to me was one of my seniors wrote, “Heading to FSU in 8 months and I never realized how unprepared I would be until now. I would be really embarrassed had I walked into college without the knowledge of a pipette. Thank you for taking the time to teach us simple lab techniques. I feel like that was the best part of it all.”
    - Vocabulary: 85%
    - Punnett squares: 77%

With the lab portion, the data collection included:

- Lab notebooks
    - Students kept notebooks in which they provided a reflection on what they enjoyed, what they were confused about, and what they learned. Students were graded for completeness of this assignment and I used these reflections to help in guiding my instruction in the lab.
- Assignments
    - Everyday in lab there were assignments the students had to complete to keep them on track with the lab. There were charts and graphs that had to be completed, as well as questions that had to be answered. One of the assessments is attached. Assignments were checked for completion and accuracy and the average for the lab packets was a 91%.

After the textbook information and the lab portion, students took a final post-test, as well as, wrote a final paper and presentation. Students were assessed in three categories:

- Use of outside resources
    - Students had a rubric for their paper. Part of their rubric included a bibliography of five different articles from the NCBI website. Most students incorporated additional information from other websites in which they had to have approved by a classmate prior to them being allowed to use it in their final paper.
- Writing
    - Part of the rubric instructed the paper to be a minimum of four pages, double-spaced, and students were provided three days to write the paper at school the rest of the work had to be completed at home. Students used their resources to complete the writing assignment. The rubric ensured that students stay on topic, pick a side (whether they find MODY to be a type 2 diabetes or type 1 diabetes), and support their idea with material from the labs, textbook, and outside resources.
- Oral presentation/project
    - Based on the writing portion of their final project, students will create a presentation. Instead of reading their papers to the class, students will design a presentation in which they persuade their audience to see their point of view. The audience (their fellow class members) will have rubrics. The students will grade each other on the presenter’s persuasion and overall presentation.

Throughout this process, I also had significant input from other teachers and administrators through classroom observations. I used this information a great deal to serve as unbiased data collection since someone else's views on the activities being performed in my class definitely helped me to improve my classroom.

Literature cited

Atkinson, Mark, and George Eisenbarth. "Type 1 Diabetes: New Perspectives on Disease Pathogenesis and Treatment." *Science Direct*. U of Florida, 21 July 2001. Web. 14 July 2011. <http://www.sciencedirect.com/science/article/pii/S0140673601054150>.

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Budget and budget justification

Pipetting by design and what you should know about diabetes are two labs I used from Bench to Bedside. These labs were provided in an equipment locker for my class. I also created a lab that is similar to part 1 from the B2B lab project where the students determined modes of inheritance for a strain of diabetes. I used the same lab protocol but changed the "gatorbait myslexia" to a type 1 diabetes strain in a family in which several members did not have type 1 but eventually were diagnosed with type 2. This lab required additional money in which I used some of the mini grant money. For the class I was gearing this intervention for, I also used the mini grant money to buy them lab notebooks. After the students completed their research and wrote their final articles, I selected four girls to accompany me to the symposium in which they presented their papers and findings. I covered the cost of the transportation to the University of Florida and JSEHS provided a scholarship for my girls' hotel room.

Permissions

Four girls came with me to the University of Florida to present their papers at the symposium in February. I needed permission from the principal and their parents in order for them to attend the symposium. The remaining activities were things that we normally could do in the classroom, therefore no other permissions were necessary.

Modifications from original proposal

The only modifications I made from my original proposal are the amount of data I collected. I had hopes of collecting data on everything I could possibly collect data on, but I had such a time crunch and there is such a demand with Biology I End of Course Exam that I really wasn't able to assess as much as I was hoping. I think I collected the best data I could to get the best information necessary, but I definitely would have liked to get more information as far as the student's attitude including insight from the parents.

Learning from your Action Research

Working at Baker County High School opened my eyes to the lack of knowledge and experience many of the students had. As I began the intervention, I thought I would have to tweak things in order to engage the students. Surprisingly, everything I had originally laid out was exactly what my students needed. The number of times I heard my students say, "Ms. Riggs, I'm giving up sweet tea this week just because of you," was enough to make me realize there is some effect working on each student. If I were to do this again, I would definitely like to bring in guest speakers from the health department who could speak to the students about the severity of the choices they make relating to their diets. I believe having another person to complement my work will definitely open their eyes to how much our environment affects our decisions. From this process, I learned that an intervention takes a lot of time but the time put into the research provides a wonderful outcome for my students. Having done this once, I know what I need to do differently to make this even more successful next year. Just taking the time to create a foundation for the research, allows for tweaking over the next few years, and continual repetition for the years to come.

Dissemination

I have not yet disseminated any information gained during Bench 2 Bedside or through my action research proposal. With the FCAT coming up and the growing number of End of Course Exams, the principal has yet to find time. I was contacted by the Baker County Press and did have a full page article published about the work that my students and I did culminating in the symposium at the University of Florida. I am working with the Vice Superintendent for a date in mid-May to gather all science teachers from the middle school and high school in Baker County and address what I have learned, what I have done, and what I plan to change. I have spoken with a colleague about my experiences at the University of Florida this summer and have even gotten her to apply for ICORE. I want everyone to hear my story. I want all of Baker County to see that these children can grow, develop, and think for themselves, but sometimes it is finding the right person, the right technique, and the right enthusiasm to drive these students to success. Anything that I can do to share my passion and interest with those who are struggling in rural areas where the is no diversity, no thrill for education, and seems to be little motivation and drive by the students and their parents, I want them to know that I did it successfully, and therefore they, too, can do it!

LESSON PLAN

The Effect of Discovery Learning through Biotechnology on the Knowledge and Awareness of Type 2 Diabetes and its Genetics Affects on Lower Income Students in a Rural Community

Key question: Is there a genetic basis to MODY being linked as type 2 diabetes?

Science subject: Biology

Grade and ability level: 9-12th graders; a regular class including mainly retained and ESE students

Science concepts: Diabetes and genetics; genetics will include Punnett Squares, vocabulary, and heredity of traits

Overall time estimate: 6 weeks

Learning styles: Due to many of my students being low level and ESE students, I try to incorporate every type of learning style in every lesson plan I create.

Vocabulary: Allele, crossing over, diploid, dominant, egg, fertilization, gamete, genetic recombination, genetics, genotype, haploid, heredity, heterozygous, homologous chromosome, homozygous, hybrid, law of independent assortment, law of segregation, meiosis, nondisjunction, phenotype, pollination, recessive, sexual reproduction, sperm, trait, zygote, fructose, glucagon, glucose, glycemic index, hypoglycemia, hyperglycemia, insulin, insulin analog, insulin resistance, lactose, sucrose

Lesson summary: This lesson covered the integration of diabetes and genetics. Students explored genetics through labs, inheritance bingos, notes, and concept maps. Students explored diabetes through labs, concept maps, and researching articles. At the conclusion of the lesson, students were able to formulate their own idea as to whether there is a hereditary basis to MODY.

Objective: By the completion of this intervention, students had enough knowledge and competency relating diabetes and genetics that they were able to formulate their own hypothesis on where they stand and create a sound argument.

Materials/Resources:

- Inheritance bingo board
- Concept map (located on bulletin board)
- Pipetting by design activity
- What you should know about diabetes activity
- Textbook
- Computers to access NCBI
- Modes of inheritance lab
- Supplemental Punnett Square worksheets

Teacher preparation: I needed to prepare labs accordingly making sure that all materials are available for the specific date needed. I also spent teacher planning week creating a concept map on the bulletin board in my room so that students can use that board as a template and we can continually change the board around to relate it to the topic being covered.

Introduction: Connections are made to the material based on family history and the student's personalization with the disease. Students have minimal knowledge on the topic since this was their first in depth encounter with genetics. I completed daily assessments through journals, observations, quizzes, and other assignments that I used to immediately clear any misconceptions on the topic.

Exploration/Application: Over a six week course of time, we covered:

- Inheritance Bingo
- Concept map for genetics and diabetes vocabulary
- Punnett Squares
- Pipetting by design activity
- What you should know about diabetes activity
- Finding articles through NCBI
- Lab determining modes of inheritance for a strain of diabetes
- Final research paper persuading audience of point of view

Each activity involved either an assignment or notes. Through grading their assignments, observations, quizzes, and journals, students assessed every day to ensure there are no misconceptions in the material being covered.

Assessments: For the genetics portion, assessments will include:

- Assignments (mainly Punnett Squares)
- Concept maps
- Quizzes (on vocabulary and Punnett Squares)
- Notebooks/journals (keeping notes and assignments)

For the diabetes portion, assessments will include:

- Likert survey
- Assignments (labs and research)
- Concept map
- Use of outside resources for research
- Quizzes on vocabulary
- Writing of final research proposal
- Oral presentation/project for research proposal

Self-reflection:

I think the assessments definitely reflected what they were learning and what they knew. It is important that I bring in a guest speaker and have other vital information for supporting their students in their knowledge and growth of genetics.

PRETEST: GENETICS

1. Different forms of a gene are called

    a. Hybrids
    b. Dominant factors
    c. Alleles
    d. Recessive factors

2. Organisms that have two identical alleles for a particular traits are said to be

    a. Hybrid
    b. Heterozygous
    c. Homozygous
    d. Dominant

3. A Punnett square is used to determine the

    a. Probable outcome of a cross
    b. Actual outcome of a cross
    c. Result of incomplete dominance
    d. Result of meiosis

4. The physical characteristics of an organism are called its

    a. Genetics
    b. Heredity
    c. Phenotype
    d. Genotype

5. A situation in which a gene has more than two alleles is known as

    a. Complete dominance
    b. Codominance
    c. Polygenic dominance
    d. Multiple alleles

Use a 1 – 5 scale for answering the following questions. A 1 for strongly disagree and 5 for strongly agree.

6. I don't need to know anything more about genetics except that I am what I am because of my parents. _____

7. I am excited about finally getting into lab and learning lab techniques. _____

8. Genetics seems intense with vocabulary. _____

9. I have seen a majority of this information before, so I'm not too nervous. _____

10. I hate math and Punnett squares deal with probability so I'll probably hate genetics. _____

11. You have seen the rubric and what is expected of you over the course of the next six weeks. In the space below, list anything that makes you nervous, that you are excited about, or that you hope to learn.

Punnett Square Exam

1. In pea plants, tall (T) plants are dominant over short (t) plants. Complete the following crosses and give the genotypic and phenotypic ratios of offspring.

a. TT x tt

b. Tt x tt

c. Tt x Tt

2. In pea plants, purple flowers (P) are dominant over white (p) flowers. Complete the following crosses and give the genotypic and phenotypic ratios of offspring.

a. A heterozygous purple plant is crossed with a homozygous purple plant.

b. A cross between two pea plants produces offspring in which approximately 50% of the flowers are white and 50% are purple. What are the genotypes of the parents? Show punnett square to support your answer.

c. A cross between two purple pea plants yields approximately 25% of the offspring exhibiting white flowers. What are the genotypes of the parents? Show punnett square to support your answer.

3. A widow's peak in humans is determined by a dominant/recessive inheritance. A person who is purebred for widow's peak is crossed with a person who is purebred for no widow's peak. All of the offspring have a widow's peak. Which trait is dominant and which is recessive? Show punnett square to support your answer.

4. In guinea pigs, black fur is dominant. If a black guinea pig is crossed with a white guinea pig and the litter contains a white offspring, the genotype of the black-haired parent is probably? Show punnett square to support your answer.

5. In minks, brown is dominant over silver-blue color.

a. What offspring would you predict if you crossed a homozygous brown mink with a silver-blue mink? Show punnett square to support your answer.

b. What would the genotypic and phenotypic ratios of two F2 generation mink from the above problem be if they were crossed? Show punnett square to support your answer.

Diagnosing Diabetes – Lab Assignment

Part 1

1. Place each picture with the correct description. Raise your hand once completed so I can check your work before you move on.

2. Once your pictures and descriptions have been paired correctly, answer the following questions.
    a. What is insulin? What does it do in your body?

    b. What do the insulin receptor molecules on the cells in your body do?

    c. List two similarities between type 1 and type 2 diabetes.

    d. List two differences between type 1 and type 2 diabetes.

    e. What health problems may result if a patient's diabetes is not properly treated to maintain normal blood glucose levels?

Part 2

To prepare for the glucose tolerance test, your patient fasted for 12 hours. To begin the test she drank a solution that contained a measured amount of glucose. Blood samples were collected immediately before she drank the glucose solution and every half hour after she drank the glucose solution. The blood sample was centrifuged to separate it into blood cells and blood plasma. You will test the concentration of glucose in the patient's blood plasma to determine if she has diabetes.

1. Your lab kit has 5 samples of the patient's blood plasma that were collected at various time intervals during the patient's glucose tolerance test.

2. Use Column 1 on the "Glucose Tolerance Testing Sheet." Place 1 drop of the appropriate plasma samples to be tested in the appropriate circles in Column 1. Save the samples of patient blood plasma for use in Part 3.
3. Place a strip of glucose test paper into each of the circles in Column 1 of the "Glucose Tolerance Testing Sheet" that contain the plasma samples that you are testing.

Immediately compare the color of the test paper with the color on the Glucose Test Paper Color Chart. Record the results of the glucose tests in Table 1 below.

TABLE 1

Time of Blood Collection Minutes after Drinking Glucose Solution	Glucose Level in Blood (mg/dl)
0 (after fasting)	
30	
60	
90	
120	

5. Answer the following questions:

a. Explain why the blood glucose level for the healthy person was low at the beginning of the glucose tolerance test.

b. Explain why the blood glucose level for the healthy person rises after drinking the glucose solution.

c. Explain what causes the healthy person's blood glucose levels to decrease after 30 minutes.

d. Explain what might cause the patient's blood glucose levels to remain high after 30 minutes.

e. Based on the information in this graph, do you think the patient has diabetes? Support your answer with evidence from the graph.

f. Do you have enough information to determine if the patient has Type 1 or Type 2 diabetes? If not, how would you go about figuring this out?

Part 3

There are two types of diabetes that result in higher than normal blood glucose levels – called Type 1 and Type 2 diabetes. A person with Type 1 diabetes does not produce insulin. A person with Type 2 diabetes does produce insulin but their cells are unable to respond to the insulin message. To determine whether the patient has Type 1 or Type 2 diabetes, you need to test the concentration of insulin in the patient's blood plasma.

1. Use Column 3 on the "Glucose Tolerance Testing Sheet". Place 1 drop of the appropriate plasma samples to be tested in the appropriate circles in Column 2 – Insulin Level in Blood.

2. Add 1 drop of the Insulin Indicator Solution to the plasma in each of the circles. After 10 seconds, compare the color of the fluid in each circle with the Insulin Test Indicator Color Chart.

3. Record the results of the insulin tests in Table 2 on the next page.

4. The graph on the next page shows the blood plasma insulin levels for a healthy person who does not have diabetes. Plot the data from the patient's insulin test results on the graph.

5. Answer the following questions:

a. Compare the insulin levels in a healthy person with the insulin levels in the patient.

b. Based on the information in the graph, do you think the patient has Type 1 or Type 2 diabetes? Support your answer with information from the graph.

c. Why would insulin injections typically not be used to treat the patient's diabetes?

d. What treatment plan would you suggest to keep the patient's glucose levels within normal range?
e. What health problems may result if the patient does not follow the treatment plan suggested to keep her blood glucose levels within normal range?