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Abstract

Following the participation of the researcher in the Bench to Bedside teacher workshop, a study was done to determine if peer tutoring is effective in improving student learning of biotechnology terminology and techniques. This researcher will assign peer tutoring to select groups of biotechnology students as a method to improve their biotechnology vocabulary and biotechnology techniques. Pre tutoring and post tutoring test scores will be compared, in addition to the comparison of tutor test scores to students who did not serve as tutors. The three activities include micro pipeting, isolating DNA and loading gel electrophoresis chambers.

Key words:

Gel electrophoresis, sample, buffer, loading dye, agarose, marker.

Rationale Peer tutoring has been reported to be an effective tool for improving both student academic and social development (Cohen, 1982). Peer discussion enhances understanding, even when none of the students in a discussion group originally knows the correct answer (Smith, 2009). It is also reported to be beneficial to use using multiple instructional strategies to teach students biotechnology (Dunham, 2002). This researcher will use peer tutoring in multiple instructional settings to improve the academic development of the student.

Intervention Throughout the school year students in the Biotechnology 1 course will learn a variety of lab techniques, such as pipeting, isolating DNA, and loading gels. Students will be assessed on the terminology and skill of the techniques shortly after learning and practicing the technique. Later in the year, during the two week Biotechnology unit being taught in the Biology class, biology students will receive direct instruction from the researcher on the protocols for the same three laboratory techniques; micro-pipeting, isolating DNA, and loading gels for electrophoresis. Instructions and lab sessions will be independent for each skill. Peer tutors from the Biotechnology 1 course will man lab stations to help biology students recall instructions, learn terms, and perform those three skills. Following the tutoring experience the biotechnology classes, including the tutors and non- tutors, will be reassessed and the results will be analyzed to determine if tutoring significantly improved the articulation and skill of the tutors in comparison to the non tutors.

Data Collection Biotechnology students will be given a test that analyzes vocabulary and knowledge of skill or protocol after learning and practicing each of the three techniques listed above. Following the peer tutoring opportunities the tutors and non-tutors in the Biotechnology class will be reassessed with the same assessment and the scores will be analyzed to determine if tutoring made a significant improvement in the test scores of the tutors in comparison to any change in the test scores of the non tutors.

Connections to Bench to Bedside During the Bench to Bedside workshop pipeting, and gel-electrophoresis were both introduced and practiced by the participants, including the researcher. This researcher, already includes these lessons in the Biotechnology 1 class, and would like to include these techniques in the biology classes, without teaching the biology students all that the Biotechnology class learns, such as was done at Bench to Bedside. For example biotechnology students will perform multiple labs utilizing micro-pipets before loading gels. Biology students will not have the opportunity to perform multiple practice sessions with micro-pipetting, but will get to load gels with help of the tutors. Using peer tutors improves the ability of the researcher to include these techniques in biology classes, and should improve the articulation and skill of the tutors as well.

References

Literature Cited

Cohen, P. A., Kulik, J. A., & Kulik, C-L. C. (1982). Educational outcomes of peer tutoring: A meta-analysis of findings. American Educational Research Journal, 19(2), 237-248. EJ 272 101

Smith et al. (2009) Why Peer Discussion Improves Student Performance on In-Class Concept Questio...Science 2 January 2009: 122-124 DOI: 10.1126/science.1165919

Dunham, Trey; Wells, John; and White, Karissa (Fall 2002) Biotechnology Education: A Multiple Instructional Strategies Approach. Journal of Technology Education Vol. 14 No. 1

Budget and Justifications Materials Needed

Molecular Weight Agar	Biorad	**161-3100EDU**	**$55.00**
Restriction Enzymes	Biorad	**#166-0047EDU**	**$48.75**
TAE Buffer	Biorad	#161-0743	$73.00
Fast Blast Stain	Biorad	#166-0420	$27.50
Molecular Marker	Biorad	#170-3605	$130.00

Title: Students will be peer tutors to others while loading DNA into gel electrophoresis chambers for DNA analysis

Key Questions: How is Gel electrophoresis is used to analyze DNA?

Science Subject: Biotechnology

Grade and Ability Level: 10th Grade Biotechnology Students

Science Concepts: DNA analysis through gel electrophoresis

Overall Time: Estimate: 50 minutes

Learning Styles: peer tutoring

Vocabulary: DNA Sample. Buffer, loading dye, agarose, marker, Micropipette, Gel electrophoresis

Lesson Summary: Lab: Biotechnology students will each tutor one lab station (4-5 students) of Honors Biology students by guiding them to perform the following procedures: obtain a sample of digested DNA, add 2uL of loading dye to the sample, mix by pipeting up and down, load the sample into the well in the agarose, close the chamber and turn on the current.

Student Learning Objectives: Biotechnology students will be able to articulate the procedures involved in loading a gel used for analysis of DNA through electrophoresis, using accurate vocabulary terms and procedures.

» SC.912.L.16.12: Describe how basic DNA technology (restriction digestion by endonucleases, gel electrophoresis, polymerase chain reaction, ligation, and transformation) is used to construct recombinant DNA molecules (DNA cloning).

Materials: Gel electrophoresis chambers, buffer, agarose gels, DNA samples, loading dye, molecular marker, micro pipettes, pipette tips, power paks.

Background information: Prior to this lesson Biology students will experience using micro pipettes, isolate DNA and learn about the structure of DNA, protein synthesis, restriction enzymes, and do the DNA mache lab to gain an understanding of how gel electrophoresis bands are analyzed. Biotechnology students will be knowledgeable of all of the above, in addition will have prepared and loaded electrophoresis chambers previously, as well as analyzed the DNA.

Advance Preparation: Prior to this activity DNA samples will be prepared in 1.5 mL microcentrifuge tubes for each student. Gels will be prepared and loaded into electrophoresis chambers, and covered with buffer. Loading dye will be aliquoted for each lab station. Tips and micropipets will be placed at each lab station, along with power supplies to run the chambers with.

Procedure and Discussion Questions with Time Estimates:

1. Opener: Gel electrophoresis parts and function, as well as the lab procedure will be reviewed. Gel electrophoresis separates DNA fragments. 10 minutes
2. Biotechnology students will meet and guide small groups of Biology students through the objectives by following this procedure at lab stations.
    a. Biotechnology students will obtain a p-20 micro pipet and set it to 2uL, explaining that 2uL of loading dye will need to be added to the DNA to help it settle into the gel. Biotechnology students will then demonstrate adding 2 uL of loading dye to a sample of DNA. Biology students should share the micropipette but use a clean tip every time to copy the tutor. The tutor should guide each student to ensure the pipette is used correctly.
    10 minutes for entire task and last student to take their turn.
    b. Biotechnology students should again obtain the p-20 micro pipette and set it to 20 uL explaining that 20uL of DNA mixed with loading dye will be needed to load into a gel. The Biotechnology student should then demonstrate loading 20 uL of the DNA sample mixed with loading dye into the gel, using proper terminology when refereeing to the sample, gel, and buffer. The Biotechnology student should explain that the buffer maintains the charge and shape of the DNA, the pH of the solution, and helps the current, and how to load into the buffer.
    20 minutes for all students to take their turn.
    c. Biotechnology student will either demonstrate adding a molecular marker to the gel, or guide a student through the procedure, explaining that the marker provides positive controls for which to compare results to. 3 minutes
    d. The Biotechnology student should guide one student to place the lid on the gel electrophoresis tank and turn the electric current. 5 minutes.
    e. Biotechnology student should guide the students through clean up; disposing of micro pipet tips and micro centrifuge tubes. 4 min.
    f. Biotechnology student should call students back to the lab station approximately 10 minutes after starting the power pak to explain how the loading dye indicates how far the DNA has traveled, and point out the first band is in front of the DNA sample and the second is behind it. 3 minutes.

Assessment Suggestions: Biotechnology tutors and non tutors will be reassessed using a test that measures the students understanding of the vocabulary and procedure of DNA analysis.

Extensions: Tutors will aide in explaining the results the following day.

*Resources/References:

Daugherty, Ellyn. "Biotechnology Science for the New Millennium." *DNA Isolation and Analysis*. comp. Paradigm Publishing. St. Paul: EMC Corporation, 2006. Print

Name _____ Period _____ Date _____

HOW WELL DO YOU UNDERSTAND GEL ELECTROPHORESIS?

1. What is Gel electrophoresis? _____
2. What is the purpose of gel electrophoresis? _____
3. Name 5 materials that are necessary to run an electrophoresis study.

   a._____ b. _____ c._____

   d. _____ e. _____

4. Explain what the purpose is for each of the materials you listed in question #3.

   a. _____

   b. _____

   c. _____

   d. _____

   e. _____

5. Write the steps to prepare a sample of DNA and load it into the gel electrophoresis tank.

   a. _____

   b. _____

   c. _____

   d. _____

   e. _____

6. After loading the Gel what other steps need to be done to complete the procedure.

   a. _____

   b. _____