The Effects of Direct Mathematical Instruction in Science Classes on Mathematical Based Science Reasoning

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GOAL

- The goal of this project was for students to be able to use and articulate mathematical reasoning strategies when approaching scientific tasks.
- To accomplish this, sophomore level Biology (Genetics) curriculum was pervaded with mathematical instruction.

BACKGROUND

- The nature of science outlined by the Next Generation Science Standards (NGSS) reveals the multidimensional components that comprise scientific practices and understanding.
- Within the eight NGSS science and engineering practices, six use mathematics as a foundation of or tool for science.

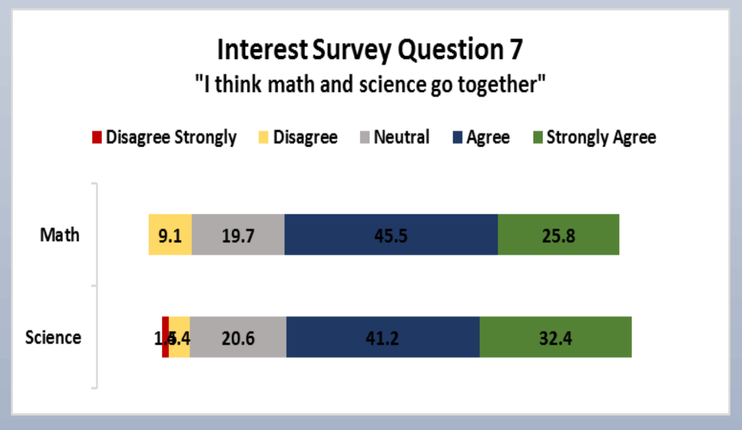


Figure 1. Math and Science Interest Surveys- Question 7.

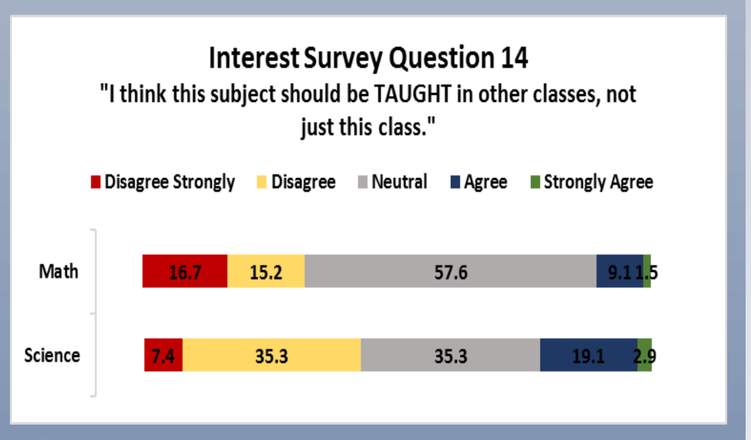


Figure 2. Math and Science Interest Surveys- Question 14.

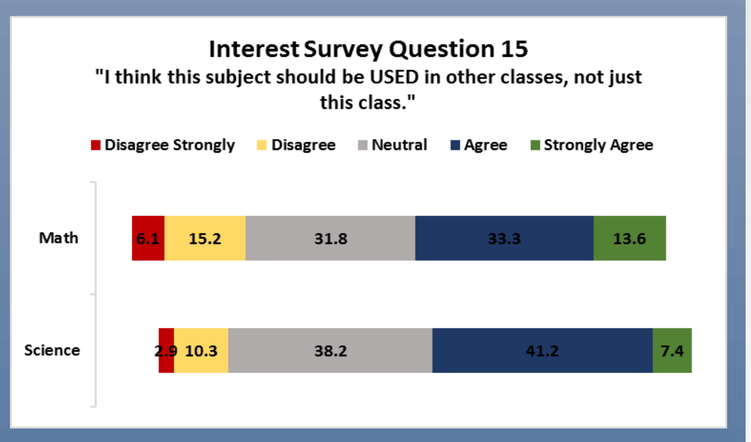


Figure 3. Math and Science Interest Surveys- Question 15.

"Data analysis! Explaining your answer... saying what that number represents."
-BHS Math Teacher

Math Teacher Survey response when asked: "What math based skills would you like to see be taught in other classes?"

METHODOLOGY

- Students explored Genetics based Biology concepts while receiving direct instruction on statistical analysis as a tool for developing scientific reasoning skills, such as, scientific claim, evidence, and reasoning.
- Student laboratory investigation claim:
  - Does Indian corn follow Mendel's Law of Independent Assortment?

Students: Parker T., Savana J., and Travis B. recording the occurrence of phenotypes in monohybrid and dihybrid ears of corn.

DATA AND ANALYSIS

- Data collection for this project involved completion of scoring rubrics by both the student and teacher following a Genetics based laboratory exercise, as well as, a Genetics summative assessment concluding the three week unit of study.
- Students were evaluated on a point scale that included: stating a claim, providing evidence, data-based reasoning, and making an argument.

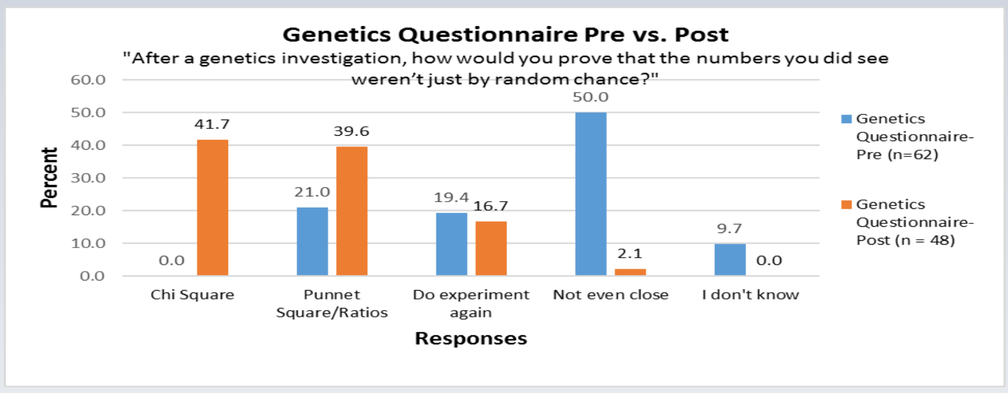


Figure 4. Genetics Questionnaire Pre vs. Post- Evaluating Genetics Claim, (Pre N = 62, Post N = 48).

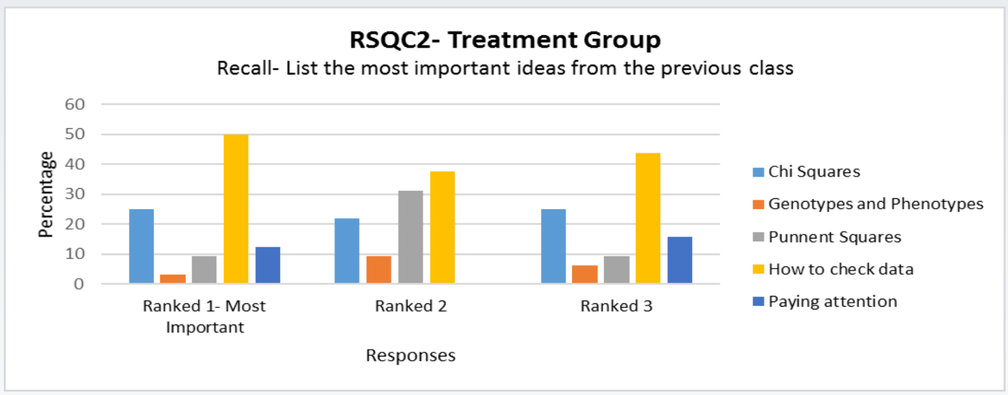


Figure 5. Treatment Group RSQC2- Recall, (N = 32). Legend: *1 = Most important, 2 = Second most important, 3 = Third most important*.

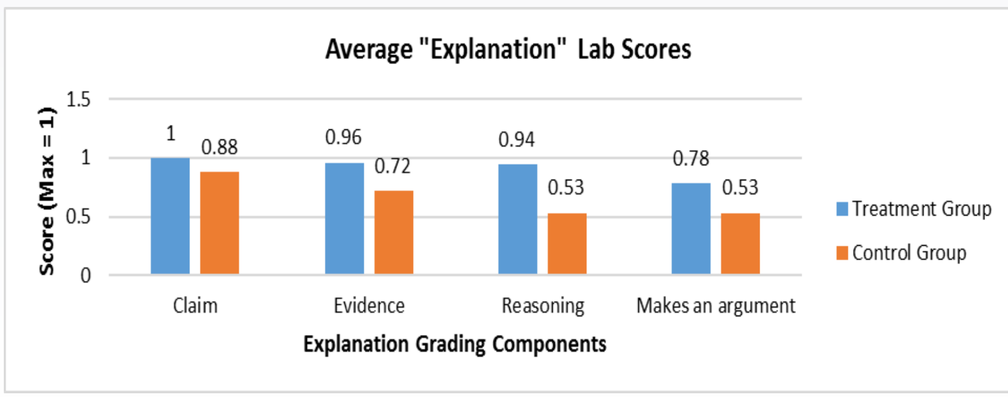
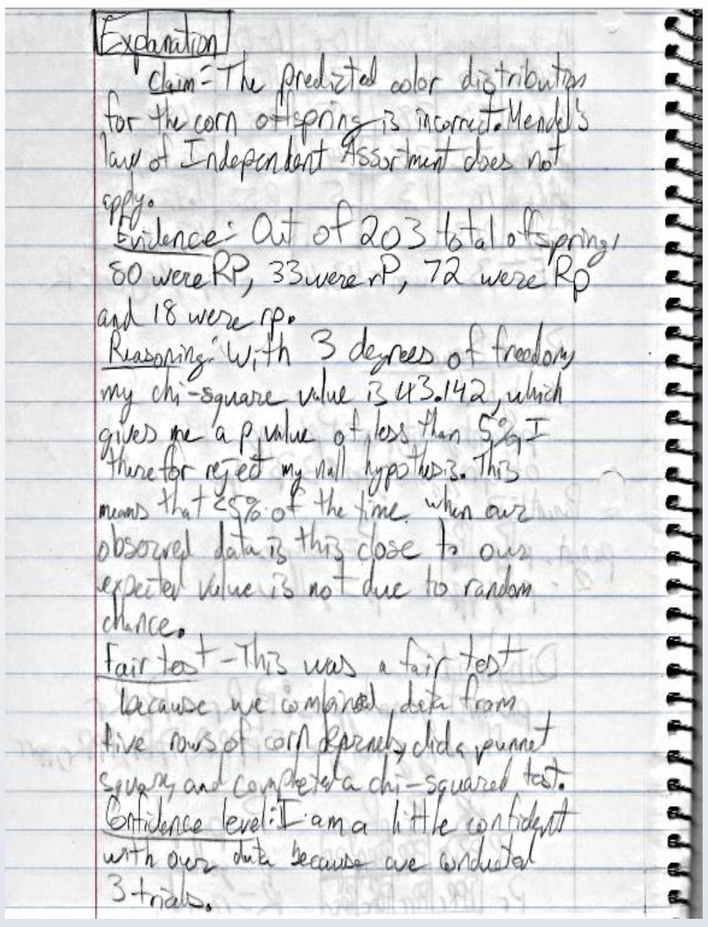


Figure 6. Average Explanation Lab Scores, (Treatment N = 34, Control N = 16). Legend: *0 = Not acceptable, 0.5 = Needs improvement, and 1.0 = Great!*.

STUDENT EXPLANATION



Explanation

Claim- The predicted color distributions for the corn offspring is incorrect. Mendel's law of Independent Assortment does not apply.

Evidence: Out of 203 total offspring, 80 were RP, 33 were rP, 72 were Rp and 18 were rp.

Reasoning: With 3 degrees of freedom my chi-square value is 43.142, which gives me a p value of less than 5% I therefore reject my null hypothesis. This means that 95% of the time when our observed data is this close to our expected value is not due to random chance.

Fair test- This was a fair test because we compared data from five rows of corn kernels, made a punnet square, and completed a chi-squared test.

Confidence level: I am a little confident with our data because we conducted 3 trials.

CONCLUSION

- The results indicated that by implementing direct Mathematics instruction on standards-based Biology concepts, students gained a greater understanding of Genetics concepts and were able to develop a more thorough claim, evidence, reasoning explanation for a standard Genetics laboratory investigation.

VALUE

- Students may not see the inherent benefit in using mathematics as a method of scientific reasoning until later in their educational career.
- My goal: That the reasoning skills students gain by practices being paralleled in both math and science be able to be applied to new or novel endeavors.
- Using mathematics in the science classroom serves to broaden students' repertoire of data analysis and reasoning.
- Mathematics need not be confined solely to math class, the same is true with science.

"What I found most useful was all that math that I can use!"
-Student