Background
Remarkable advances in genetics and molecular biology in recent decades have dramatically increased the impact of genetic information and technologies on society. In spite of increased exposure, research has shown that undergraduate students do not understand basic genetics concepts even after formal instruction (Bowling et al. 2008). One contribution to this problem is the students’ “deeply rooted conceptions and ideas” which stem from individuals’ experiences (Duit and Treagust 2003). These misconceptions inhibit the students from learning these concepts through scientific explanations and traditional teaching methods (Wandersee et al. 1994). An additional problem is that students do not retain the knowledge pertaining to these concepts. Therefore, non-traditional teaching methods may be more effective, such as the use of a conceptual change strategy (Figure 1).

Methods

Quantitative Analysis
Rubrics, developed from pilot study data and responses from genetics experts data, were used to quantify the student responses. The scale for each misconception are as follows: Q1: 0-4, Q2: 0-5, and Q3: 0-6. Reliability was established with Cohen’s kappa being κ=0.84 for rubric 1, κ=0.76 for rubric 2, and κ=0.77 for rubric 3. After reliability was established, the responses were randomly divided among scorers and scored independently and blindly.

An ANOVA was used to compare the mean scores for the different course sections. Significant differences were found between the two courses, thus in further analyses the two courses were separated. A paired samples t-test was used to compare the pre- and post-course scores for all questions.

Qualitative Analysis
Through the process of inductive coding (Thomas 2006), categories were developed for each question based on specific common phrases observed (Figure 4). Independent parallel coding was conducted throughout the project with sets of responses coded by two separate coders, and Krippendorff’s alpha was calculated with an alpha value of 0.75 or higher indicating sufficient inter-coder reliability.

Results

Discussion
Use of conceptual change tests did not result in consistent differences from pre- to post-course for all questions in the two student populations.

Common genetics misconceptions and/or incomplete ideas exist in these populations even after instruction and conceptual change strategy attempts.

Qualitative analysis supports quantitative results
• Although the idea that cells of the same individual have the same DNA was described by >95% of participants, <20% indicated that different cell characteristics were due to differential gene expression
• Confusion between genes, DNA, and chromosomes remained prevalent in post-course responses
• Despite the increase in answers reporting non-negative effects of mutations, negative effects were still referenced more frequently than any other type of effect

Future work includes the quantitative analysis of data collected one-year after the course ended which will assess students’ retention of the information.

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