MB002

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Building a Genetics Curriculum: Needs Assessment Survey of Middle and High School Students[1]

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Introduction

The field of genetics has grown exponentially in the past few years. A solid genetics education is necessary to participate in the public dialogue surrounding the Human Genome Project, stem cell debates, and other molecular advances. It is especially important that the next generation of citizens, scientists, voters, and patients possess a broad understanding of genetic terms and technologies. According to the results of the 2000 National Assessment of Educational Progress (NAEP) conducted by the Department of Education, only ~30% of twelfth graders could completely or partially answer genetics related questions correctly, and only 18% were considered proficient or advanced in science (O'Sullivan *et al*., 2003). These results indicate a decrease in science proficiency from a 1996 assessment, and 2005 NAEP results do not demonstrate any improvement. (Grigg *et al*., 2006). Additionally, data suggests that students in the United States are lagging behind other countries in science and technology, and there is a growing concern and movement to close this gap by enhancing science education (Martin *et al*., 2004; National Science Board, 2006).

To engender enthusiasm and to develop learning opportunities in an advanced and timely field such as genetics, the Microbiology and Cell Science Department and the Family, Youth, and Community Science Department are working together to develop a 4-H curriculum in genetics. In order to develop a curriculum that captures general interest and builds upon previous knowledge, the development team conducted a needs assessment survey of 140 middle and high school-aged students. Students were surveyed on their primary resources for learning about science and technology, basic knowledge of key genetic concepts, and their interest level in participating in genetics-related activities.

Methods

A total of 140 students were surveyed: 20 in middle school and 97 in high school; 56 males and 79 females. The one-page survey was anonymous, asking respondents only for their current grade in school and gender. To reduce potential bias, the respondents were asked to complete the survey while attending a 4-H sponsored event unrelated to science education.

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To ascertain the main venues of the science learning, students were asked to indicate all the options that applied to them including science class at school, the news, science magazines, science-themed TV shows, the Internet, or an alternate source.

Next, the respondents indicated their knowledge of a specific genetics concept learned in school and their interest in learning more about that specific concept. The students responded by making a mark in a column corresponding to:

- Yes, I have learned about that concept in school;
- A little, I learned a little about that concept in school; or
- No, I did not learn about that concept in school.

For each topic, the students marked a "Yes, I want to learn more" or "No," for I do not want to learn more. The topics included DNA, genes and proteins, DNA fingerprinting or forensic science, Human Genome Project, genetic engineering (genetically modified crops, cloning, stem cell research, etc), evolution, and careers in genetics or biotechnology.

Finally, to assess the type and format of activity that would be most stimulating to students, the respondents were asked to indicate their interest level as high, medium, or low for a series of genetics-related activities including: analyzing their own genetic fingerprint, identifying bacteria that live in their mouth, identifying bacteria that live in the outdoor environment, investigating the evolution of bacteria with an online program, investigating the ability of bacteria from Earth to grow on Mars, attending a genetics-themed day camp, working on individual genetics projects, or participating as a group in genetics activities.

Results

Table 1. Venues of science education.

Survey question: Where do you learn about science and technology? Select all that apply to you.[a]

Learning venue	% Who marked this option[b]
Science Class	93.0
News	51.4
TV Shows about Science (e.g., *Nova*, Discovery Channel)	49.3
Internet	37.3
Science Magazines (e.g., *Discover*)	18.3
Other	18.3

[a] Responses are listed in order of the most common to the least common answer.

[b] This number represents the percentage of total respondents, regardless of grade, that marked the option as a source of science education. There was no statistically significant difference in the responses in high school aged youth versus middle school aged youth

Table 2. Experience with key genetics concepts

Survey question: Please let us know if you have learned about these concepts in school and if you would be interested in learning more. Check the appropriate column.[a]

Concept	% Who learned topic in school		% Who want to learn more	
	High School	Middle School	High School	Middle School
DNA	69.6	42.0	48.1	71.4
Evolution	58.1	26.3	32.2	50.0
Genes and proteins	51.0	42.1	53.1	53.3
Genetic engineering/Biotechnology	40.7	44.4	50.6	66.7
DNA fingerprinting	37.2	30.0	65.9	76.5
Human Genome Project	27.8	17.6	48.7	57.1
Careers in Genetics	24.7	16.7	41.0	53.3

[a]Concepts are listed in order of the most commonly learned to the least commonly encountered topic among high school students.

Table 3. Interest in specific genetics-based activities and preference of activity format

Survey question: Please indicate how interested you would be in participating in the following activities. Mark the column that best describes your interest level as "High," "Medium," or "Low."[a]

	% Who indicated a "High" or "Medium" interest level	
Specific Activity	High School	Middle School
Analyze your own genetic fingerprint	77.9	75.0
Investigate ability of bacteria from Earth to grow on Mars	60.0	60.0
Identify bacteria that live in your mouth	48.4	65.0
Identify bacteria that live in your outdoor environment	49.0	45.0
Investigate evolution of bacteria with an online program	32.6	40.0
Activity Format		
Participate as a group in genetics activities	56.8	75.0
Day long camp to learn about genetics and do experiments	56.0	70.0
Work on an individual genetics project with adult guidance	41.5	70.0

[a]Activities are listed in order of those that garnered the most interest to the least interest.

Conclusions

The primary source for science education is the science class in school, and this result is not surprising. However, it is interesting that approximately 50% of students in grades 7-12 learn about science from the news and/or educational TV programs such as those on The Discovery Channel. Knowing where students hear and learn about science outside the classroom provides clues as to what captures their attention, as informal learning is voluntary. For example, developing genetics education materials that explore concepts underlying major new stories, such as DNA identification as a forensic tool, is likely to not only hold the students' attention, but also reinforce the scientific knowledge and give relevance to their lives.

The respondents were asked about their experience with various basic genetics concepts in the science classroom. The purpose of these questions was to determine their background in genetics and to identify any knowledge gaps in order to direct the language and depth of the curriculum. Although the percentage of respondents who cited having experience with these concepts is overall quite high and impressive, these numbers may be misleading. Unlike the National Assessment of Educational Progress, this survey only questioned students if they had learned about a particular topic, without testing their understanding of this concept. The choices presented to the students on the survey in answer to the question "have you learned about the concept in school?" were "Yes, A little," and "No." For the purpose of curriculum design, it is best to interpret these responses conservatively, providing more background on topics that were scored as "A little" or "No" and assuming a basic level of understanding by those concepts that scored in the "Yes" columns.

With all concepts, the high school students had learned more than the middle school students, which is to be expected. What was unexpected was the very small percentage of students who had learned about careers in genetics/biotechnology and specific applications of genetics like the Human Genome Project or DNA fingerprinting. Since one of the goals of a 4-H genetics curriculum will be to demonstrate the applicability of this science to their lives, it is important to develop learning opportunities to fill these gaps in their formal education.

Overall, the students demonstrated a strong interest in learning more about all the topics with the high school aged students indicating an average interest level of ~ 50% and the middle school students demonstrating a slightly increased average interest level of ~ 60%. These results are encouraging and prove that there is a need and an interest for genetics education. Providing information about careers in genetics is especially crucial at an early age. According to the Bureau of Labor Statistics, the job outlook for the biotechnology field is very good and is growing at a high rate; therefore, emphasizing solid foundations in math and science at as early an age as possible is imperative (http://www.bls.gov/oco/ocos047.htm#outlook).

Finally, the students were surveyed as to what specific type and format of activity sparked an interest. Not surprisingly, ~ 75% of all students demonstrated at least some interest in learning the science of DNA identification

through analyzing their own genetic fingerprint. At least 45% of students expressed an interest in doing all of the hands-on learning activities, and the survey indicates that the respondents prefer to do these activities in a group and/or day camp setting rather as individual projects. It is interesting to note that although there was no statistical difference, as a trend middle school students have a higher interest in learning more about all the topics and in participating in all of the activities than the high school students. This trend suggests that middle school may be a key target age group to capture a student's interest in science. Likewise, female students demonstrated a greater interest in learning more about every topic and in participating in activities versus male students, but the results are not statistically different.

The results of this survey indicate a strong interest in genetics among middle and high school aged respondents, and these results will be used to tailor a genetics curriculum to their specific needs and preferences. The curriculum will focus on hands-on, inquiry-based genetics projects that appeal to the students such as the science of DNA identification and investigating microbial diversity in the mouth. The curriculum will emphasize the applications of molecular biology and include discussions regarding future careers in genetics.

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