

Addressing Next Generation Science Standards: A Method for Supporting Classroom Teachers

Abstract

The Next Generation Science Standards (NGSS) will define science education for the foreseeable future, yet many educators struggle to see the bridge between current practice and future practices. The inquiry-based methods used by Extension professionals (Kress, 2006) can serve as a guide for classroom educators. Described herein is a method of taking a simple graphing exercise and turning it into a youth-led activity that addresses Practice 4 of the NGSS.

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Introduction

History has shown that teachers often struggle to adapt to changing academic standards (Davis, 2003). Today, teachers are being challenged to achieve Next Generation Science Standards. Inquiry-based learning strategies long embraced by Extension offer a bridge between mediocrity and excellence in the classroom. To illustrate a five-step process for introducing these strategies into the classroom, we describe the implementation of a classroom hydroponic program. This same process can be applied to additional teaching activities.

Method

Following is an example of how teachers can address NGSS Practice 4, Analyzing and Interpreting Data, using a five-step process to turn the simple graphing of data into a deeper learning opportunity.

The process builds on two key ideas: first, that the ability to interpret data increases along with graphing skills when students engage in genuine scientific explorations (Mokros & Tinker, 1987), and second, that this exploration should be youth led to maximize learning potential (Bourdeau, 2004). This process is similar to the experiential and project-based learning models used by Extension with slight changes that better serve teachers.

- Acquire tools/data

- Inspire through discussion
- Orient the activity
- Challenge youth to learn
- Share and debrief

Acquire Tools/Data

Educators should take the time to plan ahead so the learning experience can be as genuine as possible. The collection of data, observations, or experiences is the first step. The more hands-on this acquisition is, the more enthused youth will be about interpreting the subsequent data.

In this example, students grew plants using a hydroponic unit. Each week, students were asked to measure their plant using two methods, height and one other parameter such as number of leaves, branches, or flowers, etc. This activity was adapted from the Grow with the Flow curriculum from Cornell Extension (Warner, Rackow, & Mazza, 1993). At the conclusion of the 12-week program, students had compiled their own data to analyze. Collecting data is an important skill, but educators can use existing data for this activity as well. For this activity a computer lab was also reserved.

Inspire Through Discussion

The educator then introduced a discussion that forces students to think critically and creatively about the data and inspires them to explore their interests on the topic.

In the hydroponic activity, the educator introduced a number of graphs shared during the recent presidential election campaign. The graphs had a persuasive intent, not necessarily empirical. The educator encouraged a discussion about the design of the graph and how our perception can be manipulated by changes to labels, titles, and scale.

Orient the Activity

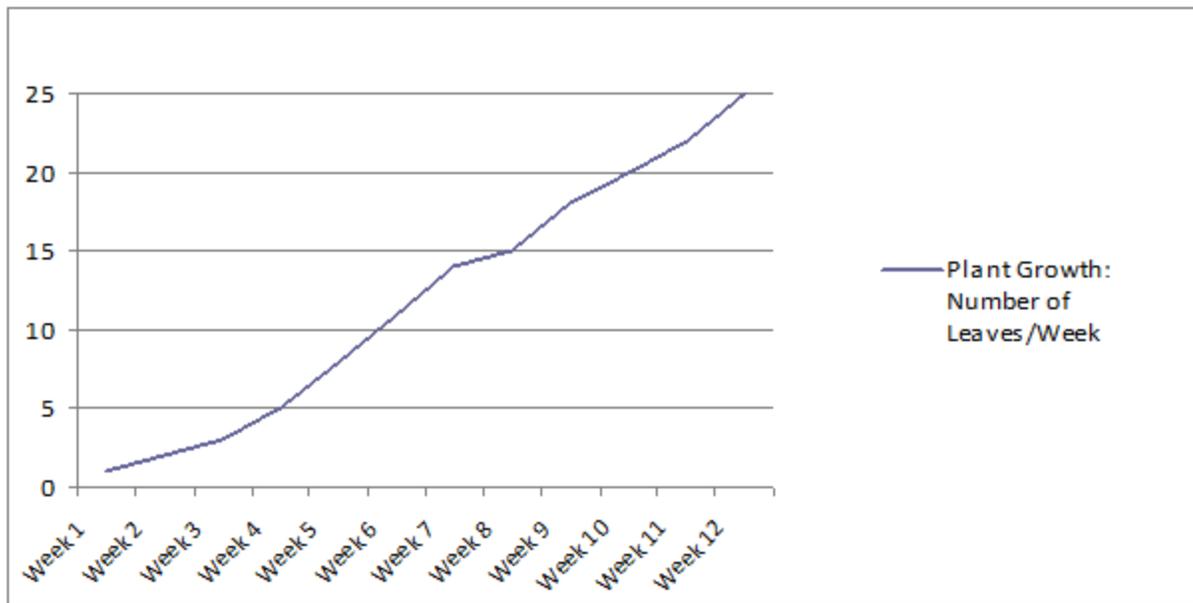
The educator then oriented the activity by demonstrating how to use Microsoft Excel and produce a simple graph. The educator deliberately did not demonstrate how to change or label axis, reformat scale, or use more complicated graphing options and design elements. With limited teacher guidance, students were encouraged to "tinker" with the technology and share newly acquired methods and skills with each other. This youth-led learning method increased students' pride and confidence as they chose learning speed and direction, discovered new abilities, and embraced creativity. Such exploration could even be considered a tenet of NGSS Practice 3, Planning and Carrying out Explorations.

Present a Challenge

The educator then posed a series of challenges designed to make students analyze the data and interpret the possible representations. For example, the first challenge was "Make a graph that shows that your plant grew really well." If students had measured their lettuce plant in height and by the number of leaves growing, they may choose to show growth in terms of the number of leaves in a given week. In this way the plant would appear to grow well throughout the entire 12-week program (Figure 1).

Figure 1.

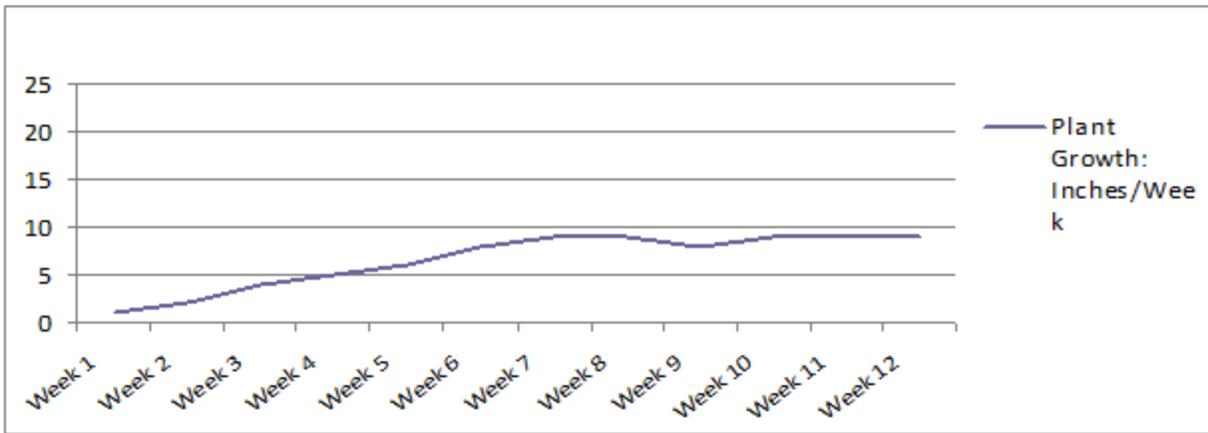
Plant Growth: Number of Leaves Per Week



When challenged to "Make a graph that shows your plant not growing well," the same student could graph the plant growth in inches with a Y axis that has a large range but graphed points are compacted. This would seem to show a plant that grew in the beginning but stopped growing in the 6th week. Throughout the activity, students were not permitted to change their data, just the labeling, graphing, and design methods.

Figure 2.

Plant Growth: Inches per Week



Share and Debrief

Finally, touching on all aspects of the project and the collection, compilation, interpretation, and communication of data, the educator debriefed the session and asked students to extrapolate the lesson of interpreting data and apply it to another learning opportunity. In this case, students were asked to interpret the graphs submitted by each group and determine which plant actually grew the best. Additionally, students considered the manipulation of data and how we think about what we are seeing or being told. This is where Practice 4 is truly realized—students learn to analyze and critically interpret data, as well as consider the messages data convey.

Impact

Evaluation results showed that there was a positive impact on student learning in a number of areas specific to Practice 4, "Interpreting and Analyzing Data." Youth participants were asked to rate their abilities using a four-point Likert scale (1 = no ability, 4 = great ability) using a retrospective evaluation. Of the 125 participants, 85 evaluations were collected. When asked about their ability to communicate, discuss, and graph experiment results like scientists do, students showed great growth in ability (Table 1).

Table 1.
Results of Evaluation: Interpreting Data

Question	Before	After	% Increase
Ability to discuss/debate experiment results like scientists	1.96	3.26	60%
Ability to communicate the results of experiments like scientists do	2.04	3.37	61%
Ability to graph experiment results like scientists	2.02	3.48	58%

Conclusion

Today's teachers can benefit from the inquiry-based methods used in Extension. The Next Generation Science Standards are going to force teachers to employ more hands-on, experiential methods in the classroom environment, and Extension is uniquely poised to guide this transformation by providing teachers with guidance and tools that demonstrate effective methods to address the new science standards.

Described above, is a method that can help teachers address NGSS Practice 4, Analyzing and Interpreting Data, by taking a simple graphing exercise and transforming it into a deeper learning opportunity. Similar to the project-based learning method, this structure can be applied to a number of learning practices that teachers are asked to address in the NGSS.

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