"INVITE A SCIENTIST" PROGRAM – MIDDLE SCHOOL EDITION

INTRODUCTION

A principal objective of middle school science should be to give students the knowledge and experience needed to understand the work being carried out by scientists. Introducing students to who scientists are as "regular people" and the behavior of scientists in their pursuit of knowledge helps to tear down the stereotypic images of scientists and promotes science as a possible career path for young students. Another objective of middle school science classes is to help develop students who can continue to provide for the practical needs of society through science, engineering, and technology (Owens, 2000). Consequently there is a need to develop future practitioners whom are able to infer, synthesize, generalize, predict, and solve problems. Research has shown that inviting scientists into the classroom and teacher collaboration with scientists can provide strong professional development opportunities for the teacher and scientist (Chankook & Fortner, 2007). Illustrating long-term values of a professional development program with scientists is an effective way for teachers, and consequently, students, to hone scientific knowledge and skills. By inviting scientists into the classroom, teachers allow potential role models, leaders, and advocates of scientific discovery to share their message and increase the likelihood that student interest will be increased to seek a career in science.

This lesson will provide an opportunity for middle school students to get to know what scientists do and how scientists became scientists. The important derivative of this lesson is to enhance the thoughts and extend conversations between middle school students, teachers, parents, and scientists about how careers in science are an exciting and worthwhile academic path and life goal. The lesson provides for classroom discussion, question and answer sessions, and hands-on activities to be used in a format that is easy and constructive for teachers, students, and the volunteering scientists.

BACKGROUND

The North Carolina Science Festival's "Invite a Scientist" program provides "ambassadors of science" to schools in the state by recruiting scientists to go to schools to tell students about their work and their lives. The scientists talk to students about their current research and projects and share why they are passionate about science and how they got that way. The scientists talk to students about the skills, practices, and knowledge needed to pursue a career in science and the pathways for academic success.

This program was initially implemented in high school but has been modified for middle school students. This middle school version of "Invite a Scientist" includes a hands-on activity to further engage and interest students in science and to illustrate the importance of collaborative practice in science.

ALIGNMENT TO STANDARDS

The scientific process and the "art of science" require collaboration between the scientific community and society in general. The learning outcomes of this lesson are multiple. Scientific inquiry is an important component of the North Carolina Science Essential Standards (NCSES). The NCSES heading for science in grades 6 through 8 provides that:

> The process of scientific inquiry, experimentation and technological design should not be taught nor tested in isolation of the core concepts drawn from physical science, earth science and life science. A seamless integration of science content, scientific inquiry, experimentation and technological design will reinforce in students the notion that "what" is known is inextricably tied to "how" it is known... Teachers, when teaching science, should provide opportunities for students to engage in "hands-on/minds-on" activities that are exemplars of scientific inquiry, experimentation and technological design (NCDPI, 2011).

Additionally the Common Core Standards (CCS) conveys that:

> To be ready for college, workforce training, and life in a technological society, students need the ability to gather, comprehend, evaluate, synthesize, and report on information and ideas, to conduct original research in order to answer questions or solve problems, and to analyze and create a high volume and extensive range of print and non-print texts in media forms old and new. The need to conduct research and to produce and consume media is embedded into every aspect of today's curriculum (CCSSI, 2010).

Scientists employ the goals of the NCSES and CCS in every aspect of their professional lives. Therefore this activity is a good fit for promoting science and scientists.

This project is aligned with the STEM principles recognized by the North Carolina department of Public Instruction (NCDPI) of:

- Integrated Science, Technology, Engineering, and Mathematics (STEM) Curriculum Aligned with State, National, and Industry Standards
- On-going community and industry engagement and,
- Connections to postsecondary education (NCDPI)

NORTH CAROLINA ESSENTIAL STANDARDS IN INFORMATION AND TECHNOLOGY FOR MIDDLE SCHOOL

6-8.SI.1 Analyze resources to determine their reliability, point of view, bias, and relevance for particular topics and purposes.

6-8.TT.1 Use technology and other resources for the purpose of accessing, organizing, and sharing information.

6-8.RP.1 Apply a research process for collaborative or individual research.

6-8.SE.1 Apply responsible behaviors when using information and technology resources.

LEARNING OUTCOMES

Students will be able to:

1. Describe what a scientist does and refute misconceptions about and stereotypical images of what a scientist looks and acts like.
2. Better understand what motivational and academic behaviors are needed to pursue a career in science.

Additionally, students should realize by these I can statements.

I can:

- construct thoughtful and detailed hypothesis based on observations and research
- understand that the scientific method is a cyclic process
- practice/engage in accountable and constructive discussion between each other
- build on each other's content understanding
- question each other to address misconceptions

CLASSROOM TIME REQUIRED

The estimated classroom time needed is one class period of minimally 50 minutes. Additionally, a 20-30 minute session 2-5 days prior to the scientist's visit and a 20-30 minute session 1-2 days after the scientist's presentation are needed to perform a pre- and post-session assessment of the impact of the scientist's visit with the students.

MATERIALS NEEDED

- Science journal or notebook
- Mystery Boxes (8-for groups of 3 or 4 students)
- Scientist's Bio
- Scientist activity (to be provided by scientist) or Scientist's presentation

TEACHER PREPARATION

CREATION OF MYSTERY BOXES

- Obtain 6-8 small boxes (cigar boxes are ideal size).
- Gather 6-8 items of any type to go into the boxes. Items can be any shape or size. You can use the same item or different shaped items to add to the mystery. Interesting objects include bolts, batteries, small rubber or plastic balls, pencils, etc.
- Close the boxes with the item inside making sure to note what is inside each box for your records. Wrap each box completely with tape (duct tape is best and you can obtain different colors). The boxes should be as non-descript as possible.
- Mark an identifying mark or number on the outside of the box so that you will know which box contains what item.

TECHNOLOGY RESOURCES

Equipment for scientist's presentation may include:

- Computer with internet connection and PowerPoint software
- Projector
- Laser pointer/presentation tool (optional)

ACTIVITIES

PRE-ASSESSMENT

The pre-assessment for this lesson examines the perceptions and misconceptions students have with the image of who a scientist is and what a scientist does. Two days to a week prior to the scientist visit, tell the students that your scientist is coming to give a presentation to the class. Discuss what the scientist does, their field of study, and how and if it relates to what you are currently studying. The inquiry nature of science is generally the most common denominator for discussion.

Have the students generate questions that they would like to ask the scientist based on the description and information given. During this exercise, have the students either, write their best description of a scientist, tell what a scientist does or, draw a picture of a scientist or what a scientist does. These can be written in their science journals or on paper to be checked or handed in. Have the students share some of their descriptions with the class voluntarily or call on students that have interesting images. Make note without being critical of the student's misconceptions. Teachers will address these misconceptions during a post –assessment comparison after the scientist's presentation.

Note – It is important that the scientist is aware of the approximate level and special interests of the group of students that will be at the presentation. The teacher and scientist must communicate this information well before (at least two weeks) the presentation so that the scientist has time to adjust their presentation and activities to the appropriate level.

SCIENTIST PRESENTATION

The day of the presentation have a place for the scientist to speak ready and accessible. Tell the students there will be a demonstration/activity, if time allows, after a question and answer session. Tell the students to allow the scientist to complete their presentation and to save questions until after the presentation. Tell the students if they have any questions during the presentation, to write them down and ask them at the end of the presentation. Introduce the scientist and their title but allow the scientist to describe what their job entails. In addition to the work persona of the scientist, the scientist should provide a biographical history of him/herself for the students. The scientist will also give personal background of why they chose the field they did and what did they need educationally to achieve their goals. The scientist should discuss their current work and how their work is affecting society.

Prior to the scientist presentation, the teacher and scientist must discuss if the scientist will bring an inquiry-based or hands-on activity to go along with their presentation. Student will be provided with a question-and –answer session at the end of the scientist's presentation. Prior to the day of the presentation the teacher and scientist may decide if there is time for a science activity. The scientist may have a hands-on activity to perform with the students. Teachers should assist with the set up and facilitation of the activity.

If the scientist does not have an activity then perform the mystery box activity from the instructions and materials provided. The mystery box exercise can be stopped at any point during the activity. The teacher can stop 5 minutes before dismissal to allow for student assessment or reflection or may extend the Mystery Box exercise into the next class period.

MYSTERY BOX EXERCISE

Adapted and modified from *Making the "black box" model more transparent* from the "Metacognition Workshop, 2008"

Discussion

- Key Discussion points should focus around the scientific process and scientific literacy.
- The ideas of models (limitations and assumptions) can be used as an anchor for you and the students to refer back to throughout the course (if done early on) to help students to understand how scientists seek to understand concepts.
- Individual effort and collaborative work are important steps in understanding the scientific process.

Activity

- Instructors and scientists can support students by attending each group as they work though their analysis.

Part I: Mystery Box Activity

1. Assign students in groups of 3 or 4 to ensure a mix of performance levels. Tell students you will bring them over a box with a mystery object inside but they are not (initially) to touch the box.
2. The teacher or scientist will give a box to each group. Place the box carefully on the table as if there is something extremely fragile or explosive inside.
3. Tell students to write their observations of the box in their science journals or notebooks. Students should not get up or move around the box. They should write what they see from their perspective. Tell students to include direct observations, drawings of your interpretations, questions, and thoughts from where they sit.
4. Tell students to discuss with their group their individual observations.
5. Tell each group to choose one student to gently pick the box up. Only one student can tell the others their observations. That student can use their five senses (maybe not taste) to generate observations. The other students should write down what their observer notes.
6. Have the initial observer pass around the box to the other students in their group. Tell students to record any additional observations that are noticed.
7. Once the group has completed the investigation, have each student generate a scientific explanation in their notebook individually. Create a hypothesis. List evidence (data) that supports the hypothesis. Remind students that data can include observations. Use figures (sketches) to support the hypothesis.
8. Have the students regroup and generate questions (what's going on in the box?), generate hypotheses (I think this is what's going on), and test out those ideas (Do the tests support or refute the hypotheses?), then come to a group decision of the most viable scientific explanation for the group.

9. Have each group share their scientific explanation with the class and, as a class, decide the most plausible explanation is to what is in the box, given the observations and data.

Note – Boxes may contain different objects, at different orientations, so look for different observations and different conclusions.

Part II. Individual Reflection

After discussing the class findings, take a moment to have the students write some thoughts down in their science notebooks about your comfort with the strength of your group's scientific explanation. Prompt questions can be: Were your initial thoughts about your group's explanation similar to the feedback you received? How were your ideas similar to or different from that of the group or class? Has your confidence in the contents of the box changed?

ASSESSMENT

The post-assessment is used as a comparison to the pre-assessment to determine if any perceptions or misconceptions evident in the pre-assessment have been addressed. Have the students again write their descriptions of a scientist or draw a picture of their current image of a scientist or what a scientist does. Tell the students to review what their perspective was prior to the scientist visit and compare and contrast the two perceptions. The level of individual student discussion or teacher comparison of pre- and post-assessments, or both provide evaluation of student interest and learning.

Additional assessment could entail students composing a short summary of their pre- and post-presentation views, what kind of scientist would they like to be and why, or what are the necessary criteria for becoming a scientist?

MODIFICATIONS

Student drawings and diagrams can be used to modify the pre- and post-assessments for students with special needs or English language learners. Mentioning the diversity of scientists throughout history and their contributions are a good tool to increase interest in diverse classrooms.

Scientists may be able to provide lectures for larger classes or combined classes. The hands on activity can be performed at a different time with individual classes.

CRITICAL VOCABULARY

Scientific inquiry: a way to investigate things and propose explanations for their observations.

Quantitative observation: observations that consist of measurements and numerical data.

Qualitative observation: observations that consist of descriptions of perceptions outside of measurements and data.

Scientific literacy : knowledge and understanding of scientific concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity (United States National Center for Education Statistics)

Hypothesis: a proposed explanation made on the basis of limited evidence as a starting point for further investigation.

Experiment: a scientific procedure to test a hypothesis

Collaboration: working with someone to produce or create something

Communication: exchanging of information

WEBSITES AND RESOURCES

For students:

What do Scientists do? – http://sciencenetlinks.com/esheets/what-do-scientists-do/

For teachers:

Scientific and Engineering Practices in K–12 Classrooms Understanding a Framework for K–12 Science Education – http://www.nsta.org/about/standardsupdate/resources/201112_Framework-Bybee.pdf

Scientists in Schools – Canada – http://www.scientistsinschool.ca/for-teachers.php

What do Scientists do? – http://sciencenetlinks.com/lessons/what-do-scientists-do/ - Teacher accompaniment for students "What do Scientists do" sheet.

NC Science Festival Invite a Scientist Program - http://www.ncsciencefestival.org/get-involved/k-12-educator-toolkit/middle-school-educators/

For scientists:

Resources for Scientists: K-12 Classroom Visits – http://www.complex-life.org/K12Resources

COMMENTS

Although there are not many studies corroborating the effectiveness of scientists in the classroom, there is much anecdotal evidence that such programs, especially longer term programs, help to increase student engagement and achievement and serves as a professional development tool for teachers (Laursen, Liston, Thiry, & Graf, 2007). Teachers and scientist presenters have observed and reported increased student engagement and interest in science, exposure to new science learning opportunities, and changing ideas about what science is and who can do it. Teachers benefit by learning new content and new ways to teach it, and they feel supported by the presence of interested individuals from the science community university.

AUTHOR

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