**“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 of 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).

The goals of the NCSES and CCS are employed by scientists in every aspect of their professional lives. So 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)

In addition this exercise aligns to all North Carolina Essential Standards in Information and Technology for grades 6-7 (6-8.SI.1; 6-8.TT.1; 6-8.RP.1; 6-8.SE.1).

**Learning Outcomes**

Students will be able to:

1. Describe what a scientist does and belay 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.

There are additional objectives that 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

There are other observational and formative assessments that could be made during the lesson. Activities before, during, and after the scientist visit constitute assessment in the interest and understanding of the student’s learning of what scientists do. Any modification of this lesson should be made by the teacher as it is deemed appropriate for their individual classrooms.

**Curriculum Alignment**

Scientific inquiry is an important component of the North Carolina Science Essential Standards (NCSES). This lesson promotes interest in science and what scientists do. The in-class activities align and support the NC Essential Standards descriptors for scientific inquiry. The expertise and information that the scientists bring to the classroom align to the various strands of earth, physical, and life sciences through scientific inquiry. The pre- and post-assessments of this lesson plan support the (scientific) literacy component of the CCS.

Middle school science content in North Carolina currently encompasses strands in the earth, physical, and life sciences. The general content of middle school science provides a good fit for this activity. Scientists may be from any specific discipline and may still have an impact on student perspectives on the importance of science education.

**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.

The lesson will begin with the scientist introductions and a description of the work they do. The scientist will be sharing what they do, how they do it and why it matters. They will share images, scientific tools, work samples, etc. that they use in their work. The remainder of the time, if any, will be used for a hands-on activity that the scientist and teacher will facilitate.

There is listed in the instruction a hands-on activity that will take approximately 25-30 to complete. The teacher may alter the hands on activity to account for the time the scientist presents. The focus of this lesson is the conversation and relationship of the class, scientist, and teacher. If more time is warranted for the scientist portion because of questions, presentations, or discussion then that time takes precedence.

**Materials Needed**

Materials needed for the successful implementation of this lesson include:

* 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

**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 boxes with item inside making sure to note what is inside each box for your records. Wrap each box completely with tape (“duck” tape is best and you can obtain different colors). 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.

**Technology Resources**

Equipment for scientist’s presentation includes:

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

**Activities**

**Pre-assessment**

The pre-assessment for this lesson will examine 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, 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 constructed on notebook 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. 15-20 minutes.

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. 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 can assign student groups to ensure a mix of performance levels.
* 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. Tell students you will bring them over a box with a mystery object inside but they are not (initially) to touch the box (2 min).
2. Teacher or scientist will give a box to each group. Place box carefully on table as if there is something extremely fragile or explosive inside (1 min).
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 (3 min).

1. Tell students to discuss with their group their individual observations (3 min).
2. Tell each group to choose one student to gently pick the box up. Only one student can tell the others of 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 (2 min).
3. 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 (2 min).
4. Once your group has completed the investigation, on your own, generate a scientific explanation in your notebook (i.e., work on your own ideas first). What is your hypothesis? What is your evidence (data) that supports your hypothesis (remember, data can include observations)? Use figures (sketches) to support your hypothesis (5 min).
5. As a group generate questions (what’s going on in the box?), generate hypotheses (I think this is what’s going on), and test out those ideas (This why this is going on. Do your tests support or refute your hypotheses?), then come to a group decision of the most viable scientific explanation for your group (5 min).
6. 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 your observations and data and record it (10 min) (Teacher 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 class 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 your ideas were similar or different to that of the group or class? Has your confidence of the contents of the box changed?

**Post-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 prospective perspective was prior to the scientist visit and compare and contrast the two perceptions. Evaluation of student interest and learning is indicated by the level of individual student discussion or teacher comparison of pre- and post-assessments or both.

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 learning disabilities 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
* Qualitative observation
* Quantitative observation
* Scientific literacy
* Hypothesis
* Experiment
* Collaboration
* Communication

**Websites**

* 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.

**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 Info**

Jeff Faulkner is an eighth grade science teacher at C W Stanford Middle School in Hillsborough, NC (Orange County Schools - OCS). He has taught secondary science for 7 years. He holds a Masters in Secondary Education and at the time of this lesson plan is a Doctor of Education candidate in Organizational Leadership from Grand Canyon University (GCU). Jeff has Received Educational Testing Service Special Recognition for General Science Content Knowledge PRAXIS test, Center for Teaching Quality – ASSET Fellow, NC Leadership and Assistance for Science Education Reform (LASER) member, OCS District Science Curriculum Planner. He a science teacher-leader for OCS and a 2012-2013 Kenan Fellow.

**References**

Chankook, K., & Fortner, R. (2007). Educators’ Views of Collaborators’ with Scientists. American Secondary Education, 35(3), 29-53.

Common Core State Standards Initiative (CCSSI, 2010). Common Core State Standards for English Language Arts & Literacy in History/Social Studies, Science, and Technical Subjects. Retrieved from <http://www.corestandards.org/assets/CCSSI_ELA%20Standards.pdf>

Laursen, S., Liston, C., Thiry, H., & Graf, J. (2007). What Good Is a Scientist in the Classroom? Participant Outcomes and Program Design Features for a Short-Duration Science Outreach Intervention in K–12 Classrooms. TCBE Life Sci Educ. 2007 Spring; 6(1): 49–64. doi: 10.1187/cbe.06-05-0165 Retrieved from <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1810206/>

Metacognition Workshop (2008). Making the “black box” model more transparent. Retrieved from <http://serc.carleton.edu/NAGTWorkshops/metacognition/activities/28952.html>

North Carolina Department of Public Instruction (NCDPI, 2011). ACRE: Accountability and Curriculum Reforem Effort. Retrieved from http://www.ncpublicschools.org/acre/standards/new-standards/

Owens, K. D. (2000). Scientists and Engineers in the Middle School Classroom. Clearing House, 73(3), 150.