P1.19 APPLICATION OF INQUIRY METHODS IN STUDENT'S ORIGINAL RESEARCH PROJECTS

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1. INTRODUCTION

National and state science education standards intensely promote the advancement of science inquiry and process skills in our students along with the science content for particular courses in science. By employing science inquiry-based learning methods on a regular basis in the classroom, an educator will not only meet the national and state science standards, but also create future independent thinkers and problem-solvers. Students make tremendous gains towards this end when they design and implement individual research projects using the inquiry process.

From the onset of the academic year, Earth Science students at Chatham High School in Chatham, NJ undertake the inquiry process as they design and implement a 6-month research project. After receiving exposure to the inquiry process through various class activities, students select an area of Earth Science where they can make quantitative, real-time measurements on a regular basis, and create a research question focusing on the gathering and analysis of the data. In gaining background information, students are encouraged to seek outside professionals, such as those in the Office of New Jersey State Climatologist or from local universities, for help in obtaining and understanding data. Upon completion of the research projects, students have not only gained experience in original research, but they have grown as learners and are ready to ask deeper questions and seek the answers, independently.

2. RATIONALE

Current and past research in science education advocates the use of inquiry-based teaching methods to closely approximate research methods used in various scientific fields, and to develop scientific literacy in students as they investigate their natural world. Benchmarks for Scientific Literacy (AAAS, 1994) and the National Education Standards (National Research Council, 1996) advocate the use of inquiry methods from the time students enter elementary school so that by the time they enter secondary school, they are ready to design their own investigations. As students advance through school, the role of content becomes secondary as the inquiry process begins with what the students already know as a foundation of their investigations. It is through this inquiry process, and when a depth of understanding is the focus rather than breadth that the nature of science emerges.

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The inquiry process is a tool for the curious, a tool for those who seek to understand their surroundings, and a tool that offers a methodical approach for acquiring knowledge. To use inquiry-based methods effectively, an understanding of how the brain works is a necessity. The National Research Council (2000) and Lowery (1998) suggest that students will use their previous knowledge to construct new knowledge once they begin to recognize relationships, and that "effective learning requires that students take control of their own learning". The use of student centered research projects allows students to satisfy their curiosities by exploring their natural world through the inquiry process, and allows students to build their own knowledge base in the process of investigating their own questions.

3. LONG-TERM RESEARCH PROJECT

Students enter 9th grade Earth Science at Chatham High School with varied backgrounds in the scientific inquiry process, therefore the academic year begins with an in-depth analysis of all aspects of the inquiry process. Open-ended lessons in observations and interpretations develop observational skills, and sequencing skills, since students are required to make careful observations before developing an interpretation of what they are looking at. After performing a variety of activities, students become proficient in using specific terms rather than vague terms, can identify quantitative versus qualitative observations, and can begin to understand how scientists create models of the unseen.

The school community is a great example of an outdoor classroom complete with ready designed inquiry-based lessons. The Chatham community is fortunate to have a variety of topographic features that are conducive to microclimates, and students recognize this by studying a topographic map of the community. Based on where they live and their background knowledge about temperature variations, the students themselves select three students in each class to take home a HOBO, a professional grade computer operated thermistor from Onset, Inc., to place in their yards for a 60-hour period. The students bring the HOBO's back to school after the weekend and the hourly data are downloaded. Data tables and graphs are created, and then the fun begins. Students are amazed at the temperature variations within their community, and start to make interpretations of the data. At this point, students are ready to start asking their own questions, and designing their own research project.

Students select a topic that is feasible for a 6-month project, and then develop a proposal that is carefully reviewed with the teacher. A major key to the success

and effectiveness of this project is in the excitement and curiosity of the students as they select their topics, so ample time is spent brainstorming possible investigative topics. In selecting a topic, students are encouraged to analyze their local surroundings for an interesting problem to study, or they may search various websites for real-time data. One website that they have successfully integrated into their local research projects is that of the Office of the New Jersey State Climatologist, http://climate.rutgers.edu where they compared their local climate data to data from another area in the state. In gathering their background information for their project proposal, students are encouraged to solicit the help of area scientists such as those in the Office of the New Jersey State Climatologist, and from local universities, such as New Jersey Institute of Technology. It is this type of relationship between the classroom and the professional that keeps the students excited about their individual projects, and helps them to see the validity of their efforts. Student investigations in the past have included a variety of temperature studies in New Jersey as well as in other areas of the country, various hydrologic studies of local streams, ponds, and rivers, ocean swell monitoring, and solar activity monitoring to name a few. Within the proposal, students develop a hypothesis based on their background information, propose a procedure and material list, and provide a data table that would be used during their investigation. Once a student has had their investigation approved, they begin the data collection process. One class (or more) is set aside at the halfway point of data collection for students to share experiences with their classmates.

4. OBSERVATIONS AND RESULTS

Throughout the data collection period, students occasionally have questions regarding methodologies, especially when an instrument breaks, or if an unforeseen circumstance causes a break in the data. At this point they begin to understand that there is more to the inquiry process than gathering data and analyzing data. They become problem solvers as they develop ways to work around roadblocks they stumble across in their research. Some students may elect to change their method and start over again, while others continue their dialogue with the professional that had guided them earlier in the process. After students have collected their data, possible display methods are discussed, and they decide which method would be most appropriate for their data set. On the due date for their project, students proudly share their results with their classmates, as well as any stories that have from performing their investigation. A research project that monitored solar activity on the sun and one that identified locations for concentrations of novae in M31, the Andromeda Galaxy, were accepted for publication in the RBSE Journal of National Optical Astronomy Observatory. Because of the outstanding work of the students in Earth Science at Chatham HS, it is the desire of their teacher that a wider audience sees the research projects of all the students. A method of disseminating their efforts is currently under consideration, such as via a website, or in a science fair type setting.

5. CONCLUSION

Leading the students toward independent thinking can be an arduous task, but if inquiry methods are continuously employed in a teacher's methods, students will make tremendous gains toward that end. A long-term research project is one inquiry-based method that is not only extremely effective, but is an extremely rewarding process for the learner and the educator. Students receive a grand sense of accomplishment at the end of the investigation, and are enticed to investigate their project further as they think deeply about their results. Through this, the educator has satisfied the requirements of national and standards to incorporate science inquiry and process skills into the curriculum by using long-term research projects as a methodology.

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7. REFERENCES

American Association for the Advancement of Science, 1993, *Benchmarks for Science Literacy, Project 2061*.Oxford University Press, New York, 9-13.

Duvall, C. and M. Holzer, 2001: Inquiry-based Weather Lessons Utilizing Real-Time Data. Preprints, *Tenth Symposium on Education*, Albuquerque, NM, January 14-19, 2001; American Meteorological Society, 93-96.

Lowery, L., 1998: *How New Science Curriculums Reflect Brain Research*. Educational Leadership, 56(3), 26-30.

National Research Council, 1996: *National Science Education Standards.* National Academy Press, Washington, DC, 22 and 105.

National Research Council, 2000: *Inquiry and the National Science Education Standards*. National Academy Press, Washington, DC, 115-128.