

**INTERDISCIPLINARY PROGRAM FOR IN-SERVICE TEACHERS;
WORKING WITH INDUSTRY AND UNIVERSITY TO ENHANCE
LEARNING EXPERIENCES IN THE STATE OF OHIO**

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ABSTRACT:

Science Teaching for Ohio's New Economy (STONE) is an interdisciplinary professional development program that in-service teachers grades K-12 that experience the integration of earth and physical science in an inquiry-based field. There are various field trips to various industrial settings that teach how geoscientist works in the aggregate industry. During the academic year there is a support system where the industry and the in-service teachers engage their students into real world industrial applications in the aggregate industry. This paper will discuss the utilization of high – tech instrumentation such as X-Ray Fluorescence and Scanning Electron Microscopy to teach real-world science applications of concern. Pre- and Post-test assessments as addressed by R.R. Hake have shown that these inquiry-based professional development workshops that integrated academia with industry as a positive outcome for our students in Ohio.

Keywords: Hands-on /Inquiry-based learning, Professional development, Interdisciplinary science, and Informing via Research.

INTRODUCTION:

Colleges and universities, whether large or small, public or private, well or poorly funded are all wrestling with the challenge of integrating an interdisciplinary experience between the university setting and the industrial setting [1]. These interdisciplinary experiences between university and industrial for our in-service teachers are vital to meet the state standards of teaching. One of our programs that address the interdisciplinary learning aspects for our graduate level in-service teachers is called "Science Teaching for Ohio's New Economy (STONE).

The key interdisciplinary aspects of this STONE program are working with the following organizations: OAIMA (Ohio Aggregates and Industrial Minerals Association), Barrett Paving Materials, Shelly Company, Ohio State Core

Repository, Caesar Creek Park, Columbus Limestone Quarry, Enon Sand and Gravel Aggregate Plant, Cemex, Sauls Seismic, Ohio Environmental Protection Association and Bowser-Morner Industry. These in-service teachers that visited all of these industrial settings were enlightened on the administration, structure and complexities of the aggregate industry. These field experiences provided the in-service teachers participating in STONE with the career opportunities for their own students and how to prepare students for these career options in the aggregate industry.

This interdisciplinary program between our university and industry had assisted in-service teachers in the state of Ohio to learn about the aggregate industry. These learning experiences are expanding to their students during the academic year as well while meeting the state standards to integrate math and science content together. The STONE features the following:

- 1) A summer professional development program for in-service teachers to visit and work with industry. These summer experiences are expanded with their students during the academic year.
- 2) A role for industry personnel in classrooms and laboratories during the academic year. Additionally, field trips are a vital part of these collaborations between industry and academia.
- 3) A new model for industry-college – K-12 (in-service teachers) to utilize novel instrumentation such as X-Ray Fluorescence and Scanning Electron Microscopy/Energy Dispersive Spectrometry.

EXPERIMENTAL:

Sediment samples collected at the quarry were analyzed by the following instrumentation: S-4 Pioneer Bruker X-Ray Fluorescence (XRF) Spectrometer

Instrument, and Aspex/ RJ Lee Personal Scanning Electron Microscope/Energy Dispersive Spectrometer. All samples /rocks were broken down with a mortar and pestle into fine powder before placed into the XRF instrument.

RESULTS/DISCUSSION:

The STONE program has allowed the participating K-12 teachers to integrate novel technology and has focused attention on the high school teachers. These participating high school teachers have integrated the novel technology such as the XRF and the SEM/EDS to analyze rock samples and concrete samples. The industrial collaborator Bowser-Morner has been an excellent partner in this program STONE to encourage teachers and students to utilize the latest technology while developing skills needed for industry jobs in this setting. Figure 1 displays ancient rock sample that was analyzed for fluoride ions. The XRF allows the rock sample to interact with radiation. The rock material is excited with high energy and short wavelength radiation hits the rock sample and thus the material becomes ionized. When the energy of the radiation is sufficient to dislodge the tightly held inner-electron then the atom becomes unstable and the outer electron replaces the missing inner electron thus fluorescent radiation as shown in Figure 1.

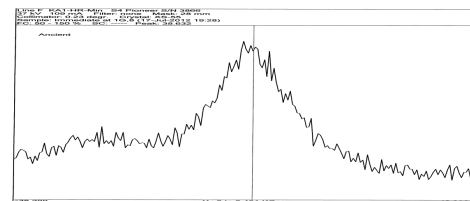


Figure 1. Ancient rock sample displayed Fluoride ions.

The STONE project was focused on the aggregate industry and how to produce concrete, which was a focus of the field trip at Bowser-Morner. The in-service teachers during the academic year require their own students to make stable concrete product and undergo testing to determine the optimized conditions to produce the overall best concrete material. Figure 2A and Figure 2B illustrates the use of an SEM instrument from Bowser-Morner to examine their concrete samples (before adding acid and after adding acid). One of the inquiry activities was to examine their concrete samples before acid rain and after acid rain (Does acid rain change the concrete material?). These concepts can be further examined using SEM/EDS to study the different elements present on the surface as well, which integrates the chemistry and geology concepts further as well.

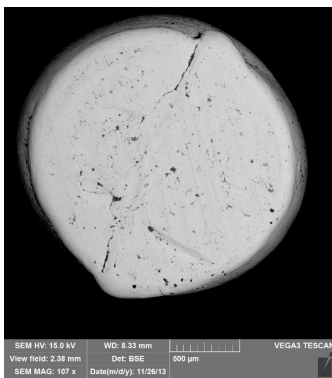


Figure 2A. SEM of Concrete sample with no acid rain.

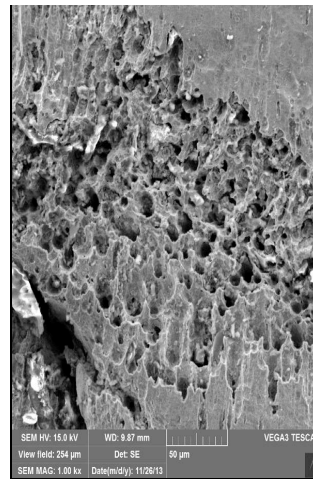


Figure 2B. SEM of Concrete sample with 0.1 M sulfuric acid rain.

CONCLUSION:

STONE has assisted the participating teachers to develop diversity in scientific thinking, The importance of personal experiences and connections with real scientist in industry, and communication of their findings while learning novel instrumentation and technology. Many students do not have the opportunity to transfer their learning knowledge into real-world applications. The content of looking at rock samples and examining for ions present focuses on the content area of geology and chemistry with real-world technology such as XRF instrumentation. This instrumentation was utilized to examine the non-metal anions such as F^- present. These field experiences have allowed our teaching participants to take a journey in the process of mine to mill

optimization thus drawing on the latest technology. Viewing mineral processing systems enable the participating teachers to learn about the concepts such as: grinding mills, crushers and screens, conveyors, separation equipment, slurry-handling equipment, pyro processing solutions, bulk materials handling equipment, wear products and mill linings. Pre- and Post-test surveys were performed of the participants and for their students as well to ensure a gain in content from these field experiences and hands-on labs with the aggregate industry. It was found that the participating teachers Normalized Gain was greater than 0.7, which typically are found for inquiry-based/hands on experiences in science classes [2]. These hands-on experiences and field trips have engaged students to learn and be excited about new technology in the aggregate industry [3-6].

The Pre- and Post-test exam questions engaged students into the following questions such as: What is the aggregate industry?, What is limestone?, What is an XRF?, What is an SEM?, What is concrete and what is cement?, Are concrete and cement the same or different and explain?, What is specific gravity and is in an important concept for industrial purposes in the aggregate industry?, What is OAIMA? These were the typical pre- and post-test questions that were part of the STONE program to ensure content knowledge was gained for the participating teachers and their own students as well. The participating teachers have continued field trips to industry such as Bowser-Morner, and Columbus Limestone Quarry, with their own students engaged in the real-world industrial experiences.

Project STONE participants in-service teachers have made such comments, as “they never understood what was an

aggregate and what was the industrial process. It was intriguing to learn about the importance of the aggregate industry and how it is essential part in the state of Ohio.” The Ohio Board of Regents funded this program and it has assisted the in-service teachers and their own students to excel in real-world science experiences that require their students to problem-solve and relate to future careers in the aggregate industry with technology [5-6].

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REFERENCES:

1. G.M. Bodner , W.J.F. Hunter, R.S. Lamba, *The Chemical Educator*, **3**, 1-21 (1998).
2. R.R. Hake, *Am. J. Phys.*, **66** (1) 64-74 (1998).
3. American Association for the Advancement of Science. *Benchmark for Science Literacy*; Oxford University Press: New York, 1994.
4. National Research Council. *Inquiry and the National Science Education Standards, A Guide for Teaching and Learning*; National Academy Press: Washington, D.C., 2000.
5. C. Chin & D.E. Brown *International Journal of Science Education*, **24**(5), 521–549 (2002).
6. M. Cole, *Computers & Education*, **52** (1), 141–146 (2009).