Pre-Service Teachers using their VOISES to verify STEM and Inquiry Training

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Abstract

It is well known that science education in the United States has shifted focus to accommodate the current and future demand of STEM and inquiry education. Pre-service teacher training is crucial to this movement and these students are given an opportunity to verify their STEM and inquiry training by participating in a voluntary program titled "Verification Of Inquiry & STEM Education Skills" (VOISES). This three semester program based upon the National Science Education Standards requires students to verify the competencies by completing indicator tasks. Once completed, the pre-service teacher usually places the letter and certificate in their student teaching portfolio and it can be referenced during an interview process.

Key Words: Nation Science Education Standards, STEM Education, Inquiry, Pre-service teachers

STEM education can be defined as an "approach to STEM subjects that are integrated through an instructional method that uses designed-based, problem solving, discovery, and exploratory, learning strategies" (Fioriello 2010). However, Gerlach (2012) warns that the definition of STEM can vary significantly pending upon who is asked. No matter the definition, the demand on STEM education has drastically increased in the past decade because STEM employment is expected to grow three times as fast as employment in other fields (Andres 2006). In order to keep up with the demand, teacher training and pre-service teacher training is at the utmost importance. Current, studies have indicated that current elementary (K – 5) teachers have a limited background in STEM education and the need to implement profession development is critical to increasing their confidence, attitude and knowledge of STEM education (Nadelson etc. al 2013). Additionally, Teo (2014) indicated the need for STEM education training for pre-service teachers, but cautions that focusing on just STEM training may limit the transition of the candidate to mainstream schools.

In my science methods courses, for both secondary and elementary pre-service teachers, the students are given the foundations of inquiry-based and STEM based education through classroom instruction. Furthermore, we conduct a minimum of seven classroom inquiry and/or STEM activities throughout the semester. Additionally, students are required to complete a variety of assignments that are inquiry and/or STEM related. These assignments include: an internet search of current science and/or science education primary article in which one of them needs to be STEM/inquiry related. Furthermore, students are required to find 3 internet science games in which at least one of them needs to be inquiry/STEM based. Finally, students are required to create a 10 lesson unit plan where one of the lessons needs to be inquiry based and a second one needs to be STEM based. Even with a large portion of the semester dedicated to inquiry/STEM education, pre-service teachers need additional training to become more proficient in these fields.

As a voluntary capstone program, pre-service teachers (early childhood and secondary) are afforded the opportunity to verify their inquiry and STEM training by participating in "*Verification Of Inquiry & STEM Education Skills*" (a.k.a. VOISES) program. The program is introduced in a science methods course and requires approximately three semesters to complete via acquiring signatures from various professors, advisors, supervisors and cooperating teachers.

Since our state has not adopted the Next Generation Science Standards, the VOISES program is linked to the National Science Education Standards (NSES). Although formatted differently for pre-service teachers, it is presented in its entirety for this manuscript. Each major category (I – VI) of the VOISES program corresponds to Chapters 3 – 5 (Teaching Standards, Professional Development Standards, and Assessment Standards) of the NSES and the program subcategories have indicators that represent a specific task the student must complete in order to verify satisfactorily completion of that competency. For program completion, the student must complete all indicator tasks; a letter of completion and a certificate is awarded at the conclusion of the program. Typically, the pre-service teacher adds these components to their student teaching portfolio that may be presented to a potential employer.

I. Professional Development

The first section of VOISES corresponds to *NSES Professional Development Standards* (Chapter 3) in which the student verifies "professional development for teachers of science requires learning essential science content through the perspective and methods of inquiry" (National Science Education Standard, Professional Development Standard A 1996). In order for pre-service teachers to fulfill this section, he/she must complete the two indicators and obtain signatures from a college advisor and/or co-operating teacher.

a. Indicator: Candidate attended an approved science workshop, lecture or symposium that falls outside the required college curriculum for teacher candidates.
b. Indicator: From an approved list, candidate observed an inquiry or STEM elementary, middle school, or high school class during pre-student-teaching.

In addition to content deepening that is acquired by completing the above two indicators, additional content deepening occurs through "professional development for teachers of science requires integrating knowledge of science, learning, pedagogy and students. It also requires applying that knowledge to science teaching" (National Science Education Standards, Professional Development Standard B 1996). In order for a pre-service teacher to complete this section of the program, he/she must verify the following three indicators:

a. Indicator: Assigned to a teacher who uses hands-on inquiry or STEM materials, candidate earns B average or better in Pre-student-teaching Seminar.[1]
b. Indicator: In the science methods course, candidate teaches an inquiry-based or STEM lesson to peers.
c. Indicator: Assigned to a teacher who uses hands-on inquiry or STEM materials, candidate earns B average or better in Student-teaching.[1]

[1]Note: Our pre-student teaching seminar includes the pre-service teacher spending 1 day/week with the co-operating teacher and a 90 minute seminar for 15 weeks. Our student teaching program includes the pre-service teacher spending 5 days/week with the co-operating teacher for 15 weeks.

The final subcategory correlates to the NSES professional development standard that includes "professional development for teachers of science requires building understanding and ability for lifelong learning." (National Science Education Standards, Professional Development Standard C). Pre-service teachers must verify completion of the following indicator:

a. Indicator: Candidate attended an approved science workshop, lecture or symposium that falls outside the required Saint Vincent College curriculum for teacher candidates.

II. Planning and Preparation

The second section of the VOISES program emphasizes the planning and preparation training for pre-service teachers where they are required to develop STEM and/or inquiry lesson plans. Correlating to the NSES Science Teaching Standards (Chapter 3), "teachers of science plan an inquiry-based or STEM based science program for their students (National Science Education Standards, Teaching Standard A 1996). Pre-service teachers must verify completion of the following indicator:

a. Indicator: Candidate develops an inquiry-based or STEM laboratory exercise congruent with curriculum and state science standards.

The second subcategory of planning and preparation includes "teachers of science guide and facilitate learning" (National Science Education Standards, Teaching Standard B 1996). In order for a pre-service teacher to verify this category, he/she must complete the following three indicators:

a. Indicator: Candidate researches and compiles materials for a discussion, debate or research paper on a current events topic or on current professional literature related to science. Topic is presented to peers in a science methods course.
b. Indicator: Assigned to a teacher who uses hands-on inquiry or STEM materials, candidate earns B average or better in Pre-student-teaching Seminar.
c. Indicator: In a course candidate generates a variety of levels of questions using the structure of Bloom's Taxonomy.

The final subcategory of this section includes, "teachers of science design and manage learning environments that provide students with the time, space and resources needed for learning science" (National Science Education Standards, Teaching Standard D 1996). In order for pre-service teachers to verify this category, they must complete the following two indicators:

a. Indicator: Candidate plans a mini-lesson to be presented in a teaching of science course that includes content, laboratory exercise, and assessment. Appropriate background content, all laboratory materials and assessment with clear directions will be provided.
b. Indicator: During science methods course candidate develops a lesson plan with several levels of inquiry strategies or a complete STEM lesson.

III. Teaching an inquiry/STEM lesson

Part three of the VOISES program focuses on a pre-service teacher's and student teacher's teaching while at their placement. The first of such subcategory correlates to the NSES (Chapter 3) where "teachers of science guide and facilitate learning (National Science Education Standards, Teaching Standard B 1996). For validation, the pre-service teacher must complete the following two indicators:

a. Indicator: Based on experiences in pre-student-teaching or in student-teaching, candidate designs and creates a science-oriented interactive bulletin board related to a lesson's objectives.
b. Indicator: Candidate uses inquiry strategies and STEM strategies during Student-teaching.

The second subcategory focuses on the classroom environment where "teachers of science design and manage learning environments that provide students with the time, space and resources needed for learning science (National Science Education Standards, Teaching Standard D 1996). A pre-service teacher can validate this category by completing the 2 indicators listed below:

a. Indicator: Candidate develops lesson plans and teaches a hands-on inquiry or STEM unit including content, laboratory exercise and assessment to students during student-teaching semester. Appropriate background content, all laboratory materials and assessment with clear objectives will be provided.
b. Indicator: Candidate uses cooperative learning in teaching a hands-on inquiry science lesson.

IV. Engaging students in the science lesson

Part four of VOISES continues verification by evaluating a student's performance during pre-student teaching and/or student teaching. The first subcategory corresponds to the NSES Science Teaching Standard (Chapter 3) which includes the notion that "teachers of science guide and facilitate learning (National Science Education Standards, Teaching Standard B 1996). Verification is complete when "Indicator a" is met.

a. Indicator: Candidate plans and facilitates a hands-on inquiry or STEM laboratory exercise during student-teaching semester. Where age-appropriate, students will select variable in a lab exercise, and the candidate will complete lab set-up with appropriate materials and will facilitate the laboratory exercise.

The second subcategory is based on NSES Science Teaching Standard that states "teachers of science develop communities of science learners that reflect the intellectual rigor of scientific inquiry and the attitudes and social values conducive to science learning (National Science Education Standards, Teaching Standard E 1996). Verification of this competency is completed with the single indicator.

a. Indicator: Candidate facilitates a cooperative laboratory exercise assigning roles to the students so that the completion of the task is facilitated.

V. Assessing in a science classroom

The final category of the VOISES program has three subcategories based on the Assessment in Science Education (Chapter 5) of the NSES. These particular indicators could be completed during a pre-service teacher's course work or during the pre-student/student teaching experience. The first subcategory correlates to "assessments must be consistent with the decisions they are designed to inform (National Science Education Standards, Assessment Standard A 1996). Verification of this competency is completed with a single indicator.

a. Indicator: In a methods course candidate designs assessments associated with a hands-on inquiry or STEM unit that are congruent with state standards and lesson objectives.

The second subcategory correlates to "achievement and opportunity to learn science must be assessed (National Science Education Standards, Assessment Standard B 1996). Completion of this subcategory has two indicators.

a. Indicator: Candidate earns a B average or better in Educational Psychology and Teaching and Psychology of the Exceptional Student.
b. Indicator: Candidate earns a B average or better in two or more science courses.[2]

[2]Note: All undergraduate students are required to complete a minimum of two science courses (with labs) for graduation.

The third subcategory correlates to "the technical quality of the data collected is well matched to the decisions and actions taken on the basis of their interpretation (National Science Education Standards, Assessment Standard C 1996). This competency is verified by the completion of 5 indicators.

a. Indicator: Candidate explains to the student-teaching supervisor the implications of an assessment or activity at the conclusion of a lesson.
b. Indicator: Candidate demonstrates modifying and adjusting during pre-student-teaching.
c. Indicator: Candidate demonstrates modifying and adjusting during student-teaching.
d. Indicator: Candidate uses self-reflection techniques during pre-student-teaching.
e. Indicator: Candidate uses self-reflection techniques during student-teaching.

Further verification of assessment is conducted in the second subcategory of this section that includes "Assessment practices must be fair *(National Science Education Standards, Assessment Standard D)*. One indicator is needed for verification.

a. Indicator: During student-teaching semester, candidate plans and implements three performance assessment strategies consistent with lessons' objectives.

The final subcategory includes verification that the pre-service teacher will "engage in ongoing assessment of their teaching and of student learning. Teachers of science guide and facilitate learning *(National Science Education Standards, Teaching Standard C)*. This subcategory includes 4 indicators:

a. Indicator: As a result of a hands-on inquiry or STEM lesson, candidate receives a favorable observation report from student-teaching supervisor during student-teaching semester.
b. Indicator: As a result of a hands-on inquiry or STEM unit, candidate receives a favorable observation report from cooperating teacher during student-teaching semester.
c. Indicator: Candidate is able to use self-reflection techniques during student-teaching.
d. Indicator: Candidate uses formal and informal reflection techniques with students during student-teaching.

VI. Science content

As a result of completing this program, it is anticipated that pre-service teachers have acquired inquiry/STEM skills in planning and preparation, teaching and modifying, questioning, and assessing. Furthermore, by completing VOISES, pre-service teachers should have an understanding of science as inquiry/STEM; and content mastery in physical science, life science, and earth-space science. Finally, pre-service teachers who complete this program should have an understanding of science in personal and social perspectives, and a history and nature of science.

VII. Conclusion

One of the challenges to the VOISES program is finding appropriate placements for our pre-service teachers. At the secondary level, our pre-service teachers are placed with a cooperating teacher of the same discipline as the certification sought (i.e., a biology certification seeking pre-service teacher is placed with a certified biology teacher). This usually does not inhibit the completion of the VOISES program. However, at the elementary level, our pre-service teachers are not always placed with a teacher who teaches science. This can create a nearly impossible completion scenario. The VOISES program is a relatively new and the first set of pre-service teachers were oriented in their science methods course during the Fall 2014 semester. As of today, there have been 24 pre-service teachers (both elementary and secondary) introduced to the program. It will take until the spring of 2016 to evaluate how many pre-service teachers complete the program.

So, as the demand for STEM skills increases in the work force, there is an increase in demand for qualified STEM instructors. Professional development of certified teachers is one way to increase the number of teachers trained in STEM, but training pre-service teachers is another way of increasing the number of STEM trained teachers. The VOISES program goes beyond the science classroom training and provides pre-service teachers an opportunity to enhance and verify their STEM training.

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