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Mixing Framework from Next Generation Science Standards (NGSS) to a Local Project

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Abstract

Lesson activity has a very important role in teaching Physics. Curriculum gives specific viewpoints about the frameworks of planning lesson activities. In each country, being familiar with these frameworks helps to conduct teachers to be self-planners for teaching process. This article is an experiment of studying the frameworks of the U.S. in the subject of teaching science and is a sample to show how a teacher can get involved in international projects to boost the skill of planning activities related national problems and goals. It can open a horizon of thinking about the putting together national and international goals and frameworks in learning and teaching physics in local.

Keywords

physics, English learning, NGSS, SSTELLA project

1. Introduction

As a Physics education researcher and visiting professor, my study started by a travel to the University of California, Santa Cruz in the summer 2015. I had a meeting with the principal investigator of the SSTELLA project, Professor Trish Stoddart (Note 1). She gave me the NGSS book relating to science teachers lesson activities and I received so many documents from the colleagues in this project. At the first step, I was invited to participate in their teacher training classes for science teachers (*English Language and Literacy Integration in Subject Areas (ELLISA) Project*). Firstly the main idea was to get familiar with their projects and the final goal was to plan activities for teaching resources in the SSTELLA project. The purpose of this paper is introducing the experiences related to study the main programs in curriculum planning for developers and teachers to know how use the resources and frameworks to plan new activities for teaching projects.

2. Method

2.1 English Language and Literacy Integration in Subject Areas (ELLISA) Project

At that time, courses based on the ELLISA project were presented for novice teachers in the University of California, Santa Cruz. ELLISA was one of the projects which were started in the California because of this state problem in students learning. The problem was introduced by some reports of resources. Students who are English Learners (ELs) make up a significant proportion of school age children in the United States. According to the U.S. Department of Education's Consolidated State Performance Report survey for 2009-2010, about 10 percent of all students or 4.6 million children were identified as ELs in K-12 public schools (U.S. Department of Education, 2010). By 2025, it is projected that English will not be the native language for about one quarter of all students (National Center for Education Statistics (NCES), 2011). Educators and policy makers have been concerned about large and persistent gaps in academic achievement between ELs and native English speakers in mathematics, science, language and literacy (Lee & Luyxx, 2006; NCES, 2010).

Although the demographic trends and achievement gaps related to ELs have been apparent for some time, few beginning teachers receive adequate preparation and training to teach subject content to ELs (Lucas & Villegas, 2011). Survey research has found that most teachers do not feel prepared to teach ELs in general (Parsad, Lewis, Farris, & Greene, 2001). In addition, results from a recent national survey indicated that only 15% of elementary teachers reported feeling well prepared to teach science to ELs (Banilower et al., 2013). ELLISA project focused on learning ambitious practices for teaching students who are English learners can be supported with representations of instruction, lessons and student work that can be analyzed and discussed, decomposing the practices for integrating language instruction in content area lessons into smaller parts, and providing novices teachers with opportunities to approximate practices through rehearsals and simulations in the methods course and in student teaching during practicums. In addition, conceptual and practical tools in ELLISA can aid teacher candidates in planning lessons and during teaching events are needed (Chee, 2014).

I participated in an ELLISA course, which guided me to get more information about the project of the group and working with experts. This course focused on lesson planning and implementing effective instructional practices that integrate the teaching of language and literacy into particular attention paid to developing lessons based on the Next Generation Science Standards (NGSS).

Figure 1. Team Working in Teacher Training Courses in ELLISA Project, UCSC, Lecturer: Dr. Joe Chee

In this project some strategies for integrating language and literacy in science instruction promote academic discourse for English language and literacy integration in subject areas were considered, which were Academic Discourse, Support Science Literacy Development, Scaffold Language and Content and Contextualize Learning.

2.2 Next Generation Science Standards (NGSS for California's Public Schools)

Inquiry science, is an excellent context for learning language and literacy. Integrating the teaching of science content with the development of English language and literacy through contextualized science inquiry has been consistently shown to increase English learners' achievement in both science and in the development of academic language and literacy (Bravo & Garcia, 2004; Rosebery & Warren, 2008). These advances in the knowledge base on teaching science and English language and literacy to English learners are consonant with the discourse about the development of NGSS. Similarly, the NGSS represents a major shift from the focus of scientific literacy as decontextualized content and process knowledge toward scientific literacy as the productive and integrated use of science language with science content while simulating what scientists do (e.g., plan investigations, develop models, argue from evidence). The NGSS, based upon the National Research Council report (National Research Council, 2012), *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas*, identifies core science ideas and cross-cutting themes that students could learn in more rigorous and relevant ways as they progress through their K-12 science education. Further, the Science Framework provides a description of eight scientific and engineering practices that promote not only investigative competence, such as asking questions, planning investigations, and analyzing data, but also representational thinking through the use of models and mathematical relationships. In addition science and engineering practices are particularly language intensive: developing and using models; constructing explanations (science) and designing solutions (engineering); arguing from evidence; and obtaining, evaluating, and communicating information (Lee, Quinn, & Valdes, 2013).

Few models of science teaching have been articulated in terms of how preservice secondary science teachers can learn to (a) promote authentic scientific discourse practices (Stoddart, 2013), and (b) engage students in rigorous, contextualized learning experiences in linguistically diverse science classrooms (Tolbert, 2013). Secondary science teachers generally consider themselves to be teachers of content rather than teachers of language, despite the fact that scientific argumentation, reasoning, and communication require a multitude of specialized written and oral literacy practices (Rodriguez, 2010). The prominent focus of NGSS on productive language use via the identification of language-intensive science and engineering practices has opened up new possibilities for all science teachers to consider the role of language in science and engineering instruction. More information about the NGSS and some experience about ELLISA project helped me to pay attention to the importance of NGSS and I focused on the standards of NGSS. For instance I chose a title for study and teaching in the K-12 to students and then find the frameworks and standards of it in the NGSS. Mixing the project strategy with the NGSS standards was the other investigation.

For instance NGSS for the subject of duality nature of light (HS-PS4-3. The Wave or Particle Nature of Electromagnetic Radiation) has this framework:

Students who demonstrate understanding can: Evaluate the **claims, evidence, and reasoning** (Note 2) behind the idea that (core idea): electromagnetic radiation (crosscutting): can be described either by a wave model or a particle model (Note 3), and that for some situations one model is more useful than the other (Note 4). (Clarification Statement: Emphasis is on how the experimental evidence supports the claim and how a theory is generally modified in light of new evidence. Examples of a phenomenon could include resonance, interference, diffraction, and photoelectric effect. *Assessment Boundary: Assessment does not include using quantum theory*.)

On the other hand NGSS mentions Common Core State Standards Connections *for English learning Acquisition/Literacy*:

RST.9-10.8: Assess the extent to which the reasoning and evidence in a text support the author’s claim or a recommendation for solving a scientific or technical problem.

RST.11-12.1: Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

RST.11-12.7: Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

RST.11-12.8: Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

WHST.9-12.2: Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.

In Physics, *mathematics standards has to be considered*: **MP.2:** Reason abstractly and quantitatively. Making connections between these areas of subjects needs deep study and considering multidisciplinary character of knowledge. I found so many relations between several areas in NGSS: *Connections to other disciplines in this grade-band and articulation of disciplines across grade-bands*.

2.3 Secondary Science Teaching with English Language and Literacy Acquisition (SSTELLA) Project

Secondary Science Teaching with English Language and Literacy Acquisition project reflects the reciprocal and synergistic relationships among science, language, and literacy. Integrating the teaching of science content with the development of English language and literacy through contextualized science inquiry has been consistently shown to increase English learners' achievement in both science and in the development of academic language and literacy (Bravo & Garcia, 2004; Rosebery & Warren, 2008). SSTELLA reflects principles from the Science Framework and is designed to prepare teachers to effectively integrate science, language, and literacy instruction for ELs by promoting the productive use of science language in authentic contexts, whereby "students are supported in using multiple resources and strategies for learning science and developing English" (Lee, Quinn, & Valdes, 2013). The framework views contextualized science activity as the gateway through which ELs can come to understand relationships between school science learning and their lived experiences outside of schools. Teachers promote scientific sense-making, scientific discourse, and English language and literacy development through these contextualized learning experiences. Science content and language then intersect as students, for example, construct oral and written explanations and engage in argument from evidence (Seyed Fadaei, 2016). Thus, the relationship between science learning and English language and literacy development can be viewed as reciprocal and synergistic.

SSTELLA aims to contribute to the knowledge base on preparing secondary teacher to teach science to ELLs. The SSTELLA instructional practices are *scientific sense-making through scientific/engineering practices*, *scientific discourse through scientific/engineering practices*, *English language and literacy development*, *contextualized Science Activity*.

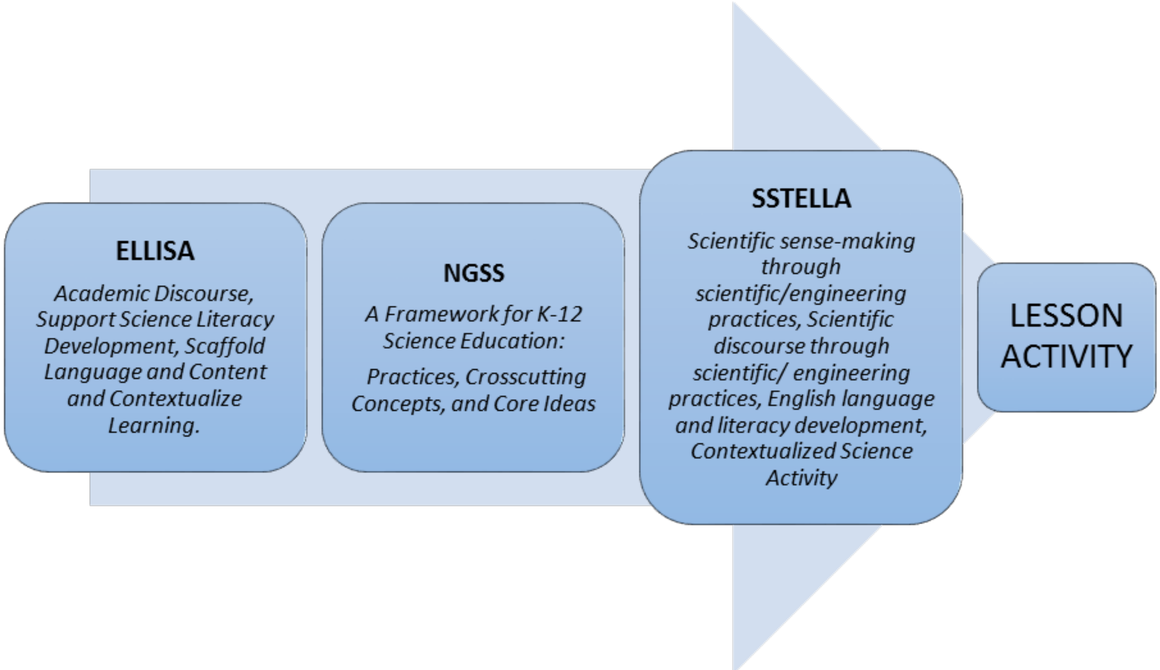

Figure 3. The Project in Progress

By engaging students in science investigations and engineering design problems in authentic, real-world problems, teachers can leverage students' funds of knowledge from their homes and communities, the local physical or ecological environment, and/or socio-scientific issues as a way to engage ELs in meaningful and rigorous science learning experiences. To summarize, the four interrelated instructional practices just described highlight the reciprocal and synergistic relationship between science learning and English language and literacy development. LESSON LEARNING OBJECTIVES AND ASSESSMENT depending on NGSS framework and SSTELLA determined the Scientific Objectives of the duality nature of light as follow (Seyed Fadaei, 2017):

1) Students will investigate the duality nature of light (NGSS, HS-PS4-3).

2) Students will identify the evidences related to wave and particle model of light (NGSS, HS-PS4-A).

3) Students will identify the reasons behind the new technologies based on duality of light (NGSS, HS-PS4-B).

4) Students will identify with discovering new evidence in nature of light while old theory does not accommodate, the theory is generally modified in light of this new evidence (NGSS, Nature of Science).

Language Learning Objectives:

1) Students will be able to assess the extent to which the reasoning and evidence in a text support the author's claim about each model of nature of light. (**RST.9-10.8**)

2) Students will be able to integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question about the

duality nature of light. (**RST.11-12.7**)

3) Students will be able to evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (**RST.11-12.8**)

4) Students will be able to write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes. (**WHST.9-12.2**)

After determining the most important factors in a lesson activity, the idea of the developer has an effective role on the details of the lesson plan. Using some diagrams, photos, videos (Seyed Fadaei, Daraei, & Mora Ley, 2013), charts and photography, questionnaire, activities and mixing them in to the verbal and writing contexts is very important for final version of the lesson activity (Seyed Fadaei & Mora Ley, 2015). The thing is very important is the developer of the lesson plan has his own choices to mix the subjects and equipment and activities but the importance of working in the frameworks and standards and relating it to the language literacy and learning English must be considered.

3. Result

In this article, we suggest using frameworks, for developing a preservice teacher education program designed to prepare secondary teachers to integrate the teaching of academic language and literacy with rigorous physics content instruction. We see the SSTELLA framework, which builds on the NGSS, as central to this integrated model of pre service secondary teacher preparation. Although this article has focused on the preparation of teachers to work with ELs, the new standards recognize the critical role that language, literacy, and discourse play in the learning of science for all students.

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Note

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Notes

Note 1. Dr. Trish Stoddart is a Professor of Education at the University of California, Santa Cruz. Dr. Stoddart is an expert at improving the teaching of science in culturally and linguistically diverse classroom. She has extensive experience in research on instructional innovation and science education and has led several large federally funded projects including the NSF funded Effective Science Teaching for English Language Learners (ESTELL) project, the NSF funded Local Systemic Initiative LASERS (Language Acquisition through Science Education for Rural Schools) which brought together seven school districts to improve the teaching of science to English Language learners in California's Central Valley.

Note 2. Science and Engineering practices:

-Engaging in argument from evidence in 9-12 builds on K-8 experiences and progresses to using appropriate and sufficient evidence and scientific reasoning to defend and critique claims and explanations about natural and designed worlds. Arguments may also come from current scientific or historical episodes in science.

-Calculate the claims, evidence and reasoning behind currently accepted explanations to determine the merits of arguments. —Connections to Nature of Science:

Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena

A scientific theory is a substantiated explanation of some aspect of the natural world, based on a body of facts that have been repeatedly confirmed through observation and experiment and the science community validates each theory before it is accepted. If new evidence is discovered that the theory does not accommodate, the theory is generally modified in light of this new evidence.

Note 3. Disciplinary Core Ideas:

Wave properties

-[From the 3-5 grade band endpoints] Waves can add or cancel one another as they cross, depending on their relative phase (i.e., relative position of peaks and troughs of the waves), but they emerge unaffected by each other, (Boundary: The discussion at this grade level is qualitative only; it can be based on the fact that two different sounds can pass a location in different directions without getting mixed up)

PS4.B: Electromagnetic Radiation

-Electromagnetic radiation (e.g., radio, microwaves, light) can be modeled as a wave of changing electronic and magnetic fields or as particles called photons. The wave is useful for explaining many features of electromagnetic radiations and particle model explains other features.

Note 4. Crosscutting Concepts:

Systems and System Models

-Models (e.g., physical, mathematical, computer models) can be used to simulate systems and interactions-including energy, matter, and information flows—within and between systems at different scales.