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Water in a Changing World: Developing Learning Materials for Pre-Professional Teachers in Brazil and the United States

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Abstract

The goal of this project is to develop learning materials for pre-service teachers. The project builds on a successful four-year environmental studies student exchange supported by the Funds for the Improvement of Post-Secondary Education (FIPSE – United States) and Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES - Brazil). The collaboration is between Colorado College (U.S.) and the Federal University of Juiz de Fora (Brazil). The FIPSE-CAPES project established new faculty-to-faculty collaborations for the enhancement of teaching science and field work distinctive to the natural settings of the host institutions and established innovative, inquiry-based environmental field experiences, data-driven learning modules, and course materials to be used by pre-teaching professionals as part of their teacher training, when taking courses to fulfill undergraduate degree requirements. As a result of the FIPSE-CAPES project, we established a framework for developing curricular materials for pre-professional teachers. The first set of materials focuses on issues related to Water Resources and utilizes the curricular design framework: essential questions, case studies, benefits and costs, and challenges to educators. The framework for development and invitation to participate will be presented.

INTRODUCTION

In the United States, the curriculum is determined in large part by either the state boards of education or by local school district boards of education. Guidelines, or standards, for the curriculum are the determining factor that influences both the development of standardized examinations (issued once per year) and the selection of curriculum materials. Pre-service teachers are generally taught to develop classroom lessons with the standards as learning targets.

However, forty-five of fifty U.S. states have now adopted the *Common Core State Standards* [1] for math and literacy (http://www.corestandards.org/the-standards). Since the implementation of the federal law known as *No Child Left Behind*, each state in the United States has been developing standards to meet the law's requirements of all students reading proficiently at grade level. However, there was large inconsistency among states as to what defined "grade level" [2]. Thus, the new *Common Core* standards provide an opportunity for each participating state to focus on alignment of expectations and, subsequent development of core competencies for annual examination.

In contrast, the curricular and teaching expectations in Brazil are determined nationally. In early 2000 and 2002, the *National Curriculum Parameters (PCN)* established the curricular guidelines for the natural sciences, with content and procedures for secondary schools in 2006 [3]. Brazilian states have the opportunity to develop regionalized curriculum that fits within the national criteria. At issue in Brazil and in the United States is that such nationalization of standards and expectations often neglect cultural relevance and practical knowledge [4, 5].

In addition to understanding national content and curricular expectations, teachers need to be well versed in learning and development. Most educators are educated on Piaget [6] and Vygotsky [7] learning

theories. Within the sciences, constructivism [8] serves as a framework for teaching the nature of scientific inquiry. Unfortunately, utilizing constructivist principles for guiding instruction conflicts with the pressure of preparing students for high stakes examinations, resulting in a more direct instruction (lecture) method of pedagogy. Thus, how can we support the development of teachers to insure sufficient science, pedagogical, curricular, and socio-cultural preparation?

RATIONAL FOR ESTABLISHING A FRAMEWORK

The United Nations Educational, Scientific and Cultural Organization (UNESCO) publication *Water in a Changing World* [9] provides an argument for research in finding solutions for building human capacity organized around six drivers: agriculture, energy, health, industry, environment, and poverty (p. 79). The report recognizes e-learning and tradition education as critical in developing such capacity.

Effective education provides a socio-cultural feedback loop: innovation as a result of a well educated workforce improves sanitation, which improves the ability for school-age children, particularly females, to attend school rather than focusing on collecting safe water. Improved access to education enhances the ability to build an educated workforce. It is therefore imperative that pre-service teachers understand key scientific principles, understand culturally relevant local issues, and utilize their pedagogical knowledge in delivering curriculum that builds capacity. Focusing on undergraduate (post-secondary) pre-service teacher education programs provides the advantage of insuring sufficient content learning coupled with development of pedagogical strategies.

THE FRAMEWORK

The design of learning materials for pre-service teachers is based on constructivist design principles [10]. In addition, our goal is to provide learning materials, which are easily accessible (electronic delivery) and economically cost-effective. The intent is for user driven materials with updates of local case studies, which provide relevance to the local concerns/issues and updates on effective implementation strategies. Recognizing the top-down approach of nationalized curriculum expectations, we purposefully connect each chapter with expectations. This aids in validation by providing teachers with an opportunity to evaluate their teaching with standardized examination results.

Each chapter is organized around key scientific questions our *essential questions* (Table 1). The essential question(s) provides the pre-service teacher with a sense of how scientists think about problems. The case study contextualizes the problem, creating necessary relevance for the teacher, and subsequently, her/his future students.

We feel it is important to include a section in the chapter on the pros and cons of the environmental issue. Policy shapes the conversation and, therefore, it is important for teachers to be aware of the (often) conflict between policy decision-making and local needs.

All cultures face challenges to translating knowledge into learning into worker productivity. Challenges are often economic: reduction of costs for delivery; hiring of sufficiently prepared teachers; unavailability of sufficient learning resources; keeping up with pedagogical reforms [11]. We feel by focusing on pre-service teachers still in university settings, they can more readily address these challenges and propose solutions within their own learning communities. Each chapter provides illustrative examples of such challenges and proposes solutions.

Table 1. Design template for each chapter.

Section	Purpose
Essential Question(s)	What essential question(s) does the lesson to answer? This section includes information about what scientists currently understand and the issue relates to climate change and the hydrologic cycle. We also include standards for learning in Brazil (PCN) and in the U.S. (Common Core; New Generation Science Standards). The aim of this section is to describe why the information is important for teachers to know and understand.
Case Study	The case study provides an example that illustrates the social issue and scientific understanding. The case study also discusses the context of the problem. Is this problem unique?
Pros and Cons	Policy makers are sometimes faced with conflicting ideas about how to address the environmental problem. What are the pros and cons of these ideas? What might be the best solution?
Challenges to Science Education	What can teachers do? What are some other similar cases they could discuss with their students? What are some other ideas for further reading and or curriculum materials that might help teachers?
Resources	List scientific resources, useful websites, and/or books that will help the teacher learn more.

EXAMPLE CASE STUDY – HEALTH

Access to sanitary water has been an issue for humans since the first identified illness from water born disease became public knowledge. Solutions often focus on *engineered solutions* (e.g., water treatment facilities), which are often cost-prohibitive in developing countries. Moreover, such solutions are not part of the base knowledge of teachers. Thus, our chapter on *Human Use and Health* is driven by the essential question, *what is the underlying biological or physical cause of the contamination?* The chapter presents a case study on a common parasite, *Schistosoma mansoni*. The case study focuses on the life cycle of the parasite and intermediate host, and how coming in contact with contaminated water leads to “water belly.”

The chapter presents the life cycle of the *S. mansoni* in context of the life cycle of the parasites intermediate host – a snail indigenous to Brazil. Solutions include use of chemicals or biological predators to eradicate the snail. However, these solutions either present consequences in water contamination or fail to completely impact the parasite issue (e.g., biological predator-prey balance). This case study does not pretend to present the absolute solution to the pre-services teacher. Rather, to engage the pre-service teacher in a dialog around the science, preparing them to do the same with their students, in hopes that the students would develop a localized, innovative solution to the sanitation problem.

SUMMARY

We present here our structure for developing learning materials for pre-service teachers and invite comment on four major topics: water use for agriculture; water use for energy; water use for human consumption; and, water for maintaining ecosystem biodiversity. The materials are designed for pre-

service teachers, and to be presented during their university preparation experience. The goal is to provide an approach to science education that expands the possibility of more localized solutions to common issues around water.

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