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# Safe science classrooms: Teacher training through serious educational games



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## ABSTRACT

STIMULATE (Science Training Immersive Modules for University Learning Around Teacher Education) is a Serious Educational Game (SEG) designed to advance science teacher preparation and development, by creating a laboratory safety module that immerse teachers in scenarios previously taught using only hypothetical case studies. This study employed a two-phase design based methodology. The first phase was a cognitive task analysis of a convenience sample ( $n = 10$ ) of preservice and in-service science teachers in which they described their key issues and concerns regarding chemical laboratory safety planning, response, management plan, and assessment. Phase 2 examined the usability and effectiveness of STIMULATE's initial build on 31 preservice teachers. The  $t$ -test for equality of means demonstrates that there is a statistically significant difference between pretest and post-test scores,  $t(30) = 14.79$ ,  $p < .001$ ,  $d = 2.56$  (large) Overall, results suggest positive learning gains from the preservice science teachers who engaged in STIMULATE program.

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## 1. Introduction

Science education in the United States is undergoing a major shift toward pedagogy that embeds the use of technology as a vehicle to understand both practice and fundamental concerns within science classrooms; yet current preservice science teacher learning approaches and supporting tools allowing for viable scale-up toward this shift are absent in much of teacher education.

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### 1.1. Game scenario and explanation

This following vignette is designed to introduce what a teacher playing the STIMULATE Serious Educational Game will encounter upon login. The teacher takes the role of Samantha, a first year teacher who will be responsible for teaching high school chemistry. It is the summer before she is to start teaching at *Patriot Lake High School* and she is eager to see her assigned classroom. Samantha is taken aback by the lackluster conditions in Room 361 as she opens the door for her first look at her classroom. What must have once been a 'state of the art' chemistry classroom in the 1980's is now a neglected and potentially dangerous workplace. Samantha's somewhat idealized visions of 25 young scientist-students engaged in exciting chemistry laboratories is quickly replaced with a reality of dilapidated laboratory tables, drooping fume hoods, and a dirty, disorganized chemical storage room that is in desperate need of some attention and order.

This fictional scenario closely mirrors what many of today's high school science teachers potentially face. Some questions that quickly come to mind when seeing the conditions of her room are; how does Samantha ensure the safety of her students? Does she know how to conduct a safety audit? Does she know what Material Safety Data Sheets (*MSDS*) are? Is she able to sift through and organize the chemical storage room? Will she have the practical hands on experience with laboratory safety that will enable her to deal with emergencies, which, may arise.

Many teacher education programs do not offer training or an answer to the myriad of problems or questions raised within vignette. This lack of substantive guidance is compounded by the lack of focus in secondary science teacher programs on how the initial entry teacher would address the problems of an inadequate or unsafe laboratory. Many times teacher education programs leave it to local districts to train their new teachers in laboratory safety and maintenance [24].

### 1.2. Purpose and research questions

The intent of the STIMULATE project is to provide preservice teachers with an authentic scenario driven training environment simulating an initial licensure science teachers first day at school handling an unsafe laboratory environment. All of the tasks and problem-solving approaches are within the confines of a Serious Educational Game (SEG) offering a soft-failure low stakes environment for teacher training. The aim of the project is to provide preservice teachers within science education teacher preparation programs exposure and practice in solving real-life laboratory safety concerns in this real-time responsive virtual environment. The eventual desired outcome is the transfer of knowledge, practice, and heuristics to actual classroom practice during the preservice teachers first year of teaching. Training based in the STIMULATE SEG fulfills a critical gap in science teacher education by providing instruction and practice related to secondary science (grades 9–12) laboratory maintenance and safety procedures, which are not otherwise, addressed in science-teacher preparation programs.

This article describes the iterative design and testing process of a Serious Educational Game (SEG) [2] called *STIMULATE* (Science Training Immersive Modules for University Learning Around Teacher Education).<sup>6</sup> The authors of the study explore the effectiveness of gaming scenarios for teaching secondary school preservice science teachers practical knowledge of chemical safety. Along with this exploration the authors, crystallize some of the preservice science teachers concerns related to laboratory safety and response. The authors also discuss usability and implementation issues that will feed future design and test cycles related to *STIMULATE*.

To this end, the study investigated the following research questions:

1. Do preservice science teachers learn safe classroom practices from playing *STIMULATE* in terms of safety knowledge and emergency responses?
2. Do preservice male and female science-teacher learning experiences as measured by pretest and posttest outcomes differ significantly while using the *STIMULATE* SEG?
3. What are preservice science teacher concerns about lab safety and how do they inform future iterations of *STIMULATE*?

### 1.3. Background

#### 1.3.1. The importance of science safety

Laboratory safety is a critical component of K-12 science instruction; with no primary literature related to the topic within the science education realm for schools and teachers to develop best practices, the National Science Teachers' Association (NSTA) has put forth *declarations* that speak to laboratory safety importance within the K-12 classroom (NSTA, n.d). For example, NSTA recommends that school districts and teachers adopt written safety standards; hazardous material management, disposal procedures for chemical and biological waste, and share the responsibility of establishing and maintaining safety standards. They (NSTA) go onto suggest that all science teachers must be involved in an established and on-going safety-training program relative to the established safety procedures updated on an annual basis. Further, Standard 9 of the *NSTA Standards for Science Teacher Preparation* (NSTA-SSTP) [28] suggests that science-teacher preparation programs provide initial licensure science teachers with the knowledge and skills to understand and successfully engage students in a safe

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