Chapter 32
Implementing Virtual Lab Learning to High School

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ABSTRACT

Science is traditionally considered one of the most complex and demanding subjects in school, yet can be one of the most inspiring experiences one has encountered in their academic life. Scientific knowledge can be applied to and explain everyday life phenomena beyond the boundaries of a conventional classroom. This is the key to teach and learn science effectively and can be assisted by technology as a pedagogical tool. The i²Flex model was implemented in a High School Science IB class as online/virtual laboratory investigations, in an effort to enhance high cognitive skills and academic performance of students. By allowing students to self-pace and self-direct their learning and practice to some extent, students not only engaged more actively in the science curriculum but improved their practical, writing and even collaborative skills. Teaching time in class became more flexible and productive and addressed areas of learning, such as critical thinking, analysis and elaboration of performed work, which have always puzzled students and perhaps lowered academic outcome.

INTRODUCTION

Many would agree with the French physiologist Claude Bernard's quote (BrainyQuote, n.d.): "Observation is passive science, experimentation an active science". This is fundamental when teaching or learning science at any level. In a traditional school setting, science would be taught by an instructor in a lecture-based lesson with students passively listening and participating occasionally in oral discussions spurred by their instructor or classmates. Testing of taught theory by experimentation would involve conducting a procedure in an appropriately equipped laboratory under specific conditions with certain materials available. Paper lab manuals and lab notebooks would be used by students to record data and make observations. In recent years, the traditional chalk boards in most schools have been replaced by the novel interactive smartboards, which already urge instructors to think more creatively about teaching

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science, and make the lesson more interactive and appealing to students even beyond the class boundaries. Traditional lab booklets can now be replaced by electronic manuals and students may now take lab notes using their laptops or tablet devices. Experimental science is in the center of technological advancement and this should be taken into account when teaching or learning it. This is exactly what this chapter attempts to approach from the instructor's point of view but always maintaining the focus on student-centered learning.

BACKGROUND

In the final years of High School and especially in demanding and rigorous high honors classes and/or International Baccalaureate (IB) classes, science often seems to the eyes of students as really "rocket science''! Academic outcome may frequently be hindered by lack of interactive and life-connecting experiences of scientific concepts. As a former science researcher and a current instructor in IB/AP Biology and Environmental Science, I seek-alternative to conventional-ways of teaching Biology or Environmental Science in a theoretical and practical level not only to satisfy academically the college or university requirements, but to instill the scientific method and way of thinking in young individuals, who will become science professionals and the future citizens of our society.

Empowering young individuals to construct their own learning by being autonomous, taking initiatives, analyzing, synthesizing and evaluating their knowledge and understanding is the basis of constructivist pedagogy (Brooks & Brooks, 1999). Initially, this new methodology may seem utopic or even radical to many traditional instructors but it gains more and more ground in modern schools as it challenges instructors to transform into mediators of students and environments, instead of simply being providers of information and managers of behavior. Taking this into consideration, the idea of implementing blended learning into the teaching of experimental science in the form of complementing the face-to-face class meetings with virtual or online laboratory activities formed my own action research topic as an educator, and opened up a new era to me as an instructor to use technology as a pedagogical tool to meet student needs and address different learning styles. Specifically, virtual/online laboratories are delivered with computer technology and offer investigations, which involve simulated material and equipment and are performed by the students. Additionally, another type of online laboratory can be performed by students with physical apparatus operated at a distance or alternatively students can base their investigation on datasets already manipulated by usually professional organizations (de Jong *et al.*, 2014). In recent years, a repository for online experiments has been developed which includes online labs, learning applications, and virtual inquiry learning spaces making them accessible to teachers all over the world (Dikke *et al*., 2014). In my class setting I have mainly used virtual simulations of well-known experiments in Biology (see examples below), which offered the opportunity to compare them directly with hands-on laboratories and were user-friendly, easily accessible online for all students, and provided a wealth of experimental skills to students of all learning levels.

Although the value of physical hands-on experience cannot be disqualified, there is now a wealth of literature about using virtual teaching of experimental skills and practices starting from K12 up to higher education. Numerous universities have included in their educational programs online courses and many university instructors have already incorporated online components in their teaching. K12 studies have investigated physical *versus* virtual experimentation in specific science subjects. For instance, Zacharia and Olympiou (2011) conducted an experiment on heat and heat transfer that showed that virtual labs