

Utilizing Online Technology to Effectively Teach Chemistry in Secondary Education

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Commentary

Integrating technology in the secondary education classroom allows students to build 21st century technology skills that they will be able to carry into any workforce and use for the rest of their life. As chemistry instructors consider new ways to integrate technology into their lessons they must consider how technology will help students reach their student learning outcomes required by the state. For instructors, determining the effectiveness of using online technology to teach chemistry students in secondary education can be a difficult undertaking [1,2].

Technology use has been found to increase student achievement and motivation [3-8]. More evidenced-based research studies are needed that measure the effectiveness of online technology by secondary chemistry teachers on student achievement. Teachers are under great pressure to meet the guidelines and requirements for student learning outcomes. Teachers who fail to meet these guidelines and requirements for student learning outcomes which are assessed by student achievement scores could face great consequences.

Herein, a review of evidence based research studies that use student achievement scores in secondary schools for determining the effectiveness of online technology to effectively teach chemistry was conducted. Based on high school student achievement scores from five studies it was determined that the use of online technology to teach chemistry was indeed effective [9-13]. The definition of "online technology" in the context of this review refers to any form of technology that affords students in a classroom access to outside resources using 21st century technology.

The review begins with a rural school in a foreign country looking to implement computer-based instruction into a chemistry classroom. For this rural school, determining the effectiveness of computer-based instruction in chemistry classes needed to be established before money could be invested into the new concept of online educational technology. The objective behind implementing computer-based instruction was to offer computer simulations and audio recordings to help students better understand difficult to learn abstract chemistry concepts. Measurement of student achievement was determined by pre-test and post-test administered to control and experimental groups of high school chemistry students. Results of post-test scores concluded that chemistry can be taught effectively though computer-based instruction [13].

A different research study conducted by Lamb and Annetta, supported Saminathan's 2012 findings [10]. The investigators

determined the efficacy of online modules on student learning outcomes in a high school chemistry classes. Lamb and Annetta measured student achievement by administering pre-, intermediate-, and post-test during and after chemistry laboratory online simulations. Analysis of test measuring student achievement demonstrated students obtained a deeper level of understanding chemistry content [10].

A more recent study, "Promoting Intrinsic and Extrinsic Motivation among Chemistry Students Using Computer-Assisted Instruction" conducted by Gambari et al., concluded in their findings, students who used virtual chemistry labs in the academic setting had improved student achievement scores. Gambari et al., findings support the effectiveness of using online technology to teach chemistry in secondary schools [9].

Another research study published by principle Dr. Anita Menon analyzes the effectiveness of smart classrooms to teach chemistry in secondary schools [11]. A smart classroom consists of interactive technologies that allow teachers to have immediate access to various types of multimedia along with online computer access. In this study, two groups of students were formed to create a control group and an experimental group. Students in the control group were placed in a traditional classroom, while students in the experimental group were placed in the smart-classroom setting. Analysis of pre-test and post-test measuring student achievement demonstrate greater student achievement scores for students in the smart classroom setting over students in the traditional classroom setting [12].

The National Center for Education Statistics published a report in 2002 highlighting results of the 2000 National Assessment of Educational Progress (NAEP) Science Assessment [12]. In this report, the National Center for Education Statistics took 8th grade student's science assessment scores and created a graphical representation showing test scores of students whose teacher used computer(s) for simulations or data analysis verses the student test scores of teachers who did not use computer for simulations or data analysis. The data revealed that the students whose teacher used computers for simulations and data analysis achieved significantly higher test scores when compared to their peers whose teacher did not use computers [12].

In the midst of education reform, secondary education science teachers are being held accountable more than ever before. Increasing numbers of vacant Science Technology Engineering and Mathematics (STEM) jobs combined with insufficient output of STEM graduates to fill these jobs forced state governments to rewrite student learning outcomes for science [14]. In their 2011 published report, Carnevale,

Smith and Melton, explained how and why Next Generation Science Standards prepares students to move directly into a STEM field or pursue their higher education in a STEM area [15]. In a 2008 report, "Benchmarking for Success: Ensuring U.S. Students receive a World-Class Education," investigators report Next Generation Science Standards as being internationally benchmarked standards for K-12 science education making students globally competitive [16]. Raising the standards and depth of knowledge for future and current chemistry students in order to produce a STEM field workforce is a justifiable and necessary discussion and decision for the future outcome of our nation. Unfortunately, raising standards in spite of good intentions does not make difficult abstract chemistry concepts any easier to learn or teach.

Restructuring of chemistry lessons to accommodate new course standards and meet student learning needs has chemistry teachers looking to online technology for answers. The conflict for implementing online technology to teach chemistry in the secondary schools arises when trying to validate successful student learning outcomes gained from using online technology that correlates to standardized student achievement test [12].

According to U.S. Department of Education in 2010, educators and technologists have published thousands of research studies and literature reviews aiming to discover how chemistry students learn best. Grossly lacking in research studies conducted is student learning outcomes on formative, summative, and state assessments as a result of using online technology to teach [17].

Currently teacher's academic effectiveness and student's academic success is measured by student achievement scores on standardized achievement test. In this literature review, emphasis was placed on reviewing research studies that used data from student achievement scores as a determination for effectiveness of online technology to effectively teach chemistry in secondary schools [9-11,13].

The greatest evidence for supporting the effectiveness of online technology to effectively teach chemistry in secondary schools came from results of the 2000 National Assessment of Educational Progress (NAEP), Science Assessment [12]. The National Center for Education Statistics analyzed 8th grade science assessment scores from 2,100 schools across the nation that revealed significantly higher test scores for students whose teacher used computers for simulations and data analysis which correlates with other research findings described by Gambari et al.; Lamb and Annetta; Menon; Saminathan [9-11,13].

The statistical evidence from the National Center for Education Statistics 2002 findings are difficult to refute due to the large size of the population studied; however, supporting evidence to validate these findings are essential [12]. Samanthian's 2012 studies focused on the "Effect of Computer Based Instructional Strategies in Learning Chemistry at Higher Secondary Level" closely resembles a smaller more detailed scenario of the 2002 National Center for Education Statistics offering new insight into students learning with online technology [13].

In the study entitled the "Effectiveness of Smart Classroom Teaching on the Achievement in Chemistry of Secondary School Students," Dr. Anita Menon aimed to determine the effectiveness of a smart classroom to teach chemistry compared to a conventional classroom with traditional style teaching [9]. Results of Menon's study concluded higher student achievement test scores for students who receive instruction with smart classroom teaching which was also demonstrated in similar research studies conducted [9,10,13].

Chemistry laboratory online simulations can be of great benefit to secondary schools with limited chemistry lab resources [9,10].

In two research studies conducted independently of each other, Gambari et al.; Lamb and Annetta demonstrated the effectiveness of computer simulated chemistry labs in secondary schools. Post-test measuring of student's achievement taken by secondary education chemistry students in Gambari et al.; Lamb and Annetta studies demonstrated improved student achievement scores and a greater understanding of chemistry content [9,10].

The purpose of this review was to demonstrate the effectiveness of online technology to effectively teach chemistry in secondary schools supported by evidenced based research that measures student achievement. Based on high school student achievement scores from five studies it was determined that the use of online technology to teach chemistry was effective [9-11,13].

While increased efforts to integrate technology into secondary schools and classroom practices is of great importance, more evidence-based research studies are essential to support the accountability demands of teachers [18,19].

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