Social distance teaching and learning: An online DNA nucleotide binding lab experience for health sciences and non-major students

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Abstract
DNA analysis is a common diagnostic tool in healthcare: ranging from microbial typing (e.g. DNA strands of viral, bacterial and even fungal pathogens), oncological screen (e.g. Breast cancer detection via DNA analysis of any BRCA gene mutations), genetic amniocentesis test (a medical technique used in determining chromosomal conditions such as down syndrome in the fetus) and a host of other medical diagnostics based on the knowledge of deoxyribonucleic acid (DNA) and the genetic information carried in this macromolecule. However, such a wide-range of medical diagnostic mechanisms using DNA begs the question: How much does the undergraduate health sciences and/or non-major students understand about the basic biochemical properties of DNA? Here, a virtual lab module was used (with the addition of Pre and Post Lab Questions and a Discussion Topic relating DNA to Healthcare) along with a learning management system, to help undergraduate health sciences students visualize the biochemical properties of DNA molecule, such as binding constant and Gibbs free energy of binding. This lab was adapted to offer a platform on which an Instructor can design steps for students to explore the DNA nucleotide binding module during a time in which social distance curricula is necessary.

KEYWORDS
laboratory exercises, medical education, web-based learning

1 | INTRODUCTION

A fall semester virtual lab (VL) chemistry course designed for undergraduate nursing students (of which less than 10% were exercise science majors), has hosted over 530 enrollees with a passing rate of over 95% (from Fall 2017–2019). The general VL set-up is for students to use laptops or tablets (with a previously installed Firefox or Chrome internet browser) to complete the lab tasks in a lecture hall, following a Pre-Lab presentation by the Lab Instructor - but during this pandemic paradigm the VL class is able to meet via video conferencing. A principle objective of this course was to make connections between General, Organic, Biological, and Analytical (GOB-A) chemistry topics and healthcare. In doing so, students were often encouraged to transcribe answers to discussion questions proposing connections between each chemistry lab topic and healthcare practices (in a Lab Report submitted online).
TheVLmoduleemployedwasthe“DNAProb lem”onlinemoduleatchemcollective.org (http://chemcollective.org/vlab/86). Inthisexperience,studentsinvestigatedthe
binding constants (K) and free energy of binding (ΔG) of
four nucleotides(dAMP,dCMP,dGMP, anddTMP) and
an unknown nucleotide “X”. Thesteepspecially
designedforthehealthsciences(non-major)students
inthisonlinelabcourseareoutlinedinFigure1. Thetimeallottedforthe“DNAProb lem”labwas1 hour,
55 min. The Lab Instructor gave a Pre-Lablectureout-
lining Nucleic Acid structures (RNA vs DNA), calcula-
tionsforenthalpy (H), entropy (S) and Gibbs free energy
(ΔG), and binding constant (K). Following the Pre-
Lablecture,studentsloggedintotheChemcollective.org
site, completed the step-wise instructions (Figure 1) and
tabulateddata. Data for this experiment was both
recordingfromtheinformationprovidedintheleft
pane of the “virtual workbench” window for the VL mod-
ule(e.g. nucleotide concentration values) and student
calculations. A Post-Lab quiz was administered via Sakai
LMS3 consisting of questions such as defining terms, cal-
culatingKandΔGvaluesofeachnucleotide sample, and
identifying the unknown nucleotide “X.” Finally, students
weretoldtowriteanduploada Lab Report with
datasetsandtheirresponse (and the interviewed response
of a classmate) to a discussion question asking them to
identify biochemical practices of DNA research and/or
diagnostics in healthcare.

3 | QUALITATIVE STUDENTS RESPONSES

During the fall 2019 semester, 120 of the 161 enrolled stu-
dents completed a survey outlining their experience with
the “DNAProb lem”lab. Of the 120 students surveyed
(i) 99%agreethattheVLeasytouse,(ii) 92%agreed
that the overall lab experience helped to increase “their
knowledge of chemistry,” and (iii) 88% agreed that they
would “recommend the DNA Lab Problem[experience]
tobe utilized in future undergraduate chemistry for
health professions lab courses.”

FIGURE 1 DNA lab instructions. Students were provided with the following instructions for completing the online lab module
CONCLUSION

Adapting the presently available online chemistry lab resources to promote course objectives can be helpful during this time of “social distance” teaching and learning. Student qualitative responses to the lab experience suggests the successful applicability of this lab in future health sciences (non-major) VL chemistry lab courses.

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