

STEM Course Enhancement: Online Microscopy Tutorials for Introductory Level Biology Courses

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Summary

The Department of Biological Sciences at Sam Houston State University (SHSU) offers three introductory (BIOL 1411, 1413, and 1408) biology courses with laboratory sections (37 total) that rely heavily on light microscopes for biological specimen observations. Nearly 900 students enroll in these course offerings every semester from Biological Sciences and STEM Departments within SHSU. It has been reported that students who pursue medical, dental, veterinary and pathological studies regard the use of microscopy as a professional skill necessary for their careers.¹ Real-time microscopic studies of normal tissues and their changes with disease progression, physiological adaptations of micro-organisms towards environments, cellular/molecular and genetic imaging for clinical screening and diagnosis are some of the significant applications of microscopy in teaching and research institutions.² Instructors and graduate assistants supervising these courses familiarize students with the handling and operation of microscope instrument in the first week of laboratory sessions. However, course structures and time restrictions make it difficult for students to acquire adequate training on these instruments. Insufficient microscopy skills are an impediment for students who operate these instruments, which indirectly lessens their enthusiasm for understanding biology subjects and also reduces the retention in STEM.³ Here, we propose a short video lectures on microscopy for undergraduate biology students of SHSU that will provide necessary resources on microscopy theory, handling and operation of the instruments. Use of video mini-lecturers for introductory level courses have proven to increase student's satisfaction with the course and make it more likely to excel in the course with passing grades.⁴⁻⁵ These tutorials will be incorporated into the current grading system of all introductory 1000 level biology courses as part of their pre-labs points.

Introduction

In the fields of science and technology, great efforts are being dedicated to study ultrastructural information and physiological processes of organisms. Microscopes have been widely used as an imaging tool for viewing and understanding the biological processes of species in real time. The implementation of conventional light microscopes in undergraduate education have aided students in the mastery of sciences and are a technological cornerstone for visualizing scientific evidences in cell and molecular biology, histology, pathology, material chemistry, and forensics.¹ Light microscopes presently used in introductory STEM courses can provide 10x-1000x times magnification and 0.5 micron resolving power which is vital for distinguishing microstructures that are invisible to naked eye. This allows students to employ microscopes for small experiments not limited to identifying blood cell types, plant cell morphological study, physiological behavior of micro-organisms and forensic analysis of evidences (hairs, wood, pollen, and diatoms) in STEM laboratory courses. Universities and colleges devote immense portions of their budgets to purchasing these light microscope in quantity to enhance the quality of undergraduate education. However, the biology freshman and sophomores of SHSU are exposed to such instruments with less training and experience. This directly impacts student's laboratory

grades that employ microscopes predominantly for observations, experiments and results in lab sessions. Reports show that a strong relationship exist between the competency of a student taking an acceptable optical image (without artifacts) to the ability to accurately learn information and evidences from the image.¹ Hands on experience with the instrument is vital to the students' adequate understanding of the material covered in their course. Additionally, the lifetime and quality of microscope instrument are also critically reduced due to higher risk of damages to sensitive optics. Maintenance, troubleshooting and replacement of these instruments are time-consuming, highly expensive and require trained technicians. This hinders the students from continued use of microscope in lab sessions and leading to false science information from misleading/invisible ultra-structures that occur primarily due to defects on objective lenses and condenser optics.

Aim of this proposal

The aim of this proposal is to design, create and implement a weblink containing video tutorials on microscopy for introductory level courses in the Biological Sciences Department. This will provide necessary resources for proper handling and operation of light microscopes for biological species investigation. The proposed aim will be achieved by designing and creating a series of video tutorials on microscopy. The content of the microscope tutorials will include the basics of light microscopy, main parts of the microscope and its operations, easy troubleshooting and proper handling with safety precautions. The basics of light microscope (light path) and its main components (namely eyepiece, lenses, stage, light source and condenser) will be shown in 3D model and animation using Autodesk Inventor. The operation of the light microscope consisting of (i) light intensity and condenser adjustments, (ii) mounting of specimen on the stage, (iii) viewing of specimen with different objective lenses, and (iv) focusing of specimen with coarse and fine adjustments will be demonstrated by a trained personnel. The live demonstration will be recorded as a short video and will be available online through weblink for student access. Topics including but not limited to the use of appropriate solvents and lens paper for cleaning, preventing the damage of objective lenses while viewing and proper handling of 100x oil objective lenses will also be provided. Series of microscope related questions will be posted at the end of each tutorial for students. The tutorials will be made mandatory training based on outcomes of the proposed learning method.

Impact of the proposal

The proposed online mini-lectures on microscopy will serve as an additional tool for undergraduate students besides laboratory training provided by the instructors and graduate assistants. Questions at the end of each tutorial will test the proficiency of students with microscopy contents for pre-lab points. This will also allow the students to re-visit the short video lectures anytime during the course and enhance their microscopy skills with less instructor interventions. Receiving this grant will likewise help create an opportunity for the undergraduate students to develop skills in analyzing and discovering new specimens under the microscope for research purposes. Implementation of the grant as proposed has the potential to reduce the

withdrawal from the course while increasing the success rate. Overall, this new method with reusable materials will indirectly allow the instructors to enhance the quality of the course content by saving the time consumed on microscope training/troubleshooting during lab sessions.

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