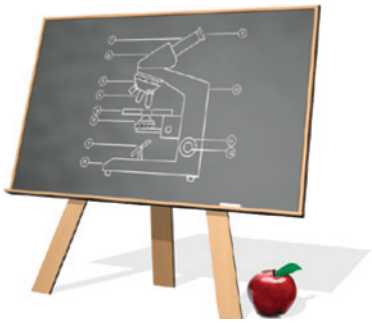
https://doi.org/10.1017/S1551929516000353 Published online by Cambridge University Press

Microscopy**Education**

Online Education and Training for Microscopy and Microanalysis: MyScope™



Bronwen Cribb,[1,2]* Joe Shapter,[3] and Miles Apperley[4]

[1]The Centre for Microscopy & Microanalysis, The University of Queensland, Brisbane, QLD 4072, Australia

[2]School of Biological Sciences, The University of Queensland, Brisbane, QLD 4072, Australia

[3]School of Chemical and Physical Sciences, Flinders University of South Australia, Bedford Park, South Australia, 5042, Australia

[4]Australian Microscopy and Microanalysis Research Facility, The University of Sydney, NSW 2006, Australia

*b.cribb@uq.edu.au

Abstract: MyScope™ was conceived and mentored by staff from the Australian Microscopy and Microanalysis Research Facility (AMMRF), which now hosts a website (www.ammrf.org.au/myscope) to address limited time and resources available within busy laboratories for training staff and students. The online learning and teaching website, MyScope provides self-paced training in research techniques, specifically modules covering scanning and transmission electron microscopy, scanning probe and atomic force microscopy, confocal microscopy, X-ray diffraction, and microanalysis. The website has been operational since 2012, from which time it has seen international use steadily increase.

Introduction

Even with the best equipment and employees, student and staff training is limited by time and resources. This is especially so in the areas of microscopy and microanalysis. The rise of nanotechnology and its application to materials science and medicine has put further pressure on laboratories and facilities to handle more students and more research hours on machines. One solution is to train staff and students more quickly and efficiently.

In 2010 we began work on a series of modules for an online learning and teaching website covering a range of research techniques. The aim was to provide self-paced frameworks that could be tailored to individual needs because different users have different levels of knowledge and approach learning differently.

MyScope™ [1] was conceived and mentored by staff from the Australian Microscopy and Microanalysis Research Facility (AMMRF), which now hosts the site www.ammrf.org.au/myscope. The AMMRF is a collaborative research infrastructure network that links 13 core microscopy and microanalysis facilities across Australia to form a national capability for advanced characterization. The initial partners driving the creation of MyScope were: The University of Queensland, the University of Sydney, the University of NSW, the Australian National University, the University of Western Australia, and Flinders University.

In this article we unpack and explain the features of the site and look at how it can be used to develop microscopy and microanalysis skills and competency for researchers. We also show the extent of usage around the world.

Materials and Methods

Educational aims. The MyScope project brought together experts in six techniques who provided the technical content. Project personnel then arranged for illustrating and animating the concepts and methods. Underlying the planning process was an education committee that assessed the content from a pedagogical perspective. The team wanted to create an interactive and engaging platform that provided a set of educational tools, not an online textbook. Working with teams of specialists in each technique, we determined what they wanted their students to know—the core knowledge. From there we broke the material down into sections, aware that graphics and interaction would be very important in engaging users. In addition, the site would integrate text, flowcharts, and videos as well as contain a glossary and search functions. There are many different ways to construct learning and teaching sites. Choosing a structure is an important step, and much discussion and evaluation of other sites led to the final product.

From an educational perspective we saw MyScope as a platform to accelerate learning as part of a blended learning environment. The approach was to supply a personalized journey able to be tailored by student or educator. The developer involved with the project had online games industry experience and reveled in the challenge of producing virtual machines, which we planned to be a focal point for the development of practical skills for real equipment.

The modules. The first six modules chosen for development span techniques that make up approximately 60 percent of the beam time across the facility (Figure 1). For these modules the team drew from the core techniques used in microscopy and microanalysis and developed a framework that would enable

https://doi.org/10.1017/S1551929516000353 Published online by Cambridge University Press

Figure 1: The home page of MyScope showing the six modules currently present as active tiles.

MyScope to expand with other modules and functionality in the future.

The menu. Each of the current modules has been built with the same basic layout. A menu of contents on the left side (Figure 2) is a gateway to the following kinds of material:

1. Introductory material, including the ability to tailor the site to user and teacher needs.
2. In-depth information and concepts related to the module topic.
3. A section on developing practical skills, including an interactive virtual machine, operational information, and, where relevant, information on sample preparation and occupational health and safety.
4. Links to other sites, textbooks, and general information.
5. A multiple-choice test with automatic marking and a certificate, when the test is passed.

These are accessed on the left of the screen. On the right a user can search for videos and images or consult the glossary. Hyperlinked text within the modules is also linked to the glossary.

Tailoring the site. Site users can gain some guidance on what menu items to explore by looking at the "Tailor this module" option. Here it is possible to select just those items that are considered relevant to this particular user's needs. Such filtering of content provides guidance and can save time by reducing the amount of material to be viewed.

For educators and trainers there is a specialized tailoring available. By simply dragging and dropping module pages

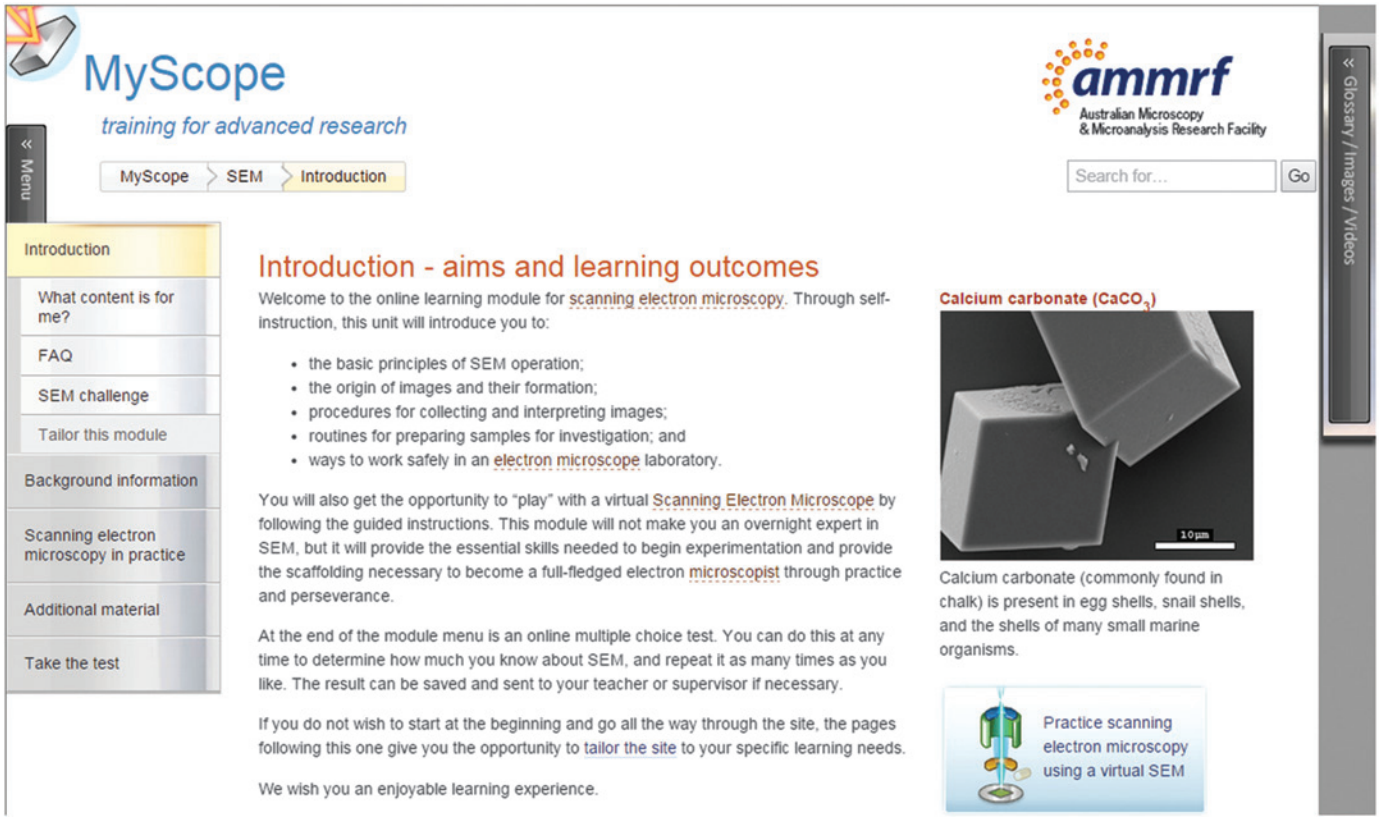


Figure 2: The first page within the Scanning Electron Microscopy module of MyScope. The left-side menu lists a range of options including an introduction, background information, practical elements, additional material, and a test page. The right side shows a panel that lists videos, images, and a glossary.

from a list into a blank column, the site creates a personalized module. The order of pages can also be rearranged during this process. This function is found under the tailoring option "Educators: how to create a customised menu for your class."

The new site created has a unique address and is password-protected so that the creator is the only editor. Staff members can use this function to create their own websites with just one page of a module, or as many as required. Examples of the use of such custom sites include rapid access to limited material during a lecture, setting a select number of pages for student use in a project, or setting material for students to review.

Background information. Each module presents a section that deals with facts and concepts needed to understand the technique. These include such topics as magnification, resolution, and electron-matter interactions; X-rays, crystals, and diffraction; or beam interactions, imaging modes, and artifacts. Colorful graphics are used along with the text and interactive options to invite user interaction (Figure 3).

Practical skills. Machine operation involves knowledge about equipment parts, their location, and their function. By working with generic functionality, the aim is for users to become familiar with terminology and procedure. Virtual machines in MyScope allow users to explore the equipment (and even break it) before experiencing on the real thing (Figure 4). So, for example, the filament will fail if handled incorrectly in the electron microscope machines. File sizes are kept small deliberately to avoid loading issues.

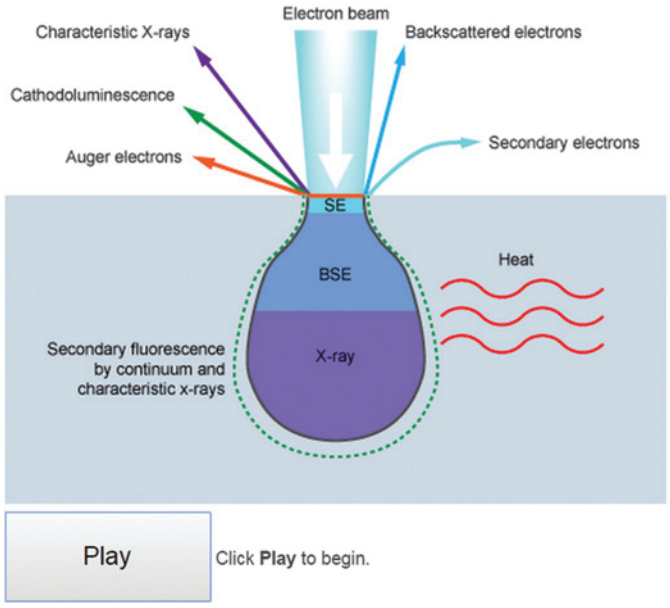


Figure 3: An interactive graphic that demonstrates beam-sample interactions.

Images of real samples are provided within a library for each virtual machine. Most involve one or two options that can be explored with four samples available in the virtual scanning electron microscope. These libraries are readily expandable to reflect the diversity of projects and specimens that researchers bring to multi-user, core facilities. We aim to expand sample options in the near future. The reasoning

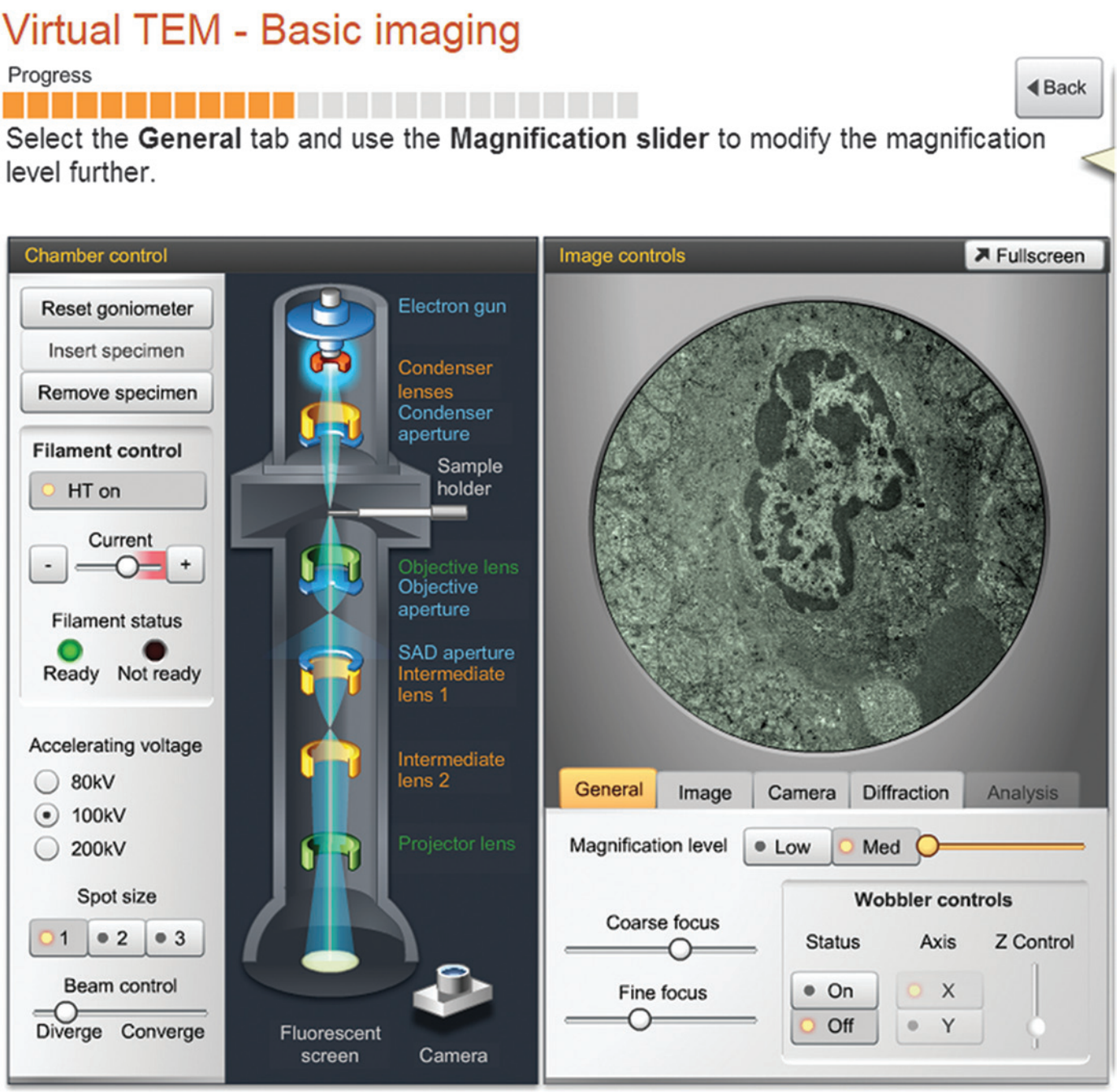


Figure 4: The virtual transmission electron microscope interface, with a sample of rat liver cells being imaged.

behind using real samples is so that a user can see what samples should look like and so that they can explore the material if interested.

It can be frustrating to enter a website and not know how much time will be required to complete a task. This is particularly the case when a virtual machine is involved. So we added a progress bar on the virtual machines to show the number of steps and allow a user to track the approximate time that will be needed to complete the task.

Experienced technicians and researchers know that sample preparation is vital to good imaging and useful data, so the site also provides flowcharts for sample preparation. Sample preparation steps are augmented with videos and/or text; occupational health and safety issues are also addressed.

Additional information. There are numerous sites, texts, references, and interesting links available on the topics of microscopy and microanalysis. We have gathered these together as "additional information."

Take the test. Assessing one's own progress or the knowledge of students is helped by some form of test. So we constructed extensive question banks within the modules. At any time the site user can access a ten-question multiple choice quiz from the menu list. A range of new questions will appear each time the test is selected because the test is randomly

selected from the question banks. This means that it can be taken as many times as desired.

Feedback is also important in the learning process. The test is automatically marked. Correct responses are recognized with a green tick, and a "well done." Incorrect responses show a red cross. They also include the correct answer below the response and links back into the module to those areas that deal with the relevant facts or concepts for the failed question. Thus the site user is guided rather than left wondering how to succeed in the next attempt.

We have set the pass rate at 80% because mistakes in the laboratory can be costly. Those passing the test need to have skill and competency so they are ready to be instructed on actual instruments.

A pass is accompanied by the offer of a certificate. The user is asked to provide a name for the certificate, and it can be printed out or downloaded and emailed to any address. The site does not keep copies or store names.

We use the certificate as an entry to hands-on instruction in the laboratory. Students are asked to send a copy to the laboratory manager or education officer in the relevant core facility. Of course there is the possibility that site users may cheat if they are not taking the test in a controlled environment. However, the lack of knowledge is soon exposed in the laboratory when hands-on training commences.

Evaluation. Numerous surveys and discussions have been undertaken to evaluate how well MyScope has fulfilled expectations. We have tested students who have used MyScope, as well as those who have not, and compared results. This has allowed us to look at whether the site boosts academic achievement. Google Analytics, used as a site tool, has enabled us to track visitor and session numbers as well as repeat use. We have also assessed the sentiments of site users through surveys and online comments.

Results and Discussion

Impact. Use of MyScope has increased steadily since it was provided in its complete form in 2012 (Figure 5). Initially designed for Australian needs, we have found the number of users from across the globe has increased steadily with the top countries including the USA and several from Europe and Asia regions (Figure 6). Currently use is running at about 15,000 sessions per month calculated across 2015.

Many of the sessions are associated with new visitors, however a third of them (33%) are from return visitors. It is pleasing to see this number of repeat visits because it indicates continued use and gives us confidence that the site is meeting educational needs for a large user base.

We will not go into detail about assessment methodology and data here because these are currently undergoing separate publication, but we can provide a summary. Over 80% of MyScope users were found to have a significantly positive attitude toward the site and its material. In fact, use of MyScope improved views held about online tools. Academic achievement improved by 28% in a controlled test environment where we compared students who had accessed the site with students who had not been to the site. We also found that MyScope accelerated learning because students and educators who relied on MyScope as an educational aid reported a 10 to 25% decrease in training time.

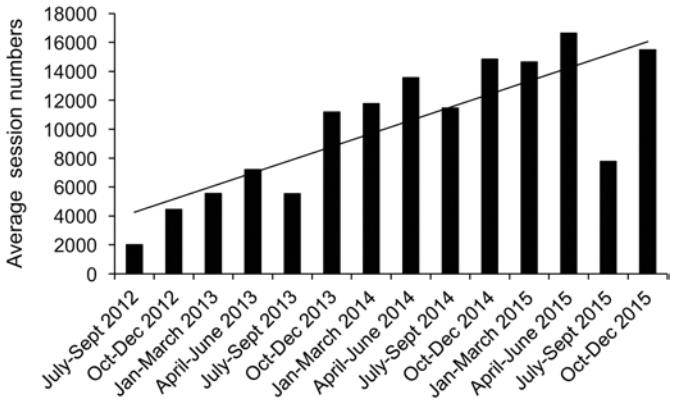


Figure 5: MyScope session data obtained from Google Analytics as a three-month average across the period 2012 to December 30, 2015, with a linear trend line fit.

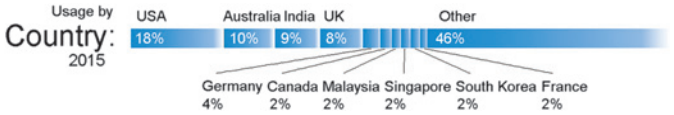


Figure 6: A bar chart showing MyScope global use, obtained via Google Analytics for the 2015 period.

From talking with people in Australia and at international conferences, we have found that there are many ways the site is used. It works as an aid in undergraduate classes to assist students with the technologies involved in undertaking research projects. Faculty staff members tell us they have been using the site to bring up relevant pages during a lecture when dealing with specific concepts. Students have reported using the site to study for exams. Supervisors tell us they send their research students to MyScope to learn about topics and review the concepts. Core facilities also use the site to train staff in new techniques. We have even encountered individuals who have used the certificate in their job applications.

Conclusion

MyScope is an online platform that presents a personalized learning environment and enhances core knowledge. It enables researchers to develop skills and competency that can be assessed. The benefit of this is accelerated learning about microscopy and microanalysis and improved efficiency of instrument and technique training in core facilities.

Acknowledgements

The MyScope project was supported by the Australian Government Office for Learning and Teaching grant CG10-1490 and The Australian Microscopy & Microanalysis Research Facility. We wish to acknowledge the many academics, scientists, technicians, educators, administrators, and developers who contributed to the project and who still keep it updated.

References

[1] BW Cribb et al., *MyScope: a national approach to education in advanced microscopic characterisation through integrated learning tools*, Australian Government Office for Learning and Teaching (2013) ISBN: 978-1-925092-03-5. Available at: http://www.olt.gov.au/resource-MyScope.

MT