

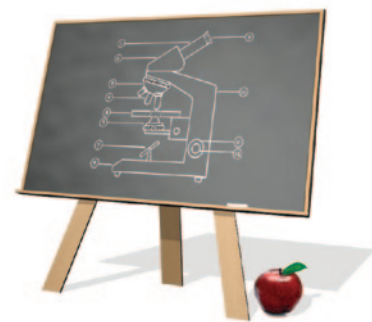
# Microscopy Education

## Sustainable Outreach

A. Chumbley\* and L.S. Chumbley

Materials Science and Engineering, Iowa State University, 214 Wilhelm Hall, Ames, IA 50011-3020

\* chumbley@iastate.edu



### Introduction

Over the past decade numerous institutions have developed programs geared toward providing scanning electron microscopy capabilities for use by teachers and educators in K–12 classrooms. Perhaps the longest continually running outreach effort began at Iowa State University in the mid-1990s [1–4]. Termed Project ExCEL, the Extended Classroom for Enhanced Learning, this effort employs a web-operable SEM, termed the WebSEM (Figure 1), which was developed in cooperation with RJ Lee Group. Lessons have been conducted in a number of states around the U.S., as well as several international locations (Figure 2). Several other sites also exist; perhaps the most successful at maintaining a steady user base and marketing itself is Bugscope [5] at the University of Illinois. A summary and listing of other sites most easily found by a simple web search is included in reference [6].

When the WebSEM was first developed, it was commonly believed that “if you build it, they will come,” that is, teachers and schools would be so overwhelmed by the promise and possibilities of remote microscopy in their classrooms that the demand for use would be tremendous. However, despite the enormous potential and promise associated with such programs, the reality is that the WebSEM has been underutilized, despite widespread advertising of the system. This situation is not unique; a review of similar systems offered by other institutions has shown that many of them are also under-utilized and poorly subscribed, often to the extent that programs have been discontinued [6]. This is surprising, especially given the fact that teachers who have availed themselves of such services almost universally praise the idea, often in glowing terms. Students are excited, teachers are pleased by the enthusiasm of the students and the assistance they receive from the sponsoring institution, and the sites offering the service also report satisfaction and considerable enjoyment in providing microscopy capabilities in a classroom setting. In short, it seems to be a win/win proposition for all concerned.

Why, then, are such programs failing for lack of use? In an effort to determine what the problem(s) may be, a number of assessments have been conducted at ISU to better understand the factors that need to be addressed when seeking to establish and sustain a consistent level of outreach with committed K–12 partners [5]. These results show that four main reasons exist that hinder consistent use of a web-based system such as Project ExCEL, and these are discussed below.

### Problems in Maintaining Outreach Efforts

The problems faced at ISU are not believed to be unique to Project ExCEL but represent common problems that exist in



Figure 1: The WebSEM.

building and maintaining an outreach effort that is sustainable in terms of having a consistent, committed user base that employs the equipment regularly on a yearly, semester-long, or, ideally, a monthly basis.

**Problem #1: Teacher movement/retirement.** Assessment has shown that the most likely teachers to use the WebSEM are those that have been teaching for several years in the same classroom and who were comfortable in their positions. Unfortunately, this group is also the most likely to take advantage of their experience to better (or retire from) their careers. Of the teachers surveyed, 15 percent of the teachers that once used the WebSEM had either retired or had moved to take a position elsewhere, which did not involve classroom teaching, eliminating them as viable candidates to conduct a lesson. A considerable number had also moved to a different school district and, being new to the district/school, were still trying to get acquainted with the new environment and thus were less likely to schedule a WebSEM lesson initially. Simply overcoming this constant attrition requires considerable effort to maintain a stable user base.

**Problem #2: Curriculum Fit.** Given the flexibility of scanning electron microscopy, suitable lessons usually could be arranged for essentially any subject. Thus, addressing curricular “fit” really is more a question of teachers having the time and motivation to make the application. The most common problem voiced by teachers is that there is “too much to teach in too little time.” Even if a “fit” is seen, the extra commitment required to schedule and conduct a WebSEM lesson may appear overwhelming, particularly to younger teachers. As teachers



Microscopy & Microanalysis | August 1-5 | Portland, OR



**VISIT US AT:**

[www.microscopy.org](http://www.microscopy.org)

# CALL FOR PAPERS NOW AVAILABLE!

Printed copy is bundled with  
this magazine.

Go to [www.microscopy.org](http://www.microscopy.org) for  
complete information,  
including:

- All symposia & contributed paper topics
- Full symposia descriptions
- Paper submission info and online portal
- Complete awards info, including application instructions, criteria & prizes
- Other educational events, including Tutorials, Intensive Workshops, & Short Courses

**DEADLINE: February 15, 2010**



Figure 2: Map showing locations of WebSEM clients.

struggle with how best to use their time to cover all of their required topics, use of the WebSEM is often considered an extra that is easy to omit, unless one is comfortable in the classroom and has the opportunity and time to try new things. This is supported by the data, which show that a majority of all WebSEM users have five or more years of experience. The problem of “fit,” therefore, can only be solved by giving teachers more time or more incentive to consider WebSEM-based lessons.

**Problem #3: Scheduling Problems.** It was recognized early on by Project ExCEL planners that in order to succeed the WebSEM had to be available on the teachers’ terms, rather than on the operator’s terms. Thus, Project ExCEL has always strived to provide any type of lesson at any time on any day, unlike other systems where use is restricted to certain days and times or certain investigations outside K–12 classrooms. Project ExCEL also differs from other systems in that use of the WebSEM can be arranged by either a simple e-mail or telephone call; no application form or lesson plan need be submitted. Despite elimination of all paperwork and making the system as teacher-friendly as possible, a significant number of teachers (19%) stated they had problems scheduling a lesson. Comments revealed that the scheduling problems were all related to internal conditions that existed within the school. Specifically, teachers had trouble scheduling in advance because of the changeable nature of public education. Often lessons planned for a certain day were delayed or shifted to other days due to conflicts with other activities at the school (for example, snow days, extra-curricular events, practices, etc.). Some teachers found that they could not schedule all of their class sections to use the school’s computer lab during the preferred class time due to high demand. The teachers are then faced with the choice of either allowing only some students use of the WebSEM or rescheduling to a later time. In the latter case, the result is that the students experience the WebSEM out of the desired time sequence, and the value of the experience is diluted because students do not see the relationship between the samples viewed in the WebSEM and the current topic being covered in class. When

faced with this choice, given their time constraints, it is much easier for teachers simply not to use the WebSEM.

#### **Problem #4: Technical Problems.**

A large number of teachers (34%) have had technical difficulties in establishing a connection with the WebSEM. These difficulties are serious because if teachers have problems, experience has shown that it is extremely rare that they will try a second WebSEM lesson. This outcome is relatively independent of where the problem originates, that is, whether at ISU or within the school. In some schools the computer personnel were unwilling to assist the teachers with the initial connections for fear that they would compromise their local networks.

The use of several ports by the WebSEM

to pass commands and images back and forth in the most timely and efficient manner can trigger some types of firewall software if the settings are too restrictive. Although the port information necessary is routinely provided to teachers to give to the information technology (IT) specialists, many IT people are still reluctant to open the ports, and others flatly refuse. A complete re-write of the connection software is necessary; however, because the WebSEM project allows free access and does not generate any funds itself, thus far it has been impossible to perform this crucial upgrade. Although technical difficulties within Project ExCEL can be addressed, the problems within schools deal more with personnel issues than hardware and are therefore more difficult to overcome.

### **The Way Forward**

So the question becomes, how do we move forward from the current outreach model to a more sustained one where the WebSEM is regularly used? Various efforts have been attempted and are still in use, which might eventually produce a higher usage rate. Currently at ISU the WebSEM is introduced to future K–12 teachers through classroom work they are required to complete in their science methods classes as part of a collaborative effort with the College of Education. Students are shown the capabilities and limitations of the WebSEM and are then expected to write and present a lesson using the WebSEM within their chosen subject and level.

Another strategy being pursued that might produce better results is to approach not the teachers themselves but the school administrators. By approaching administrators we hope to establish partnerships where use of SEM technology becomes a high priority within a school or district, thereby ensuring that teachers are allowed the time needed to incorporate SEM into their classrooms. In these partnerships, use of the WebSEM will be mandated by the school administrators; instead of being an option, it will be a requirement. Teachers will be given release time to learn about the WebSEM through workshops held at ISU, and they will work with ISU faculty and staff to determine how best to incorporate the technology into their classroom within the constraints of their curriculum. The



school will receive support from ISU to solve any technical problems and will be specifically targeted by ISU programs designed to increase awareness of science, technology, engineering, and mathematics among students. The goal is to develop a relationship that is mutually beneficial to both parties.

Clearly, maintaining a sustainable program requires a steady source of funds to provide for continual equipment and web interface updates, cover routine costs, pay assistants, etc. Project ExCEL has managed to exist on a shoestring budget, employing discretionary incentive funds available to the PI and some departmental assistance. Although the ideas expressed above may result in the sustainable program we seek, they require outside funding to perform necessary upgrades and modernize the entire system.

The one thing that has proven to be successful in attracting regular users year after year is the development of close working relationships between WebSEM administrators and teachers. Our willingness to meet their schedule, to facilitate their lesson plans, and to find samples suitable for their curriculum promotes a feeling of trust and reliability and establishes a positive working relationship. That stability not only keeps users coming back but gives them the courage to try more advanced lessons and encourage students to use the WebSEM for independent study projects.

An excellent example of this is the relationship established with Immanuel College, a High School in Adelaide Australia (Figure 3). A pair of teachers, Dawn and David Turnbull, made contact through the website in 2002. Although there have been technical difficulties along the way, they continue to use the WebSEM at least twice each year for multiple days, and the professional relationship now includes regular e-mail contact, including stories of families and the latest local happenings. Their positive comments concerning our close working relationship at local education events has resulted in new clients elsewhere in Australia. A recent connection was established with a school in Darwin, on the north coast. Although the time difference is often a challenge in such long distance connections (Adelaide and Darwin are 14.5 hours ahead of Ames, Iowa, requiring early lessons in Australia and late nights at ISU!), this is considered a minor inconvenience because each cooperating institution is committed to making the connection work and providing an interesting and educational experience to the students.

The way forward appears to depend little on continued development of better and faster systems, or even CD-based “virtual” microscopy systems. Based on the premise that online systems are too slow or difficult to manage or use, virtual systems will still face the problems of teacher time and lesson “fit.”



**Figure 3:** Students at Immanuel College, Adelaide, Australia, using the WebSEM for a science class investigation.

## Conclusion

In summary, after more than 10 years of operation, we feel that remote instrumentation has proven to be an important way to bring technology to the classroom. Assessment has revealed that once a user-friendly interface is established, the major hindrances have very little to do with the technology itself. Rather, local considerations within a school take precedence over the opportunity to try something new.

In short, there is no easy answer for introducing electron microscopy into K–12 classrooms in a self-sustainable manner. However, providing constant, personal, and sufficient support for teachers to utilize systems that are available, whether virtual or on-line, appears to be the best method for increasing client numbers, client retention, and lesson depth.

## References

- [1] LS Chumbley, M Meyer, K Fredrickson, and F Laabs, The Instructional SEM Laboratory at Iowa State University, *Proc Ann Meeting Micro Soc Amer*, GW Bailey et al., (eds.), (1996) 396–397.
- [2] LS Chumbley, M Meyer, K Fredrickson, and F Laabs, Outreach Opportunities Using the Instructional SEM Laboratory at Iowa State University, *Proc Ann Meeting Micro Soc Amer*, GW Bailey et al., (eds.), (1996) 412–413.
- [3] LS Chumbley, CP Hargrave, K Constant, B Hand, and T Andre, *J Eng Ed* 91 (2002) 202–210.
- [4] LS Chumbley, G Cassucio, D Kritikos, H Lentz, C Mannes, and K Mehta, *Micro Res and Tech* 56 (2002) 454–461.
- [5] <http://bugscope.beckman.illinois.edu/>
- [6] AE Chumbley and LS Chumbley, *Scanning* 29 (2007) 20–26.