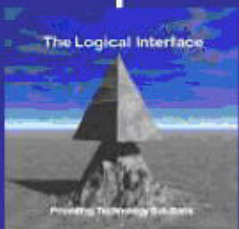


The Teacher's SMART Guide To Choosing and Using Digital Microscopes



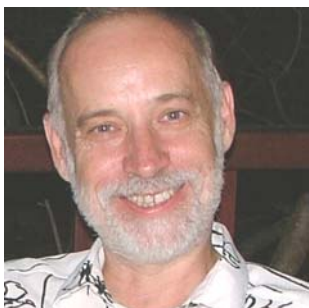
- S**ave time and money choosing your digital microscopes
- M**ake light work of covering the syllabus
- A**lleviate your anxiety about teaching practical lessons
- R**ecieve praise from parents, students and colleagues on your teaching ability
- T**ransform your students from apathetic to enthusiastic

BY PHIL JONES
The Logical Interace



RRP
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About the Author



Phil Jones is passionate about science and science teaching.

At the age of twelve, he cleaned out his school banking account to buy the parts to make a telescope. His parents were furious, not only about the money, but also because they preferred him to follow more “practical” pursuits.

This did not deter him. Phil went on to build his working telescope (which he later donated to one of the schools he taught in) and pursued his interest in science.

He received a Bachelor of Science with Honours from Sydney University, and a Master of Science with Honours from Macquarie University. He taught in Australia and UK for a number of years and for four years was a researcher in bio-physics at Sydney University. However he kept being drawn back to his main interest: teaching others to share his love of science.

This led Phil to opening *The Logical Interface* (TLI) in 1986, a business dedicated to supporting maths and science teachers in making their classes more relevant and engaging. TLI provides educational technology consultancy services; reviews, assesses and supplies cost-effective classroom options; and designs and develops effective solutions where there are gaps in provision.

Phil is a sought-after speaker at Science Teachers Association meetings around Australia, is a long-term supporter of The Young Scientist Award in NSW, and runs technology workshops for teachers at universities, TAFE colleges and schools.

Information on Phil’s workshops can be found on www.logint.com.au or contact Phil at philjones@logint.com.au.

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What is a digital microscope and how does it work?

A digital microscope does what a normal microscope does but it typically has to be connected to a computer to see the images and has the ability, unlike a traditional microscope, to save and manipulate the images that are captured. It works in much the same way as a digital camera but with microscope lenses attached. Some models even have their own in-built screens and memory and are no bigger than a camera, making them a fully portable option.

Once the images are captured through a digital microscope, they can be saved; they can be manipulated and measured; changes over time can be compared; they can be projected to a wider audience via a data projector or interactive white board, or emailed to others for discussion.

Why should we use digital microscopes in the classroom?

Digital microscopes are used widely in industry and research:

- in art galleries for restoration work
- by scientists (entomologists, palaeontologists, marine biologists and others) in laboratories and in the field
- in engineering workshops to examine tooling and printed circuit (PC) boards
- by horticulturalists for identifying insects and plant diseases
- in pest control work
- by printers to check the quality of print
- in forensic analysis and the identification of forged documents
- by veterinarians to identify and remove such things as small ticks
- by beauticians to identify skin problems and in fine tattooing work

Like a computer, they are a standard piece of equipment many of our students will encounter in the workplace, and must be familiar with.

In addition to this, they are a powerful tool in primary and secondary classrooms for motivating students and developing the skills of observation, awareness and analysis; order and organisation; change and measurement; pattern and prediction.

What are the different types of digital microscopes?

Some digital microscopes are portable and can easily be held in the hand making them ideal for use in industry as well as in education.

Other digital microscopes are really conventional microscopes with a digital camera where the eyepiece would be. Such microscopes have the same limitations as conventional microscopes in that they are bench-mounted (fixed) and so are not portable.



A conventional microscope can become a digital microscope quite simply with the addition of a digital eye-piece. A digital eye-piece is a special digital camera that replaces the standard eye piece of the microscope and is attached to a computer.

However the most popular digital microscopes for education are the hand-held variety that can be taken into the field with a laptop, or the smaller ultra-mobile PCs, so students are able to explore the world around them: bugs, leaves, skin, hair and the surface of inanimate objects. In industry, they are used in restoration work; forensic science; document analysis and quality control



Most hand-held (portable) digital microscopes work with a computer but there are a few that stand alone with their own memory and screen.

Stand alone digital microscopes such as the ViTiny store images in their own internal memory and require batteries for power. As with a digital camera, these images can also be transferred to a computer.

Other digital microscopes only work when they are connected directly to a computer through the USB. These digital microscopes use the computer's memory and screen to display and store images e.g. ProScope and DinoLite



What are the main differences between digital microscopes?

The features that set digital microscopes apart are

- whether they are bench-mounted (fixed), hand-held (portable), or able to stand alone
- quality and type of lenses
- differences in resolution
- magnification

Some models offer resolution as high as 5 megapixels with the same effect as digital cameras: better quality printing, particularly printing larger sized images. However, lower resolution digital microscopes are adequate for publishing to the Web and viewing on the screen.

Microscopes with interchangeable lenses such as the Proscope offer magnification up to 400x. The DinoLite range offers a special purpose scope with 500x magnification. However, for educational purposes, 200x is usually adequate.

Another feature that makes a difference are polaroid filters to cut down reflection on shiny surfaces.



The majority of digital microscopes can be used with any PC. Not all are compatible with Apple Macintoshes. Always check whether the digital microscope you wish to purchase is easily connected to your computer

How do you record and view images with a digital microscope?

All digital microscopes are bundled with software which allows you to view and capture images. Once installed it is a simple process to view images and record them as still images, video or time lapse video. Video frame rates can go up to 30 fps (frames per second).

When the images have been recorded, they can be analysed either in the classroom or while you are still in the field. Some software provides the ability to measure, count items in the field of view, and manipulate them.

If the software provided with the digital microscope does not support all features, advanced software is available separately for use with most digital microscopes.

How do I select the right digital microscope?

To select a suitable digital microscope, ask yourself the following questions:

1. How do I want to use the digital microscope?

Do you want a portable digital microscope to use in the field like the DinoLite, or do you want a fixed microscope?

Portable microscopes are used for the same applications you would use a dissection microscope, viewing things like rocks and insects. They are not suitable for viewing microscope slides.

For viewing slides, a digital eye-piece attached to a traditional microscope with its better quality optics and higher magnification is a better option. Specialised fixed digital microscopes are also available but are usually more expensive than combining a traditional microscope and eye-piece. Since eye-pieces can be attached to any good quality microscope, there is rarely any need to purchase special microscopes for this purpose.



Want to convert a portable microscope into a fixed microscope for use in the laboratory? All you need is a stand. Most manufacturers offer stands as an optional accessory.

2. Will I have access to a computer while I conduct an experiment?

If you have no access to a computer, your best option may be the ViTiny or similar digital microscope with its own power supply, memory and screen. However, be aware that you will probably be sacrificing some image quality for greater flexibility. While these devices are excellent in primary schools and junior secondary classes, they may not be of the quality required for more sophisticated experiments and data collection.



Consider a small ultra-mobile PC as the core part of your field kit, rather than purchasing a variety of stand-alone devices such as microscopes and dataloggers. It will offer more flexibility and better value for money.

3. How do I want to use the images?

All digital microscopes with USB output can be used with data projectors or interactive whiteboards in the classroom. Captured images can be stored and published electronically.

However, if the purpose is to use the images for postcards or to illustrate an article or book, a higher resolution digital microscope such as the DinoLite 1.3 MP is better.

4. What magnification do I require?

Some portable digital microscopes have adjustable magnification that works like a zoom lens on a camera. The ViTiny is adjustable to 100x. The DinoLite is adjustable to 200x. These scopes provide a high degree of flexibility.

The Proscope is not adjustable but it has multiple lenses up to 400x available.

The highest magnification currently readily available in a portable digital microscope is the DinoLite 500x. However its magnification cannot be adjusted.

5. How sturdy do our digital microscopes need to be?

Like all microscopes, digital microscopes need to be handled with some care. Those that require lenses to be changed are the most likely to suffer breakages. Repairs can be expensive and may not represent good value given the purchase price.

The best prevention is ensuring sufficient equipment is available for class numbers so rough handling is minimised; students are given instruction on how to care for the devices before taking portable microscopes into the field, and appropriate protective bags are provided for storing and carrying the devices.

Some digital microscopes like the ViTiny have their own bags for greater protection during transportation. The DinoLite offers a bag as an optional accessory. Digital eye-pieces usually have their own solid storage boxes and should always be stored in the box when not in use.

6. What is my budget?

Price is not necessarily a signifier of quality, though always be careful of cheap look-alikes of quality branded products.

If comparing branded products, you will find difference in price depends on such things as the quality and type of lenses; the resolution of the images; and the number and type of features offered. Digital microscopes requiring multiple lenses and those with higher resolution and magnification are more expensive.

The most important consideration should not be price, but suitability for the purpose.



See the ***SMART buyer's guide*** at the end of this book to help you compare the digital microscopes you are looking at to make your decision.

What support and implementation is required?

It takes very little support to introduce digital microscopy. In most cases installation requires installing the USB drivers and the software. The only issue is occurs when the computer to be used is linked to a network. In this case an IT administrator with the appropriate network rights will need to do this for you.

Manuals are provided with all branded microscopes and on-line help is also available. Using the manual, technologically adept staff should not require more than a couple of hours practice. Nonetheless, an hour's training on the advanced features of imaging software such as measurement, time-lapse video etc. is useful and may be a consideration when making your purchase.

However for the less technologically adept, it is wise to set aside more time, perhaps half a day, for a training session to demonstrate some of the uses of digital microscopes and how to save and manipulate images

Using digital microscopes to improve class participation.

The digital microscope is a tool with huge learning potential for students from Year 3 upwards.

It engages students and shows them how truly fascinating common objects can be under magnification, promoting inquiry skills including observing, classifying, inferring, predicting and analysing. In primary school, this can be the first step towards helping students understand how scientists go about their work. In secondary school, students can gain a vision of science as active and evolving, new and interesting, rather than "stuff in textbooks".

While a generation ago, 70 percent of students were what researchers Dunn and Price called "structured auditory learners", meaning they learnt by listening to the teacher, nowadays less than 30 percent learn this way.

Students today have been shaped by technology almost from birth. They are multi-modal communicators, living in a highly visual hyperlinked world. They absorb information from multiple sources, rather than a single source (the teacher). They spend their leisure in virtual worlds that are far more real to them than the classroom.

Yet the digital microscope with its amazing revelations of microscopic life, and fascinating creatures living in a mini-universe, has the ability to provide a bridge between these worlds.

Those students who can become easily bored unless surrounded by stimulation, are also experiential and participative, and endlessly curious about "stuff". They *love* doing things and working together, and have a sixth sense about how to use any technology.

So you won't need to worry about teaching them how to use digital microscopes or encouraging them to accept the technology. If you are comfortable about relinquishing some control, they'll probably be able to teach you what to do with them and create experiments that will advance their own learning well beyond your expectations.



Unconvinced? Not comfortable with the technology? Budget for a short course in digital microscopy before making a purchase. A number of organisations and consultants provide basic training in using new technologies in the classroom. The best are those that are independent of any particular brand.

Activities to get you started.

Exercise 1 – What am I?

This can be a teacher or instructor led activity, or alternatively a group work activity, where the microscopic image of an object is examined by the whole class using the interactive whiteboard, a projector, or printed copies.

A selection of unusual, and sometimes startling images, created from magnifying ordinary objects such as skin, fabrics, coins and notes (microprint) make a great classroom display and can also provide inspiration for art and creative writing projects.

Suitable for: Primary school, Year 3 upwards

What you need: Portable digital microscope(s) and a selection of ordinary objects. Try pieces of fabric, human or animal hair, carpet, a flower or leaf, the sole of a shoe, a coin, a piece of carrot, a slice of lemon/orange.

If using this as a team exercise, four is an ideal number with three members having the job of finding at least one object and capturing it; the whole team deciding on the image they will submit and why; and the fourth member being responsible for caring for the microscope and acting as the spokesperson.



Use the DinoLite to observe the microprint above Henry Lawson's hat on the Australian \$10 note to reveal his most famous poem. This is a great thought starter for a range of creative activities.

Exercise 2 – Time lapse video

Most digital microscopes come with software that allows video and time lapse video using low magnification. This can be used in a range of experiments:

- metamorphoses of a butterfly or moth
- growth of slime mould
- a flower opening
- growing crystals

Students observe the action on the computer and record their observations in a logbook.

Suitable for: Junior secondary school students

What you need: A portable microscope (maximum 200X magnification) with a stand; time-lapse software; the equipment/items for the relevant experiment, plus a log book for each student or group.



Consider purchasing an insect breeding kit to record the entire lifecycle of a bug. See the resources section at the end of this book.

Exercise 3 – Capture animation of microscopic creatures

Take a sample of pond water, sea water from a rock pool, or stagnant water from the garden and capture the images of the insects and small invertebrates using the video feature of the digital microscope.

Suitable for: Year 6 upwards

What you need: Collection jars; watch glasses for each student or group to be used for the observation; portable microscopes with video software and stands.



Using the internet to identify the insects and invertebrates, students can develop their own guide to local ponds or streams. Relevant sites are noted in the resources section.

Exercise 4 – Insect encyclopedia

Ask the class to create an insect encyclopedia using images they record in the field and information they obtain from the internet to identify the insects.

Suitable for: Years 5 to 6

What you need: Portable microscopes and laptops or ultra-mobile PCs. Students should wear gloves, long sleeves and appropriate footwear to ensure they are not accidentally stung by spiders, bees or ants.



Do some pre-work on identifying dangerous insects before taking students into bushy areas. Unlike traditional collection and examination methods, with a portable microscope there is no need for the students to touch any of the insects they find.

Exercise 5 – Is it clean? (Before and after.)

A simple activity is to examine a section of a bench top or floor with a digital microscope. After the first examination, sweep or mop it, and examine it again. A discussion of what “clean” means can be an interesting one for primary school students.

This could develop into a discussion about television advertising claims for cleaning products.

Suitable for: Year 3 to 4

What you need: A portable digital microscope; a brush and dustpan; detergent, water and cleaning cloth.

Exercise 6 – Soil search

Divide the class into groups and provide each group with a bucket and a different location from which to collect a soil sample eg the vegetable garden; a sandpit; beside a creek; the bush etc.

The groups sieve the contents of their buckets and place what is left in the sieve on a piece of white butchers paper or a drop sheet. Using a hand-held digital microscope the material is examined and the results recorded by the groups and compared with the other groups' samples.

The exercise can be made more rigorous by requiring students to not only observe such things as particle colour and insect life in the sample, but also to measure and compare particle size.

Suitable for: Junior secondary students

What you need: Gloves, buckets, spades and sieves for each group; butchers paper; hand-held digital microscopes with upgraded software for measurement and comparisons.

Exercise 7 – Fibre detectives

An example of the practical application of forensic science is identifying fibres that have been collected as evidence. Examining the differences between synthetic and natural fibres and identifying different fibres by their structure requires skilled observation.

Suitable for: Middle to senior secondary students

What you need: A selection of identified and unidentified fibres, A good quality portable digital microscope (at least 200X magnification) and stand, or digital eye-piece and traditional microscope.



Fibre kits containing a selection of fibres from the three main categories (natural, regenerated and synthetic) are available commercially. Kits contain a comprehensive manual of exercises. See the resources section.

Exercise 8 - Aging

This is an easy exercise to allow parent involvement on school open days.

What happens when things get "old"? Students compare the skin on the back of their hands with that of their parents. This promotes discussion about the process of aging, sun damage etc.

Suitable for: Primary school students, Year 3 upwards

What you need: A portable digital microscope and computer

Exercise 10 – Blood cells

Using a good quality microscope, a digital eye-piece and appropriate software such as TLI Scope, students can measure the diameter of blood cells on a microscope slide. Images are captured and results recorded.

Suitable for: Years 11 and 12

What you need: Good quality powerful microscopes (binocular or minocular) and digital eye-pieces; software that has measurement features; prepared slides

Exercise 11 – Who dunnit? (Just like CSI)

Another one for open days and a good, robust cross-curriculum activity that is fun for parents as well as students.

Create a mock murder where clues are planted and the students examine the forensic evidence using a portable digital microscope. This can include hairs, dust, pollen, fingerprints, as well as tiny fragments of paper, cloth, paint etc from the site. These are measured and catalogued and then compared with samples taken from the “suspects”.

This exercise can go beyond science and reporting to conclude with a mock trial, providing a platform for students to learn how to put together a logical argument, argue their case, develop questioning techniques, and handle objections.

Suitable for: Years 8 to 10

What you need: Apart from a hand-held digital microscope and some note books, let imagination be your guide:

- a prepared script of the “crime” (who, what happened and where, with some suggested suspects and motives)
- a simulated crime scene
- planted clues that relate to more than one suspect (fibres, fingerprints, hair, spilt powder, flecks of paint) with some others that will be purely accidental, such as dust.

Resources on the Web

Identification Guides

- Australian freshwater invertebrates: www.mdfrc.org.au/bugguide
- Australian Museum Online: www.amonline.net.au/explore/index.cfm
- Common Australian insects such as cockroaches: www.insectguide.net
- NSW water bugs: www.bugsurvey.nsw.gov.au

School Sites

Bannockburn Primary School: <http://bannockburnps.vic.edu.au/DigitalMicroscopes>

Suppliers

- Fibre and other kits, prepared histology slides etc: Southern Biological www.southernbiological.com
- Insect breeding kits: The Insect Farm www.insectfarm.com.au
- Microscopes: www.microscope-shop.com.au

Support sites

- Australian Science Teachers Association (including information on state branches): www.asta.edu.au
- CSIRO Education Centres: www.csiro.au/csiro/pchat.html
- Questacon: www.questacon.edu.au
- Science News for Kids: www.sciencenewsforkids.org
- Science Portal: www.science.gov.au

Training

- The Logical Interface www.logint.com.au

The SMART buyer's worksheet

Questions	Criteria	Digital Microscopes Matching Criteria
Can we connect to a computer when using the digital microscope?	e.g. Computer connected	
What resolution will we require?	e.g. 0.3 MP, 1.3 MP, 5 MP	
What will we use the scope for? What magnification will be required for this work?	e.g. Flexible magnification for field work	
How sturdy does the digital microscope need to be? (Will only the teacher or instructor use it, or will it be available to students to use?)	e.g. Teacher only – sturdiness not a problem.	
What is our budget?		

The formula for a SMART decision

Check what brands meet all your criteria, list them, and answer the questions.

Brand and Model	Price	Is supply reliable? yes or no	Support service available from supplier? yes or no	Easy to use? yes or no

Just add up the number of "Yes" answers and compare the prices to decide.

The digital microscope that is best for us is _____

Number of digital microscopes required _____

(Note: One digital microscope for every 3 to 4 students is recommended as a class set)

Budget Estimate

Digital microscopes	\$ _____
Lenses (if applicable)	\$ _____
Advanced software	\$ _____
Freight	\$ _____
Total	\$ _____

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