Teaching Secondary Mathematics

Module 4

Conducting practical and collaborative work:
Focus on contours

4

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Introduction to Module 4: Conducting practical and collaborative work: Focus on contours

Use of this module

This module allows for flexibility in modes of engagement with professional learning. The module booklet needs to be used in conjunction with the PowerPoint slides accompanying this resource.

The Teaching Secondary Mathematics Resource provides support and guidelines for effective practice for classroom teachers and school leaders of mathematics, especially from Years 7–10.

This resource is for:

- all secondary mathematics classroom teachers to deepen their understanding of mathematics. This will inform their planning for mathematics and highlight opportunities for assessment of mathematics in other domains of the Victorian Essential Learning Standards (VELS)
- mathematics leaders in schools to plan opportunities for professional learning for the teachers of mathematics, in professional learning teams and/or for individual teachers
- differentiating the professional learning needs of mathematics teachers in schools.

Workshop approach

The materials of this module can be used by a presenter in a workshop for a school or a cluster of schools. A presenter appointed from within or outside a school or cluster, is responsible for preparing presentations, facilitating discussions and outlining processes for collaborative planning.

Where a group is working collaboratively through these modules, a designated area is required for participants to share ideas, stories and samples in a climate of mutual respect. Regular after school meetings in a particular venue, such as the library, create a productive sense of community.

Individual use

The materials of this module are also suitable for private study and reflection. Individual users become both 'presenter' and 'participant'. While they are not able to engage in group discussions or whole-school planning, individual users can readily adapt the suggested group discussions and whole-school planning activities to private reflection, writing and classroom planning.

It is suggested that individuals identify a colleague or a buddy with whom to share their thoughts and to support the development of their understandings through ongoing dialogue. Individuals may complete all the modules or choose a combination depending on their interests or needs.

Web connections

The 'Teaching for Secondary Mathematics' resource is located at http://www.education.vic.gov.au/studentlearning/teachingresources/maths/teachsec/default.htm.

Before commencing to plan any elements of the program, schools are strongly advised to visit the Mathematics Domain page to review the most up-to-date advice, resources and information relevant to each module of the program. Many elements of this resource are available online in a downloadable format. There are links to assist schools to locate relevant information.

- Mathematics Domain (http://www.education.vic.gov.au/studentlearning/teachingresources/maths/default.htm)
  See the website for further details about this additional information or contact the student learning help desk on studentlearning@edumail.vic.gov.au

Content of the module

This module comprises this booklet, Module 4 – Conducting practical and collaborative work, and the accompanying slide presentations which can be downloaded from http://www.education.vic.gov.au/studentlearning/teachingresources/maths/teachsec/module4.htm

The following are included in this document:

- the **User's Guide** that assists the user through the professional learning program
- hard copies of the **slide presentations** and **resource sheets**
- selected **resources.**

Organisation of the module

Computer access is required for all modules. If a group is completing the modules, a data projector and tables that enable people to sit together and work collaboratively are also necessary. The presenter should encourage participants to raise questions throughout the ensuing presentation. This presentation should take approximately two hours, depending on the depth of discussion and types of activities that facilitators incorporate.

Required resources

This module requires the resources listed below.

- Indicator of progress: Understanding Contour Lines 5:0 (http://www.education.vic.gov.au/studentlearning/teachingresources/maths/mathscontinuum/space/SP50001P.htm)_
- Mathematics Developmental Continuum – Mapping the Indicators of Progress (http://www.eduweb.vic.gov.au/edulibrary/public/teachlearn/student/mathscontinuum/indicatorsgrid.pdf)
- Developmental Overview of Space (http://www.eduweb.vic.gov.au/edulibrary/public/teachlearn/student/mathscontinuum/mcdospace.pdf)
- Contour model (http://www.eduweb.vic.gov.au/edulibrary/public/teachlearn/student/mathscontinuum/contourmodel.pdf)
- Contour profile templates (http://www.eduweb.vic.gov.au/edulibrary/public/teachlearn/student/mathscontinuum/contourprofiles.pdf)
- 'Match the views' maps (http://www.eduweb.vic.gov.au/edulibrary/public/teachlearn/student/mathscontinuum/matchtheview.pdf)
- 'Imaginary bushwalk' maps (http://www.eduweb.vic.gov.au/edulibrary/public/teachlearn/student/mathscontinuum/bushwalks.pdf)

Materials

- clean (not waxy) potatoes cut in half
- permanent markers
- rulers
- newspapers
- topographic map which includes cliffs and caves (not essential).

Icons

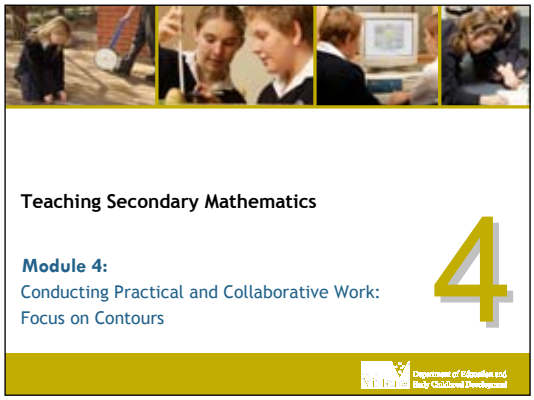
The following icons have been used in this workshop program:

Distribute handout:

Group discussion:

Group activity:

User's Guide to Module 4: Conducting practical and collaborative work: Focus on contours



Slide 1: Title slide

Slide 1 is the title slide

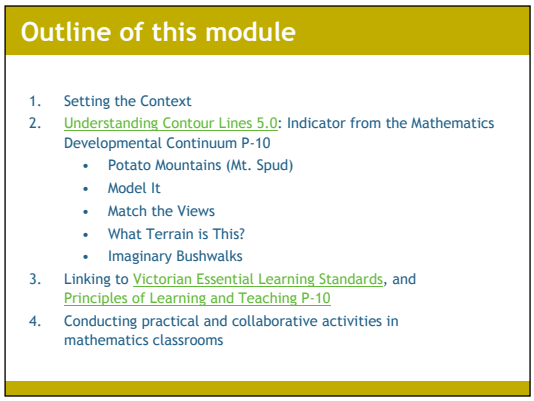
This module, which focuses on conducting practical and collaborative work, has been adapted from the Mathematics Developmental Continuum P–10: 'Understanding Contour Lines: 5.0'.
There are two themes running concurrently in this module:

- how to give students an opportunity to work practically and collaboratively
- how to provide them with the opportunity to gain a better conceptual understanding of contours.

It is essential that teachers provide students with the opportunity to have hands-on experience with three-dimensional models so that they can make the connection between the physical world and what is depicted symbolically on a map. Connecting mathematics learning in schools with the student's own world will support each student's growth as a community member as well as raise their achievement in mathematics.

See

- Indicator of progress: Understanding Contour Lines 5:0 (http://www.education.vic.gov.au/studentlearning/teachingresources/maths/mathscontinuum/space/SP50001P.htm)



Slide 2: Outline of this module

Outline

Slide 2 provides an outline of this module. The module includes:

1. Setting the context
2. Indicator of progress: Understanding Contour Lines 5.0 (http://www.education.vic.gov.au/studentlearning/teachingresources/maths/mathscontinuum/space/SP50001P.htm)
   a. Potato mountains (Mt. Spud)
   b. Model it
   c. Match the views
   d. What terrain is this?
   e. Imaginary bushwalks
3. Linking the activities with:
   - the Victorian Essential Learning Standards (http://vels.vcaa.vic.edu.au/assessment/ppoint/maths/index.html)
   - Principles of Learning and Teaching P–12 (http://www.education.vic.gov.au/studentlearning/teachingprinciples/principles/default.htm)
4. Conducting practical and collaborative activities in mathematics classrooms.

Setting the context

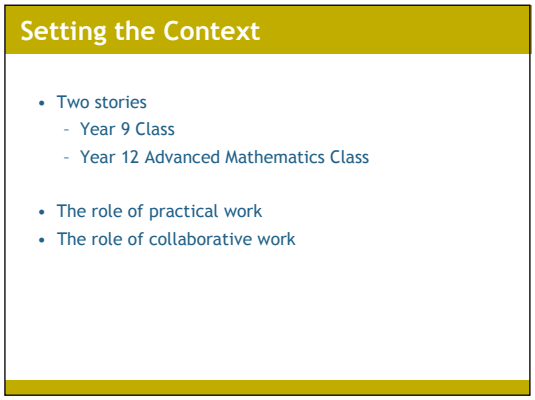
Slide 3 invites participants to discuss in small groups how they have used and applied practical work in their mathematics classes.

Refer to slide 3: Setting the Context

Here are two anecdotes describing how a teacher incorporated practical work in mathematics.

> A Year 9 class went out to measure the slope of a local steep street. The teacher used hoses to create a water parabola and then made a photo. The students then applied a grid and worked out the equation of the parabola.
>
> A Year 12 advanced maths class got to build some 3D functions with straws and plasticine one Friday afternoon. They appreciated the use of the concrete materials, although the 'if anyone walks past they will think this is the "vegie" maths class' was a little telling and highlights some of the issues about moving students from the concrete to the abstract.

Discuss the value of practical work as it develops students' thinking into a more abstract mathematical understanding. The value of collaborative work is that it encourages student discourse and provides opportunities for students to clarify and articulate their thinking. However, practical work maybe challenging to some teachers who have an over-reliance on skill and drill activities.



Slide 3: Setting the context

Working with different maps

Slide 4 illustrates a 'Melway' map of Mt. Holden. It provides a context for discussion. A good way to engage the participants is to tell a story.

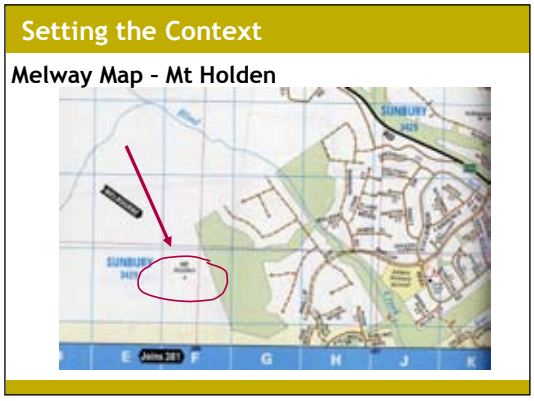
Use slide 4: Maps

Ask participants to imagine that they are climbing Mt Holden in Sunbury.

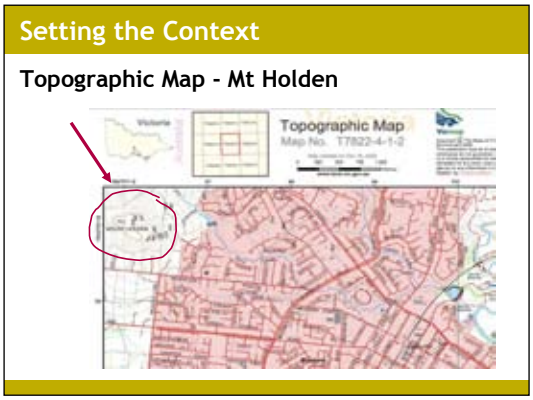
They only have a 'Melway' map.

- What sort of an experience do you think they would have?
- Does this map provide enough information?

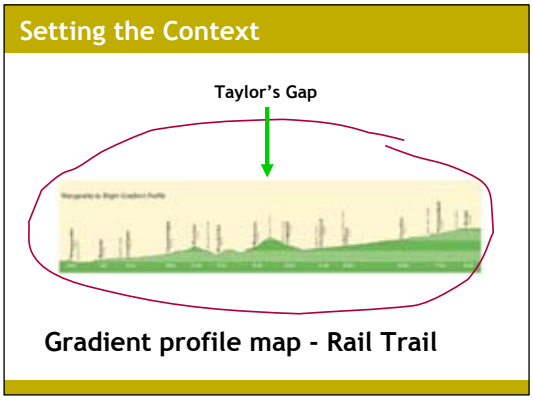
Participants may observe that this map only indicates the location of Mt. Holden. It does not provide any other information.



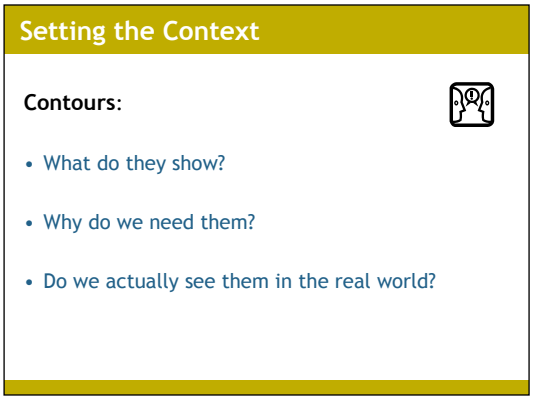
Slide 4: Setting the context — 'Melway' map of Mt. Holden



Slide 5: Setting the context — A topographic map



Slide 6: Setting the context — Profile map



Slide 7: Setting the context — Contours

A topographic map

Slide 5 presents a topographical map.

Use slide 5: Topographic Maps

Ask participants to consider a topographic map and ask them what sort of experience that they would have.

Possible responses:

Walking, possibly staggering up Mt. Holden.

May have experienced walking in a valley or a gulley.

Ask participants what information they could get from the topographical map?

Possible responses:

By reading the contours from the map, noting the intervals and the heights marked on the contour lines, you can get a sense of the terrain.

These responses are not exhaustive – in fact participants may come up with other responses not included here that are still valid and reasonable. These responses could be recorded.

Profile map

Use slide 6: Profile Maps

Slide 6 presents a profile map — a different method of representing height.

When looking at this rail trail gradient map, ask the participants:

- What does this map show?
- What are the green layers?
- How is it different from the other maps?

Points to note:

Green layers show bands at similar heights.

This is a different way of showing how height changes, but it only does so for one path through the countryside (the rail trail itself). It is a vertical slice and it cannot show what is just to one side or another; these would be shown on different vertical slices.

It does not show that, in fact, Taylor's Gap is a saddle with higher mountains on either side of it. This would be evident on a contour map.

Contours

Slide 7 lists the following questions about contours:

- What do contours show?
- Why are contours useful?
- Do we actually see contours in the real world?

Use slide 7: Contours

Invite participants to discuss these questions in small groups.

Suggested responses may include:

- What do contours show?

  Height (above sea level).

  Lines of constant height.

  High tide, low tide, decreasing water level in a dam or lake in a drought, flood levels.

  Weather map shows lines of constant pressure while contour lines are lines of constant height.

  Contour-plough paddocks on the side of a hill (to reduce erosion).

  Maps of oceans can show contours of equal depths.
- Why do we need contours?

  To show the third dimension (height) on flat (2D) paper.
- Do we actually see contours in the real world?

  No: the actual lines don't exist on the ground.

  Yes: some features follow contours e.g. tiered seating at the MCG.

  Other features almost follow contours, e.g. water race (mining), gravity-fed water pipeline, train tracks, rice terraces.

Importance of learning about contours

Slide 8 lists the questions:

- What is important to learn about contours?
- Is it good enough to know 'When the lines are close together it is steep, when the lines are far apart it is quite flat'?

Use slide 8: What is important to learn about contours?

Invite participants to discuss these questions in small groups.

Suggested responses could include:

Contour lines don't exist in the real world as such … although if you can walk without going uphill or downhill you are actually following a contour line.

You need to know the contour spacing to gain full information about how steep something is.

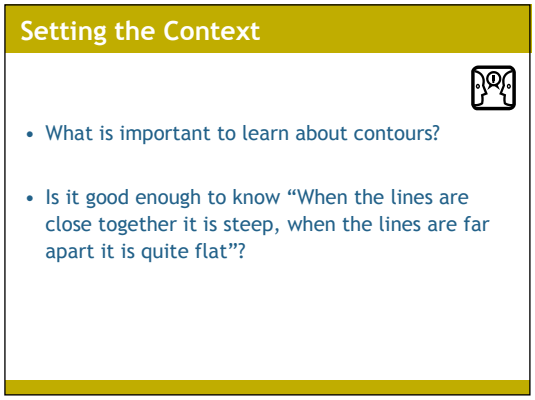
There are contour lines between the contour lines (e.g., a map may only show the 10m contours, but there are 1m contours as well, etc).

Depending on the contour interval some features may not be apparent because the contour spacing hasn't been close enough to make it show up.

How features of the flat contour line pictures translate into 3-D features.

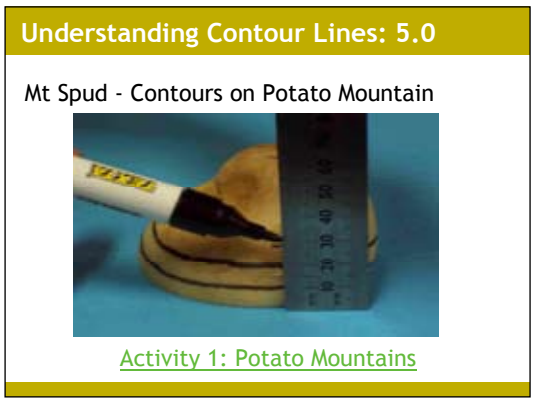
Contours provide useful information about the terrain, for example when planning a bushwalk.

Some of these issues will become more evident in the following activities.



Slide 8: Setting the context — Importance of learning about contours

Slide 9: Undertanding Contour Lines: 5.0



Slide 10: Undertanding Contour Lines: 5.0 — Activity 1: Potato Mountains

Mathematics Developmental Continuum P–10 – Understanding Contour Lines 5.0

Activity 1: Potato Mountains

Use slides 9–14 Contour Mountain

Slide 9 refers to a teaching activity which will be used by participants to explore a three-dimensional model. It is essential that students have hands-on experience with three-dimensional models so that they can make the connection between the physical world and what is depicted symbolically on a map.

This activity has been adapted from teaching strategy 'Potato mountains' found at:

- Indicator of progress: Understanding Contour Lines 5.0 (http://www.education.vic.gov.au/studentlearning/teachingresources/maths/mathscontinuum/space/SP50001P.htm)

Using the photos on slide 9, examine the Mt Spuds that these teachers have marked up.

Explain to participants that they are to take the role of students in this activity.

Discuss with participants how the contour lines show the shape of the mountains.

Demonstrate that by just viewing from above shows what the contour map looks like (i.e., you don't actually have to cut and draw each layer).

Take this opportunity to provide participants a copy of the relevant indicator of progress, and give them time to explore:

- Indicator of progress: Understanding Contour Lines 5:0 (http://www.education.vic.gov.au/studentlearning/teachingresources/maths/mathscontinuum/space/SP50001P.htm)

Mt. Spud — Contours on a potato mountain

It is essential that students have hands-on experience with three-dimensional models so that they can make the connection between the physical world and what is depicted symbolically on a map. The aim of this activity is explore contour lines by drawing them on a 'real' mountain.

This activity has been adapted from teaching strategy: Potato Mountains found on:

- Indicator of progress: Understanding Contour Lines 5.0 (http://www.education.vic.gov.au/studentlearning/teachingresources/maths/mathscontinuum/space/SP50001P.htm)

Materials needed for activities

Provide the following materials:

- clean, not waxy, potatoes cut in half. Try to choose a variety of potato shapes: some that have bumps, some steep on one side, some that are quite flat. May want to give pairs two halves that contrast. Don't peel the potatoes (the juice clogs up the pen).
- permanent markers
- rulers
- newspapers
- topographic map which includes cliffs, and caves (not essential).

Method and discussion points

- Discuss in small groups: 'How do you allow for the gap at the end of the ruler?'
  - Suggested response may include:

    It is unlikely to find a ruler which has the 0 at the end of the ruler; so you have to allow for the gap between the end of the ruler and the first 0 mark, and make the remaining measurements accordingly. This is an issue that needs to be discussed with students.
- Draw the contours on the potato using a scrap piece of paper under the cut face of the potato.
- Discuss with participants issues that may arise from marking contours.

Issues that might arise from marking contours

Vertical measurements (Slide 11)

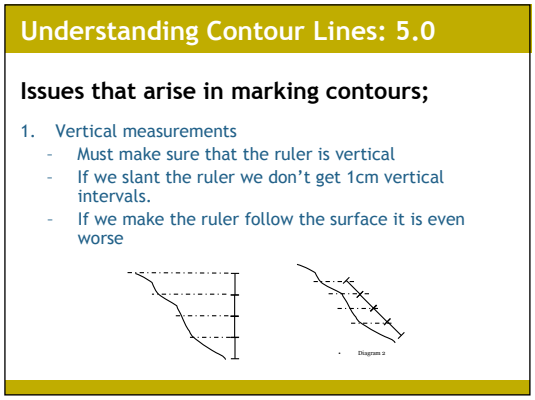
- Must make sure that the ruler is vertical (e.g. diagram 1).
- If we slant the ruler we don't get 1cm vertical intervals (diagram 2).
- If we make the ruler follow the surface it provides an inaccurate measurement.

Little Circle on top (Slide 12)

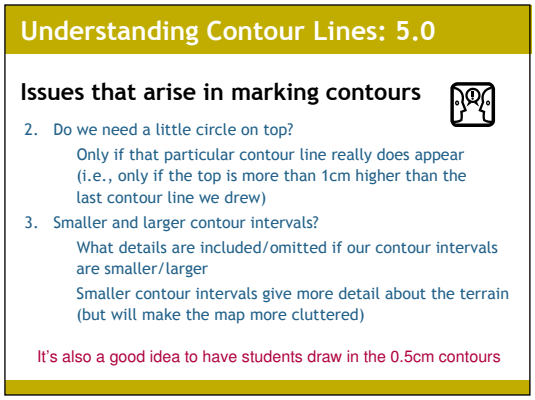
- Should only be drawn if that particular contour line really does appear (i.e., only if the top is more than 1cm higher than the last contour line we drew).

Smaller and larger contour intervals (Slide 12)

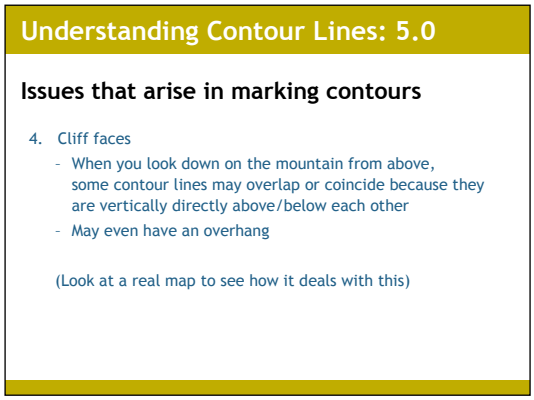
- Smaller contour intervals give more detail about the terrain (but will make the map more cluttered).
- It may be a good idea when teachers are working with students to get them to put in the 0.5cm contour intervals as well, which could provide more detail about the terrain.



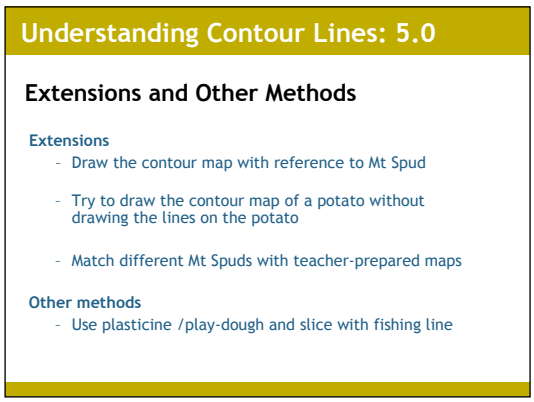
Slide 11: Understanding Contour Lines: 5.0 — Issues that arise in marking contours



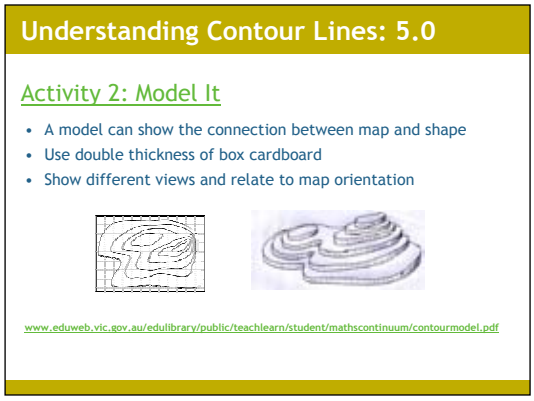
Slide 12: Understanding Contour Lines: 5.0 — Issues that arise in marking contours



Slide 13: Undertanding Contour Lines: 5.0 — Issues that arise in marking contours



Slide 14: Undertanding Contour Lines: 5.0 — Extensions and Other methods



Slide 15: Undertanding Contour Lines: 5.0 — Activity 2: Model It

Cliff faces (Slide 13)

If you are lucky, one of the potatoes may produce a vertical face or even an overhang or cave. The resulting contour lines when viewed from above are worth highlighting and discussing why real maps have separate symbols for cliffs and caves. Look at a real map to see how it deals with this.

Extensions and other methods

Slide 14 demonstrates some other methods that could be used with students.

Extensions:

- Draw the contour map with reference to Mt. Spud.
- Try to draw the contour map of a potato without drawing the lines on the potato.
- Match different Mt Spuds with teacher-prepared maps.

Other methods:

- Use plasticine or play-dough and slice with fishing line.

In Conclusion

This activity provides the opportunity for teachers to provide for a supportive and productive environment. Refer to:

- Principles of Learning and Teaching P-12 (http://www.education.vic.gov.au/studentlearning/teachingprinciples/principles/principlesandcomponents.htm)
- Resource 1 (Principles of Learning and Teaching P–12)

Model-it

Slide 15 presents 'Activity 2: Model it' which provides a template and instructions for a useful model that will assist students with their visualisation of three dimensional objects.

This model can show the connection between map and shape. It also shows different views and relates to map orientation.

Provide participants with a copy of:

- Contour model (http://www.eduweb.vic.gov.au/edulibrary/public/teachlearn/student/mathscontinuum/contourmodel.pdf)
- Contour profile templates (http://www.eduweb.vic.gov.au/edulibrary/public/teachlearn/student/mathscontinuum/contourprofiles.pdf)

Use slide 15: Model it

Discuss with participants how this model (about 1.5 hours to make) relates to the contour map. Note: it is better to use double thickness of box cardboard.

Emphasise to participants the usefulness of the model:

- It allows students to try to visualise different views of the mountain from different orientations of the original map.
- It allows students to check their visualisation answers against the model, rather than needing a teacher check it.

Match the Views

Slide 16 shows the 'Match the views' activity.

Provide participants with a copy of this activity. It can also be downloaded:

- Match the views (http://www.eduweb.vic.gov.au/edulibrary/public/teachlearn/student/mathscontinuum/matchtheview.pdf)

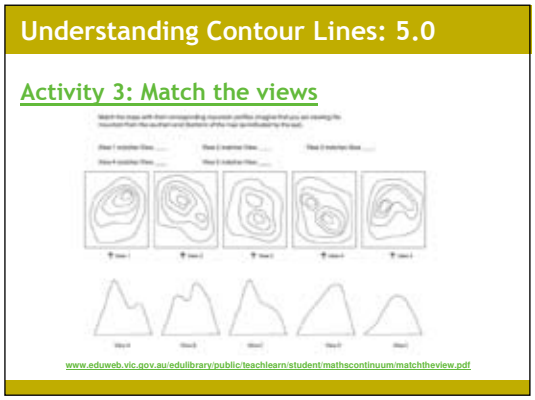
Explain to participants that the point of view is from the bottom (South) of the map.

Encourage participants to resolve their differences in pairs and then resolve differences between participants at the same table. Suggest they consider discussing steepness, number of peaks, maximum height (e.g. the mountain in View 3 is not as tall as the one in View 1, which is why it corresponds with View E and not View D). This is the sort of discussion that teachers would need to have with students.

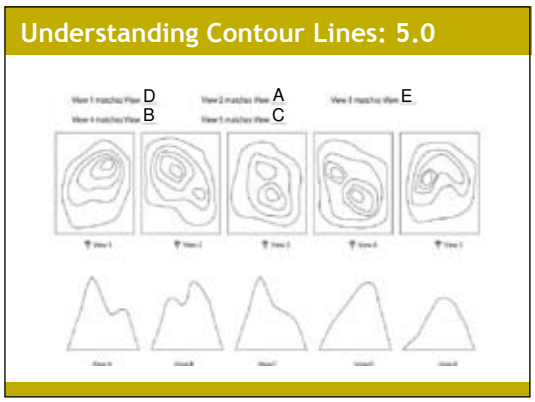
Slide 17 presents the answers to the 'Match the Views' activity.

Slide 18 may be used to point out and elicit extension ideas for the activity. Ideas may include:

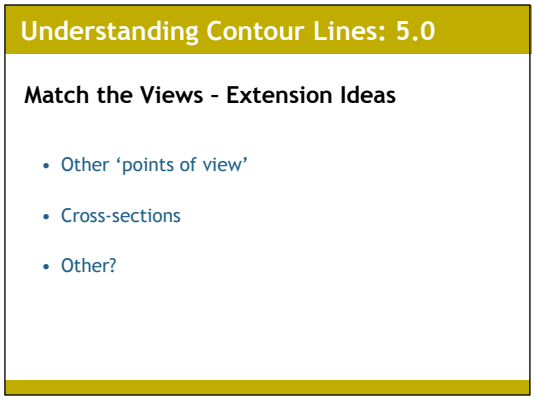
- Using the same contour maps but having students draw the mountain shape as viewed from different angles.
- Completing an accurate cross-section (issues of scale become important).



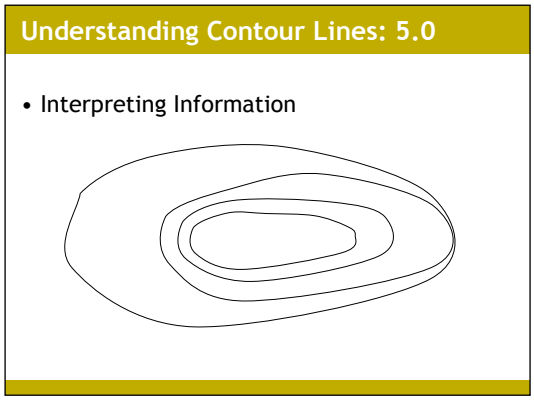
Slide 16: Understanding Contour Lines: 5.0 — Activity 3: Match the views



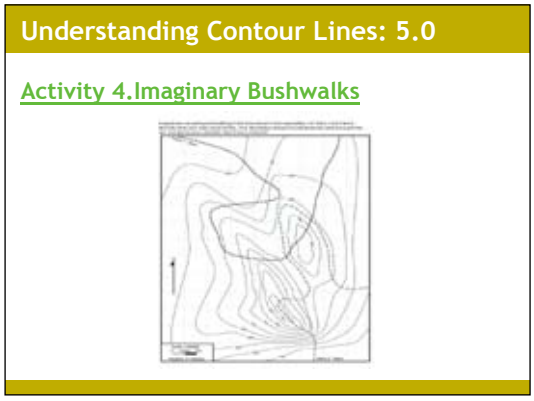
Slide 17: Understanding Contour Lines: 5.0



Slide 18: Understanding Contour Lines: 5.0 — Match the Views — Extension ideas



Slide 18: Undertanding Contour Lines: 5.0 — Interpreting information



Slide 19: Undertanding Contour Lines: 5.0 — Activity 4: Imaginary bushwalks

What terrain is this?

Slide 19 illustrates the importance of having numerical values on contour lines which would indicate if the height is increasing or decreasing. For instance, participants' first reaction may be that the diagram represents a simple mountain. However, it could be a depression, a crater or a series of moats.

Imaginary bushwalks

Slide 20 illustrates a map used with the 'Imaginary bushwalks' activity.

Use slide 20: Imaginary Bushwalks

Provide participants with a copy of:

- Imaginary bushwalks (http://www.eduweb.vic.gov.au/edulibrary/public/teachlearn/student/mathscontinuum/bushwalks.pdf)

Note: The activity must be **photocopied on A4 paper** with **no enlargement or reduction** from the downloaded document.

Invite participants to respond to the following questions:

- Can you describe the route for each of the two tracks?
- Can you identify any significant features of the journey?
- What were the maps and routes intended to highlight?

Features that should have been noticed by participants may include:

Track 1: fairly gentle walk, but does not really visit significant features. In the early stages, although it travels in a straight line from East to West, it actually drops into and climbs out of a gully (tracks don't usually do this: they tend to follow ridges because ridges aren't as steep as gullies). The track climbs across the northern ridges, but not the summits apart from possibly the second of both the peaks.

Track 2: quite steep, drops into the 'crater' at the top of the main peak, climbs out and then goes into the saddle between the two peaks, before following a contour line around the lower peak.

Linking to the Victorian Essential Learning Standards and the Principles of Learning and Teaching P–12

21st Century learning

Slide 21 presents the following statement about 21st century learning.

In our highly interconnected and interdependent world, students must learn to work with others by:

- building positive social relationships
- working and learning in teams
- managing and resolving conflicts.

Use slide 21: 21st Century Learning

Discuss with the participants what the statements on slide 21 mean for mathematics and consider some strategies for achieving these.

Some suggested responses may include:

Building positive social relationships

Take the time to know each student, and to acknowledge and value their contribution to the class. Teachers generate opportunities where student opinions are valued, and where students can initiate discussions.

Be sensitive to the way in which assessment is used to inform them of progress in students' learning. Teachers provide a range of ways of assessing student progress and provide appropriate feedback to students.

Working and learning in teams

Regularly set group activities and structure the activity so that all students have a responsible task in the team.

Allow students to evaluate themselves and other team members in terms of their contribution to the team.

Managing and resolving conflicts

Ensure that all contributions to class or group discussion are listened to and accorded respect.

Establish a climate where difference of perspective is welcomed and learnt from.

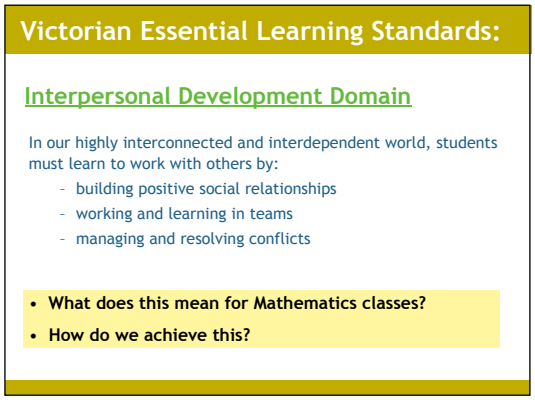
Establish agreed rules of behaviour to provide a safe and productive environment.

Model respectful behaviours.

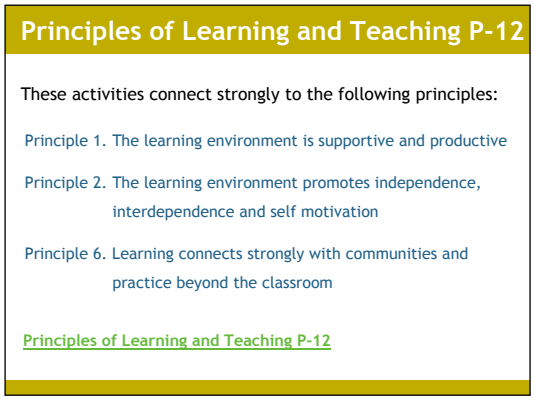
Linking to the Principles of Learning and Teaching P–12 (PoLT)

Provide participants with a copy of:

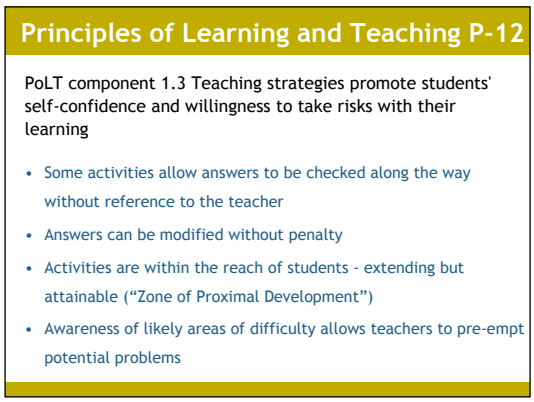
- Resource 1: Principles of Learning and Teaching, which is also available from
- Principles of Learning and Teaching P–12 (http://www.education.vic.gov.au/studentlearning/teachingprinciples/principles/principlesandcomponents.htm)



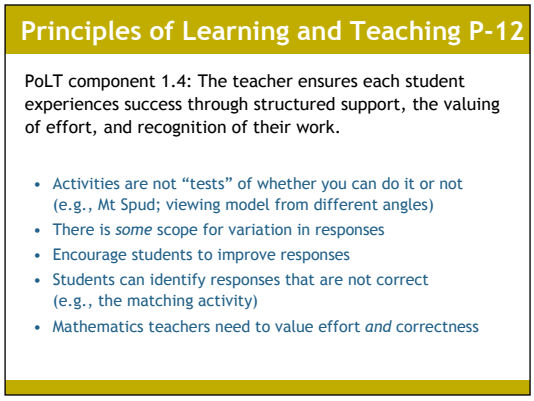
Slide 21: Victorian Essential Learning Standards



Slide 22: Principles of Learning and Teaching P–12



Slide 23: Principles of Learning and Teaching P–12 — PoLT Component 1.3



Slide 24: Principles of Learning and Teaching P–12 — PoLT Component 1.4

Relating to PoLT principle 1,2,6

Slide 22 lists the three POLT principles addressed in this module. The module presents a rich resource for teachers to provide:

- a supportive and productive learning environment that promotes students' self confidence through the building of success (PoLT Principle 1)
- a collaborative classroom (PoLT Principle 2)
- an environment that provides opportunities for students to link their classroom experiences with their local and broader community (PoLT Principle 6).

Teaching strategies promote students' self-confidence and willingness to take risks with their learning

Slide 23 shows how the module relates addresses PoLT Component 1.3:

- Some activities allow answers to be checked along the way without reference to the teacher.
- Answers can be modified without penalty.
- Activities are within the reach of students – extending but attainable ('Zone of Proximal Development').
- Awareness of likely areas of difficulty allows teachers to pre-empt potential problems.

The teacher ensures each student experiences success through structured support, the valuing of effort, and recognition of their work

Slide 24 outlines how the module relates to PoLT Component 1.4:

- Activities are not 'tests' of whether you can do it or not (e.g. Mt Spud, viewing model from different angles).
- There is some scope for variation in responses.
- Activities encourage students to improve responses.
- Students can identify responses that are not correct (e.g., the matching activity).
- Mathematics teachers need to value effort and correctness.

The teacher uses strategies that build skills required for productive collaboration (2.2)

Slide 25 outlines how the module relates to PoLT Component 2.2.

Use slide 25: Collaboration

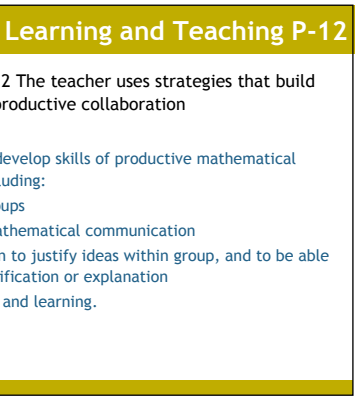
Invite participants to discuss ways that collaboration can support mathematics learning.

How could teachers help students develop these skills?

Some suggested responses could be:

- students should develop skills of productive mathematical collaboration including:
- working in groups
- using clear mathematical communication
- an expectation to justify ideas within group, and to be able to ask for justification or explanation
- peer teaching and learning.

The issue of mathematical communication and justification of solutions is an important one. Collaborative environments can also allow peer teaching and learning.



Slide 25: Principles of Learning and Teaching P–12 — PoLT Component 2.2

The teacher plans for students to interact with the local and broader communities and communities of practice (6.2)

Use slide 26: Interacting with the community

Slide 26 outlines how the module relates addresses PoLT Component 6.2:

- Finding maps of the local area.
- Deciding where and why to locate a town or house.
- Identifying relationships between creeks and gullies.
- Extending their understanding of Geography.
- Extending their understanding of isobars and isotherms.

Invite participants to discuss:

How can students apply their new knowledge?

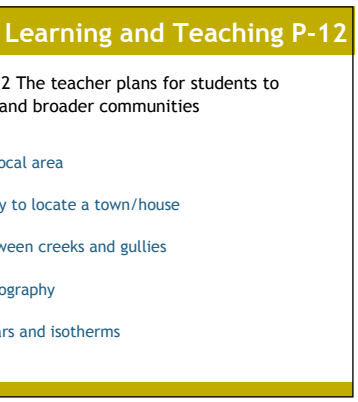
- Suggested responses could include:

  Plan walking tracks.

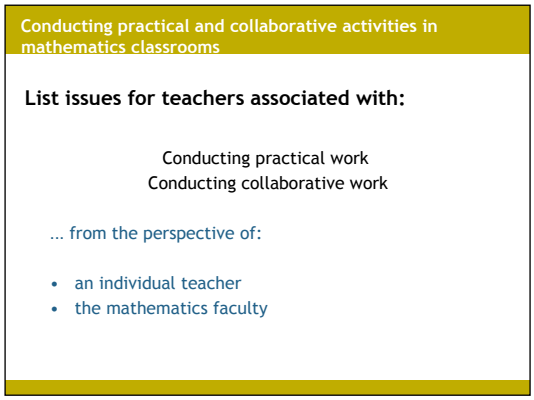
  Plan expeditions.

  In bushfire prone areas link to risk areas on ridges. Some staff or students may have CFA training with experience to add here.

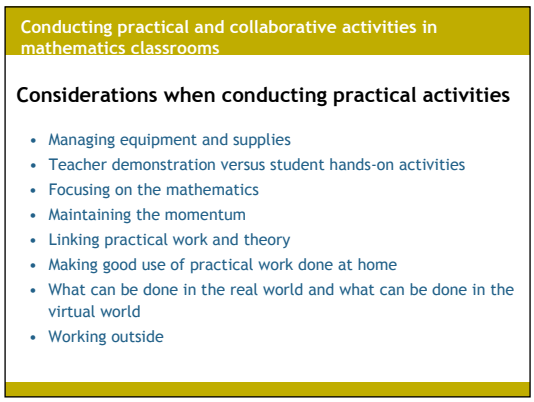
  Look at maps of other regions or countries. Learn about other places – check contour interval on maps of Nepal!



Slide 26: Principles of Learning and Teaching P–12 — PoLT Component 6.2



Slide 27: Conducting practical and collaborative activities in the mathematics classroom — List issues for teachers associated with:



Slide 28: Conducting practical and collaborative activities in the mathematics classroom — Considerations when conducting practical activities

Conducting practical work and collaborative work

Provide participants with a copy of Resource 2: Managing practical activities and collaborative work in a mathematics classroom. This information may be referred to by slides 27 to 30.

Use slides 27–30: Conducting practical and collaborative work

Encourage participants to discuss these and other issues. What are the issues? How should teachers deal with them?

Use slide 27 to elicit participant responses:

List issues for teachers associated with conducting practical and collaborative work from the perspective of:

- an individual teacher
- the mathematics faculty.

For the individual teachers the issue could be at a classroom level. It could include issues such as management of resources, whether teacher demonstration is preferable to student hands on work, and when, etc.

For a mathematics faculty the issue could be considered from the point of view as a mathematics coordinator, a teacher working within a year level team etc. The main point here is to think beyond a single classroom and consider issues that might affect a group of mathematics staff.

Considerations when conducting practical activities

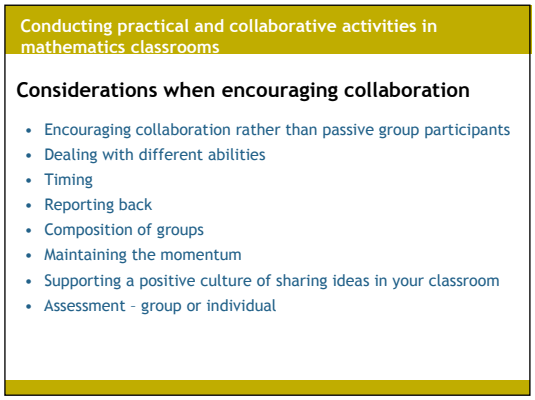
Slide 28 lists the following items that teachers need to consider when conducting practical activities:

- managing equipment and supplies
- teacher demonstration versus student hands-on activities
- focusing on the mathematics
- maintaining the momentum
- linking practical work and theory
- making good use of practical work done at home
- what can be done in the real world and what can be done in the virtual world
- working outside.

Considerations when encouraging collaboration

Slide 29 considers issues raised when encouraging collaboration, such as:

- encouraging collaboration rather than passive group participants
- dealing with different abilities
- timing
- reporting back
- composition of groups
- maintaining the momentum
- supporting a positive culture of sharing ideas in your classroom
- assessment as a group or as individuals.

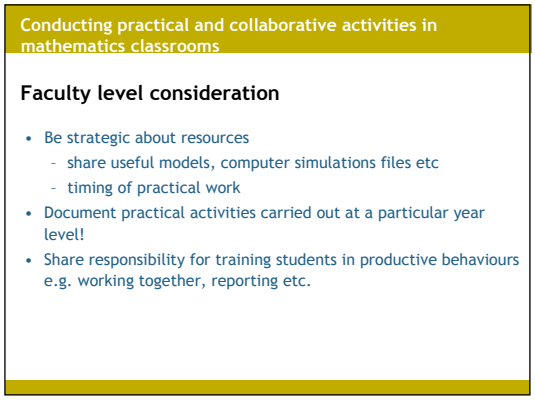


Slide 29: Conducting practical and collaborative activities in the mathematics classroom — Considerations when encouraging collaboration

Faculty level consideration

Slide 30 lists factors that need to be considered by the mathematics faculty, including:

- be strategic about resources
  - share useful models, computer simulations files etc
  - schedules and timing of practical work
- document practical activities carried out at a particular year level.
- Share responsibility for training students in productive behaviours such as working together, reporting, etc.



Slide 30: Conducting practical and collaborative activities in the mathematics classroom — Faculty level consideration

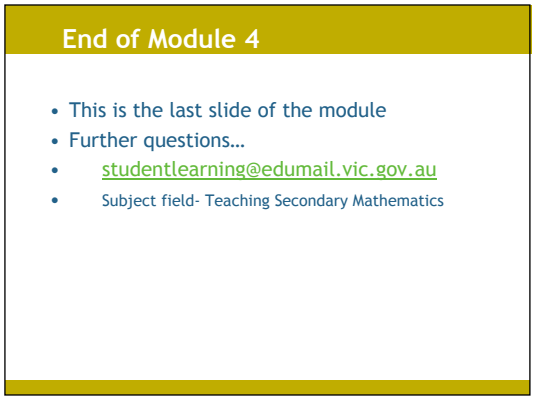
Conclusion

Slide 31 concludes Module 4: Conducting Practical and Collaborative Work: Focus on contours.

There are many resources available on the DEECD website providing strategies which will support teachers in conducting collaborative and practical activities. These include activities found on the Mathematics Developmental Continuum P–10, Digilearn resources and authentic tasks in the Scaffolding for Middle Years Numeracy resource.

There are 8 more professional learning modules:

1. Overview of learning in the Mathematics Domain
2. Overview of the Mathematics Developmental Continuum P–10
3. Narrowing the achievement gap: Focus on fractions
5. Understanding students' mathematical thinking: Focus on algebra and the meaning of letters
6. Using a range of strategies and resources: Focus on percentages
7. Learning through investigation: Focus on chance and variability
8. Working mathematically: Focus on a range of challenging problems
9. Conclusion: Planning for improvement in mathematics



Slide 31: End of module 4

Resource 1: Principles of Learning and Teaching P–12 and their components

- Principles of Learning and Teaching P–12 and their components (http://www.education.vic.gov.au/studentlearning/teachingprinciples/principles/principlesandcomponents.htm)

Students learn best when:

The learning environment is supportive and productive. In learning environments that reflect this principle the teacher:

1.1) builds positive relationships through knowing and valuing each student

1.2) promotes a culture of value and respect for individuals and their communities

1.3) uses strategies that promote students' self-confidence and willingness to take risks with their learning

1.4) ensures each student experiences success through structured support, the valuing of effort, and recognition of their work.

The learning environment promotes independence, interdependence and self motivation. In learning environments that reflect this principle the teacher:

2.1) encourages and supports students to take responsibility for their learning

2.2) uses strategies that build skills of productive collaboration.

Students' needs, backgrounds, perspectives and interests are reflected in the learning program. In learning environments that reflect this principle the teacher:

3.1) uses strategies that are flexible and responsive to the values, needs and interests of individual students

3.2) uses a range of strategies that support the different ways of thinking and learning

3.3) builds on students' prior experiences, knowledge and skills

3.4) capitalises on students' experience of a technology rich world.

Students are challenged and supported to develop deep levels of thinking and application. In learning environments that reflect this principle the teacher:

4.1) plans sequences to promote sustained learning that builds over time and emphasises connections between ideas

4.2) promotes substantive discussion of ideas

4.3) emphasises the quality of learning with high expectations of achievement

4.4) uses strategies that challenge and support students to question and reflect

4.5) uses strategies to develop investigating and problem solving skills

4.6) uses strategies to foster imagination and creativity.

Assessment practices are an integral part of teaching and learning. In learning environments that reflect this principle the teacher:

5.1) designs assessment practices that reflect the full range of learning program objectives

5.2) ensures that students receive frequent constructive feedback that supports further learning

5.3) makes assessment criteria explicit

5.4) uses assessment practices that encourage reflection and self assessment

5.5) uses evidence from assessment to inform planning and teaching.

Learning connects strongly with communities and practice beyond the classroom. In learning environments that reflect this principle the teacher:

6.1) supports students to engage with contemporary knowledge and practice

6.2) plans for students to interact with local and broader communities and community practices

6.3) uses technologies in ways that reflect professional and community practices.

Resource 2: Managing practical activities and collaborative work in a mathematics classroom

Completing investigations is a valid way of engaging students in mathematics. Teachers may need to consider the following points in order for activities to be successfully implemented in the classroom.

Classroom management

Managing equipment and supplies

- The need to prepare equipment prior to the lesson. Carrying equipment/material to the lesson.
- Ensuring that there are adequate supplies of disposable items and non-disposable items.

Teacher demonstration versus student hands-on activities

When is a good time for a teacher to demonstrate an activity and when is it good for students to experience activities first hand?

For many computer simulations of a real world situation it can be useful to have a teacher demonstration, with the teacher leading discussion, whereas a lesson involving data loggers may involve students collecting data themselves, then analysing results.

Focusing on the mathematics

- Teacher questions and discussion to promote mathematical learning.
- Attractive presentation of ideas not the main focus.
- Moving students beyond choice of coloured pencils and fonts – some students might spend considerable time on displaying work, rather than on development of deep mathematical thinking.

Maintaining the momentum

- It is useful to provide time limits for activities so that activities are not drawn out unnecessarily. Often activities will be less than one lesson in duration and so students will need to complete tasks within a given time frame. Specified time limits can provide motivation for students to engage with a task quickly.

Packing up

- Linking practical work and theory.
- Particularly important in concluding discussion.
- Relevance of practical work to achieve a specific mathematical purpose.
- Strategic decisions about the most valuable practical activity – focus on mathematics.

Making good use of practical work done at home

- If you need students to make a model, draw and colour in, collect information (counting cars etc), it is preferable for them to do this at home rather than spend class time on this.
- What can be done in the real world and what can be done in the virtual world?
- Computer simulations, dynamic geometry packages, etc can model real world situations and enable students to explore. Teacher-prepared files can save time and allow the class focus to be on the mathematics, rather than in producing files, which can often be complex to do!

Working outside

- Give instructions to students.
- Respect other classes.
- Ensure that time outside is really needed and has a mathematical purpose.
- Give time limits.

Collaborative group work in mathematics

Ensuring collaboration rather than passive group participants

This is not just about assigning roles to group members. It is about ensuring that all students are actively engaged in the maths. One strategy – when working in groups all group members must be ready to report back about the mathematical ideas, etc. Save nominating the person to report back on group progress until the actual reporting time (if appropriate).

Dealing with different abilities

How will teachers deal with correct and incorrect responses? The approach may be different:

- during work
- when reporting back
- in producing documented solutions etc.

Timing

Is everything! A useful strategy is to provide time limits (e.g. in the next ten minutes you need to ….) and to stick to them. Make direct links to other work being done.

Reporting back

Decide whether a reporting back session adds value to the mathematical learning of students. It is important not to drag out reporting sessions for too long – time limits could be useful here too.

Decide whether students will have visual props for reporting back (notes on butcher's paper, notes on overhead slides, data projector for presentation of computer file, etc).

Feedback on presentations and solutions

In a public display by students it is important to consider how incorrect solutions or comments will be addressed.

Composition of groups

Choices include homogeneous or heterogeneous by ability, gender, ethnicity, friendship, etc.

Group size

Large groups have a risk of having passive members. It is harder to avoid being involved in an activity in a smaller group. One suggestion is that group sizes range from 2–4, depending on the task.

When deciding on the composition of groups there are a few factors to take into account.

Consider the time involved in forming teacher directed groups which are not related to table groupings. If the formation of groups takes 5 or more minutes then this is a considerable amount of time in a mathematics classroom.

Maintaining the momentum

Good timing will help to keep the students actively engaged. In addition, it is useful to plan for question and answer sessions during an extended activity. Plan for times when the class will stop and points of clarification or discussion of key mathematical ideas will occur. While walking around between groups, ask students specific mathematical questions related to the task.

Support a positive culture of sharing ideas in your classroom

Assessment

Consider whether to assess according to a group or on an individual basis.

Maths faculty level issues: Conducting practical work and collaborative work

Be strategic about resources

- At a maths faculty level there are issues associated with finance, resources and there are also issues associated with timing of activities.
- Share useful models, computer simulations files, etc.
  For many practical activities teachers will develop models, props or computer files (for simulations). If one teacher makes one of these then it is good to share the resource.
- Timing of practical work.
  Consider timetabling issues.
  - If classes are blocked then classes running at the same time will make greater demands on resources than classes which are not blocked.
  - For resource intensive activities it may only be possible for one class at a time to do the activity (issue for blocked classes). E.g. computer lab for virtual activity, use of data loggers.
- Document practical activities carried out at a particular year level – don't double up!
  Incorporate the practical work into your curriculum documents to avoid doubling up.
- Share responsibility for training students in productive behaviours e.g. working together, reporting etc.