Teaching Secondary Mathematics

Module 9

Conclusion: Planning for improvement in mathematics

9



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Contents

Program Overview: Teaching Secondary Mathematics

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.

Background

The Teaching Secondary Mathematics Resource responds to the findings of the Parliament of Victoria's Education and Training Committee's *Inquiry into the Promotion of Mathematics and Science Education* in 2006. The Inquiry recommended that all Victorian schools give higher priority to Mathematics and Science learning and teaching. The report noted that whilst there are currently some excellent outcomes in Victorian schools, there is a broad range of performance among students in mathematics. A need to provide opportunities to increase student engagement in Years 7 to 10 was noted, along with imbalances in participation and achievement of some groups of students. The inquiry stated that there is considerable scope for raising the achievement of the best students and in providing support to improve the performance of under-achieving students. This resource provides teachers with current research and strategies to address some of these concerns.

Program aims

The underlying purpose of this resource is to support schools and teachers make a difference to:

- Each student's achievement in mathematics
- Each student's experience of learning mathematics. This goes beyond having fun, and includes feelings of satisfaction with meeting challenges, being valued as a person, learning things that have meaning in your life and getting rewards for making significant efforts.
- Each student's capacity as a learner. Making sure that mathematics contributes to the growth of the whole person: in the long term as a citizen with sufficient numeracy to live a fulfilling life contributing to the community; and immediately as a classroom member who interacts well with others, and assists in making school life productive.
- Each student's growth as a community member. Mathematics (and other subjects) should offer students experiences that increase their capacity to learn through ability to work independently, and their enhanced thinking and meta-cognitive processes.

Program content and organisation

This program provides many options and ideas that have proved beneficial to some teachers.

However, as usefulness depends on the particular circumstances of each school, community and student population, not all ideas will be attractive to all teachers. Each school can chart its own pathway through the program, exploring areas of particular interest and value for its own needs and purposes.

The Teaching Secondary Mathematics Resource consists of nine separate workshop modules. It is recommended that all teachers complete *Module 1: Overview of learning in the Mathematics Domain*. It is also recommended that all teachers participate in the concluding *Module 9, Planning for improvement in mathematics.*

Module 1: Overview of learning in the Mathematics Domain

The introductory module orients teachers to the 'Teaching Secondary Mathematics Resource' and provides an overview of effective mathematical pedagogies, the need for teacher's to build their craft, and how effective teaching reflects many of the initiatives currently being promoted by Department of Education and Early Childhood Development.

In the work undertaken by teachers and researchers it is seen that a number of pedagogical and mathematical themes have been found to be significant in improving learning outcomes for secondary students. Seven modules of the program are therefore dedicated to helping schools explore each of these issues. The concluding module explores how schools can plan for change in mathematics teaching.

Module 2: Overview of the Mathematics Developmental Continuum P-10

This module will inform teachers about the Mathematics Developmental Continuum P-10. It provides at outline of the main features of this Resource. The starting point is:

- Mathematics Continuum (http://www.education.vic.gov.au/studentlearning/teachingresources/maths/mathscontinuum/default.htm)

Module 3: Narrowing the achievement gap: Focus on fractions

The topic of fractions is a notorious hurdle that many students do not get over, effectively preventing them from meaningful participation in further mathematics learning. This module showcases how using diagnostic tests as assessment for learning, together with targeted teaching can help students learn fractions with understanding in a meaningful way. This opens the door to future success.

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

This module uses the topic of Contours from the Space dimension of VELS to illustrate aspects of using practical work in mathematics for engaging students in collaborative work. There are also many links to skills required outside school.

Module 5: Understanding students' mathematical thinking: Focus on algebra and the meaning of letters

This module illustrates how teaching becomes more responsive to students' needs when the teacher understands students' mathematical thinking and their common misconceptions.

Module 6: Using a range of strategies and resources: Focus on percentages

This module examines several resources used for teaching about percentages, and demonstrates a range of strategies to support the different ways in which students think and learn. These resources include: the Mathematics Developmental Continuum, Digilearn learning objects, Scaffolding Numeracy in the Middle Years and Assessment for Common Misunderstandings tools.

Module 7: Learning through investigation: Focus on chance and variability

This module focuses on chance and variability to illustrate key points about teaching mathematics through investigations. The main mathematical content is the contrast between short-run variability and long-run variability.

Module 8: Working mathematically: Focus on a range of challenging problems

Having a good appreciation of working mathematically is an important part of achievement in mathematics. Moreover, the processes of investigation, enquiry and explanation involved in working mathematically build each student's capacity as a learner. These are all important outcomes of schooling.

This module explores these issues in the context of some intriguing mathematical problems.

Module 9: Conclusion: Planning for improvement in mathematics

This module reviews the themes in the Teaching Secondary Mathematics Resource and provides an opportunity to start planning change in the teaching of mathematics in the school using a lotus diagram planning tool.

Introduction to Module 9: Conclusion: Planning for improvement in mathematics

This module concludes the Teaching Secondary Mathematics Resource and reviews the use of the resource with teachers.

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.

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 *Module 9: Conclusion: Planning for improvement in mathematics* booklet and the accompanying slide presentations which can be downloaded from http://www.education.vic.gov.au/studentlearning/teachingresources/maths/teachsec/module9.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 one hour, depending on the depth of discussion and types of activities that facilitators incorporate.

Required resources

This module requires the resources listed below.

Handouts

- Resource 1: Lotus diagram
- Resource 2: The *Seven Principles of Highly Effective Professional Learning*

  See also:
  Professional Learning in Schools – The seven principles of highly effective professional learning (http://www.eduweb.vic.gov.au/edulibrary/public/teachlearn/teacher/ProfLearningInEffectiveSchools.pdf)

Icons

The following icons have been used in this workshop program:

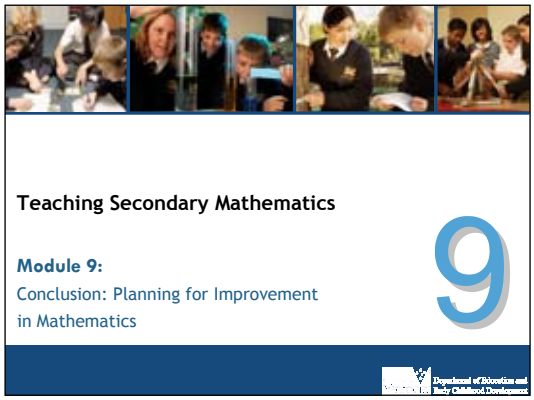
Distribute handout: 

Group discussion:

Group activity: 

Self-adhesive notes 

User's Guide to Module 9: Conclusion: Planning for improvement in mathematics



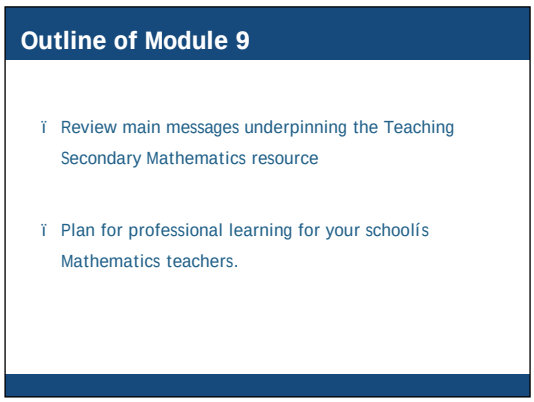
Slide 1: Title slide

Slide 1 is the title slide

Slide 2 provides an outline of Module 9.

The aims of Module 9 are to:

- revisit the underlying messages introduced in Module 1
- review the main messages underpinning the Teaching Secondary Mathematics resource
- highlight key messages and assist participants to establish a mathematics professional learning plan for their school.

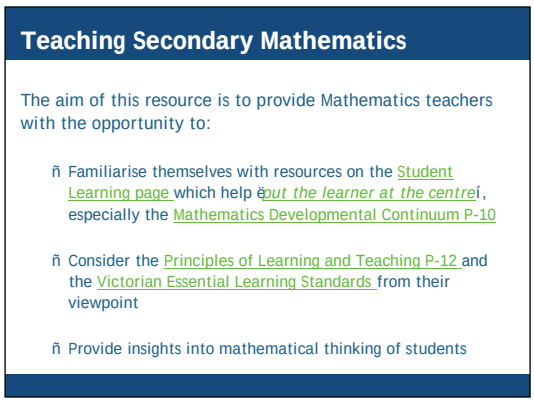


Slide 2: Outline of Module 9

The aims of the Teaching Secondary Mathematics resource

Slide 3 lists the overall aim of this resource, which is to provide mathematics teachers with the opportunity to:

- familiarise themselves with resources on the *Student Learning* page
  - Student Learning – Prep to Year 10 Resources (http://www.education.vic.gov.au/studentlearning/teachingresources/preptoyear10.htm)
- place the learner at the centre
  - Curriculum Planning (http://www.education.vic.gov.au/studentlearning/curriculum/default.htm)
- consider the *Mathematics Developmental Continuum P-10*
  - Mathematics Developmental Continuum P-10 (http://www.education.vic.gov.au/studentlearning/teachingresources/maths/mathscontinuum/default.htm)
- consider the *Principles of Learning and Teaching P-12* and the *Victorian Essential Learning Standards*
  - Principles of Learning and Teaching P-12 (http://www.education.vic.gov.au/studentlearning/teachingprinciples/principles/default.htm)
  - the Victorian Essential Learning Standards (http://vels.vcaa.vic.edu.au/)
- provide insights into mathematical thinking of students from years 7–10.

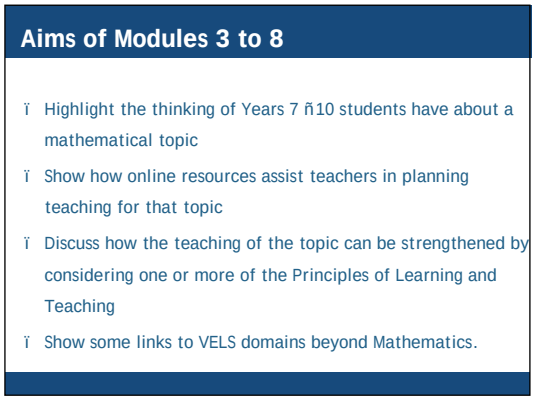


Slide 3: Teaching Secondary Mathematics

Aims of modules 3 to 8

Slide 4 lists the common aims of workshop modules 3 to 8. These modules have both a pedagogical and mathematical focus in that they:

- provide insights into mathematical thinking of Years 7–10 students
- show how online resources assist in planning teaching for that topic
- discuss how the teaching of the topic can be strengthened by considering one or more of the Principles of Learning and Teaching
- show links to VELS domains beyond mathematics.



Slide 4: Aims of modules 3 to 8

Overarching themes

Slide 5 restates the major themes of the Teaching Secondary Mathematics resource. These themes were developed by the University of Melbourne team.

To improve mathematics learning in schools we need to work on four things:

1. **student achievement**

   there is considerable scope for raising achievement of our best students and providing support to improve the performance of under-achieving students.

2. **making learning mathematics a more satisfying experience for students**

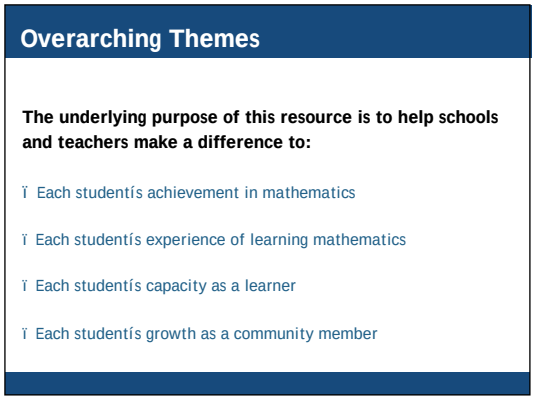
   Students' classroom experiences enable them to find learning mathematics an empowering experience with positive affect (feelings). This is not just 'fun' and 'enjoyment' but possibly even more importantly includes feelings of satisfaction, being valued as a person, learning things that have a relationship to your life and getting rewards for making significant efforts.

3. **making sure that mathematics contributes to the growth of the whole person**

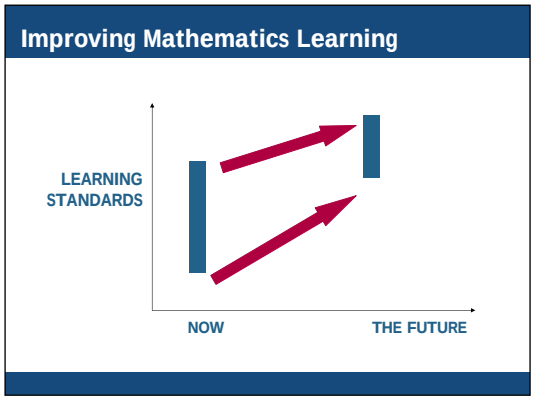
   All teaching at school needs to contribute to students' growth as a community member. For mathematics this is in two ways – as a citizen in the long term with sufficient numeracy to live a fulfilling life contributing to the community; and also as a classroom member who interacts well with others, and assists in making school life productive.

4. **ensuring mathematics (and other subjects) offer students experiences which increase their capacity to learn.**

   In turn, students with increased capacity to learn will do better in mathematics. Capacity to learn through the ability to work independently, improved thinking processes, metacognitive processes, cross-disciplinary VELS, thinking independently.



Slide 5: Overarching themes



Slide 6: Improving mathematics learning

Improving mathematics learning

Slide 6 is a diagram which illustrates that the focus of mathematics learning is to ensure the provision of high quality education and training so that it:

- raises achievement for all students
- reduces disparity between students
- leads to opportunities.

These challenges are central to the work of schools. This graph is not just an aspiration for mathematics, but for all schooling.

Slide 7: The learner at the centre

The learner at the centre

Slide 7 illustrates the learner at the centre concept. The resources of DEECD are intended to help teachers understand the needs of each student and to address them in a more targeted way than before.

For example, the Mathematics Developmental Continuum will be most effective when it is used to identify and plan for personalised student learning and to support purposeful teaching for individuals and small groups of students with similar learning needs.

The starting place is for teachers to identify where students are in their learning and then to plan the most effective teaching and learning strategy that builds on students' prior knowledge, skills and behaviours, supporting them to develop new knowledge and skills.

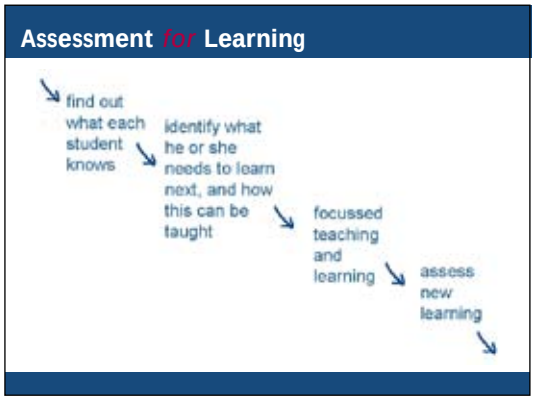
Therefore the purpose of the Teaching Secondary Mathematics workshop modules is to:

- place the learner at the centre of teaching
- differentiate the curriculum to cater for learning diversity
- teach for deeper understanding
- strengthen students' thinking processes
- build students' learning capacity by paying attention to aspects of the Personal Learning and Interpersonal Development domains.

Assessment for learning

Slide 8 displays a diagram which places assessment for learning in the context of a cycle which aims to match instruction to a learner's needs.

- It begins with finding out what each student knows.
- This information is used in a formative way to identify what the student needs to learn next.
- The teacher selects activities that focus on what the student needs next. The online resources found on the Student Learning website assist in assessment for learning. The Mathematics Developmental Continuum provides activities which give teachers some insight and evidence of students' prior knowledge which will inform their teaching.
  - Student Learning (http://www.education.vic.gov.au/studentlearning/default.htm)
- After teaching and learning, the teacher can use formative assessment to decide if the student should revisit this material, and so the cycle continues.



Slide 8: Assessment for learning

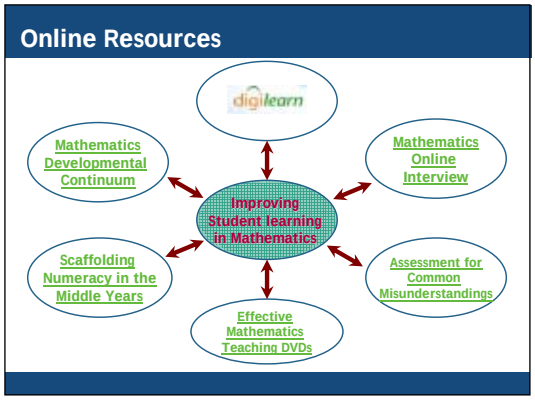
Online resources

Slide 9 provides a visual overview of the relevant online resources and full web addresses found on the Mathematics Domain page. These resources and web addresses are as follows:

Mathematics Developmental Continuum P–10 provides evidence-based indicators of progress, linked to powerful teaching strategies, aligned to the progression points and the standards for the Mathematics Domain of the Victorian Essential Learning Standards. Indicators of progress are points on the learning continuum that highlight critical understandings required by students in order to progress through the standards. (http://www.education.vic.gov.au/studentlearning/teachingresources/maths/mathscontinuum/default.htm)

Scaffolding Numeracy in the Middle Years (5–9) is an assessment-guided approach to improving student numeracy outcomes in the middle years. The suite of resources brings together, in a hierarchy, the key ideas, strategies and representations of multiplicative thinking needed to work flexibly and confidently with whole numbers, fractions, decimals, and percentages across a wide range of contexts. (http://www.education.vic.gov.au/studentlearning/teachingresources/maths/snmy/default.htm)

Digilearn is the portal for accessing exciting Digital Learning resources for use in the classroom. These resources include 'The Learning Federation' Learning Objects and Digital resources. Access is available from within your school and outside of school if you login with your pin number and your edumail password. (http://www.education.vic.gov.au/studentlearning/teachingresources/elearning/digilearn.htm)



Slide 9: Online resources

Assessment for Common Misunderstandings (P–10) provides assessment tools that expose students' thinking, but it also requires an interpretation of what different student responses might mean and some practical ideas to address the particular learning needs identified. This is particularly important in relation to a relatively small number of 'big' ideas and strategies in Number, without which students' progress in mathematics will be seriously impacted. (http://www.education.vic.gov.au/studentlearning/teachingresources/elearning/digilearn.htm)

Fractions and Decimals Online Interview is a diagnostic tool which will allow teachers to better understand their students' knowledge, skills and behaviours with regard to fractions and decimals, a known 'hot spot' of difficulty for many students. It will allow comprehensive collated data to be available that can be compared within schools to better understand student achievement and monitor student progress. (http://www.education.vic.gov.au/studentlearning/teachingresources/maths/assessment.htm#1)

Mathematics Online Interview is a diagnostic tool that is used to gather information on the most sophisticated strategies that students use during their mathematical thinking – not just for students to gain the correct answers. Data from the Mathematics Online Interview enables detailed individual and group/class profiles to be developed automatically, tracking progress through the stages of mathematical growth. Questions from the interview have now been linked to the Victorian Essential Learning Standards and progression points from Level 1 to Level 4, but could be used at the lower end of secondary school where many students are still working at Level 4. (http://www.education.vic.gov.au/studentlearning/teachingresources/maths/assessment.htm)

Algebra and Fractions – The Effective Mathematics Teaching DVD was sent to all schools during term 3, 2007. This DVD includes a variety of video clips from the classrooms of Victorian teachers. The material is intended to provide the basis of professional conversations amongst teachers regarding effective teaching practices. (http://www.education.vic.gov.au/studentlearning/teachingresources/maths/effectivemathdvd.htm)

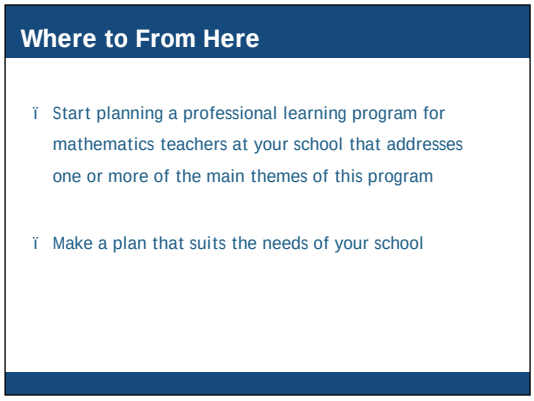
Where to from here?

Slide 10 introduces the planning process needed to deliver this resource to schools.

Refer to the webpage 'Guiding Principles' http://www.education.vic.gov.au/studentlearning/teachingresources/maths/teachsec/principles.htm

Participants will need to plan a professional learning program for mathematics teachers at their school that addresses one or more of the main themes of the Teaching Secondary Mathematics resource. This plan should be developed to suit the needs of the specific school.

Schools should have an Annual Implementation Plan (AIP) linked to their four-year School Strategic Plan. The school level report will provide useful data to assist with planning.



Slide 10: Where to from here

Use slide 10: Where to from here?

Ask the participants to consider the following key principles for effective school planning and operation:

- build teacher capacity
- develop a school numeracy plan
- create numeracy school environments and communities
- respond to diverse student needs.

Ask the participants to consider:

- Does their school have a Mathematics Professional Learning Team?
- Do teachers at their school discuss ongoing improvement in year-level teams or as a whole Mathematics department?

The Curriculum Planning Modules – Module 1, Activity 1.2 School context may be a useful resource to guide participants in their planning.

- Curriculum Planning Modules – Module 1, Activity 1.2 School context (http://www.education.vic.gov.au/studentlearning/curriculum/preptoyear10/modules/module1/mod12.htm)

The seven principles of highly effective professional learning

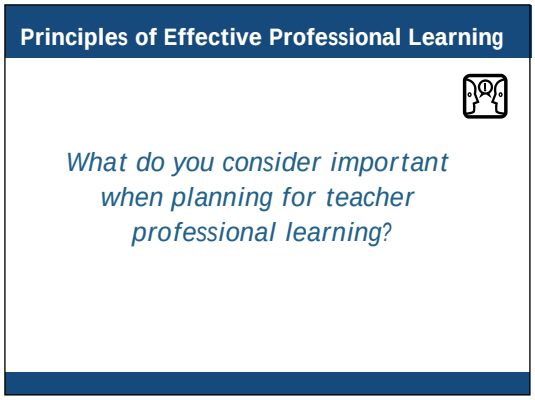
Use slide 11: Seven Principles of Highly Effective Professional Learning

Distribute self-adhesive notes for the activity

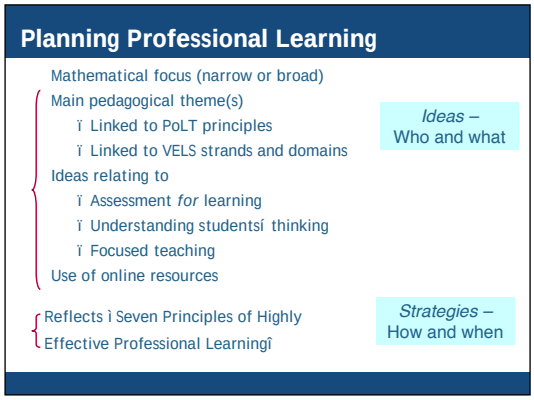
- Professional Learning in Schools – The seven principles of highly effective professional learning (http://www.eduweb.vic.gov.au/edulibrary/public/teachlearn/teacher/ProfLearningInEffectiveSchools.pdf).

These seven principles inform and enrich conversations in your school community about the importance of providing quality learning opportunities for all teachers. Effective professional learning focuses on developing the core attributes of an effective teacher. It enhances teachers' understanding of the content they teach and equips them with a range of strategies that enable their students to learn that content. It is directed towards providing teachers with the skills to teach and assess for deep understanding and to develop students' metacognitive skills.

Slide 11 provides an opportunity for participants to discuss what they consider to be important principles to consider when planning effective professional learning.



Slide 11: Principles of highly effective professional learning



Slide 12: Planning professional learning

Ask participants:

What do you consider important when planning for teacher professional learning?

Participants note their responses on self-adhesive notes and posting them onto an A3 sized table which lists the seven principles.)

The seven principles state that professional learning should be:

- focused on student outcomes (not just individual teacher needs)
- focused on and embedded in teacher practice (not disconnected from the school)
- informed by the best available research on effective learning and teaching (not just limited to what teachers currently know)
- collaborative, involving reflection and feedback (not just individual inquiry)
- evidence based and data driven (not anecdotal) to guide improvement and to measure impact
- ongoing, supported and fully integrated into the culture and operations of the system – schools, networks, regions and the centre (not episodic and fragmented)
- an individual and collective responsibility at all levels of the system (not just the school level) and it is not optional.

The main message that should be reiterated from this discussion is that professional learning should:

- make student learning the focus of the professional activities for teachers
- use good research on students' mathematical learning
- measure the outcomes of the professional learning
- be planned systematic and long term professional learning and interventions.

Planning professional learning

Slide 12 notes that when facilitators plan for professional learning in mathematics that they should consider:

- the mathematics focus
- the pedagogical theme
- online resources.

Planning should also reflect sound principles of adult professional learning as reflected in the seven principles of effective professional learning.

Planning using a Lotus Diagram

Slide 13 describes how participants could use a 'Lotus diagram' to assist them with their planning.

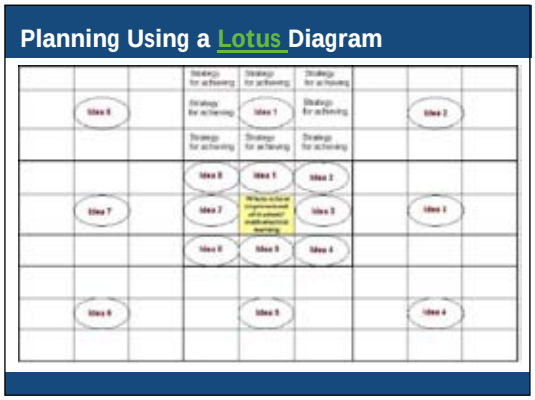
Distribute a blank Lotus diagram (refer to Resource 1 in this booklet). This diagram is to help in planning for the professional learning program.

The overall goal in this instance is whole school improvement in students' mathematical learning.

Use slides 13–18: Planning for school change

Instruct the participants:

- Begin at the centre square and write 'whole school improvement of mathematical learning'.
- In the boxes directly surrounding the 'whole school improvement' central square, write up to 8 ideas for achieving this goal.
- These 8 ideas then are linked to the 8 outer squares as shown.
- Then devise for strategies for successfully implementing and achieving each 'idea', and write them in the boxes surrounding the idea.
- Think about what might be useful measures for gauging whole school improvement – this will link to one of the seven principles of effective professional learning.

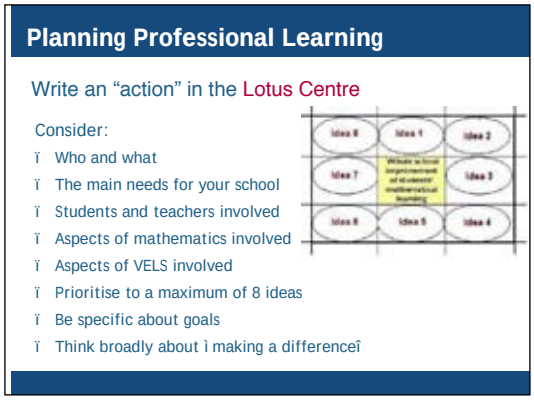


Slide 13: Planning using a Lotus Diagram

Write an 'action' in the lotus centre

Slide 14 describes some of the factors that need to be considered by participants when they are identifying ideas to fill in the first layer of the lotus diagram. These factors explore **'who' and 'what'** and include:

- the main needs for the school
- students and teachers involved
- aspects of mathematics involved
- aspects of VELS involved
- priorities – there's a maximum of eight ideas
- be specific about goals
- think broadly about 'making a difference'.

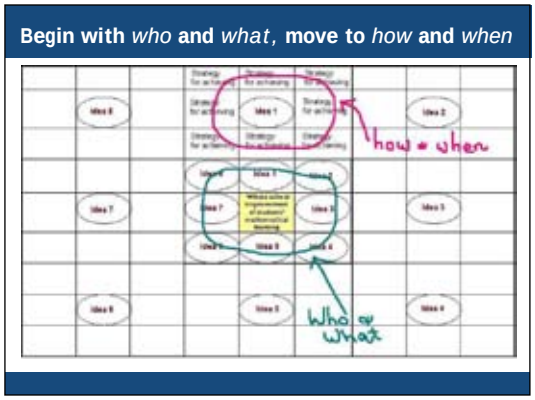


Slide 14: Planning professional learning

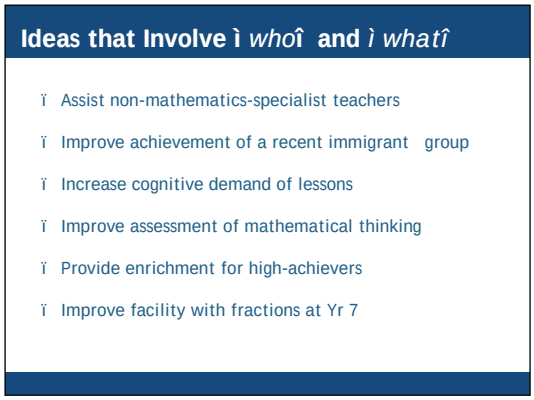
Begin with 'who' and 'what'

Slide 15 shows a partly completed lotus diagram. Suggest to participants that they include:

- 'who' and 'what' in the inner circle of the lotus diagram
- 'how' and 'when' provides further detail around the outer squares.



Slide 15: Begin with 'who' and 'what'

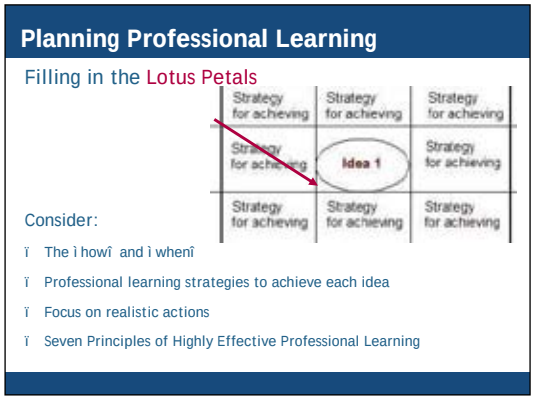


Slide 16: Ideas that involve 'who' and 'what'

Ideas that involve 'who' and 'what'

Slide 16 provides further information about what to include with the **'who' and 'what'** in the inner circle of the lotus diagram. These ideas may include:

- Assist non-mathematics-specialist teachers.
- Improve achievement of a recent immigrant group.
- Increase cognitive demand of lessons.
- Improve assessment of mathematical thinking.
- Provide enrichment for high-achievers.
- Improve facility with fractions at Year 7.



Slide 17: Planning professional learning

Filling in the lotus petals with 'how' and 'when'

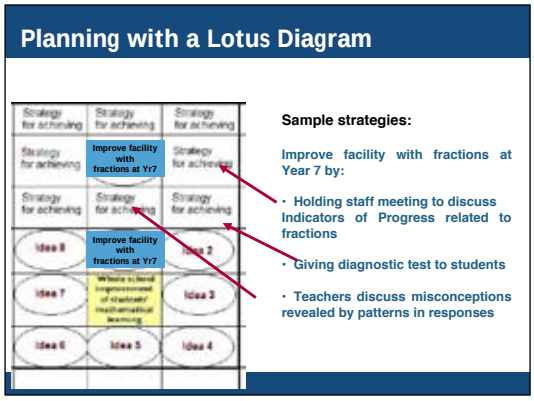
Slide 17 expands the lotus petal approach to the outer layer. In expanding **'how' and 'when'**, participants need to consider:

- professional learning strategies to achieve each idea
- how realistic their suggestions are – focus on realistic actions
- ensuring consistency with the Seven Principles of Highly Effective Professional Learning.

Sample strategies

Slide 18 illustrates how one of the 'who' and 'what' ideas is unpacked using the 'how' and 'when' strategies . The idea that is used as an example is 'Improve facility with fractions at Year 7'. Strategies could include:

- holding staff meeting to discuss indicators of progress related to fractions
- giving a diagnostic test to students
- having teachers discuss misconceptions revealed by patterns in responses to the test.



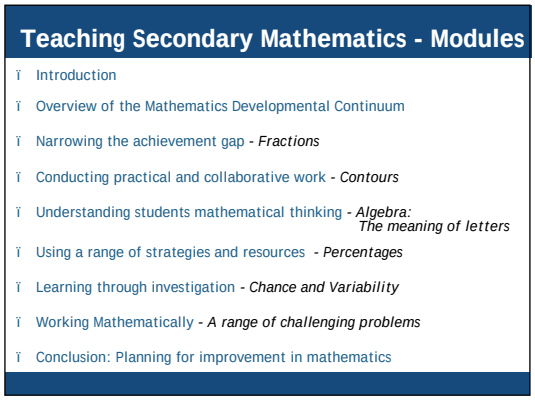
Slide 18: Planning with a Lotus diagram

In conclusion

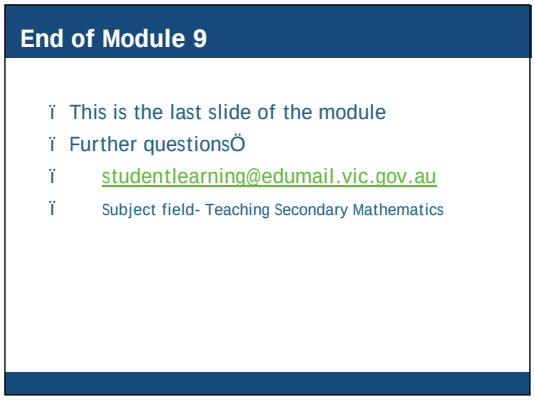
Slides 19 and 20 provide a summary of the nine workshop modules within this Teaching Secondary Mathematics resource, including this concluding module. The modules have been presented as separate workshops to allow for individuals to focus on a theme they see as a particular need or interest.

The Teaching Secondary Mathematics workshop modules include:

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
4. Conducting practical and collaborative work: Focus on contours
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



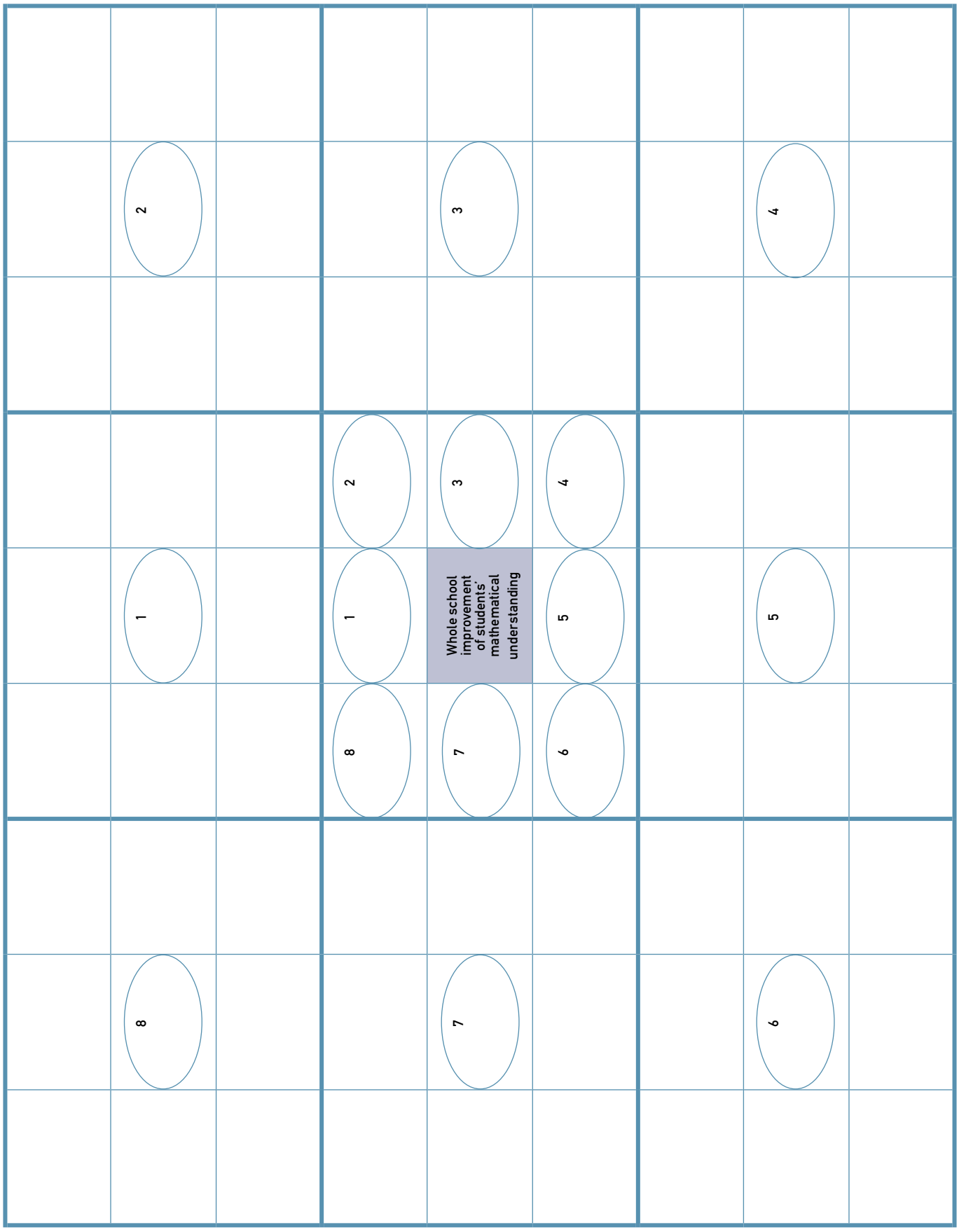
Slide 19: Teaching Secondary Mathematics – Modules



Slide 20: End of Module 9

Resource 1: Lotus Diagram

Whole school improvement of students' mathematical understanding



Resource 2: The seven principles of highly effective professional learning

- Professional Learning in Effective Schools (pdf) (http://www.eduweb.vic.gov.au/edulibrary/public/teachlearn/student/ProfLearningInEffectiveSchools.pdf)

Principle 1: Professional learning is focused on student outcomes (not just individual teacher needs).

Professional learning is aimed at maximising student learning so that all students achieve their learning potential. Using multiple sources of student outcomes data, teacher professional learning should be guided by analyses of the differences between goals and standards for student learning and student performance. Such analyses will define what teachers need to learn, make teacher professional learning student centred, and increase public confidence in the use of resources for professional learning. Student outcomes will improve if professional learning increases teachers' understanding of how to represent and convey content in meaningful ways.

Principle 2: Professional learning is focused on and embedded in teacher practice (not disconnected from the school).

Teacher professional learning should be school based and built into the day-to-day work of teaching. The most potent and meaningful learning experiences occur in the school, where teachers can address the immediate problems and challenges of learning and teaching. Being situated close to the classroom and their colleagues enables teachers to work together to identify problems, find solutions and apply them. This does not imply that beyond school learning experiences, such as postgraduate studies or attendance at workshops and seminars, are not valuable. External learning opportunities can complement school-based professional learning. Professional learning should be anchored in the school-based work of teachers but enriched with ideas and knowledge sourced from outside the school.

Principle 3: Professional learning is informed by the best available research on effective learning and teaching (not just limited to what they currently know).

Teacher professional learning that improves the learning of all students prepares teachers to apply research to decision-making. Successful professional learning programs immerse teachers in the content they teach and provide research-based knowledge about how students learn that content. Results of research need to be made accessible to teachers to enable the expansion and elaboration of their professional knowledge base. This research should include information on effective teaching and learning, how students learn particular content, classroom management, assessment and curriculum.

Principle 4: Professional learning is collaborative, involving reflection and feedback (not just individual inquiry).

Teacher professional learning opportunities should relate to individual needs but be organised around collaborative problem-solving. Organised in teams, educators take collective responsibility for solving the complex problems of teaching and learning and improving student outcomes. Teams share knowledge, expertise and experience in order to deepen learning and to foster a mutual understanding of effective classroom practice. Teams create the conditions for collegial reflection and support and help to spread workloads more evenly. Constructive, objective and actionable feedback on teacher practice is important for targeting areas where a teacher needs to improve his or her performance and for the purpose of designing professional learning opportunities that address areas for improvement. Competent, experienced teachers, school leaders or an expert sourced from outside the school can also provide teachers with feedback on their professional learning. For example, feedback from a trusted peer on the operation of a professional learning team or a coaching or mentoring partnership is useful to gauge the effectiveness of such strategies.

Principle 5: Professional learning is evidence based and data driven (not anecdotal) to guide improvement and to measure impact.

Data from different sources can be used to determine the content of teachers' professional learning and to design and monitor the impact of professional learning programs. Evidence, rather than anecdotes, needs to be collected regularly at the student, teacher and school level to help focus teacher learning. Student journals, for example, can be analysed to identify areas where students are struggling or how students are progressing from one month to another. Data can be used to measure and improve the impact of professional learning. Formative evaluations allow teachers to make mid-program refinements and corrections, while summative evaluations measure the effectiveness of professional learning activities and their impact on teacher practice, knowledge and student learning.

Principle 6: Professional learning is ongoing, supported and fully integrated into the culture and operations of the system – schools, networks, regions and the centre (not episodic and fragmented).

Professional learning needs to be ongoing, long term and sustained. Significant and long-term change in teacher practice does not occur in a matter of weeks but more often over months or years. Learning by doing, reflecting and refining is a long, multistage process.

Teachers need support for their professional learning. Solving complex problems and implementing innovative practices may require outside expertise and additional resources. Encouragement and recognition is also crucial to maintaining effort since finding new ways to do things is difficult and often painful. Sustained, immediate and quality support is essential to ensure improvement in schools and classrooms, particularly when unexpected problems arise.

Supported, ongoing professional learning must be embedded in the system. Central and regional staff have a responsibility to model good practice by participating in ongoing professional learning.

Principle 7: Professional learning is an individual and collective responsibility at all levels of the system (not just the school level) and it is not optional.

Professional learning should occur at all levels of the system. It is an individual and collective responsibility encompassing schools, regions and the centre. For teachers and school leaders, professional learning needs to be linked to schools' performance goals. These goals in turn need to reflect the needs and aims of the regions and the centre. Professional learning is inextricably linked to enhancing the capacity of the system as a whole.

Central and regional offices and key stakeholder groups should work collaboratively to determine strategies for improvement and share best professional learning practices to drive school and system-wide improvement.