



AAMT Position Paper The Practice of Assessing Mathematics Learning

The Australian Association of Mathematics Teachers Inc.



The key aim of evaluation and assessment is to improve student learning.

Preamble

The fundamental purpose of evaluation and assessment is to improve student learning and performance, and therefore students should hold a central place in the evaluation and assessment process. Students should be fully engaged with their learning and empowered to evaluate and to assess their own progress, which is also a key skill for lifelong learning. It is important, too, for students to monitor broader learning outcomes, including the development of critical thinking, social competencies, engagement with learning and overall well-being. These are not amenable to easy measurement, which is also true of the wide range of factors that shape student learning outcomes. Therefore, performance measures should not be narrow but should be broad, drawing on both quantitative and qualitative data along with high-quality analysis (OECD (2013).

The *AAMT Standards for Excellence in Teaching Mathematics in Australian Schools* (2006) describe how excellent teachers assess their students' learning:

Excellent teachers of mathematics regularly assess and report student learning outcomes, both cognitive and affective, with respect to skills, content, processes, and attitudes. They use a range of assessment strategies that are fair, inclusive and appropriate to both the students and the learning context. They maintain on-going, informative records of students learning outcomes that are used to map student progress and to plan future learning experiences. The excellent teacher of mathematics provides constructive, purposeful and timely feedback to students and their parents, and to school authorities as required.

This statement describes a practice in mathematics assessment that should be the goal for each teacher and for each school community. It is the basis for this paper—it provides the framework for the components of the AAMT position on assessing mathematics learning for improving student learning and performance. When assessments are used to guide future action, the ultimate intention is to promote learning. This is true whether assessments are used to guide the work of teachers, students, school leaders or education systems. The use of assessment to guide future action is, ultimately, assessment for improved learning outcomes.

The organisers of this position paper represent key ideas in assessment. Student learning of mathematics should be assessed in ways that:

- are appropriate;
- are fair and inclusive; and
- inform learning and action.

Under each heading, the paper outlines the AAMT's expectations for students, teachers, schools and assessment programs of education authorities.¹

Both teachers and schools regularly identify assessment in mathematics as a major priority for teacher professional learning programs. This statement identifies the complexity of the task of assessing student learning in mathematics, and the importance of doing it well. The quality of assessment is paramount, and necessarily involves the assessment of the quality of student learning. Hence, this position paper will assist in the development of programs of professional learning that will enhance each teacher's approach to assessment in mathematics.

ASSESSMENT

Practices for assessing students' mathematics learning should be APPROPRIATE

The main purpose of schooling is student learning and development, and this should be informed and supported by appropriate assessment. Assessment is undertaken to provide information about student learning and student attitudes to learning and doing mathematics. This information allows teachers to make informed professional judgements about a range of matters such as student progress and achievement, student learning and attitudes that require further attention, and future teaching actions. Assessment also provides an opportunity for teachers to evaluate and reflect on their work as teachers. Teachers should ask and satisfactorily answer the questions "Will this assessment give me information about student learning that adds significantly to what I already know? Does this assessment add significantly to my current confidence in my judgements about student learning?"

Assessment information is used:

- primarily by teachers to inform them on student concept understanding and to guide targeted intervention and future learning as required;
- to give feedback to students and parents about standards and about individual growth and progress in learning;
- to assess school based strategic intervention plans, programs and support for teachers,
- by education authorities to provide public accountability for themselves, and for credentialing of individual students.

In order to improve student learning, teachers should:

Assess by matching the purpose to the information required

Teachers should consciously plan and program a range of learning experiences, and at the same time plan appropriate assessment practices.

Opportunities for formative assessment (assessment for learning) occur on a regular basis in classrooms. Each learning task provides an opportunity to assess students' current knowledge and skills and to diagnose misconceptions, so that teachers are able to plan subsequent learning experiences. Increasing use of digital technologies is providing opportunities for real-time assessment and for adaptive teaching. Open-ended tasks are a useful tool for this purpose as they can provide information about a broader range of aspects of student learning than is possible through more narrowly constrained tasks.

Summative assessment (assessment of learning) should be used at key stages of schooling to provide feedback to both students and parents about student learning. It also serves an important purpose to inform other teachers about the learning outcomes for each student as he or she progresses from one year to another. Pen-and-paper tests are frequently used for this purpose. Interviews and observations are appropriate alternatives. Other strategies, such as extended investigations, and written explanations and verbalisations of thinking, are useful since they provide richer information about student thinking and attitudes. Such alternatives are more appropriate for assessing progress with respect to working mathematically including creative thinking and collaborative problem-solving.

Assess the full range of learning goals by using a range of strategies

Using different strategies to obtain information about aspects of student learning helps to maximise the opportunities for students to show what they know and can do. To increase their confidence in their judgments about student learning and progress, teachers can triangulate information from different sources. Using a range of strategies enables teachers to assess different components of mathematical learning and students' development as mathematicians. Consistency in teacher judgment would be enhanced by teacher collaboration.

To find out about each student's knowledge, skills and routine application, teachers need to use a variety of tasks. Today's mathematics curriculum goals go well beyond simply content knowledge and skills to include critical thinking and working mathematically, effective communication of mathematical ideas and findings, mathematical modelling, and so on. This breadth of expectations requires the use of assessment tasks and strategies that enable students to demonstrate the full extent of their learning, including understanding, fluency, problem solving and reasoning. The traditional paper based 'mathematics test' needs to be used in conjunction with other forms of assessment.

Solving problems and investigating mathematical ideas usually require more time and students frequently benefit by working with peers. Such experiences should be assessed using different strategies such as written reports and group presentations, teacher observation, and discussion with students. In short, teachers need to use a variety of ways to assess.

1. The involvement of education authorities in student assessment in mathematics (and other subjects) has, until relatively recently, been limited to the secondary years — largely at the Year 12 level — through external examinations and moderated school-based assessment for credentialing purposes. Since the mid-1990s education sectors have introduced cohort student assessment. A national testing program has been in place since 2008.

Whether as part of the certification of students at the end of schooling, or as part of systemic assessment programs in the earlier years, assessing students' mathematics through these external means should meet the expectations of this paper.

Assess taking into account the use of appropriate technology, and the appropriate use of technology

Calculators and spreadsheets are commonplace in most work environments, and their efficient and effective uses are expected in order to process and represent information and to apply mathematical knowledge to a range of problems. Similarly, students are expected to have an understanding of two-dimensional and three-dimensional shapes and how they are used and represented within everyday environments, including digital media and within computer environments.

When assessing student performance for the improvement of learning, teachers should take into account the appropriate use of digital technologies consistent with what students have had access to within the classroom and at home. The growing use of digital learning environments offers increased opportunities to track, analyse, report on and even adapt to the characteristics of students as they respond to a task in real time.

In order to improve student learning, schools should:

Support teachers to use appropriate assessment tools and technologies

Teacher learning and instructional improvement are acknowledged to be complex, ongoing and requiring support. School leadership needs to support teacher learning and the implementation of new and adaptive assessment strategies consistent with current educational research. Support could include facilitating teachers with opportunities for professional learning about different and appropriate ways to assess, and about the design of quality assessment 'tasks' apart from the traditional paper-based test type assessment.

A good starting point would be to value existing teacher expertise by scheduling time for teachers to meet together to focus on the interpretation of available student assessment data, on assessment reforms and on appropriate/improved instruction.

Schools need to support teachers in accessing appropriate software and professional learning associated with the use of digital technologies in all forms consistent with current assessment and adaptive teaching trends.

Provide and promote an appropriate school assessment policy within the school community

The traditional approach in schools usually divorces assessment from learning. A typical educational cycle is: 'teach; stop; administer test; teach, with new content.'

Modern assessment principles would suggest a school policy requiring a carefully planned and possibly differentiated assessment program, interwoven, on a yearly or semester basis, within the teach-

ing and learning program ahead of time and shared with the students and parent community in advance. This is certainly the case for the senior secondary years, and would be equally useful in the earlier years.

Create/maintain a school culture conducive to teacher use of a variety of appropriate ways of assessing

In the senior school years, many schools have a policy of 'testing' weeks when the traditional paper based mathematics tests are administered. Often multiple classes will be tested using the same 'test' on the same day. Such policies of collecting 'snap shot' data on student achievement may be detrimental to good teaching and learning practice. They tend to be used to record marks in marks books, rather than using the data for the improvement of student performance. Such policies need to be applied with caution as they often produce student 'test anxiety' affecting student attitude to further engagement with mathematics. Teachers, too, often feel the need to 'teach to the test'. This is especially so if multiple classes studying the same content are tested using the same test at the same time, without much attention being given to the possibly different learning activities and preparation that may have been used to meet individual student or different class needs.

Rather than being forced by an inappropriate and restrictive whole-school policy into a 'one-size-fits-all' approach to assessment, teachers should be encouraged to focus on understanding where students are in their learning in order to identify appropriate starting points for action, and to evaluate the effectiveness of such action.

In order to improve student learning, education authorities assessments should:

Match the published curriculum or syllabus and the assessment programs

Assessment events (such as tests, examinations, formal investigations, and so on) conducted by education authorities should be based on skills and knowledge students are expected to have had opportunities to learn. These events should include and expect appropriate use of technologies.

Match the published purpose(s) of the assessment program

Legitimate purposes of assessment can be for individual student credentialing and diagnosis, and/or meeting school or system (i.e., public) accountability measures. The purpose of the assessment program needs to be clear and clearly stated, to enable public

evaluation and critique of the appropriateness of the actual instruments and items used in the assessment program. In particular, the layout and language of reports to students and their parents need to be designed with the audiences in mind. They should be as easily understood as possible.

Use instruments that are economical

Large-scale assessment programs such as NAPLAN are expensive. Funds applied to these should be proportional to the benefits from the program to the students, teachers, parents, schools and the education authorities themselves. Excessive public expenditure on assessment programs cannot be justified in the context of limited overall funding for education.

Assessment of students' mathematics should be FAIR AND INCLUSIVE

No assessment of student learning is value-free. Whether it is a pencil and paper skills test, a digitally enhanced adaptive activity or a more open-ended task, each assessment task is effectively a contract between the teacher and the student, which communicates and reflects what is valued in the mathematics classroom.

In order to improve student learning, teachers should:

Involve students in the processes for assessing their learning

Teachers should ensure that students are aware of the criteria for success in their learning, and be able to articulate these. Students should be taught how to use assessment criteria in evaluating and guiding their own mathematical work, and be encouraged to do so. There should be opportunities for students (both individuals and groups) to negotiate aspects of their assessment, including selecting and designing tasks and the criteria to be used in judging performance. Self- and peer-assessment are readily accessible strategies for teachers to begin the process of involving students in their assessment.

Use assessment strategies and tasks that are gender neutral and take into account ethnicity and geographical location, and are as fair as possible

Each student's background is critically important in determining how he or she accesses and interprets different assessment tasks. Therefore, teachers need to ensure that assessments tasks are culturally and gender inclusive, and include open-ended questions and appropriate digital or on-screen items, so students have the opportunity to show what they know and can do, rather than what they do not know.

Circumstances such as physical and learning impairments, and transient factors such as illness, and times of family and personal turmoil, etc., can all have an impact on a student's capacity to show what he or she knows. Teachers need to be mindful of these factors and ensure that students are not disadvantaged by circumstances beyond their control.

Assess in ways that are clear and transparent to students

Teachers should ensure students have a clear understanding of the purposes of the assessment, what is required to be done to be successful, and what feedback or further action will flow from the assessment. Historically, many students have experienced anxiety as a result of mathematics assessment (i.e., the "maths test"). When teachers use assessment practices that are clear to the students, potential anxiety about the assessment task is significantly diminished. Teachers should explicitly teach a variety of techniques and strategies that would be helpful in relevant assessment tasks.

Be fair and inclusive when making judgements

Sometimes a student may be unfairly judged because of a teacher's prior knowledge of the student or prior assessment of his or her work and responses. Teachers need to be open to new information and interpretations that alternative assessment activities may afford. They should ensure that they develop assessment tasks, criteria, standards and rubrics that are inclusive and apply the assessment criteria consistently when making judgements about student learning. Collaborating with other teachers, for example by using moderation procedures such as, 'twin' independent marking of selected scripts, can assist teachers to ensure that the design of tasks and the use of well-formulated criteria when making judgements do not disadvantage individual students or groups of students.

Assess through planned means and through opportunities that arise in their work with students

Teachers should establish a timely program of "events" such as, a yearly assessment outline, for assessing student learning. They should also retain a capacity to capture and act on information on student learning that emerges spontaneously from students' work, and from their observations and interactions with students. Digital learning environments now provide teachers with an opportunity to undertake continuous assessments of learning through embedding them into the instructional materials. However, the emphasis should be on the quality of information about student learning that is obtained, not the quantity.

Ensure students are familiar with the genres of items used in their own assessment programs and in those of education authorities

Assessment items should mirror the learning strategies of the mathematics classroom, rather than asking students to do something with which they are not familiar. This does not mean that students cannot be expected to solve new or unfamiliar problems, but that it should not come as a surprise when they are expected to do so. Formal assessment programs used by education authorities use genres of assessment items that may be unfamiliar to some students through their everyday learning of mathematics in the classroom. Often high stakes assessment programs convey expectations through key terms. Teachers at all levels of schooling should ensure that students who are required to take part in formal assessment programs are familiar with what might be expected of them in their responses to the assessment items they will encounter. This is not about "teaching to the task" – it is making sure all students can access the task and show what they know and what they can do in that context.

In order to improve student learning, schools should:

Support teachers to develop assessment tools that are fair and inclusive taking cognisance of access to digital technologies

Schools need to provide support for teachers to access appropriate software and professional learning associated with the use of digital technologies, in all its forms, consistent with current assessment and adaptive teaching trends. As more digital learning materials are developed that contain 'stealth' assessments of learning, an evidence-based approach to weaving assessments directly into learning environments, equity of access to the software, and to professional learning to ensure appropriate interpretation and use of such resources, will increase in importance.

Provide and promote a school assessment policy based on fairness and inclusivity

Schools need to be aware of physical and learning impairments, transient factors such as illness or times of family and personal turmoil,

etc., when developing whole-of-school assessment policies, ensuring that teachers have the flexibility required to ensure that students are not disadvantaged by circumstances beyond their control.

Create/maintain a school culture conducive to teacher use of a variety of fair and inclusive ways of assessing

Assessment items used to construct teacher based assessment tasks are fair when they focus on curriculum concepts in a way that provides a measure of progress towards a standard rather than just whether a standard has been met or not. Schools need to work with both teachers and relevant education authorities to provide guidance to teachers about how progress towards a standard may be appropriately reported to the students and parents.

In order to improve student learning, education authorities' assessment should:

Be fair to students

Many of the expectations of teachers about fairness in assessment are also applicable to the programs of education authorities. Minimising gender bias and bias related to students' social and cultural backgrounds are critical areas for these programs to address, and it needs to be seen that they are being addressed. The contexts used in assessment items should be accessible to students through their own "local" familiarity, or as a result of explicit teaching that ensures appropriate familiarity. In addition, programs should also take account of the likely literacy levels of students and provide access to the mathematics of the tasks without having unrealistic expectations of the student literacy levels. High stakes assessments must assess within the course and relevant syllabus statements, and must be seen to do so.

Take account of students' personal circumstances as appropriate

High stakes assessment systems, in particular, need to provide accommodations that ensure access for students with physical disabilities or medical conditions that would otherwise be a disadvantage to them in demonstrating their knowledge and skills.

Assessment of students' mathematics should INFORM LEARNING AND ACTION

As all assessments should lead to educational action, teachers should ask themselves,

“How will this assessment promote and inform subsequent action by me, by other teachers, by my students and by parents or other members of the community?” (Clarke, 2005)

A student is more interested in what it all means for him or her, and what needs to be done as a result of assessments and feedback. From the student point of view, the questions are, “Where am I going? How am I going? Where to next?” (Hattie, 2011)

In order to improve student learning, teachers should:

Reflect on assessment information and use it to plan students' learning experiences

Teachers should use a range of strategies that support the principle of taking constructive, learning-oriented action on assessment information. These strategies include open-ended and contextualised tasks, student portfolios, student self-assessment, peer assessment, the classroom negotiation of assessment criteria, and student-constructed assessment items. They may also include the collection of data from carefully designed digital learning programs. Teachers should use the information they obtain from assessment of student learning to analyse and reflect on in their short, medium and long term planning for further learning. The implications for planning can be significant. It is necessary to revisit the mathematics involved when students communicate misconceptions or when they show that they do not 'get it'. This revisiting will require teachers to take a different and differentiated approach involving targeted strategies. In fact, without such intervention a wide variation in students' mathematical learning emerges.

Consideration of assessment information is the basis for seeking outside support for a student with a specific learning difficulty, or for a student who is mathematically talented.

Provide purposeful, learning-oriented feedback to students on their learning

At each stage of mathematics learning, the provision of quality and timely feedback to students is a critical part of the teaching, learn-

ing and assessment cycle. Through providing good quality feedback teachers enable students to take responsibility for their learning and progress. Students need constructive and specific feedback, so that they are able to take action to improve performance. Teachers are responsible for creating an environment that encourages students to actively seek feedback to improve performance. Feedback should also be shared with parents in ways that strengthen their capacity to actively support their child's learning.

Share assessment information with parents and colleagues as appropriate

Teachers and schools should establish timely and effective processes and practices that ensure parents receive assessment information and teacher professional judgements based on this information. In particular, sharing between professionals should be in place at times of school transition (school-to-school, or class-to-class), and, as appropriate and when required, should include specialists in learning support or in the education of gifted and talented students. The information provided to parents and professional colleagues should give a rich picture of a particular student's achievement, which goes well beyond what is communicated by a summary mark or grade, giving specific detail on the quality of work, attitudes to learning and mathematics, and directions for further learning.

In order to improve student learning, schools should:

Provide a culture/environment where teachers have flexibility to customise the teaching, learning and assessment program

Assessment that informs learning and action is not conducive to an environment that takes the approach of 'one size fits all'. For example, the school practice of having the same assessment task on the same day by all students in a particular cohort, irrespective of readiness and so on is unlikely to produce valid or useful data to inform learning and action for different teachers and students within the whole cohort.

Provide the necessary resources

These resources would should included:

- time and materials for teachers to administer diagnostic testing
- time for teachers to be up skilled in interpreting the results diagnostic testing
- time and guidance in analysis of data from diagnostic and other forms of assessing
- time and guidance for teachers to plan, implement and review strategies for future learning.

Support professional development opportunities on assessment skills and strategies for teachers of varying mathematical backgrounds, especially if teaching out of area

These opportunities should include the provision of a supportive professional learning culture by:

- disseminating quality professional learning opportunities to teachers
- budgeting for any teachers of mathematics, especially those out of area to attend appropriate PL on a regular basis
- planning for and providing mentors for, (with the appropriate time allocation) teachers who are teaching out of area or teaching a mathematics course or level for the first time.

In order to improve student learning, education authorities' assessment should:

Make claims that can be related directly to what is assessed

Mathematics learning is much more than that which can be assessed by pencil-and-paper assessments in system level programs. Reports from these programs should acknowledge this limitation. The results from assessment programs that represent a single event (for example, a test) need to be viewed in that light, as representing student performance at a particular time, only.

Provide information that maximises opportunities for teachers to capitalise, in their teaching, on the assessment information gathered

Both longitudinal data about cohorts of students and longitudinal data about a particular point of schooling can be very useful for teachers and schools to help improve the teaching of mathematics. Given the importance that is often placed on this information by teachers and schools as they plan for future student learning, it needs to be statistically legitimate and timely, and needs to report on findings in a way that will support teacher analysis of student learning needs.

Prohibit the publication of league tables of schools from their data

Each school and student context is different. The extent of this variation means that nothing is gained from public comparisons of schools, which are based on performance of students in one-off tests. Some measures of "value added" and some of the measures involving "like schools" show much greater promise and should be further developed and analysed for their usefulness to teachers, schools and systems.

Engage teachers in the design and conduct of the program

Having teachers involved as setters and markers, etc., provides a means for connecting the programs with the classroom. Teacher input helps ensure better alignment with the curriculum, sensitivity to the realities of students' cultural and social backgrounds and so on. Involvement in assessment programs in these ways is also a good professional learning opportunity for teachers.

In order to improve student learning, students should:

Be aware of the significance of their role and responsibility in the assessment process.

They must be active participants in the learning and assessment process. They need to be aware of which activities or tasks will be used for formal and informal assessment and take increasing responsibility for their preparation, participation and, if appropriate, completion by the due date.

In student centred assessment, students will increasingly:

- accept the responsibility to contribute to discussions about assessment criteria;
- make realistic and constructive assessments of their own learning;
- communicate their goals, learning progress and assessment results, with parents, care givers, or mentors (as appropriate);
- use feedback to refine their knowledge and skills;

- seek support to close the gap between current achievement and their goals;
- take an active role in the management of their time to ensure completion of assessment tasks;
- reflect on feedback, and respond for future improvement.

It is important that students engage in this reflective and evaluative process to enhance their capability to become life-long learners. This will aid the development of critical thinking, social competencies, and engagement with learning, and will improve the overall wellbeing of the learner.

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