PAT Critical Reasoning

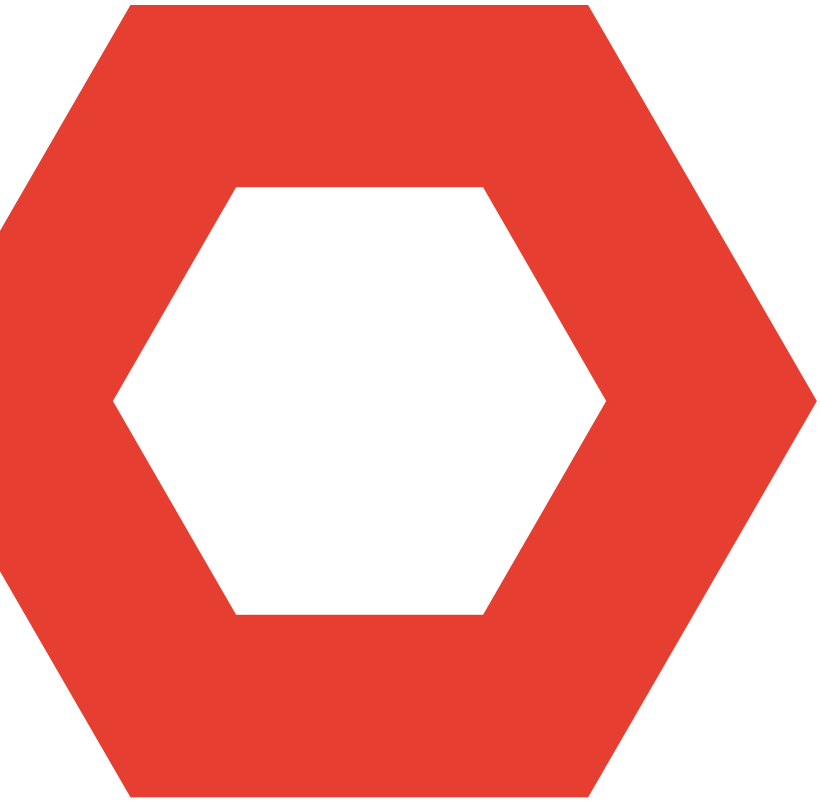
Assessment framework

Australian Council *for* Educational Research

Contents

September 2021

Figures and tables



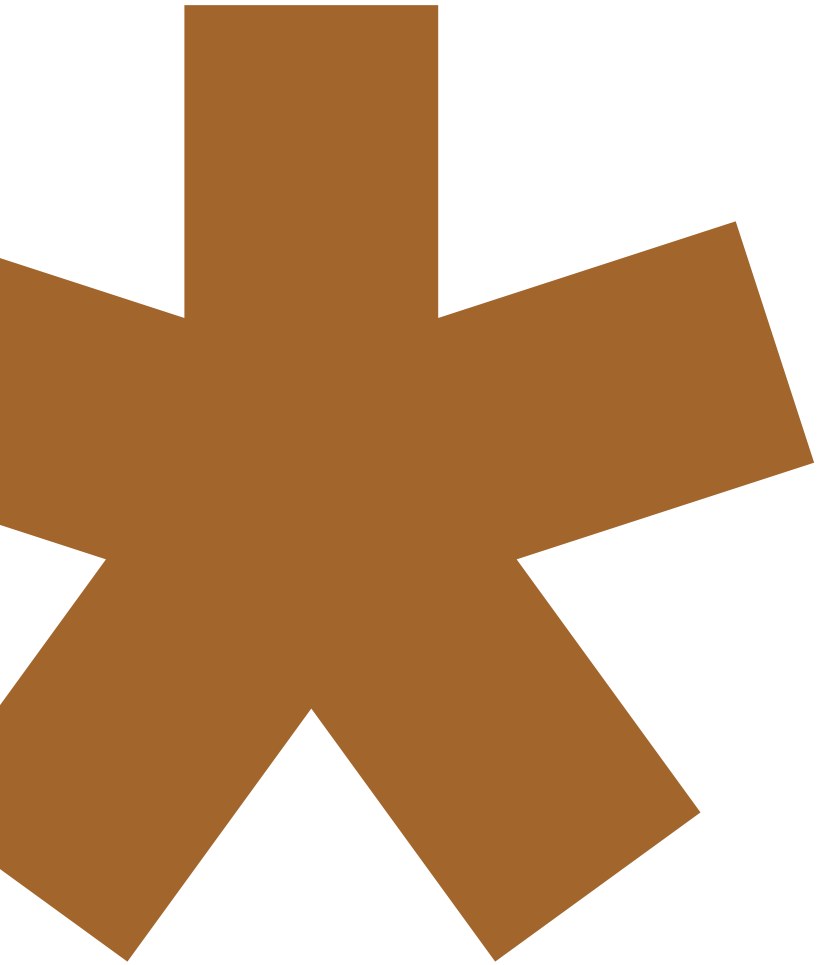
Introduction

The ACER Progressive Achievement Tests in Critical Reasoning are a set of assessments that allow teachers to accurately and efficiently measure students' abilities in critical reasoning, to diagnose gaps, strengths, and weaknesses in student learning, and monitor student progress over time. The assessments have been developed especially, but not exclusively, for use in Australian schools. The *PAT Critical Reasoning* construct is appropriate for broad international use.

PAT Critical Reasoning assesses a fundamental subset of the skills that constitute critical thinking, namely those that relate to the analysis and evaluation of ideas and arguments. The assessments have been developed to minimise reading load so that as far as possible students are being assessed for their thinking skills rather than their higher-level reading skills. Where more technical concepts and subject-specific information are introduced, they are explicitly defined so that students are being assessed for their processing of ideas rather than any prior knowledge.

The assessments target core critical reasoning skills likely to suit the ability of students from Year 5 to Year 10.

All three *PAT Critical Reasoning* tests could be suitable for middle or upper primary students, with higher performing students allocated the more challenging assessments, based on teacher judgement. Likewise, all three tests could be suitable for lower or middle secondary students.



Rationale for PAT Critical Reasoning

PAT Critical Reasoning addresses a key set of skills that is a fundamental component of critical thinking, a core competency that is applicable to all discipline areas. These skills have often been seen as developing alongside other general or subject-specific competencies without the need for separate explicit teaching. Increasingly, teachers and educational jurisdictions are seeing critical thinking as a competency that can be enhanced by explicit teaching and by assessment that identifies strengths and weaknesses in this area.

Progressive Achievement approach

The Progressive Achievement approach provides a framework for integrating student assessment, resources that support teaching practice, and professional learning. PAT assessments allow teachers to collect evidence of student learning; to identify where students are in their learning at a given point in time; to monitor growth over time; and to reflect on student attainment. They provide reliable measures that enable a variety of interpretations about attainment and progress, such as:

- what students attaining specific levels of progression are likely to know, understand and be able to do;
- how much students have improved over time and what skills, knowledge and abilities they have been able to develop; and
- how a student's level of attainment compares with other students'.

The value of an integrated approach to assessment and student learning has become widely acknowledged. There is now a wide variety of formative, diagnostic assessment tools used in Australian classrooms. Summative assessments, such as NAPLAN, are also often used to inform teaching and learning. As Dylan Wiliam makes clear (2011, p. 43) 'any assessment is formative to the extent that evidence about student achievement is elicited, interpreted, and used by teachers, learners, or their peers to make decisions about the next steps in instruction'. In his Report, David Gonski (2018, Finding 7) refers to the compelling evidence that 'tailored teaching based on ongoing formative assessment and feedback is the key to enabling students to progress to higher levels of achievement'.

ACER's PAT tests provide indicators of student achievement via scale scores and the accompanying achievement band descriptions. Upon completing their assessments, students are allocated a scale score that represents their ability in critical reasoning. The scale is divided into achievement bands from which the skills and understanding represented at each level are described. The achievement bands provide valuable evidence-based information about the concepts and skills students have achieved, are consolidating, and are working towards. As the Gonski Report recommends, reporting on assessment should have an emphasis on achievement and growth and that the growth should be measured against learning progressions (2018, Recommendation 4). Masters (2013) also expresses the idea that learning should be assessed by measuring growth over time and against empirically derived learning progressions.

The PAT reports provide targeted formative feedback, allowing the student data to be sorted and analysed in a variety of ways. Using the PAT data and the achievement band descriptions, teachers can structure learning specifically to students' needs rather than where they are expected to be.

Progressive Achievement in PAT Critical Reasoning

PAT Critical Reasoning is designed to target a key set of skills that underpin growth in critical thinking.

Critical thinking is a broad construct that overlaps considerably with problem solving and creative thinking (Ennis, 1981). For example, the ability to pose questions, to explore alternatives and to apply these to problem solving are key elements of critical thinking that clearly involve an element of creativity (Lewis & Smith, 1993). Indeed, critical thinking is so closely entwined with creative thinking that some jurisdictions treat them as a single domain.

A critical thinker is acknowledged to be someone who not only can think critically but someone who does think critically when the situation demands, and whose actions are guided by such thought (Beyer, 1987; Halpern, 1998). It is demonstrated by a student's ability to generate questions, by their willingness to identify and question their own assumptions and reasoning, and to generate solutions to problems (Glaser, 1941). Most of these qualities are best assessed through extended and thoughtful observation of a student's behaviour in a variety of educational contexts.

Consequently, *PAT Critical Reasoning* targets a manageable subset of skills that can be clearly defined as elements of critical thinking and that can be tested in the PAT format. These skills are concerned with the logical relationships between ideas and the analysis and evaluation of argument. These are also the critical thinking skills that are most readily taught by explicit instruction. *PAT Critical Reasoning* can help identify whether a student has these skills and to what degree. Educators can extend on these findings by further investigating the student's ability to apply these skills in academic or everyday contexts.

PAT Critical Reasoning and curricula

While some critical reasoning skills are domain-specific or depend upon domain knowledge, there is wide agreement that there are also general thinking and reasoning skills that are applicable across a variety of learning domains. In the context of the Australian national curriculum, these skills fall within the General Capabilities and specifically within the ACARA Critical and Creative Thinking learning continuum.

This continuum is concerned with the type of broad conception of Critical and Creative Thinking considered above. *PAT Critical Reasoning* addresses some of the crucial reasoning skills that underpin this broad conception.

In particular, *PAT Critical Reasoning* tests relate to three elements and sub-elements of the ACARA Critical and Creative Thinking learning continuum:

Element	Sub-element
Analysing, synthesising and evaluating reasoning and procedures	Apply logic and reasoning
Inquiring – identifying, exploring and organising information and ideas	Organise and process information
Reflecting on thinking and processes	Think about thinking (metacognition)

This is not to claim that *PAT Critical Reasoning* directly maps progress in those elements and sub-elements precisely as that progress is defined in the continuum. *PAT Critical Reasoning* results do not directly align with year or stage level outcomes contained in the Critical and Creative Thinking continuum. *PAT Critical Reasoning* aims to map some of the reasoning skills that fall within those elements and sub-elements.

Because the general PAT construct is based on a progressive achievement approach rather than year-based expectations, *PAT Critical Reasoning* seeks to assess these particular critical reasoning skills in a more fine-grained manner than is envisaged within the continuum. Some of the foundational skills identified in the ACARA Critical and Creative Thinking learning continuum, which may be first demonstrated at an early stage in a student's education, continue to be developed and applied in increasingly sophisticated contexts throughout a student's school career.

Construct

Definition

A construct is a description of an ability that can be measured on a single dimension (with a single numeric variable). It often refers to 'what students know and can do'. In the case of *PAT Critical Reasoning*, the focus is on what they can do.

A mathematical model is used to transform observations (eg student responses to test items) into measurements. A careful definition of ability/proficiency helps ensure that the assessment and reporting are consistent and legitimate.

The ability to think critically is fundamental to full participation in modern adult life. It is essential to educational progress across domains, but increased critical reasoning levels enhance an individual's participation in the economy and public discourse.

Critical reasoning refers to the thinking required to discern the validity of arguments, scientific claims, statements and other formulations that require logical deduction. It involves analysing and evaluating verbally constructed arguments, sets of propositions and other non-verbal representations of information and relationships to identify the premises that underpin a conclusion or truth claim, judging the logic of how conclusions are reached, and ensuring one's own arguments or formulations are sound. Reasoning can be represented in a variety of forms such as verbal, spatial, abstract, numerical, mechanical, algorithmic and graphical. When working in complex problem-solving contexts, a variety of representations of reasoning may be present.

In order to focus on critical reasoning skills, the items in the test are designed to have a low reading load. Whenever more unfamiliar terms or domain-specific content are used in the test these are explicitly defined and function solely to provide a context in which to employ reasoning skills.

Structure

The *PAT Critical Reasoning* construct is the organising principle of the assessments; it is used to guide test development and structure the PAT reports. This structure is also part of the Progressive Achievement approach because the skills and understanding represented in the assessments is designed to support educators in identifying student needs.

Strands

The *PAT Critical Reasoning* construct focuses on reasoning skills rather than any specific content knowledge. These skills are grouped into three strands. The strands identify core competencies at the heart of critical reasoning. As general competencies, they contribute to growth in student learning across a range of disciplines. When developing test items, each is targeted to one strand. The *PAT Critical Reasoning* strands are an organising component of the PAT reports, so that educators can analyse the performance of students according to these different skill areas.

There are three strands used in *PAT Critical Reasoning*:

- Conceptual reasoning
- Basic logic
- Argument analysis

Progression in the *PAT Critical Reasoning* strands is reflected by the achievement band descriptions, as discussed in the section Reporting.

Conceptual reasoning

Conceptual reasoning is a foundational skill in which students identify the logical implications of concepts both in familiar and in more technical contexts. At the most basic level, these skills are demonstrated when students can identify the most appropriate way to represent explicitly defined concepts in diagrammatic form. As students develop this skill, they are able to apply it by identifying whether particular statements instantiate a more abstract concept and by identifying the implications of more technical, though still explicitly defined, concepts. At higher levels, students can identify the hierarchical and temporal order implied by a set of concepts relating to a process.

Basic logic

Basic logic involves the application of logical rules to a scenario or argument. This includes identifying whether simple arguments satisfy the conditions for logical validity and identifying whether a given design or scenario complies with an explicitly stated set of rules. As students develop their basic logic skills they are able to identify whether a given conclusion is supported by evidence given in the form of a graph or other representation. As students develop these skills, they are increasingly equipped to apply them to complex real-life arguments.

Argument analysis

Argument analysis builds on basic logic skills, by applying them to complex arguments that more closely approximate arguments that might be encountered in the classroom or in public debate. They are able to identify whether given reasons support or challenge a given conclusion in increasingly technical contexts. They are able to identify any unstated assumptions presupposed by an argument. As their skills develop, they are able to identify the relationships between a set of propositions and a given conclusion. Some items within this strand require the student to identify how a given statement or set of statements fits into a given argument. In doing so, students demonstrate their understanding of the logical relationships between the different components of an argument; reasons, evidence, rebuttals and counter-rebuttals.

Given that argument analysis involves handling complexity, a student may achieve partial credit for some items within this strand.

Assessment design

Measuring the construct

Distribution by strand

It is necessary to assess students on an appropriate distribution of strands, so that the assessment encompasses a range of reasoning skills. This approach ensures that the formative data gained provides insight into possible strengths, gaps and weaknesses in different areas. The distribution of strands varies somewhat across the levels. In particular, argument analysis builds on skills targeted in the other strands, especially Basic logic, and consequently, there are increasing numbers of score points in this category across the tests.

Table 1 *Score points for PAT Critical Reasoning items by strand for each test*

		Strand (score points)		
Test level	**Maximum score**	**Conceptual reasoning**	**Basic logic**	**Argument analysis**
Test A	23	9	8	6
Test B	27	9	8	10
Test C	36	10	8	18

Distribution of item difficulty

It is important to have a spread of item difficulties that match the abilities of the students.

Table 2 shows the mean difficulty of the items in each of the *PAT Critical Reasoning* tests in scale score units, with their standard deviations. Standard deviation measures the amount of variation in item difficulty for a set of items.

Table 2 *Mean difficulty and standard deviation of each PAT Critical Reasoning test*

Test level	No. of items	Mean item difficulty (scale score)	Standard deviation (scale score)
Test A	18	114	5
Test B	20	119	6
Test C	18	125	8

Delivery

Choosing the right test

Planning and consistency are important in ensuring *PAT Critical Reasoning* is used effectively and that students' results are useful and meaningful. There are three *PAT Critical Reasoning* tests, which broadly target Years 5 and 6, 7 and 8, and 9 and 10 respectively. All three tests could be suitable for middle or upper primary students, with higher performing students allocated the more challenging assessments, based on educator judgement.

Table 3 *Summary of test delivery details for PAT Critical Reasoning*

Test level	Generally suitable for	No. of items	Time allowed
Test A	Year 5, Year 6	18	35 mins
Test B	Year 7, Year 8	20	
Test C	Year 9, Year 10	18	

Frequency

For the purpose of monitoring student progress, a gap of 9 to 12 months between testing sessions is recommended. Learning progress may not be reflected in a student's scale scores over a shorter period of time. Longitudinal growth should be measured over a minimum of two years of schooling, or three separate testing sessions, in most contexts. This will help account for possible scale score variation, for example where external factors may affect a student's performance on a particular testing occasion.

Test administration

Teachers are required to supervise test administration. Practice items are embedded to support administration of the tests. The recommended test administration time is 35 minutes. This should be sufficient for all students to complete their practice questions and test questions. Consistency in the time allowed to students will assist teachers in comparing the results of students.

Item response formats

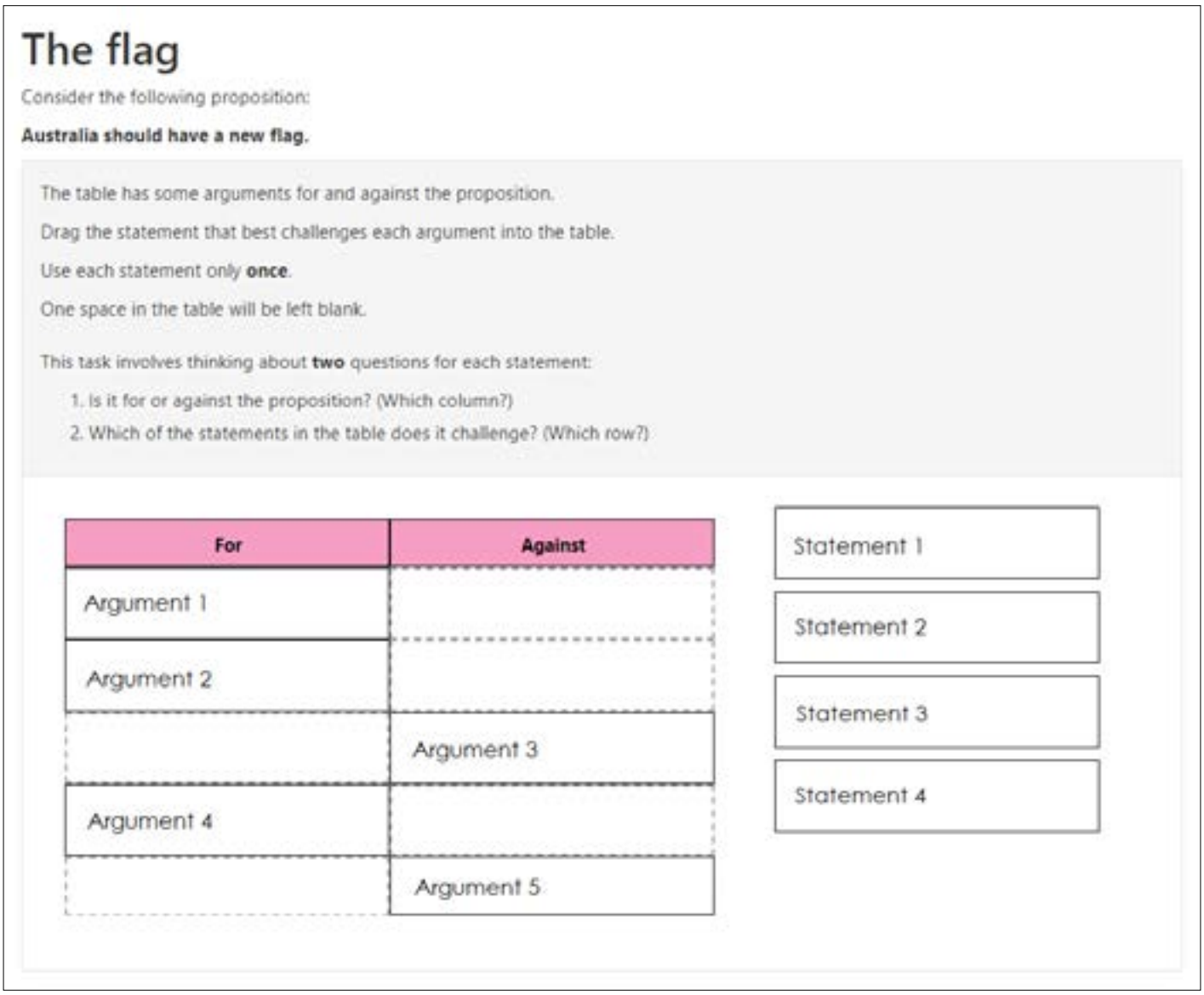
Most items in *PAT Critical Reasoning* use a selected response item format (that is, either multiple-choice or complex multiple-choice).

When the selected response format is not suitable for the skill being targeted, an interactive item type (namely, drag-and-drop item) is used. Drag-and-drop items are particularly appropriate for identifying the logical relationships between ideas, processes or arguments. Hence, drag-and-drop items are used within the Conceptual reasoning strand, when students are asked to order the logical and temporal relationship between concepts. This format enables students to visualise the logical order among concepts. Such items are among the most challenging in the Conceptual reasoning strand.

For similar reasons, drag-and-drop is used in a number of items within the Argument analysis strand. Such items are of two general types: for/against tables and line of argument items.

Items utilising for/against tables are themselves of two types. In the more sophisticated form, students are given a proposition and have to identify how the given statements relate to given arguments for and against the overall proposition already contained within the table (Figure 1).

Figure 1 *Example of a PAT Critical Reasoning item utilising a for/against table*



In order to make the nature of the task clearer, it is suggested that students think first about whether each statement supports or challenges the conclusion before considering which of the given arguments that statement is responding to.

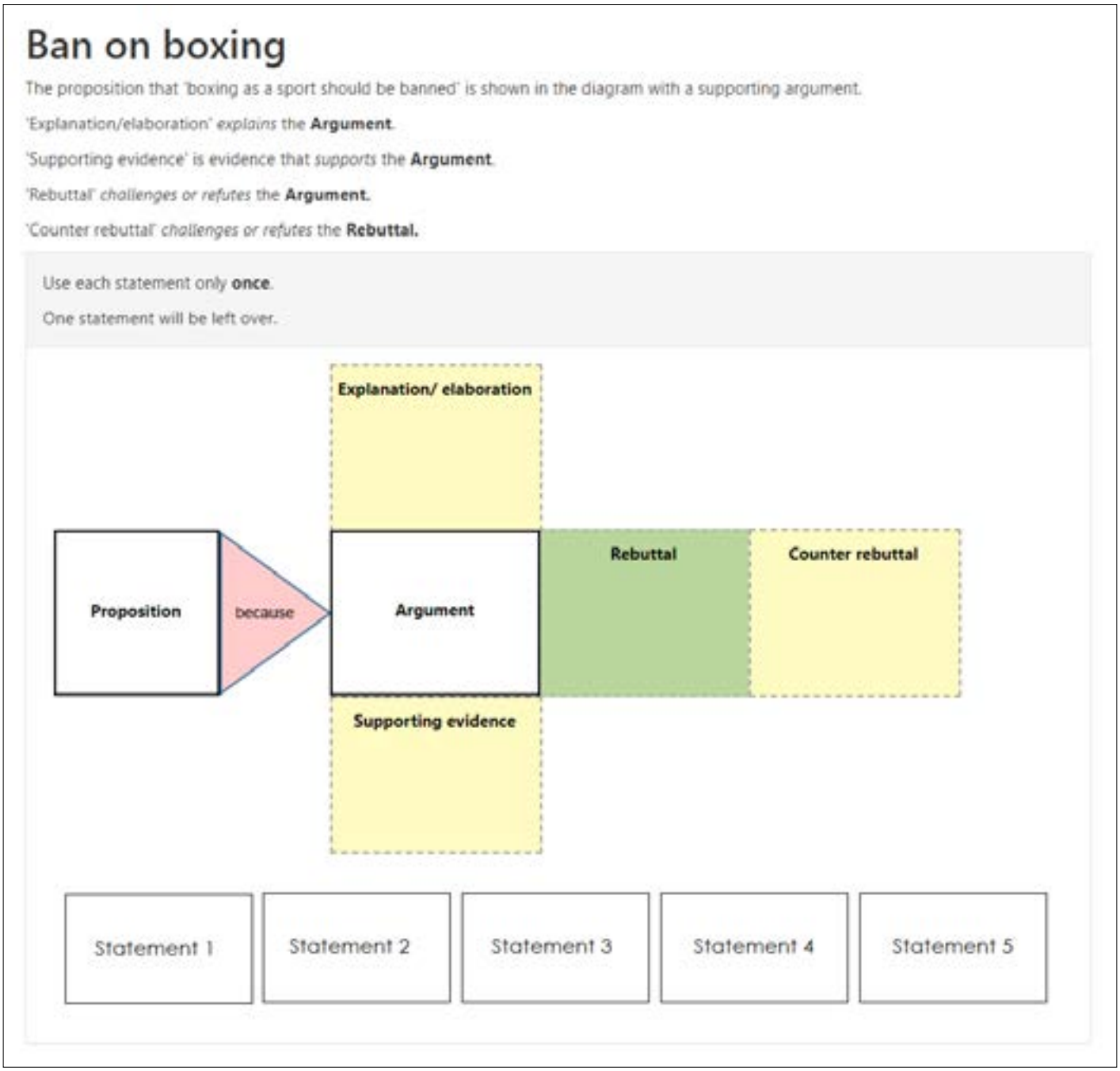
A student who identifies the correct column for all statements without correctly identifying the particular argument to which it relates has demonstrated some skill in the manipulation of arguments and receives partial credit.

This latter skill is to the fore in the more basic form of the pro–con table type in which students drag statements into two columns depending on whether those statements support or challenge a given proposition.

An example of a line of argument item is given in Figure 2.

Because these are complex items, partial credit is given to students who correctly identify the placement of some statements but not others.

Figure 2 *Example of a PAT Critical Reasoning line of argument item*



Reporting

The information provided by the *PAT Critical Reasoning* reports is intended to assist teachers in understanding their students' abilities in a fundamental subset of the skills that constitute critical thinking.

PAT scale score

A PAT scale score is a numerical value given to a student whose achievement has been measured by completing a PAT assessment. A student's scale score lies at a point somewhere on the specific PAT scale, and it indicates that student's level of achievement in that particular learning area – the higher the scale score, the more able the student.

Regardless of the test level or items administered to students, they will be placed on the same scale for the learning area. This makes it possible to directly compare students' achievement and to observe students' progress within a learning area by comparing their scale scores from multiple testing periods over time.

Item difficulty is a measure of the extent of skills and knowledge required to be successful on the item. This makes it possible to allocate each *PAT Critical Reasoning* test item a score on the same scale used to measure student achievement. An item with a high scale score is more difficult for students to answer correctly than a question with a low scale score. It can generally be expected that a student is able to successfully respond to more items whose difficulty is located below their achieved scale score than above.

By referencing the difficulty of an item, or a group of items, and the proportion of correct responses by a student or within a group, it may be possible to identify particular items, or types of items, that have challenged students.

A score on the *PAT Critical Reasoning* scale has no meaning on the *PAT Reading* scale or any other PAT scale. The units of the scale have different meanings for each scale. This is because these units are calculated based on the range of student levels of achievement, which vary widely between learning areas.

Achievement bands

While a scale score indicates a student's achievement level, and can be used to quantitatively track a student's growth, it is only in understanding what the number represents that teachers can successfully inform their practice to support student learning. For this reason, the PAT scale has been divided into achievement bands that include written descriptions of what students are able to do at that band (band description). A student scoring in a particular band can be expected to have some proficiency in that band and be progressively more proficient with the critical reasoning skills outlined in lower bands.

Students in the same achievement band are operating at approximately the same achievement level within a learning area regardless of their school year level.

Viewing student achievement in terms of achievement bands may assist teachers to group students of similar abilities. By referencing the PAT achievement band descriptions, teachers can understand the types of skills typical of students according to their PAT band.

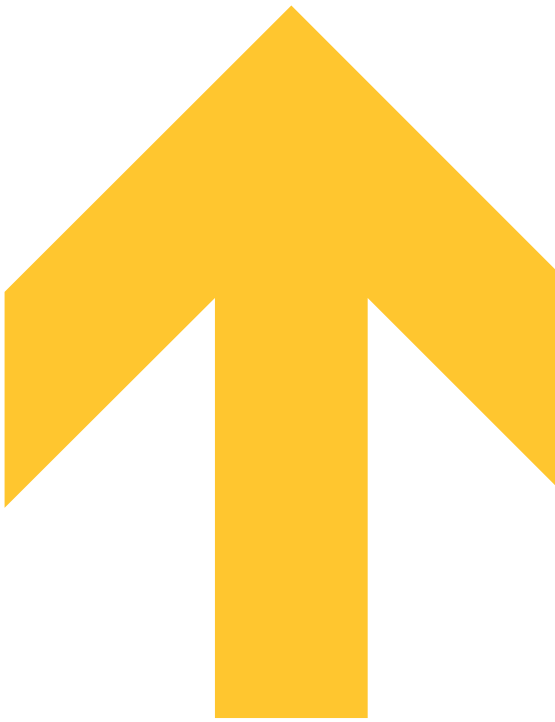
A *PAT Critical Reasoning* scale score of 120 could be considered to be at the upper end of achievement band 110–119 or at the lower end of achievement band 120–129. In cases like these, it is important to reference the descriptions of both achievement bands to understand the student's abilities.

PAT Critical Reasoning achievement band descriptions	
130 and above	Students can identify logical relationships implied in a set of definitions where there is some degree of challenge (eg where the implications are subtle or the relationship between ideas is indirect). They identify logical relationships between claims made in an argument where there are complexities.
120–129	Students can summarise an explicitly stated logical sequence where there are some complexities (eg a brief but unfamiliar sequence). They identify the degree to which a claim is logically supported by data presented in a complex graphical representation, as well as the degree to which claims are supported by given evidence where there are minor complexities (eg an implied idea). They identify the logical relationships between claims made in an argument with a familiar context.
110–119	Students identify the relationship between explicitly defined concepts when this is straightforward. They evaluate the logical status of claims made in a simple argument. They identify whether a statement supports or challenges a proposition in a familiar context.
109 and below	Students summarise the relationship between ideas expressed in simple visuals. They apply a clear and explicit definition to particular, familiar cases. They recognise whether simple patterns conform to a set of explicit rules.

While the achievement band descriptions are intended to be considered in their entirety and not as discrete components, they help to demonstrate the progression of particular skills. In 'typical' development of critical reasoning ability, students progress from being able to recognise the logical implications of simple, explicitly stated concepts and rules, to being able to analyse the logical relationships between the elements of an argument that might be encountered in an educational context or in public discourse. Knowing at which stage a student's ability is located can help target learning for students performing at these different levels, to ensure their progression from one level to the next.

Reference groups

PAT Critical Reasoning Skills reference groups will be available in the future as a reference sample against which student achievement can be compared. They will be composed of Australian students in Years 5 to 10 who have completed *PAT Critical Reasoning* once sufficient response data is collected.



Appendixes

Appendix 1

Literature review: locating PAT Critical Reasoning in the broader research context

What is critical reasoning and how does it relate to critical thinking?

PAT Critical Reasoning targets skills that lie at the heart of the broader construct of 'Critical Thinking', which is in turn central to the cluster of skills that have been identified variously as 'General Capabilities' or '21st Century Skills'. In some educational jurisdictions, such as the Australian Curriculum, this broader construct is described as 'Critical and Creative Thinking'.

Critical thinking is deemed one of the most important skills for the changing workforce, and in the era of information explosion, the demand for this skill is increasing (Society for Human Resource Management, 2008). Although thinking is something that comes naturally, thinking, left on its own, can be biased, incomplete, or uninformed. Critical thinking, on the other hand, is 'purposeful, reasoned, and goal-directed. It is the kind of thinking involved in solving problems, formulating inferences, calculating likelihoods, and making decisions' (Halpern, 1998). This type of thinking must be systematically developed, taught (Paul & Elder, 2006), and practised (Willingham, 2007).

Interest in critical thinking has been a feature of western civilisation since the time of Socrates (Paul & Elder, 2006). In the knowledge economy, developing critical thinkers has become one of the goals for education. For example, the dissemination of fake news has increased as technology creates new communication channels. With fake news comes inaccurate knowledge that devalues the overall knowledge economy. The knowledge economy benefits when knowledge contributors are capable critical thinkers who can discriminate and make decisions about what information to pay attention to and what information to share with others.

Thus broadly conceived, critical thinking is the intellectually disciplined process of actively and skilfully conceptualising, applying, analysing, synthesising, and/or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action. It involves critically evaluating information and arguments, seeing patterns and connections, constructing meaningful knowledge, and applying it in the real world. Critical thinking goes beyond just acquiring and retaining information or having a set of thinking skills – a combination of the two components is necessary, whereby the skills are applied to seek and use appropriate information to evaluate arguments, draw warranted conclusions, and make sound judgments (Glaser, 1941). There must also be recognition that a particular skill is needed and when, as well as the willingness to apply it effectively (Beyer, 1987; Halpern, 1998). Notably, although thinking occurs in the context of domain-specific knowledge, the goal of teaching and learning critical thinking is to be able to transfer these skills appropriately and seamlessly to complex real-world situations, beyond the classroom (Halpern, 1998; Willingham, 2007).

Some thinkers, particularly from the philosophical tradition, have reserved the term 'critical thinking' for a form of reflective thinking directed toward the analysis and evaluation of information and arguments (eg Dewey, 1910; Beyer, 1985; Fisher and Scriven, 1997, Browne & Keeley, 2011). This focus on reflective evaluation is captured in McPeck's (1981) definition of critical thinking as 'reflective scepticism'. Some definitions from within this tradition acknowledge the role of critical thinking not only in the analysis and evaluation of arguments but in the formulation of them as well (Facione, 1990; Epstein, 2005; Moore & Parker, 2012).

While acknowledging the value of the broader conception of critical thinking, *PAT Critical Reasoning* targets a subset of these skills, namely those concerned with the logical relationships between ideas and the analysis and evaluation of argument. Thus conceived, critical reasoning focuses on the ability to reason through sets of propositions, rules, conditions, statements, and premises to arrive at a true or valid conclusion. It requires the ability to apply concepts of propositional logic like inference, causality, contradiction, and consistency. It can be done reflectively to evaluate the truth or validity of a given conclusion. It can also be applied predictively (ie beyond the parameters of a given argument or set of conditions) in order to make sound predictions as to what an argument or set of conditions mean – or whether they are still valid – in a different context. It entails the ability to identify fallacies and technical flaws in various representations of reasoning.

Works cited

Beyer, B.K. (1985). 'Critical Thinking: What Is It?' *Social Education, 49*, 270-276.

Browne, N.M. & Keeley, S.M. (2011). *Asking the right questions: A guide to critical thinking* (10th ed.). Boston: Pearson.

Dewey, J. (1910). *'What is thought?' How we think.* Lexington, Mass: D.C. Heath, 1-13.

Ennis, R. H. (1981). Rational thinking and educational practice. In Soltis, J. (Ed.), *Philosophy of Education,* 1981 (Eightieth Yearbook of the National Society for the Study of Education, Part I.1964) Chicago, IL: The National Society for the Study of Education. 143-183.

Epstein, R.L. (2005). *Critical thinking.* Belmont, CA: Wadsworth.

Facione, P.A. (1990). *Critical thinking: A statement of expert consensus for purposes of educational assessment and instruction,* Millbrae, CA: California Academic Press.

Fisher, A & Scriven, M. (1997). *Critical Thinking: Its definition and assessment.*Norwich: Centre for Research in Critical Thinking.

Gonski, D., Arcus, T., Boston, K., Gould, V., Johnson, W., O'Brien, L., Perry, L.-A., Roberts, M., & Australia. Dept of Education (Eds.). (2018). *Through growth to achievement: report of the review to achieve educational excellence in Australian schools.*

Glaser, E. M. (1941). *An experiment in the development of critical thinking.* New York, NY: Columbia University Teachers College.

Halpern, D. F. (1998). Teaching critical thinking for transfer across domains: Dispositions, skills, structure training, and metacognitive monitoring. *American Psychologist,* 53(4), 449-455.

Lewis, A., & Smith, D. (1993). Defining higher order thinking. *Theory into Practice,* 32(3), 131-137, Summer 1993.

Masters, G., (2013) Reforming education assessment: imperatives, principles and challenges 2013, *Australian Education Review,* No. 57.

McPeck, J. (1981). *Critical Thinking and Education*. Oxford: Robertson.

Moore, B.N. & Parker, R. (2012). *Critical thinking* (10th ed.). New York: McGraw-Hill.

Paul, R. W., & Elder, L. (2006). *Critical thinking: The nature of critical and creative thought. Journal of Developmental Education,* 30(2), 34-35.

Society for Human Resource Management (2008). *A history of human resources: SHRM's 60-year journey.* Society for Human Resource Management: Alexandria, VA.

Wiliam, D. (2011). *Embedded formative assessment.* Bloomington, IN: Solution Tree Press.

Willingham, D. T. (2007). Critical thinking: Why is it so hard to teach? *American Educator,* 8-19.

Appendix 2

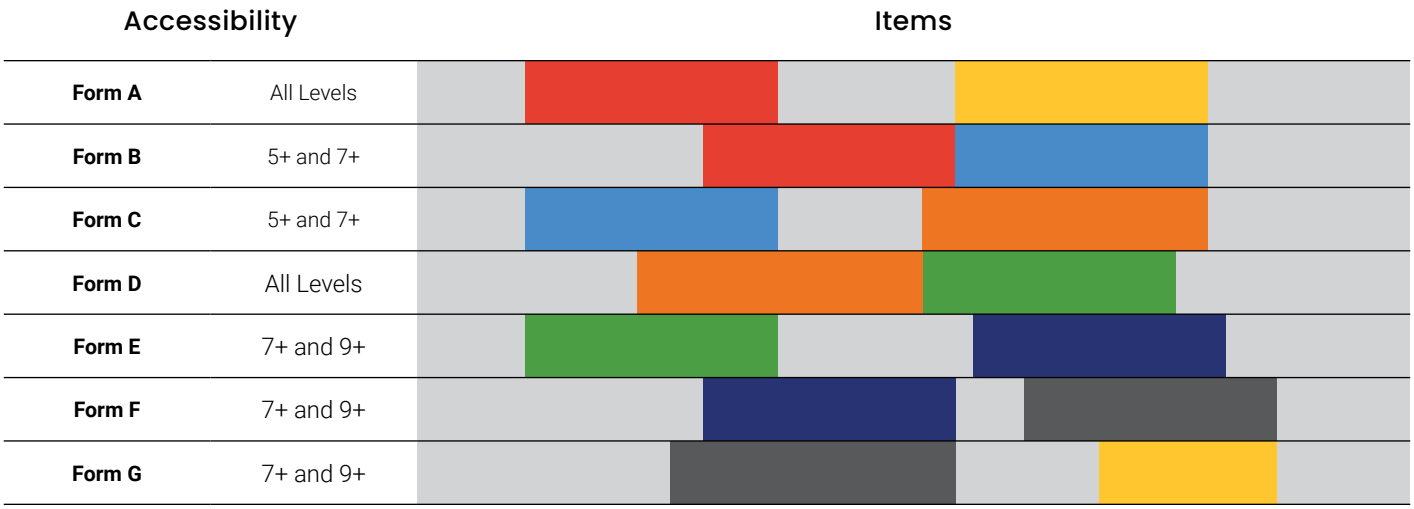
Trial design and assessment validity

The *PAT Critical Reasoning* tests are planned and constructed to assess critical reasoning skills through tasks that require skills in Conceptual reasoning, Basic logic, and Argument analysis. In constructing the tests, care is taken to include a range of these skill areas to ensure that the breadth of students' critical reasoning abilities are captured. All items are subjected to intensive scrutiny, review and revision by panels of experts and psychometricians.

The items in the assessment were developed by experienced test developers who review and panel the items until they are ready for trial. A rigorous process of quality checking, proofreading and formatting then takes place. The psychometric team provide a trial design based on the items (number, distribution of strand and item type) to ensure that the most valid and reliable data is available from the trial. *PAT Critical Reasoning* items were trialled in standalone trial test forms, with items offered across a range of year levels to determine the appropriate targeting and difficulty for each item.

Initially, 110 items were developed for trial, comprising five theoretical strands (algorithmic, conceptual, critical, diagrammatic, and logical thinking) and targeting students in Years 5 to 10. Each item was given an accessibility level with the lowest level accessible to Year 5 students and above, the middle level accessible to Year 7 students and above and the highest level accessible to Year 9 students and above. This accessibility was built into the trial design, demonstrated in Figure 3. Each block of colour represents a set of items that were linked to another trial form.

Figure 3 *PAT Critical Reasoning trial design*



Two trial forms were developed with items across all levels of accessibility to test all students from Years 5 to 10. Two forms were targeted at the lower levels of accessibility, but also trialled at all year levels from 5 to 10. Three forms were targeted at the higher levels of accessibility and only offered to students in Years 7 to 10.

The calibration procedures identified items that appeared to be measuring skills other than those measured by the other items at trial. Items 'misfitting' in this way were not retained. The items retained for PAT Critical Reasoning were shown to fit the Rasch measurement model satisfactorily. All items retained could be regarded as measuring a student's location on a single underlying continuum of critical reasoning skills.

Originally the test was conceived as a test of 'critical thinking'. But because the skills targeted in this test represent a subset of the broad construct 'critical thinking (cf. Appendix 1) and because ACER is developing instruments that address other parts of this broader construct, the test was renamed 'critical reasoning'. As part of this process, test developers reviewed and reorganised the theoretical strands assessed with these items, settling on the final strands Conceptual reasoning, Basic logic, and Argument analysis. Items formerly classified as 'algorithmic' and 'logical thinking' were grouped together as Basic logic and 'diagrammatic thinking' items were reclassified as a subset of Conceptual reasoning. The classification 'critical thinking' was renamed Argument analysis, which more clearly describes the skills assessed by these items.