PAT Inquiry and Problem Solving in STEM Contexts

Achievement band descriptions

Australian Council *for* Educational Research

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PAT STEM CONTEXTS ACHIEVEMENT BANDS

Background

In PAT Inquiry and Problem Solving in STEM Contexts (also referred to as PAT STEM Contexts), the contexts of the test items are underpinned by core concepts that cut across the learning domains of Science, Technology, Engineering and Mathematics. These core concepts relate to pattern; cause and effect; scale, proportion and quantity; systems and models of systems; energy and matter; structure and function; and stability and change.

The practices that are required to answer the test questions in PAT Inquiry and Problem Solving in STEM Contexts cut across the discipline areas of Science, Technology, Engineering and Mathematics. These core practices relate to defining questions and problems; working with models; planning and conducting empirical investigations; analysing and interpreting data; and evaluating and communicating information.

In PAT Inquiry and Problem Solving in STEM Contexts, progression is conceptualised in terms of the different cognitive skills employed during the inquiry or problem solving processes. The cognitive skill categories (ways of thinking) from the large-scale international assessment Trends in International Mathematics and Science Study (TIMSS) are used for this purpose.

These categories are explained below:

- Knowing – refers to the amount of specific knowledge possessed. Students demonstrate this by being able to: recall/recognise/retrieve; describe; provide examples; classify/order; compute; measure.
- Applying – refers to the extent to which knowledge is applied. Students demonstrate this by being able to: compare/contrast; relate; represent/model; interpret information; explain; determine; implement.
- Reasoning – refers to the extent to which reasoning is employed in order to answer research questions and to solve problems. Students demonstrate this by being able to: analyse; integrate/synthesise; formulate questions/hypothesise/predict; design investigations; evaluate; draw conclusions; generalise; justify.

The described scale for PAT Inquiry and Problem Solving in STEM Contexts

The described scale for PAT Inquiry and Problem Solving in STEM Contexts comprises a number of achievement bands, each correlating to a scale score range.

For each level, the achievement band description details the kinds of inquiry and problem-solving processes that the students working in the band are consolidating, and the kinds of STEM contexts they can meaningfully engage with to demonstrate their skills and understandings. Each band description is based on the skills typically required to correctly answer the test questions in that band, and the contexts of the test questions in that band.

In developing the band descriptions, the aim was to draw out the core concepts, core practices and the three TIMSS cognitive skills described above.

PAT STEM CONTEXTS ACHIEVEMENT BANDS

Achievement band 135 and above

Interpret and reason about complex and abstract systems

Students apply understanding and reasoning skills where STEM contexts are unlikely to be familiar. Contexts generally involve several abstract concepts or an abstract representation of a system, where students are required to extract key features and explain interactions of elements within a system.

They apply their knowledge and conceptual understanding to interpret many interactions in a system (eg to complete a complex food web or to infer the behaviour of a cart on a roller coaster track by applying both an understanding of acceleration and how multiple forces are acting).

They use reasoning to solve a problem by extracting relevant information from an abstract representation of a novel application and accompanying data source (eg find the width of wood used from a diagram of a nest box suited to a bird of a specified size).

Achievement band 125–134

Recognise interacting cause-and-effect relationships in systems, and predict outcomes of simple changes to a system

Students identify or explain the relationships between the elements of a system by applying understanding of more than one abstract concept, where STEM contexts are likely to be only somewhat familiar.

They apply their knowledge and conceptual understanding to explain the sequence of events in a technological system (eg those necessary for electrical charge to flow), recognise the relationship that represents a change over time (eg calculate percentage decrease from the reduction in diameter of chips of stone), and select an appropriate calculation strategy to solve a problem that matches a design brief.

They use reasoning to interpret a situation from a third-person rather than a personal perspective (eg interpret a visual pattern from a bird's eye view to create a robot's pathway), predict the effect of changes in a system (eg the behaviour of a cart on a roller coaster track taking into account the forces acting upon it), and they evaluate alternative problem solutions taking into account a number of factors.

Achievement band 115–124

Develop and use rules for several aspects (or for single cause-and-effect relationships) within a system

Students identify and then apply a rule for a cause-and-effect relationship to make a prediction in less familiar STEM contexts, drawing from everyday experiences, classroom activities and investigations. Students link their observations to more than one abstract concept, but they consider each separately to draw a conclusion.

They apply their knowledge and conceptual understanding to make a link from experienced properties of materials to describe how the material suits its purpose, or apply a rule for an abstract concept or element of a system to a new context (eg apply the rule for angle of reflection to the function of a solar cooker box).

They use reasoning to integrate two aspects required to solve a problem (eg rank planets by considering both dimensions and comparing each planet to Earth), make predictions based on patterns (eg predict the extent of weathering for sandstone compared to granite), and identify the value in a data set that does not conform to a set of plausible values.

115

110

105

100

Achievement band 105–114

Recognise cause-and-effect relationships

Students describe cause-and-effect relationships in familiar STEM contexts, drawing from everyday experiences, classroom activities and investigations. Students link their observations to an abstract concept, generalising from their immediate experience.

They apply their knowledge and conceptual understanding to make a link between a natural phenomenon and its effects (eg infer how a lesser-known animal, a numbat, finds food; interpret a diagram or data to identify the number of low tides or the coordinates of a contact point on a technology device).

They use reasoning to identify the relationship between factors and features, such as the connection between the presence of light and sensor activity, and the relationship between a product design feature and its use. They also use reasoning to decode a simple visual program, and compare bar graphs to evaluate changes over time.

Achievement band 104 and below

Understand single observations with the help of basic STEM knowledge

Students make observations about aspects of their immediate environment they have directly experienced, including those in everyday STEM contexts.

They recall individual facts, single concrete concepts they have experienced, and specific procedures. They may be able to identify the key purpose of designed products. They are developing the ability to apply knowledge and conceptual understanding to compare or rank events based on observations.

They may use reasoning to identify the key element required to solve a problem (eg interpret a diagram or understand commands in a simple computer program).