Developing Programs in Science for Gifted and Talented Students

Australian Science Innovations
PO Box 7251 Canberra Mail Centre, ACT

Telephone 02 6215 6228
Email asi@asi.edu.au
Website www.asi.edu.au

Contents

Background

This resource on developing programs in science for gifted and talented science students has been prepared by Australian Science Innovations for use by science teachers and other interested readers. Australian Science Innovations, as a provider of high quality science extension programs for students and teachers including programs specifically designed to challenge and inspire gifted and talented students, understands the challenges and rewards of guiding this special group of students.

The module provides a definition of the meaning of gifted and talented, an overview of the various models that have been developed to guide teaching and learning for gifted and talented students, a brief outline of some significant extension opportunities available for these students, and useful links for further information.

This resource forms part of a suite of professional development material developed by the Australian Science Teachers Association (ASTA) in partnership with Education Services Australia (ESA), and held on ScienceWeb Australia

In addition to preparing this overview module for gifted and talented students, ASI has also worked in conjunction with ASTA to prepare eighteen extension worksheets that accompany each of the six units for years 7 to 10 on ScienceWeb Australia

Introduction

Gifted and talented students have the capacity to learn more at a faster rate and at a more abstract level than is typical for their age peers.

> *'Gifted and talented students are entitled to rigorous, relevant and engaging learning opportunities…aligned with their individual learning needs, strengths, interest and goals.'* 'Student Diversity and the Australian Curriculum – Advice for principals, schools and teachers' ACARA Jan 2013, p. 19.

The **Australian Science Innovations extension materials** for ScienceWeb are mapped against the **Maker model** of curriculum development (Fig. 1) and provide opportunities for students to accelerate their science learning and:

- extend their interests and skills in science
- employ creativity, originality and high order thinking and problem-solving skills
- engage with novel contexts
- make use of digital devices and tools.

The Maker model incorporates strategies for the adjustment of **content, process, product** and the **learning environment.**

Figure 1. Maker model: Audit of ScienceWeb extension materials

Characteristics of curricula and materials designed to cater for gifted and talented students		Yr 7 Mixing	Yr 7 Classification	Yr 8 Cells	Yr 9 Ecosystems	Yr 9 Tectonics	Yr 10 Universe
CONTENT MODIFICATIONS (adjusting WHAT students learn)							
Strategy	**Method**						
Abstraction	Going beyond the facts, with more abstract concepts	✓	✓	✓	✓	✓	✓
Complexity	Greater breadth and depth and more difficult concepts	✓	✓	✓	✓	✓	✓
Variety	Delving into new ideas and varying the aspects around a theme	✓	✓	✓	✓	✓	✓
Organisation	New ways of arranging content	✓				✓	✓
Study of People/Creative Processes	Using biographies to relate content to the scientists and their place in time	✓	✓				✓
Methods of Inquiry	Exploring the methods used in a particular field at the time of discovery	✓	✓				✓
PROCESS MODIFICATIONS (adjusting HOW students learn)							
Higher Order Thinking Skills	Stress the use of knowledge by concentrating on analysing, evaluating and creating knowledge	✓	✓	✓	✓	✓	✓
Open-ended Processing	Encouragement of divergent thinking through use of stimulus tools such as:						
	• analogy	✓	✓	✓	✓	✓	
	• ambiguity	✓	✓	✓		✓	✓
	• heuristic approach	✓	✓		✓	✓	✓
	• freedom of choice of investigation (N/A; prepared units)						
PRODUCT MODIFICATIONS (adjusting HOW students demonstrate their learning)							
Real-world Problems	Investigation of real-life problems to add meaning and sense of worthiness in tackling the problem	✓		✓	✓	✓	
Real Audiences	Developing products that can be utilised in the real world by students themselves and the wider global community	✓		✓	✓	✓	✓
Evaluation	Consciously pitching the product to a specific and relevant audience such as teachers, peers, wider community and experts in the field	✓	✓	✓		✓	

Transformation	Producing original and unique product which has practical applications outside the classroom (not just an exercise)				✓		
	Diversifying methods of representation of science understanding; including use of digital technologies and tools in accessing, analysing, synthesising and presenting information.	✓	✓	✓	✓	✓	✓

Adapted from 'Gifted and talented Education – Differentiating the curriculum and its applicability to the science and technology syllabus', New South Wales Department of Education and Training website, http://www.curriculumsupport.education.nsw.gov.au/policies/gats/assets/pdf/ust3elctr.pdf (2006)

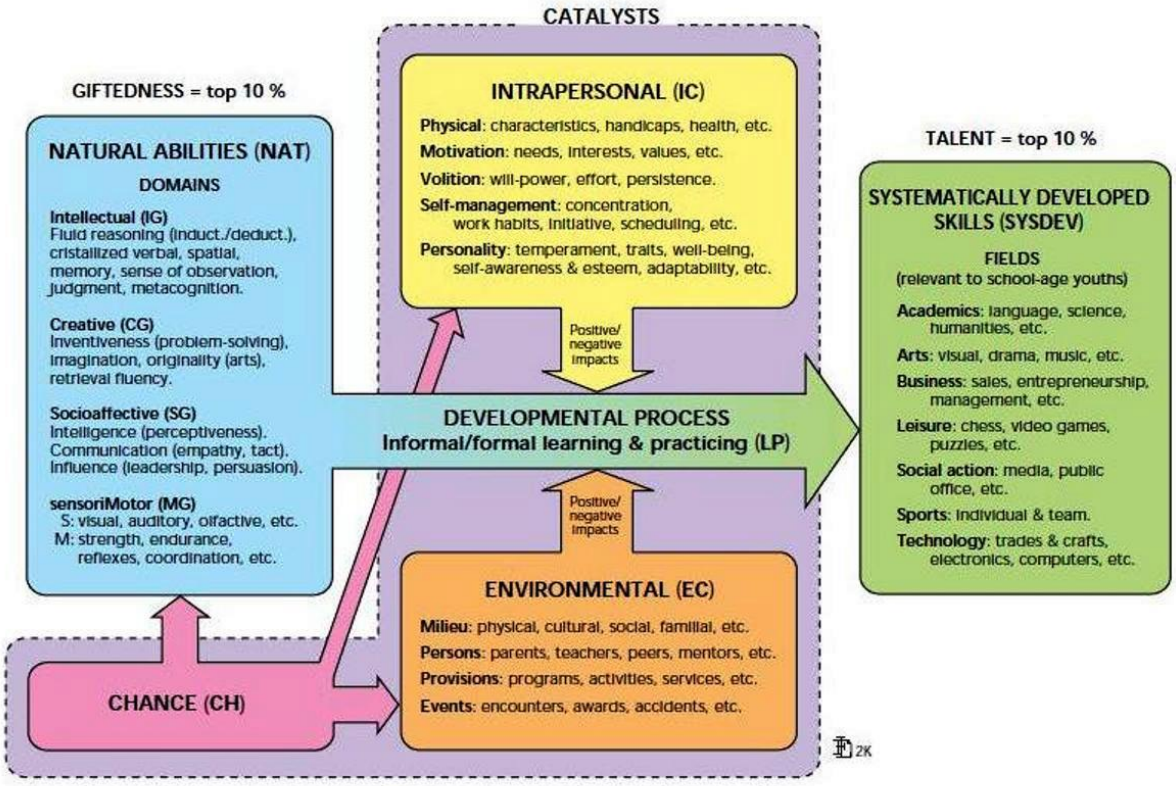
What does 'gifted and talented' mean?

'Giftedness and talent' are often thought of as being synonymous and equated with achievement, but underperformers actually may be gifted. A generally accepted definition is aligned with Gagné's Differentiated Model of Giftedness and Talent (DMGT) (Gagné 2008) (Fig. 2).

- **Giftedness** refers to a student's outstanding natural ability (or potential) in one or more of intellectual (IG), creative (CG), socio-affective (SG) and sensory-motor (MG) domains.
- **Talent** describes outstanding performance in one or more fields of human activity (including science) that has been systematically developed through learning and practising over time.

A student can be gifted without being talented. Gagné's model explains how exceptional natural ability (giftedness), or its potential, can be **progressively transformed in the developmental process** into outstanding talent, given the intrapersonal and environmental **catalysts for change**.

Figure 2: Gagne's Differentiated Model of Giftedness and Talent



Gagné's Differentiated Model of Giftedness and Talent (DMGT.EN.2K)

In Gagné, F.(2002).*Transforming Gifts into Talents: The DMGT as a developmental theory.* In Colangelo, N & Davis,G (Eds), Handbook of Gifted Education (3rd ed.), pp60-74, Boston: Allyn & Bacon.

What are indicators of ‘giftedness’?

A child can be considered to be gifted if more than three-quarters of the following characteristics are demonstrated (adapted from Silverman 1993):

- good problem-solving/reasoning skills
- rapid learning ability
- extensive vocabulary
- excellent memory
- long attention span
- personal sensitivity
- compassion for others
- perfectionism
- intensity
- moral sensitivity
- unusual curiosity
- persevering when interested
- high degree of energy
- preference for older companions
- wide range of interests
- great sense of humour
- early or avid reading ability
- concerned with justice, fairness
- at times judgement seems mature for age
- keen powers of observation
- vivid imagination
- high degree of creativity
- tends to question authority
- good at visual puzzles
- shows ability with numbers

Characteristics tend to be displayed within a **cultural context** so the observable behaviours may differ from one culture to another. This is significant for ‘build[ing] on the hidden resource of **gifted and talented Indigenous** kids in our schools’ **(**National Indigenous Education Conference: 'Identifying and Catering for the needs of gifted and talented Indigenous students’, 2009).

Reliable assessment by both objective and subjective measures is important. Factors that can mask potential include low-level language proficiency, dominance of one learning preference over another, social-emotional issues and physical impairment.

Gifted students from minority groups or low SES backgrounds are frequently ‘invisible’ underachievers (Chaffey and Bailey 2003). Underachieving gifted children may exhibit significant **behavioural difficulties** that occur when gifts or talents are not recognised or adequately addressed in a classroom setting or elsewhere. (see Characterisitics of Gifted Children and Talented Children and Possible Associated Problems)

Some children are **misdiagnosed** as having learning disabilities; in some instances learning disabilities themselves may mask giftedness.

Gifted children are often categorised on the basis of their intellectual abilities, talents or interests, but different profiles of the gifted and talented (Betts and Neihart 1988) have been developed according to their behaviours, feelings and needs. The profiles offer guidance for school and home support.

Research suggests that up to 10% of the population may be gifted and between 10–50% of gifted students **fail to perform** at levels of which they are capable.

How can we cater for gifted and talented students?

- Policy and advice are provided by state and territory education authorities.
- Associations for Gifted and Talented Children in each state and territory offer information and support for teachers, students and parents

Developing differentiated programs for gifted and talented students involves designing extension or enrichment material that relates to the mainstream program but is characterised by:

- Gagné's four Ds of enrichment (Gagne 2008): density (faster pacing), difficulty (complexity), depth (in-depth exploration and reflection) and diversity (exploring associated possibilities)
- **providing choice** about what and how to learn and how to demonstrate that learning.

Curriculum models can be used to assist in adjusting the curriculum to meet the needs of gifted and talented students. Examples include:

- The Maker model provides practical strategies for the adjustment of content, process, product and the learning environment. The **ASI extension materials** of the ScienceWeb units are mapped against this framework.
- Williams model (Fig. 3) includes strategies to develop expression of personality attributes such as imagination, risk-taking, curiosity, fluency, visualisation.

Figure 3. William's model

Teaching strategy	Result
Paradox	Observes apparent contradictions that challenge ideas; leads to evaluation
Attribute Listing	Involves analysis; identification of characteristics
Analogy	Finds similarities from obvious to obscure; makes knowledge their own
Discrepancy	Notes inconsistency of characteristics or incongruity in possible examples; due to incomplete understanding
Provocative question	Stimulates debate and further research
Examples of change	Understands that slight changes or substitutions in application may give altered/unexpected results; especially with progress in thought and change in world perspectives
Examples of habit	Challenges habit-bound thinking; being locked into one perspective
Organised random search	Structures tasks to provoke further research from a personal point of view to expand understanding
Skills of search	Searches/investigates a topic in a novel way
Tolerance for ambiguity	Asks 'What if…?' questions; to incite self-directed learning
Intuitive expression	Utilises role playing or guided imagery to promote creativity
Adjustment to development	Realises how mistakes can be serendipitous
Study creative processes	Explores the human endeavour in science discoveries, particularly through biographies
Evaluate situations	Studies in depth to evaluate repercussions, both positive and negative
Creative reading skills	Generates ideas from a reading stimulus
Creative listening skills	Generates ideas by listening to a stimulus
Creative writing skills	Stimulates novel ideas from the stimulus of organising own thoughts in writing
Visualisation	Expresses ideas using a non-traditional context; from a different perspective

- **Bloom's taxonomy** (1956) defines functions of thought in a hierarchy from lower order to higher order levels of thinking, and often represented as a pyramidal table.
  - Revised by Anderson and Krathwohl (2000) in Beyond Bloom – A New Version of the Cognitive Taxonomy, represented in different forms including as a pyramid.
  - Apps and Web 2.0 applications to support Bloom's revised taxonomy (assembled by Kathy Schrock)

What opportunities are available for extending gifted and talented students in science?

Australian Science Innovations

Australian Science Innovations offers students the opportunity to identify and develop their talents by participating in its programs.

- The Big Science Competition tests students' scientific inquiry and problem solving skills as well as their scientific literacy. This one-hour competition consists of multiple-choice questions (Junior years 7/8, Intermediate years 9/10 and Senior levels years 11/12) and is designed for students of all abilities, as well as to identify '**top performers'** in science.
- The Australian Science Olympiad Competition (Biology, Chemistry, Physics) is the **ultimate extension opportunity** for talented secondary students and the stepping-stone to the International Science Olympiads – the 'Olympic Games' for science students.

  To earn a place in the Australian Science Olympiad teams, top performing year 10 and 11 science students must first sit an Australian Science Olympiad exam in biology, chemistry and/or physics. Top performers in these exams are offered a place in the Australian Science Olympiad Summer School, a two-week intensive residential program providing an opportunity for talented students to study with others passionate about science.

  The very best of the summer school students are selected to represent Australia at the International Science Olympiads.

- The Asian Science Camp is an initiative of Nobel Laureates in Asia that aims to promote international cooperation and networks among the best young science students of the next generation in Asia, Australia and Oceania and encourage deeper thinking about science and scientific knowledge. Students are selected through an application process where they are judged on their **originality and effectiveness of communication** in a medium of their choice.

Science teacher associations, CSIRO and other organisations offer a **variety of opportunities** for students to engage more deeply in science and exercise their talents. Their interests can be stimulated, their talent further developed, and the diversity in purpose, process and product offers choice and flexibility.

Opportunities provided by science teacher associations

- Australian Science Teachers Association: 'SPECTRA Awards' (2013). A range of science topic cards that offer a variety of extension activities for students in years 1–10. Ideally suited to independent learners.

Eight state and territory **science teacher associations** conduct local **science competitions**. The top entries in each are entered into the national BHP Billiton Science Awards.

- Science Teachers Association of Queensland (**STAQ**): Queensland Science Contest
- Science Teachers Association of New South Wales (**STANSW**): Young Scientists Competition
- Science Teachers Association of Victoria (**STAV**): Science Talent Search
- Science Teachers Association of Victoria (**STAV**): Science Drama Awards
- Science Teachers Association of Tasmania (**STAT**): Tasmanian Science Talent Search
- South Australian Science Teachers Association (**SASTA**): Oliphant Science Awards
- Science Teachers Association of Western Australia (**STAWA**): Science Talent Search
- Science Teachers Association of the Northern Territory (**STANT**): The Territory's Young Scientist Award
- Science Educators Association of the ACT (**SEA*ACT**): SEA*ACT Science Fair

Additional opportunities

- 'The Sleek Geeks Science Eureka Prize', University of Sydney website, (2013). For primary and secondary students.
- 'EngQuest', Engineers Australia, (2013)

CSIRO Education

- 'CREST awards', CSIRO Education, (27 June 2013) Green, orange, blue, bronze, silver and gold awards offer a progression of levels of scaffolding.
- 'Double Helix', CSIRO Education, (2013)
- 'Science by Email', CSIRO Education, (26 June 2013)
- 'Maths and Stats by Email', CSIRO, (20 January 2013)
- 'Do-it-yourself science', CSIRO Education (2013)

For a more complete list of national science extension activities go to https://www.asi.edu.au/userfiles/file/Science%20Extension%202013_Feb.pdf

Education authorities

Australian Curriculum, Assessment and Reporting Authority (ACARA): Gifted and talented students (2013)

Catholic Education Office, Sydney Gifted Education K-12 Position Paper (2010)

Independent Schools Queensland and the Queensland Association for Gifted and Talented Children Action plan for gifted students in Qld Independent schools: Strategies and Indicators of Achievement (2013)

Principals Australia Institute 'National Curriculum Perspective Conference: Identifying and catering for the needs of gifted and talented Indigenous students', Dare to Lead website (2009)

State and Territory Departments of education: policies and advice

Australian Capital Territory

'Gifted and talented students policy', ACT Department of Education and Training website (2008)

New South Wales

'Policy and implementation strategies for the education of gifted and talented students' New South Wales Department of Education and Training website. Revised 2004' (2004)

'Policy and implementation strategies for the education of gifted and talented students. Revised 2004. Support package: Identification', New South Wales Department of Education and Training website (2004)

'Gifted and talented education: Differentiating the curriculum and its applicability to the science and technology syllabus', New South Wales Department of Education and Training website (2006)

Northern Territory

'Policy Gifted Education' Northern Territory Department of Education and Children's Services website (2013)

Queensland

'Supporting information: Gifted and talented students', Queensland Department of Education, Training and Employment website (2013)

'Gifted Education: Understanding Giftedness', *The Learning Place*, Education Queensland website (2013)

South Australia

'Policy Statement – Gifted and Talented Children and Students Policy' South Australian Department for Education and Child Development website (2012)

Tasmania

'Policy statement: Education for students who are gifted', Tasmanian Department of Education website (2000)

Victoria

'Gifted and Talented Education: New opportunities for the gifted and talented – directions paper', Victorian Department of Education and Early Childhood Development website, (2013)

'A model of giftedness', Victorian Department of Education and Early Childhood Development, (2013)

Western Australia

'Gifted and Talented: Developing the talents of gifted children', Western Australia Department of Education (2013)

Associations for the Education of Gifted and Talented Children

Associations for the Education of Gifted and Talented Children offer information and support for students, parents and teachers.

ACT: http://www.actgifted.net.au/actgt/
NSW: http://nswagtc.org.au/
NT: http://www.ntaegt.org.au/
QLD: http://www.qagtc.org.au/
SA: http://gtcasa.asn.au/
TAS: http://www.tasgifted.com/
VIC: http://www.vagtc.asn.au/
WA: http://www.gatcawa.org/

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Chaffey, G. W. and Bailey, S. B. 2008 'The use of dynamic testing to reveal high academic potential and underachievement in a culturally different population*', Gifted Education International* 24 no 1, 67–81

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Maker, C. June 1982 *Curriculum development for the gifted.* Austin, Texas, Pro-Ed

Silverman, L.K., 1993 'A developmental model for counseling the gifted', L.K. Silverman (ed) *Counseling the gifted and talented*, pp 51–78, Love Publishing Company, Denver

Williams, F.E. 1993 'The cognitive-affective interaction model for enriching gifted programs', J.S. Renzulli (ed) *Systems and models for developing programs for the gifted and talented,* pp. 461–484, Hawker Brownlow, Highett, Vic

Electronic resources

The following resources were available August 2013:

'A model of giftedness' (Gagné) Department of Education and Early Childhood development, Victoria website, http://www.education.vic.gov.au/school/teachers/teachingresources/diversity/pages/giftedmodel.aspx (24 May 2013)

Betts, G., Neihart M. 1988, 'Profiles of the gifted and talented', *Gifted Child* Quarterly, National Association for Gifted children, Davidson Institute for Talent Development http://www.davidsongifted.org/db/Articles_id_10114.aspx

Cathcart, Rosemary, (nd), *The Conundrums of Success,* REACH Education Consultancy, Rotorua, New Zealand http://www.gifteddevelopment.com/PDF_files/THE%20CONUNDRUMS%20OF%20SUCCESS.pdf

'Characteristics of gifted children and talented children possible associated problems', The Queensland Association of Gifted and Talented Children website, http://www.qagtc.org.au/characteristics-gifted-children-and-talented-children

Gagné, F 2007 'Ten Commandments for Academic Talent Development' *Gifted Child Quarterly*, Spring, vol 51, no 2, pp 93–118, specifically p. 104, Learn Lab, Pittsburgh Science of Learning Center website, http://www.learnlab.org/research/wiki/images/c/c7/Gagne_2000.pdf

Gagné, F 2008 *Building gifts into talents: Brief overview of the DMGT 2.0*, NSW Association of Gifted and Talented Students website, http://nswagtc.org.au/images/stories/infocentre/dmgt_2.0_en_overview.pdf

Gagné, F 2008 ‘Talent Development: Exposing the Weakest Link’*, Revista española de Pedagogia*, año LXVI, no. 240, mayo agosto. 221–240 http://revistadepedagogia.org/descargar-documento/16-el-desarrollo-del-talento-sobre-el-eslabon-mas-debil.html

‘Gifted and talented Education – Differentiating the curriculum and its applicability to the science and technology syllabus’ , New South Wales Department of Education and Training website, http://www.curriculumsupport.education.nsw.gov.au/policies/gats/assets/pdf/ust3elctr.pdf (2006)

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June Maker’s model of gifted curriculum website, http://junemakersmodel.weebly.com/ (Accessed 4/08/2013)

Krathwohl, D.R. 2002 ‘Revising Bloom’s Taxonomy’*, Theory into Practice*, vol 41, no 4, Autumn 2002, College of Education, Ohio State University, Ohio http://www.unco.edu/cetl/sir/stating_outcome/documents/Krathwohl.pdf

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Owen Wilson, Leslie, 2006 ‘Beyond Bloom – A new version of the cognitive taxonomy’, Dr. Leslie Owen Wilson’s Curriculum Pages, University of Wisconsin website, http://www4.uwsp.edu/education/lwilson/curric/newtaxonomy.htm

Renzulli, J.S and Reis, S.M (nd) *The Schoolwide Enrichment Model Executive Summary*, Neag Center for Gifted and Talent Development, University of Connecticut website, http://www.gifted.uconn.edu/sem/semexec.html

Silverman, L. 2007 ‘What is giftedness?’, Gifted Development Center website, http://www.gifteddevelopment.com/What_is_Gifted/whatis.htm

Silverman, L. n d ‘Characteristics of Giftedness Scale: Research and Review of the Literature’, Gifted Development Center website, http://www.gifteddevelopment.com/PDF_files/scalersrch.pdf

‘The William’s model’ (Frank Williams, 1993) Extract from *Support Package: Curriculum Differentiation*, NSW Department of Education and Training website, http://www.curriculumsupport.education.nsw.gov.au/policies/gats/assets/pdf/uhsi3hstanzac.pdf (2004)