***Investigating patterns of inheritance*** Differentiated learning Catering for gifted and talented students

Gifted and talented students tend to work at a more rapid rate, at a more abstract level and more creatively than their age-peers do. They might have other characteristics too that distinguish them, though some students might not be easily identifiable as gifted.

**Gagne’s Differentiated Model of Giftedness and Talent** (2008) provides research-based definitions of giftedness and talent in abilities in the intellectual, creative, social and physical domains.

**Students looking for or needing a challenge could include:**

* those wishing to consolidate their core understanding relating to the mainstream program or to **extend** their skills in representing their knowledge and understanding in creative ways. This is enabled by their being free to **choose** the particular content, the purpose and audience, and their media of communication including digital technologies;
* those who complete the core activities and develop a thorough understanding of concepts **more quickly** than others and are wishing to **pursue and extend** associated interests;
* those wishing to develop **open-ended inquiry tasks** and feasible investigations (first-hand or second-hand) that extend their abstract, problem-solving and critical thinking skills in the context of the CLE;
* those who engage readily in the **digital medium** to further their knowledge, interests and communication skills.

## Implications for teachers and students

### Management

Planning and monitoring progress will be important for both teachers and students. Conferencing, informal assessment and feedback are crucial to success in enabling differentiation for personalised learning to take place.

Clear expectations and directions, together with the development of a collaborative schedule will support the process. These will be necessary, particularly for those students who are assessed as gifted and who have the potential to achieve highly, but are without the systematic development of the necessary skills to do so. It’s a matter of providing opportunities for transforming ‘giftedness’ into ‘talent’ for them to be able to achieve at a high level.

### Adjustment to curricular activities

A number of different models is available that assist in adjusting the curriculum to suit the learning needs of gifted and talented students. Adopt or adapt those suited to your purpose.

### Models to draw on

* **William’s model**[[1]](#footnote-1) includes strategies relating to personal attributes such as visualisation, curiosity, imagination, creativity as in for example, drama, art, music, other.
* **Bloom’s Taxonomy**: hierarchy of cognitive functioning revised by Anderson & Krathwohl 2000[[2]](#footnote-2) largely by converting nouns to verb form, and particularly valuable in relation to higher-order thinking skills.
* Kathy Schrock’s Guide to Everything: **Bloomin’ Apps**[[3]](#footnote-3). Apps and online tools to support each of the levels of Bloom’s Revised Taxonomy (Assembled by Kathy Schrock)
* The **Maker Model** of 1982(3rd ed 2005 [[4]](#footnote-4))

The **Maker Model** is commonly used. It categorises curricular adjustments according to content, process, product and learning environment. These categories are readily applicable to both mainstream and other curricula in providing for individual needs bur particularly those of gifted and talented students.

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| Characteristics of curricula and materials designed to cater for gifted and talented students | |
| CONTENT MODIFICATIONS (adjusting WHAT students learn) | |
| Strategy | Examples |
| 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 (learning from experience such as trial and error) |
| * freedom of choice of investigation |
| 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 local or global community |
| Evaluation | Consciously pitching the product to a specific and relevant audience such as teachers, peers, wider community and experts in the field, who evaluate the process and and product; includes self-evaluation |
| 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. |
| **LEARNING ENVIRONMENT (adjusting the SETTING, the culture and behaviours, in which students learn)** | |
| Student-centred | Open, independent, flexible, respectful, mobile, accepting, responsible, resource-rich… |

Fig 1: The Maker Model (adapted from ASI, *Developing Programs in Science for Gifted and Talented Students* © 2013 Australian Science Innovations[[5]](#footnote-5))

## Adjustments and modifications for gifted and talented students

### Applying the Maker Model

A matrix could be used as a planning tool to identify where adjustments could be made to meet the interests and needs of individual students.

* Existing activities and investigations in the mainstream CLE can be mapped against the Maker Model. Mapping a particular task against the Maker Model could show how that task incorporates a number of strategies or features, not only a single one (see Fig 2).
* Modifications or adjustments, including the design of new tasks, can be mapped according to multiple characteristics of the model. See Fig 3 for examples of single-strategy mapping.

If necessary, explain and discuss the various strategies of the Maker Model. In consultation with you or with their peers, students could identify the features associated with a particular task; whether they could be emphasised in the description of the task and whether they could be included in any evaluation or assessment. You could apply this method to other curriculum models you choose to draw on. You or your students might have to modify the language used depending on needs.

Individual gifted and talented students, or those who might prefer to work with other such students, could transform the composite model creatively to suit their purpose. This could be during the planning process or during the progress of their work. Independence, initiative, flexibility in approach and in completing tasks is characteristic of many such students.

It is also important that the relevant content descriptions of the Australian Curriculum Science are referred to for alignment.

The approach you take and the level of guidance and direction you give to your students depends, for example, on the nature of the resources available, what experience your students have had in working independently, and to what degree they have language skills (scientific and other) and other skills and abilities.

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|  | CLE activity | Categories and strategies of the Maker Model: examples | Suggestions for Adjustments for Gifted and Talented (G&T) students  Refer to the Teaching and Learning (T/L) plan |
| Activity | **A tour of basic genetics** | *Content modification: abstraction, complexity, variety and organisation.*  *Process modification: higher order thinking skills*  *Product modification: evaluation, transformation* | * Explain and represent the relationship between genes, environment and traits, other than in a table. * Design a model or other representation that shows the location, scale and structure of DNA. Explain the significance of DNA to a targeted audience. * Represent the relationship between genes, DNA, genome, chromosomes, and inheritance. Expand this to include other aspects you consider are relevant. * What is the difference between the number of chromosomes in a body cell of an organism and the number in a sex cell of the organism? Why is this so? Do all cells contain DNA and chromosomes? * The word list contains terms associated with genetics and heredity. Having found out their meaning, search and give real-world examples of how these terms are used. Take into account your audience. |
| Inv 1 | **What traits do you have?** | *Content modification: abstraction, complexity, variety, organisation, method of inquiry*  *Process modification: higher order thinking skills*  *Product modification: real-world problems and audiences, transformation* | * What is the relationship between the genotype and phenotype of an organism? Give examples that are relevant to your fellow students. What examples would you choose if you were talking to a horticulturist, horse-breeder or other ‘audience’? * What is genealogy? How can analysis of the DNA of persons be used to trace a family’s lineage? Investigate other ways in which analysis of DNA can be used to solve problems. |
| Inv 2 | **Exploring the inheritance of single gene traits (Mouse genetics)** | *Content modification: complexity, variety, organisation, study of people, method of inquiry*  *Process modification: higher order thinking skills*  *Product modification: transformation* | Investigate examples of monogenic inheritance in other organisms. State the organism and the particular trait you investigate. Predictions of the results of crosses can be represented by Punnett squares, mathematically and other ways.   * Who was Punnett? * Demonstrate a mathematical form of representing predicted results of parents of different genotypes |
| Inv 3 | **Exploring the inheritance of single gene traits (seed germination)** | *Process modification: higher order thinking skills*  *Product modification: transformation, evaluation* | Think of how data can be represented. Transform (transpose) the sets of data obtained by the group and by the class into a different mode. Evaluate its effectiveness in terms of ease of analysis of data and communication of findings. |

Fig 2 Maker Model: Mapping current CLE tasks with suggestions for adjustments.

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| CONTENT MODIFICATIONS (adjusting WHAT students learn) | | CLE Investigating Patterns of Inheritance  Creation of novel activities and tasks for G & T students, aligned with the Maker Model | |
| Strategy or Feature | Examples | Suggestions for adjustments: mainstream or novel tasks addressed to students  **NOTE:** A task incorporates more than the particular strategy or feature it is mapped against. |
| Abstraction | Going beyond the facts, with more abstract concepts | * Choose a video (see Resources) that challenges your understanding of certain concepts. Devise a series of questions whose answers would form a summary of those concepts or ideas. What further information might you need to clarify your understanding or to extend your interest? Choose how you will communicate your responses. * Choose a relevant topic, concept or process that you think might be difficult to understand generally. Translate this into a model, infographic or other type of representation to explain it to a relevant, named audience. Explain your approach. |
| Complexity | Greater breadth and depth and more difficult concepts | * Explore the structure of genes and their functioning. Keep a record of the sources/references you have used. [Ref Scootle Learning Objects] * Explain the role and significance of epigenetics in controlling the expression of genes. [See Nova resource] |
| Variety | Delving into new ideas and varying the aspects around a theme | Choose a theme or area of content you are interested in. Design a game, digital or otherwise, that explores and expands on that interest. |
| Organisation | New ways of arranging content | * Choose one of the investigations carried out by you or your class that has generated data. Design a novel way of presenting it. Include its analysis and the conclusions drawn. * Draw a map or other representation, of all the fields of study or careers that you can find that are associated with genetics and inheritance. Present it for display. |
| Study of People/Creative Processes | Using biographies to relate content to the scientists and their place in time | * Generate a biography of Gregor Mendel and his investigation into inheritance of characteristics in pea plants. Explain the significance of his work. Choose the format and medium for presenting your findings. * Generate a biography of a more recent named scientist and her/his contribution to ‘genetics’ or an associated field. Explain the significance of her/his work. |
| Methods of Inquiry | Exploring the methods used in a particular field at the time of discovery | The development of technologies and processes of inquiry and investigation has been considerable. How have they contributed to advances in knowledge and understanding of genetics and associated fields? Trace the development of a particular field of inquiry or aspect of technology and their contribution to creating knowledge. How will you record and present your findings? |
| Higher Order Thinking Skills | Stress the use of knowledge by concentrating on analysing, evaluating and creating knowledge | Mathematical skills and informatics are used extensively in analysis of information, creating knowledge and contributing to solving problems. Choose an example associated with genetics, or an allied field, that illustrates this. Decide how you will present the results of your findings. |
| Open-ended Processing | Encouragement of divergent thinking through use of stimulus tools such as:   * analogy * ambiguity * heuristic approach (learning from experience such as trial and error) * freedom of choice of investigation | * What is an analogy? How do analogies help understanding? Think of a difficult concept or idea you have encountered. Invent 3 analogies that you could try out with other students that will help explain the concept. Keep a record of the way you went about your investigation. Which analogy was most useful in helping students understand the particular concept? Explain why it was. * Devise a trial and error game associated with ratios of genotype to phenotype of a named or imaginary trait. Clarify the purpose of the game, the rules of play and evaluate its success as a way of learning. * Plan a feasible (do-able) investigation (first-hand or second hand) into a named aspect of genetics or inheritance of characteristics. What is its purpose or what problem is it trying to solve? Take into account what resources and time are available, safety factors and risk assessment etc. Conduct the investigation itself if approval is given. Ensure accurate reporting in the format of your choice. |
| Real-world Problems | Investigation of real-life problems to add meaning and sense of worthiness in tackling the problem | Search for examples of real-world, current problems or issues associated with genetics and /or inheritance, such as gene therapy, genetic modification in food crops, control of disease, pests; genetic disorders in people; lack of diversity in crops.  Present evidence-based arguments for and against ways of addressing the problem. Are there organisations in the wider community that have particular interest in the topic of your choice? They could be support groups, expert practitioners, other…  See Resource list for a selection of videos that might be useful starting points. Newspaper or other articles could be useful startng points |
| Real Audiences | Developing products that can be utilised in the real world by students themselves and the wider local or global community | Consider activities you have completed or are about to design. Is there one that is relevant to the wider community in some way? How could you adjust the product to improve its chances of reaching, and perhaps influencing, a wider audience? Explain your decisions. |
| Evaluation | Consciously pitching the product to a specific and relevant audience such as teachers, peers, wider community and experts in the field, who will evaluate the product and process; include self-evaluation | * Consider a task you have completed that has resulted in a ‘product’. What was the purpose of the task or investigation? Who was it for (the audience)? Why did you choose that particular ‘product’ or kind of communication? What steps or procedure did you go through to complete the task and produce the ‘product’? Compare the meanings of ‘process’ and ‘procedure’. How successful do you think you were in communicating your method and findings? Design a survey (online or other) to find out. * Review several videos (see Resource List) and order them according to their level of difficulty. Evaluate how appropriate they are for developing understanding of particular topics. What criteria would you use in your evaluation and why? Find out what other students might be findng difficulty with and suggest what to view to help them with their learning. |

Fig 3 Maker Model: Applying the Maker Model to the design of novel activities and tasks for Gifted and Talented students.

1. Williams, F.E. (1993). *The cognitive-affective interaction model for enriching gifted programs* [↑](#footnote-ref-1)
2. Bloom’s *Taxonomy of Learning Domains: the Cognitive Domain* <http://www.nwlink.com/~donclark/hrd/bloom.html> and *Understanding the new version of Bloom’s taxonomy* <http://thesecondprinciple.com/teaching-essentials/beyond-bloom-cognitive-taxonomy-revised/> [↑](#footnote-ref-2)
3. Kathy Schrock’s Guide to Everything: *Bloomin’ Apps* (2013) <http://www.schrockguide.net/bloomin-apps.html> [↑](#footnote-ref-3)
4. Maker, C.June & Shiever, Shirley W. (2005) *Teaching Models in Education of the Gifted*, Pro-Ed [↑](#footnote-ref-4)
5. ASI <https://www.asi.edu.au/programs/teaching-gifted-talented-students/> [↑](#footnote-ref-5)