Teaching Gifted Students: A Knowledge Based Framework

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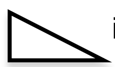
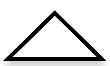
1. What high ability learning looks like in the classroom: Some anecdotes

1.1 High ability in a Year 8 science lesson. A year eight class learns about how the human body digests food. The teacher describes the journey followed by a mouthful of hamburger, through the buccal cavity, the oesophagus, the stomach and into the intestine. The teacher mentioned that the gastric juices in stomach include hydrochloric acid that break down protein foods such as meat, eggs and milk. The class accepts what they are told, converting the teaching information to knowledge and internalizing it. The teacher asked: "Did anyone think of questions about this that I haven't mentioned?"

Gina, raises some questions: How do the glands in the stomach know how much protein there is in the mouthful so that they can control how much hydrochloric acid and enzymes to squirt out? If a person changed what they ate, would the amount of hydrochloric acid build up and damage the lining of the stomach? She explained what she knew and how she had thought of the question, by guessing that the amount of acid had to be controlled because too much acid could be dangerous and too little would not break up the food. She guessed that it would have to be controlled and wondered whether there were an 'acid sensor' or 'food analyzer' in the body.

A second student, Zac, learnt these ideas very rapidly. He no sooner heard the information than he had mastered it. He seemed to 'take in' the new information in larger 'chunks' or bites than his peers. In this lesson he said, immediately after the discussion about the digestive system, "So you're saying that....." and effectively summarised what had been said. His summary showed that he selected the main ideas and organised the details around them in the appropriate hierarchy much faster than his peers.

1.2 High ability in a Year 9 maths class. A similar situation in some Year 9 classes learning about Pythagoras. The maths teacher introduced the students to the idea that the area of the square on one side of right angled triangles, (the hypotenuse) for example,  is equal to the addition of the area of the squares on the other two sides. They learn this as a formula, for example, $c^2 = a^2 + b^2$ and use it to calculate the length of the sides in triangles of this type. This teacher also asked: "Did anyone think of questions about this that I haven't mentioned?"

Dan, without being taught explicitly, speculated about whether $c^2 = a^2 + b^2$ also to right angled triangles such as  and can be used to find lengths in sets of triangles. Anna, in another class, linked the ideas with another trend, for example, where she had seen two or more joined right angled triangles in building construction, architecture, civil engineering, for example, in the triangular struts in girders holding up bridges. She was interested in solving more difficult real world problems.

Con looked at curved surfaces in the classroom and wondered whether Pythagoras holds on a curved /wavy/3D surface. Gus, during the lessons about Pythagoras, reflected on the whole number triplets that are described by $c^2 = a^2 + b^2$, for example, 3, 4 and 5 or 12, 5 and 13 and wondered what the special pattern is between these numbers. He asked whether the tetruplet relationship $d^2 = a^2 + b^2 + b^2$ existed and whether there are sets of 4 whole numbers that satisfy it. He asked: "What the sum of four squares would look like spatially?" Toni imagined a cube on each side of a right angled triangle instead of squares and questioned whether $c^3 = a^3 + b^3$ would hold for some whole numbers and what this might look like spatially. She recalled rational numbers: "Are the fractions that fit the pattern only those that comprise the whole number triplets or tetruplets?"

Other students learn Pythagoras very rapidly, after 1 or 2 examples only and are ready to use it to solve more difficult tasks. Through guided dialogue and teaching they extend their understanding of Pythagoras to more 2- and 3 dimensional word problems. They are dependent on the explicit teaching but can extend, apply or 'stretch' the taught understanding.

1.3 High ability in a Year 1 classroom. A year 1 class went on an excursion to a display of old fashioned steam driven tractors. The owners of one of the tractors explained how they worked. The teacher took photos of some of the tractors as a record.

Back in the classroom, the children were asked to draw a picture of what they had learnt. Most children drew year 1 level pictures of some of the tractors. Tom's drawing not only showed the detailed parts of one of the tractors, but also the sequence of steps from the coal or wood being placed in the firebox to the piston moving the wheels. The students hadn't seen this being done, they had only heard a brief description of this. Tom's picture showed that he guessed that the piston was circular inside the cylinder. He explained how the piston moved backwards and forwards by having the steam 'take turns going into the cylinder at both ends'. Tom showed this unusual ability in a range of contexts and not restricted to mechanical situations. His ability to synthesize what he saw and heard, imagine and link in those aspects he couldn't see or hear and synthesize the whole was exceptional.

2. How well are high ability knowledge and understanding recognised in regular classrooms?

These anecdotes illustrate 'gifted learning in action' in regular classrooms. These students typically displayed the broader thinking and more advanced understanding in a range of topics they were taught. Their peers, teachers and parents were often aware that these students learnt quickly and/or 'thought differently'.

To cater for students like these, teachers first need to identify the 'high ability' qualities of their understanding and to value it. They also need to know how to use it to plan and implement appropriate teaching. Teachers differ in their ability to do this. Differentiation for high ability students in regular classrooms is infrequent (Hertberg-Davis, 2009). Talented primary and secondary readers who read above their chronological grade are unlikely to receive differentiated reading instruction or challenging learning tasks (Reis, Gubbins, Briggs, Schreiber, Richards, Jacobs, Eckert & Renzulli 2004).

Differentiation involves matching students' approach to learning and their understanding with the appropriate pedagogy and curriculum goals (Anderson, 2007; Ellis, Gable, Greg, & Rock, 2008). It isn't practised more often in regular classrooms because teachers lack both the knowledge needed to differentiate the content for high achievers and the relevant pedagogical skills (VanTassel-Baska & Stambaugh, 2005).

This paper examines a model for understanding how high achievers learn and know. It describes how the quality of their understanding can be identified in the regular classroom. A second paper will describe how differentiation based on what these students know can be implemented. The model can be used as a conceptual tool to describe gifted and talented knowledge and understanding and the learning strategies used to construct it.

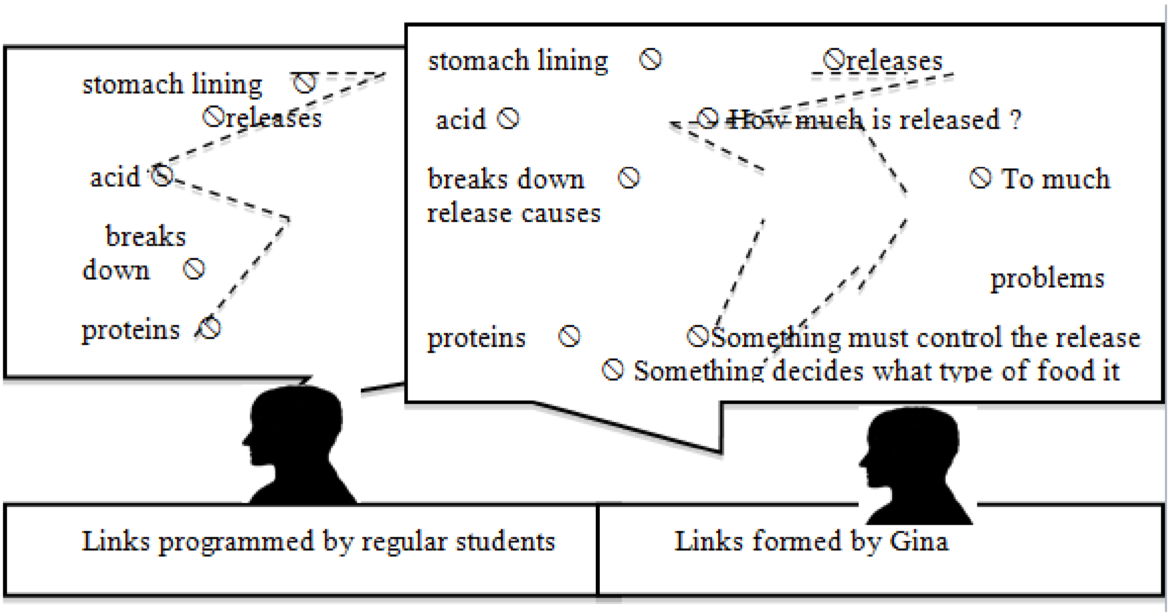
3 Frameworks for describing how individuals know.

To explain high ability knowing and thinking, we need classroom-friendly frameworks to describe student knowledge more generally. We can look at what a person knows about any topic from two perspectives. Each helps in understanding particular characteristics of gifted knowing and understanding. These are:

3.1 *The 'microscopic' perspective.* Here we focus on the individual 'meaning units' that comprise an individual's knowledge at any time. These units are linked into networks. When we detect information, some of our networks are 'lit up' or stimulated and we use networks to comprehend the information, think about it and to respond to it. This perspective helps us 'get inside students' heads' and speculate about how they link ideas. It gives us tools for examining how students link the ideas they are learning at any time.

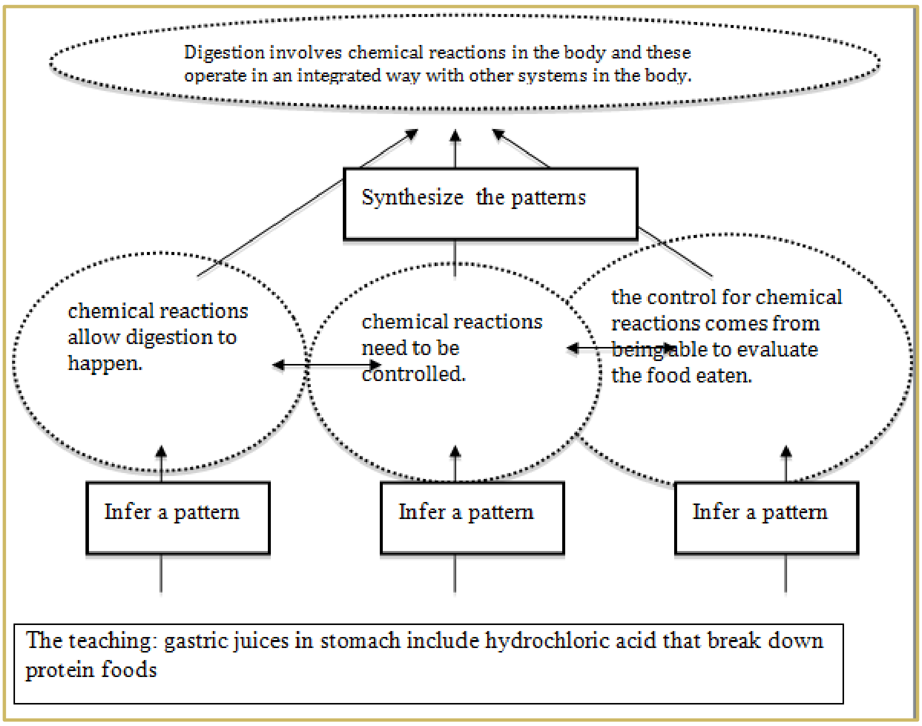
3.2. *What does gifted knowledge look like: the microscopic perspective?* The anecdotes of high ability learning help us see what the knowledge of these students is like and how they go about learning.

3.2.1. Gifted knowledge is more elaborated and differentiated. In terms of the microscopic model, high ability students have more elaborated and differentiated networks of meanings. The links Gina made about digestion during the lesson are shown in the following diagram.



Average learners internalize the teaching information and form an essentially literal understanding of it. The links formed match those in the teaching. They may infer and extend spontaneously what they have learnt beyond the teaching but their inferences are usually low level.

Gina's interpretation of the teaching comprised both links from the teaching and links she made by herself. She inferred these links and formed intuitions or suppositions. Her unpacking of what she knew showed she had extended parts of the teaching information by seeing them as parts of patterns. Her understanding was organized into her personal intuitive theory about digestion. She could ask questions about her understanding and test the ideas she had linked. In other words, she inferred patterns from the information and then inferred a 'big idea' that synthesized the patterns. This is shown in the following diagram.



The teaching: gastric juices in stomach include hydrochloric acid that break down protein foods

The broader, more extensive, 'enlarged and enriched' meaning networks of gifted learners allow them to understand their worlds in ways that are qualitatively different from their non-gifted peers.

3.2.2. The types of networks formed by high ability learners. We have noted that there are multiple forms of gifted knowing and understanding. Some high ability learners learn faster. They form the intended understanding much faster than their peers. Their understanding comprises the network of concepts that are coded in the information. They learn more rapidly than their peers because their more elaborated and differentiated networks allow them to process the teaching information in larger chunks or bits and deal with more information at a time. They don't wait to be programmed in a 'bit by bit' way. They infer, 'see the big picture', select, link and organize the main and subordinate ideas in the intended ways. They structure and fit together the ideas in their own ways and check their interpretations against the information. Prior to this checking their initial interpretations are likely to be intuitive.

Other high ability learners learn differently. They form spontaneously a broader understanding that 'goes beyond' the teaching. They infer and make links with ideas they know that not mentioned in the teaching. Con and Gus made inferences about Pythagoras that extended the teaching into their personal intuitive theories. Given the opportunity, these students can test their theories and see the extent to which they are supported. They link questions with the various aspects that they can investigate. Their understanding at this time is an intuitive theory about the topic that has not yet been validated. It may be shown to be inaccurate or illogical.

High ability learners differ in the extent of elaboration and differentiation of the meaning networks they have formed; some will be much more elaborated and differentiated than others. They also differ in the form of the links, amount of knowledge they can think about at once and extent of their inferences or extensions and syntheses. We examine these in the next section.

Students who are not gifted in a domain can also extend what they know beyond the teaching and form intuitive theories. Their theories, however, are usually less elaborated or extensive and much more closely linked with the teaching information.

3.3 The macroscopic perspective. Here we look at the types or forms of knowledge a person has for encoding any topic or domain. These multiple aspects of knowledge synthesize or combine to account for how the student understands or knows a topic. This perspective is useful in identifying and analyzing the learning profiles of high achievers. What an individual knows or understand about a topic at any time comprises the following aspects:

Know in imagery, experiential ways This includes the individual's bank of past experiences, taught images, the stereotype or prototype forms of ideas, the personal, images created by the individual and their 'virtual imagery understanding. Ideas are linked in time and place.	**Know the learning context** This includes what the individual knows about the key roles of being a learner and a teacher and what is permitted in the learning context	**Know attitudes and dispositions** This includes knowing through one's attitudes and dispositions to the topic (positive or negative), how prepared a person is to learn the topic, their motivation to learn it, the interest and emotion they link with it.
Know in conceptual abstract ways This including knowing the topic in abstract ways with ideas linked in hierarchies (main ideas, subordinate ideas, details). This includes culturally taught generalisations, patterns, concepts, rules and conventions and literacy. It also includes the personal, intuitive theories an individual creates about a topic.	what person knows, one's understanding of a topic	Know self and social identity This includes how an individual knows or identifies themselves as a learner of the topic, the emotion they link with learning it, their self-efficacy, their belief about how well they can learn it, the extent to which they see the knowledge as part of them and defining them and their identity.
Know in procedures, actions This includes knowing through action sequences, knowing how to automatize these and knowing how to 'do' what you know. This includes both taught and self-created action sequences.	**Know the topic culturally** This includes knowing what and how the cultures to which the person belongs values the topic and how individuals in the culture are permitted to think about, use and apply the topic	**Know how to think and learn** This includes knowing how to • think about the topic, for example, how to analyse, question, evaluate, how to synthesize parts of it, • manage/direct one's thinking and learning about the topic.

The microscopic level networks link ideas within each form or aspect in the macroscopic model, for example, conceptual-abstract networks or experiential-imagery networks. They can also link across forms, for example, a concept such as 'dog' or 'one third' can be linked with images and characteristic actions, how the individual values it, thinks about it and uses it.

The multiple aspects of knowing at any time combine to form the understanding of a topic held by any student, including gifted learners.

3.4 What does gifted knowledge look like: the macroscopic perspective? While any individual probably knows about a topic in all of the ways shown in the macroscopic perspective, some can know at high level in one or more of the aspects.

1. Some students have richer, more elaborated networks of imagery and episodic knowledge. In the classroom they think about and use their bank of stored experiences easily and rapidly, learn easily new ideas as imagery, form patterns and prototypes of ideas and 'virtual imagery understanding. Their intuitive theories are about using actions in time and place, They are the 'visual-spatial' gifted (Mann, 2001)
2. Some have richer, more elaborated abstract conceptual ways of knowing a topic. In the classroom they comprehend and think about ideas in more abstract ways. They learn abstract generalizations, concepts, hierarchies, rules and conventions, including literacy at a high level. They create personal, intuitive theories about a topic that comprise patterns and rules.
3. Some have richer, more elaborated procedural or kinaesthetic ways of knowing a topic. In the classroom they learn action sequences at a high level, interpret topics through actions. They know how to 'do' what they know. This includes both taught and self-created action sequences. Their intuitive theories are about using actions in time and place, for example, "if you do X you will probably ...."
4. Some students have richer, more elaborated ways of thinking about what they know. The more differentiated and elaborated meaning networks that characterize high ability learning in the classroom are not incidental. Instead, they are a consequence of earlier thinking.

   There are two aspects here: how these students manipulate the meanings in their networks and how they manage and direct their thinking (that is, their metacognitive activity).

   Both gifted and regular students use a range of thinking strategies. They infer, analyse, question, evaluate, synthesize, create, organize and re-prioritize. They differ in:

- how and when they use particular strategies; either spontaneously or when cued by the teaching. The high ability students use the thinking strategies spontaneously and independently.
- their selective use of these strategies; gifted children are more likely to use higher level more complex thinking strategies over lower level strategies than their average learning peers (Muir-Broaddus, 1995). They use problem-solving strategies more flexibly and shift from one strategy to another more efficiently for complex problems. They are similar to regular peers in judging the effectiveness of a strategy and adopting alternative ways of solving problems.
- how much knowledge they think about at a time and how many thinking strategies they use at once. Gifted students can think in 'larger chunks' of knowledge at a time. They retain more knowledge in their short term memories or thinking spaces for the domain/s in which they are gifted (Hermelin & O'Connor, 1986). Their more elaborated networks in a specific domain allow them to scan, 'encode' and interpret the teaching information more efficiently, comprehensively and rapidly and 'make meaning links that are more complex than their peers.

  They can 'keep track of several ideas and think in several directions at once. They learn and understand more quickly, because they process more of the information at once. Some gifted students are more easily programmed externally than others; they need fewer learning experiences to acquire an idea.

- their ability to infer and synthesize what they are think about. They organize and use their conceptual networks in a 'big picture' way and form subjective patterns and personal rules for the information. Some impose their own unique organization on the ideas, rather than using the conventional organization that it taught. What they know may seem not to fit with the 'conventional understanding'.
- their ability to make analogies between topics that seem unrelated to others. They 'see' similarities between topics that may seem superficially different. They cross 'topic boundaries' and link topics in unexpected ways. They transfer and use what they know about one topic to comprehend a second topic.

  This analogistic thinking allows them to make wider links within what they know, draw in a more extensive range of ideas and end up with a broader understanding. They think and learn in larger steps. This thinking is referred to as fluid analogising and has been linked with giftedness (Geake, 2007).

  The gifted learners make 'far transfer' between topics and link ideas in lateral, novel unexpected ways. An example of far transfer is when students use a strategy to solve a problem that is distinctively different from the problem type linked with the strategy. An example of near transfer, on the other hand, is when they use a strategy to solve a problem that is similar to the problem used to learn the strategy. Gifted learners are much more likely to use strategies in far transfer situations than average learners; they don't differ in near transfer (Carr and Alexander, 1996). They show far transfer from a young age (Gross, 2004). It helps them solve problems in unusual or novel ways, use imagination and fantasy and show 'intellectual playfulness'.

  When they first make an analogy between two topics, their new understanding is often intuitive (Robinson & Clinkenbeard, 2008). They may not be able to justify their interpretation logically at that time or explain how they came to that understanding. They can ask relatively complex questions to investigate these intuitions.
- in the extent to which they are programmed by the teaching. Many students, including some gifted learners, internalise the teaching information; they are easily programmed in how they learn. Others, particularly those who engage in analogical thinking, are less easily programmed by the teaching; they are more 'self-programming'.
- In how they organize what they have learnt. Many high ability learners organize and re-organise the ideas that comprise their new understanding in more complex ways. They recognise and infer the main idea/s in information more rapidly than their peers. They can search what they know more rapidly and recognize more easily situations in which the information doesn't match or clashes with what they know. They can 'see' problems, enquiries,

uncertainty or inconsistencies in the links between the teaching information and what they know and to frame up intellectual challenges, problems or questions.

- how they manage and direct their thinking activity. High ability students manage, self-regulate and direct their thinking and learning (use their metacognition) more spontaneously and efficiently than their regular peers. They set goals, plan, rehearse, monitor or self-check, focus, persist and correct (Alexander, 1996; Alexander, Carr & Schwanenflugel, 1995). Their metacognitive knowledge emerges earlier. When beginning an unfamiliar task, they know better why particular strategies work, use them more efficiently and learn new strategies more easily (Annevirta & Vauras, 2001; Schwanenflugel, Stevens, and Carr 1997). They take more time and care when planning how to solve problems (Shore & Lazar, 1996). They learn better from mistakes (Steiner, 2006).

  Young children's metacognitive processing is linked with their creative ability (Daugherty & Logan, 1996). The egocentric speech of five- and six-year olds during creative task completion was correlated with three indices of creativity: fluency, imagination, and originality.

  Metacognition is associated with the quality of giftedness displayed by children (Sastre-Riba, 2011); the higher the degree of complexity of the profile (gifted or quadruple talented versus simple talented), the greater the metacognitive regulation is, despite the fact that the differences in metacognitive functioning

  The thinking strategies transform our knowledge at any time and contribute directly to the quality of understanding formed and hence to changing the meaning networks. New knowledge and understanding come from using particular thinking strategies.

5. High ability students have strong attitudes and dispositions towards particular topics. Their attitudes and dispositions to learning and to themselves as learners initiate and sustain their learning activity. They show a focused, intense interest in some topics and are intrinsically motivated to know more to and learn. Their attitude to learning and thinking focuses on reducing uncertainty in what they know. They believe they can do this. They are self-motivated, prepared to learn and to pursue a topic and task focused in how they do this.

The cultural influences for high ability students refers essentially to how the elaborated meaning networks of high ability learners influence, and are influenced by others. Like their peers they interact in a range of cultures; the regular peer and friendship groups, the extended family, the classroom, leisure contexts and possibly 'like-minded peers'. Their interactions are in terms of what the participants know and believe. The success of their interaction is determined by how well they can 'read' the other participants in their cultures and engage with them. Accepted ways of operating in any culture are largely learnt from the culture. High ability students differ in their ability to do this.

This aspect of knowledge adds these types of awareness or understanding to the meaning networks. The cultural influence can operate in a range of ways:

- Some gifted learners share their understanding and knowing successfully with peers and others. They have an enhanced capacity to engage and 'read' well what others know, think and how they feel and are motivated to align with it. They show high level leadership awareness and ability and can lead the group to change its thinking and understanding.
- Some hide their higher understanding and knowing. They haven't developed ways of sharing it and aren't sure of how the culture/s will respond to them. These are the *high ability hidden ability students* described in the following section.
- Some are dis-engaged or alienated from particular cultures, such as the classroom. These are the *high ability emotionally disengaged students* described later.

  Some don't learn how to share their understanding with peers, to judge what peers know about a topic and to show how their understanding can solve problems. They often seek 'like thinking' peers that understands and accepts their knowledge, their intense interest in it or commitment to it. Some try to create cultural experiences with others who they judge more understanding and prefer to exchange ideas with older students and adults.

6. For some high ability learners, the dominant beliefs in their classroom about what it is to be a teacher or a student don't work for them. Teachers, through their practice, show the belief that all students learn in the same way, by being programmed by the teaching, even though they know high ability students generate different outcomes. The students are aware that their more rapid learning or the lateral learning outcomes are not valued.

   Many high ability learners form the belief that teachers don't understand how they learn and may not recognise what they know. It is useful to ask the high ability students to tell their teacher/s how they learn.

   Because these beliefs are usually implicit or unconscious, they are not challenged. The high ability learners are aware that the teaching doesn't match how they learn. Usually, however, they don't have the opportunity to try to conform to the teacher's beliefs about how students should operate or to give feedback to the teacher. They can dis-engage from classroom learning, become behaviour or management problems or try to 'be normal'.
7. Like other students, a high achiever's self-identity is learnt through one's social identity; what a person learns about themselves from their interactions with others. Adolescents talented in maths or verbal abilities don't differ from their high academic performance peers on general self-esteem, social self-concept, social attributions and peer relationships (Bain & Bell, 2004; Brody & Benbow, 1986) and have higher self-perception than non-gifted peers (Pyryt & Mendaglio, 1994).

   Despite popular assumptions regarding an inverse relationship between peer acceptance and giftedness, gifted students don't usually suffer from greater peer rejection than the general population (Bell & Schindler, 2002; Rimm, 2002). Characteristics common in popular children, including good social skills, few behavior problems, leadership skills, high academic success, and high self-esteem (Frentz, Gresham, & Elliott, 1991; Jackson & Bracken, 1998) are often noted in gifted students. These qualities have a positive influence on peer acceptance, as well as on the development of self-concept, as demonstrated by Coie, Dodge & Coppotelli (1982). However, high ability students often report feeling different from peers regardless of whether they receive gifted education services and rated themselves less popular than peers (Brody and Benbow, 1986; Rimm, 2002).

An individual's understanding at any time is a synthesis of these aspects of knowledge. Each aspect develops and changes. Many high ability learners show 'asynchronous development'; some aspects develop more rapidly. Some high achievers, for example, show high reasoning ability with immature social interaction skills.

3.5 ***Brain studies tell more about the differentiation***. The neurological processes that underpin gifted learners learning support the idea that they have a knowledge base that is more differentiated and elaborated and an enhanced short term working memory for the domain/s in which they are gifted.

Gifted and average maths learners, for example, process maths information in different ways. While average learners are more likely to use largely left hemisphere processes to process symbolic number tasks, gifted learners are more likely to use both hemispheres simultaneously (Singh & O'Boyle, 2004). The high ability students but not their matched peers used brain areas linked with episodic memory to calculate. This provided them with the unlimited storage capacity of long-term memory to retain task relevant information, such as the sequence of steps and intermediate results used in complex calculation. They are more likely to use right hemisphere processing and show better communication between the hemispheres. The increased bilateral cortical use provides additional processing resources.

3.6 ***In summary.*** Gifted students generate intuitive theories about the topics they learn. Their networks of meanings contain both links that are programmed by the teaching and links that are, at one time, more intuitive. These latter links are based on inferences gifted learners generate through their far transfer thinking. Steiner (2006), for example, showed that gifted and average-ability 2nd-graders differed in their thinking as they engaged in a novel computer game. The gifted learners were more likely to use information they learned from their strategies to make future hypotheses. They were generating an emerging theory about their activity that they continually monitored and evaluated through their strategic ability. Their average peers used strategies based on how had worked earlier.

Exceptionally, moderately and mildly gifted peers differ quantitatively and qualitatively in their ability to manipulate knowledge, reason abstractly, display empathy, use strategic and non-strategic memory and to grasp the essential elements of an issue.

4 What are characteristics of the high achievement?

The anecdotes above suggest multiple types of high ability achievement. Some students learnt faster than their peers and in a given time period, learnt more. Others learn differently. They extend what they are taught and make links with ideas that were not mentioned explicitly in the teaching.

4.1 Domain specificity. Students differ in the knowledge areas or domains in which they be gifted. They have advanced conceptual networks in some subject areas or domains; they do not show advanced development universally. Giftedness is domain specific.

A student who is creatively gifted in music will have enhanced conceptual-abstract knowledge of music, rich bank of elaborated music experiences and can think in ways that allows them to construct creative music outcomes.

4.2 How to describe high ability in the classroom. To get an insight into the features of the high achievement displayed in a classroom, teachers need to interrogate the achievement, how it is related to the teaching information and the conditions under which it is displayed. We can identify categories of high achievement by asking these questions:

1. *What is the high achievement 'like'?* This examines what the student learns and ends up knowing, doing, understanding or believing. Is the depth of understanding not usually shown by peers? Does the student learn only the content taught or do they form additional ideas and make links with topics not mentioned by the teaching? Gina, Anna, Dan, Tom and Gus included concepts that were not mentioned in the teaching.
2. *How fast did the student acquire the intended knowledge or understanding?* The rate at which a student learns is determined in part by what they know about the topic, the learning strategies or actions they use to construct an interpretation and their motivation. A faster rate means that over a period of time they learn much more about a topic than their peers. Having learnt the ideas they find it relatively easy to infer and to see implications.

   Zac learnt the maths ideas very rapidly. Tom internalised rapidly and stored efficiently what he heard about steam engines.
3. *How active was the student in managing the learning independently?* Do they manage or direct aspects of the learning, often spontaneously and incidentally or do they learn by being 'acted on' by the teaching?

   Several of the students formed impressions that 'went beyond' the teaching information. They did this spontaneously, without being instructed or cued to think in these ways and directed in part their learning. Each framed up a challenge; they perceived an issue or question in the teaching information.

4. *Where did the motivation to learn the ideas come from?* Who decided the student would learn them; her /himself or others? Does the student learn the ideas because it is expected / required or are they self-motivated to learn them?

5. *How does the student use the knowledge?* Does the student transfer spontaneously the ideas to other situations not mentioned by the teaching, the ideas?

   Not only do teachers need to recognise instances of high ability understanding. In order to assess it formatively and to respond to it appropriately in the classroom context, the teacher needs to see its characteristics or qualities by collecting information about these five questions.

4.3 Types of high achievement in the regular classroom. We can identify six categories of high achievement in the classroom. These are similar to the more general six gifted profiles noted by Betts and Neihart (2010).

1. Three categories show reasonably consistent high achievement:

- Knowledge internalisers who internalize rapidly and at a high level what they have been taught (Renzulli's 'school-house giftedness', Tannenbaum's 'consumers of knowledge', Sternberg's 'analytical intelligence'.
- Knowledge extenders who internalize rapidly and at a high level what they have been taught and then extend it in predictable ways and

  Knowledge creators who create new knowledge (Renzulli's 'creative-productive giftedness', Tannenbaum's 'producers of knowledge', Sternberg's 'creative intelligence'.

	Learning characteristics : students	**KI**	**KE**	**KC**
Programmed externally vs self programming	find ideas easy to learn, learn the topics as they are taught at a high level, 'very easily programmed' by the teaching, learn rapidly.	X	X	
	need few tasks to learn the ideas, automatise the key ideas well and find it easy to recall what they have been taught.	X	X	
	learn by exploring ideas and making possible links that they modify, resist being programmed by classroom teaching in a sequential way.			X
Motivation to learn	drive to internalize the information; don't generate personal enquiry	X	X	
	become motivated intrinsically to pursue topics, particularly if peers show a similar interest.		X	
	initiate the drive to learn, they have questions they want to answer, intrinsically interest in ideas and pursue them spontaneously.			X
Taking what they learn further	Basically learn what they are taught, make near transfer to similar situations	X		
	extend ideas spontaneously in 'expected', conventional ways, creative outcomes are 'obvious' rather than 'left field' or 'lateral', make moderate transfer.		X	
	think laterally about the ideas, make unexpected, 'unconventional' 'left field' and 'lateral' creative links and extension, ask questions that suggest they are looking from perspectives not taught directly, challenge the conventional' orthodoxy, rather than simply extending ideas, make 'far transfer' of ideas.			X

Characteristics of what they know	often come to classes already having the knowledge you will teach.		X	X
	can 'see' ideas that are developmentally higher than what you would expect.	X	X	X
	they teach themselves the ideas, may not know them in 'conventional ways'.			X
	they learn topics by linking ideas mentally without writing down every step; learning sequentially and by 'giving the answer' is a constraint to learning.			X
	they develop their own ways to interpret information that work well for them.			X
	frequently do not automatise the key ideas but develop their own idiosyncratic ways of dealing with knowledge they need to automatize.			X

Three categories show irregular or fluctuating high achievement in the classroom. They may show advanced verbal, visual spatial understanding and/or performance of the areas of their exceptional knowledge, such as excellent oral vocabulary, exceptional analytic, evaluative and synthetic skills, superior spatial abilities, excellent long term memory; advanced divergent thinking, problem solving and a high level of creativity in these areas of knowledge. They are described in greater depth in Munro (2012). The three categories are as follows:

High ability underachieving students

- show the 'dual' exceptionalities of giftedness and learning difficulties, twice/multi exceptional or gifted underachievers and gifted learning disabled students.
- have difficulty using the conventional 'windows of opportunity' to show their knowledge.
  The cause of the underachievement at least for those gifted students who have a specific learning disability is an analytic sequential processing difficulty associated with using phonological and symbolic information learning by rote,
- a wide variety of interests specific aptitude (artistic, musical, or mechanical) and task commitment in areas of knowledge not influenced by the specific learning difficulty.

High ability emotionally disengaged students

- high achievement is irregular and fluctuates in the classroom; a profile similar to the *high ability underachieving* students but without the specific learning difficulty;
- dis-engage from regular classroom learning, show a negative emotional disposition to their classroom and school because their knowledge is not valued or acknowledged. This may become a social, emotional and behaviour problem.
- show advanced verbal, visual spatial and/or performance understanding, divergent thinking, problem solving and a high level of creativity in areas of their exceptional knowledge.
- a wide variety of interests specific aptitude (artistic, musical, or mechanical) and task commitment in areas of knowledge not targeted in the classroom.

High ability hidden ability students

- high achievement is irregular and fluctuates in the classroom; some seek to avoid appearing to be different from their peers; their motivation to be 'one of the group' is stronger than their motivation to show all that they know.
- take steps to hide their exceptional knowledge and thinking and show examples of it intermittently and often in unexpected ways.

The common feature of the six profiles is high achievement in the classroom that indicates exceptional knowing and understanding. They differ in

1. the qualities / features of the high achievement.
2. how and when students display the knowledge and are influenced by the classroom culture and the teaching style. A high achieving student may be more prepared to show the creative aspects of exceptional knowledge in some classrooms and with some teachers rather than with others.

5. The expert knower as a guiding model

Characteristics of the knowing and understanding formed by gifted and talented learner described here are similar to those shown by individuals who are expert knowers and thinkers about an area of knowledge. Researchers have proposed the use of the expert performance framework as a conceptual model for describing gifted knowing and thinking (Ericsson & Lehmann, 1996; Ericsson, Nandagopa & Roring, 2005, 2007; Ericsson, Patel, & Kintsch, 2000; Farrington-Darby & Wilson, 2006; Shavinina, 2007; Sternberg, 2005).

The expert approach describes how a person's understanding and skill in an area changes as they move from a novice to an expert knowledge of it. Not all novices become expert knowers of a topic. Those who do can use a range of metacognitive skills manage and direct their learning activity, for example, to use learning strategies selectively according to specific learning demands at any time (Bransford, Sherwood, Vye, & Rieser, 1986; Bransford & Stein, 1984).

Some of the similarities between expert and gifted understanding (Munro, 2011, 2012) include

1. Both have more elaborated and differentiated conceptual networks than their non- gifted or non-expert peers. These allow them to interpret new information very rapidly and more broadly and deeply and look for and analyse big picture patterns and rules in information.
2. Both experts and gifted knowers retain knowledge in which they are gifted/expert more efficiently in working memory. They can also use their conceptual networks more automatically.
3. They can see more under the surface general relationships and principles than novices, infer more broadly when monitoring various effects and the implications of their decisions and actions.
4. They can learn a topic by linking simultaneously several aspects at a time, rather than working on one aspect in a sequential way.

5. They can categorise and classify issues and problems more efficiently and completely.

The novice-expert knower transition doesn't match all aspects of gifted learning. In describing these, you need to remember that researchers differ in what they mean by expertise. The version of the novice–expert knower model used here draws on work of Anderson and Schonborn (2008).

Given that individuals can be experts in multiple ways and students can be gifted in multiple ways, gifted learners are more likely than experts to

1. impose their subjective patterns and order on information rather than use the taught patterns.
2. frame up intellectual challenges or questions in a broad way and form more complex and differentiated links between concepts to form more complex relationships.
3. transfer and apply their knowledge across content area boundaries, and make unusual and 'far' links and generate outcomes that are creative and novel.
4. form a personal, intuitive 'semantic theory' understanding of a topic (Schwitzgebel 1999) that frequently leads to creative outcomes.
5. move through the novice to expert knowing trend more rapidly and in a self initiated and focused way and using their broad-based thinking ability need much less practice.
6. may know or understand an idea in a big-picture way but lack the skill to actually do it. Some areas or domains of expertise require the use of automatised motor behaviour skills that experts use to apply their expertise. Gifted students may understand ideas in expert-like knowledge forms that generate easily possibilities and questions but lack the technical skills to use them to generate expert outcomes.
7. are self-managing and directing in pursuing understanding and often operate as 'intuitive philosophers'. They are more likely to infer how they think and learn. They form theories of intelligence, a stronger goal orientation for learning, prefer harder tasks in reading and mathematics and show persistence when completing difficult tasks (Hsueh 1997).

In other words, this paper proposes a modified expert knower model to describe gifted and talented learners, to account for the unique ways in which they learn and for the multiple ways in which they can be gifted and talented. The expert knower model is modified to add creativity and far transfer, self-initiated and motivated learning, with motivation more mastery focused. The gifted students can talk about their big picture understanding but not necessarily implement it physically in some domains. This is referred to as the **expert+** model of gifted understanding.

6. The expert+ model of gifted understanding.

When exposed to regular classroom instruction, it proposed that students can potentially form one of three broad interpretations of the teaching information that indicate their understanding of the topic (Munro, 2010, 2011, 2012):

1 a novice understanding that essentially represents the internalization of the teaching information. The information is interpreted in a literal way. This understanding allows students to understand the new ideas in partial, separate them and use in restricted ways. They show superficial recall of specific details. They need to be taught to link and relate the ideas.

2 a spontaneous patterned, more general understanding. Some students, without formal instruction, extent spontaneously the taught ideas and generate patterns from them. They infer new concepts and relationships such as possible causal or consequential links. They question the patterns and ask : "How / why did the trend / pattern / change direction ?" They generate ideas and possibilities that were not mentioned in the teaching information; How did the patterns affect / contribute to …? In other words, these students form interpretations, without being instructed, that are more general. These may be in the form of patterns, rules or more abstract formulations.

3 a spontaneous, big picture understanding that is typical in some ways of an expert understanding. Their understanding is broader than that of the patterned understanding. They understand the topic in a big ideas way; they can think about two or more patterns, rules or general propositions at once. As well as formulating rules and principles, they often link moral / ethical issues with them and see possible moves and options.

They can apply their big ideas understanding to solve problems fluently and automatically. They make decisions that show they are thinking in terms of multiple patterns at once, for example, 'If this happens, then …, but because of … I would … They can plan how they will use their new knowledge in creative, novel ways and use to solve problems and make decisions, manage and use their knowledge more efficiently, monitor how they use it and readily change direction or re-question what they know.

Their understanding frequently includes creative interpretations. They make links between ideas that are novel, functional and un-expected. Their understanding allows them to see possibilities and options that suggest a far transfer of the ideas. This aspect moves the knowledge from the traditional expert descriptions made by some models of the novice-expert knower to the beyond expertise understanding proposed by Subotnik and Jarvin (2005) and that encompasses Sternberg's concept of wisdom as part of the WICS model of gifted knowledge (Sternberg, 2005).

7. Implications for pedagogic differentiation

This perspective provides a means for unpacking and analyzing how gifted and talented students know and learn (Munro, 2010). Teachers and schools can use the expert+ model to describe, for topics they are teaching, the quality of the understanding formed by these students. You can compare, for example, how 'far away' a gifted student's understanding of a topic is from a novice understanding of it. This helps you identify the thinking the gifted student engaged and also what to teach next to this student.

You can also use the expert+ model to anticipate or infer the types of understanding gifted and talented students might form of a topic and use this to plan how you will differentiate regular curriculum topics you intend to teach so that you give these students the opportunity to form the high ability understanding. The use of the model for identification, differentiation and on-going monitoring of high ability learning will be developed in a second paper.

The two broad higher levels of understanding of any topic are shown in the following diagram.

Novice understanding – typical, expected understanding

- use new ideas in particular contexts as they are taught, understand the topic literally, internalise the teaching information, recall specific details, main ideas, rely on the teaching to make links and to 'fit' them together, understand the ideas in the specific, taught contexts unless the teaching guides students to generalise and transfer.

↓

Patterned, more general, understanding

- identify patterns and relationships in the ideas, use new ideas in more general, abstract, patterned, rule oriented and abstract ways,
- link two or more patterns in possible causal or consequential trends. *How / why did the trend / pattern / change direction ?*
- question, speculate about the patterns, generate unknown new ideas , and possibilities; *How did the patterns effect / contribute to .... ?*

↓

Expert 'big ideas' understanding

- understand and use 'big ideas' in topics, use them fluently and automatically to solve problems and make decisions; *What are the big ideas in the information*?
- manage and use their knowledge efficiently, monitor how they use it and readily change direction or re-question what they know,
- think about two or more patterns, rules or general propositions at once, formulate and understand rules and any moral / ethical issues linked with them, build principles in the topics.
- plan how they will use their new knowledge in creative, novel ways
- Think broadly about an issue and see possible moves and options: *"If this happens, then.., but because of ... I would....*

This can be used to show the two multiple ways of being gifted reported by Renzulli (2005):

Novice understanding Patterned, more general, understanding presented in information Expert 'big ideas' understanding in information	Novice understanding Patterned, more general, understanding that extends the information, shows far transfer Expert 'big ideas' understanding in information extends the information, shows far transfer
School-house gifted	Creative-intellectual gifted

8. Conclusion

This paper began by identifying the issue of the lack of differentiation for gifted and talented students in regular classrooms. It linked this with the lack of knowledge of what gifted knowing and understanding 'looks like' in the classroom. The expert+ knower model provides a means for doing this and leads directly to pedagogic and curriculum differentiation.

The expert+ model is consistent with other models of gifted knowing and learning. Gagne's DMGT distinction between giftedness and talent matches the distinction between being having the capacity to learn in a 'big picture' way and the expert knowledge learnt in particular subject or topic areas through a range of 'skill shaping' processes.

It fits with Subotnik's conception of giftedness as elite talent or scholarly productivity or artistry beyond expertise by including the key skill factors of to do with being able to display and communicate one's knowledge socially and culturally.

The wisdom component and the balance of intelligence, creativity and wisdom in Sternberg's (2005) WICS model of giftedness, mediated through the synthesis process match the 'big picture' view of understanding and the use of this understanding in social and cultural processes, particularly for solving social and cultural problems. This is the concept of the gifted knower being a 'leader of cultural knowledge'.

In Ziegler's actiotope model, giftedness is defined in terms of excellent outcomes. Outcomes of this quality come from 'expert +' understanding.

The expert+ model assists in dealing with the question: What is the cut-off point for saying someone is gifted? The model focuses on the quality of students' knowledge, as well as its quantity, using the 'regular student understanding' as a reference point. Rather than talking about 'extent' or 'level of giftedness' in terms of the proportion of the population showing this knowledge, the 'expert +' model focuses on the quality and complexity of the knowledge or understanding constructed. This is particularly relevant to the work of teachers, who interact daily with students' knowledge and understanding.

It equips teachers to see evidence of students extending their knowledge. It described how this issue could be resolved in part by equipping teachers and schools with the conceptual tools for describing the understanding of gifted and talented learners. There are two aspects of this; using the familiar curriculum 'measuring stick' to direct regular student learning and using the novice-expert knower continuum to differentiate topics on it.

Australia needs to build a strong national knowledge base. The mining boom is running its course. We know from PISA data that our educational provision is not strong at extending the learning outcomes of the higher achieving students. We can mine iron ore. Can we mine the minds of our students?

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