

NMSSA Key Competencies 2017 – Report Series

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REPORT 5:
Disciplinary meaning–making:
Synthesis of findings from a retrospective analysis

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1. Overview

Disciplinary meaning-making requires students to take the ‘perspective’ of the discipline (to think like a scientist, mathematician or literary critic for example). This is a complex and multifaceted type of capability. It is most closely related to the key competency of Using Languages, Symbols and Texts. Students also need to think critically as they work with the various texts of a specific discipline area. This type of capability is essential for accessing the ideas of others, as well as expressing understanding and ideas, and creating ideas.

There is much more to disciplinary meaning-making than the words used or the way they are assembled, i.e. the *grammar* of the written texts of a discipline. All of the following can have discipline-specific differences: conventions for organising data (as graphs, tables etc.); how ‘models’ of reality are created and used as thinking supports (actual models, diagrams, maps, plans, metaphors etc.); what symbols convey and how their meanings have been agreed as conventions; and how visual images are constructed – e.g. how colour, perspective and symbolism are used to convey meaning in literary texts.

We carried out a retrospective analysis of students’ meaning-making capabilities, as demonstrated in selected NMSSA assessments in mathematics, science, and English: Viewing. The methodology is outlined in the first report in this series and the specific analyses constitute reports 2-4. This short fifth report looks across the separate pieces of work to describe high-level patterns in the findings.

There are two important general points to note.

1. Each discipline has its own epistemic practices (e.g. how it builds and justifies new knowledge, how ideas are shaped and conveyed). Therefore, each of the three inquiries has its own distinct mix of practices, which makes it difficult to draw broad generalisations across the learning areas.
2. In spite of this limitation, it is possible to make an important generic statement about how students make progress between Year 4 and Year 8. At Year 4 they are still mainly drawing on everyday practices for meaning-making but by Year 8 they are expected to be able to use an expanding repertoire of specific meaning-making practices relevant to each discipline. Students who have not demonstrated expected progress against the NZC curriculum levels are less likely to have a grasp of these meaning-making practices than those who have made expected progress.

One implication that might be drawn from this pattern is that some students are not explicitly learning about specific meaning-making practices and have not successfully picked these up by indirect signals (such as how other people use these types of practices). Not knowing how to use disciplinary meaning-making practices appears to hamper students’ overall achievement. Yet the actual practices outlined in the three learning area reports are not especially difficult and could be readily learned if more teachers were more aware of their scope and importance.

2. Disciplinary meaning-making in science

Science disciplines seek to understand and explain natural phenomena using *empirical inquiry* methods that evolve over time. An important characteristic of epistemic practices in science is that scientists strive for transparency and clarity of evidence-based reasoning, underpinned by clearly articulated theoretical assumptions. Science inquiry demands rigour and transparency. *Precision* and *clarity* of communication are valued, and are aided by use of specific conventions governed by the relevant community of practice.

Students gradually increase their own repertoire of conventions and meaning-making strategies, as used by scientists themselves, but adapted to be accessible and meaningful to them. In effect, this means that their meaning-making develops alongside their growing repertoire of science concepts. In the NMSSA analysis, students' meaning-making capabilities and their knowledge of key science ideas were more clearly correlated at Year 8 than at Year 4 (though the broad association was evident at both year levels – see the second report in this series).

Things that made scientific meaning-making harder included:

- being required to use precise 'objective' language to record observations or shape causal explanations
- understanding simple science conventions used in diagrams and models (e.g. the meaning of arrows in specific circumstances) and using these conventions appropriately when constructing their own diagrams
- drawing on more than one piece of evidence when building a more detailed observation record, or when making and justifying inferences from provided texts
- using correct and precise conventions when reading data from tables and graphs (e.g. always including the unit of measurement; making estimations of data points not specifically marked on a scale)
- conveying simple science concepts using appropriate vocabulary.

Things that made scientific meaning-making easier included:

- being allowed to convey ideas and observations in everyday language
- using idiosyncratic methods for sketching their ideas visually
- taking account of one idea or feature at a time
- interpreting simple diagrams (as opposed to drawing them)
- working with familiar contexts and phenomena.

Items located above the cut score associated with achieving NZC level 4 and above on the NMSSA scale required Year 8 students to use simple science conventions while either making meaning them self, or when interpreting meaning made by others. There was a wide gap between the level of capability demonstrated by students who could do these things and those who continued to draw on everyday communication conventions, as appropriate at Year 4 (see report 2 in this series).

3. Disciplinary meaning-making in English: Viewing

When making meaning in English students explore the relationship between function (social purpose) and form (e.g. elements such as structure, and language features) of the selected text. The form, or way in which the text is constructed, is considered to be an integral part of the text's meaning. In English there is an interest in the *relationship* between function and form for meaning-making.

Visual texts provide specific meaning-making challenges. Students need to identify and describe how visual techniques and conventions are used to create particular effects – for example how they convey character or setting. When working in the linguistic mode a student who knows how to apply meaning-making capabilities in English knows that a character may be interpreted through: their thoughts, words, and actions; through the way in which other characters think, talk about, and act towards them; and through more indirect means, such as descriptions of the setting, or the character's possessions. In visual texts other sources of information come into play, such as the use of colour, perspective, and proximity to other characters or objects.

Things that made literary meaning-making harder included:

- using symbolism to portray abstract concepts (e.g. use of size to represent power and dominance; use of colour to convey feelings or mood)
- making reference to specific visual techniques, such as the use of line or comparative perspective
- identifying more complex, subtle, or nuanced feelings (e.g., perplexed, embarrassed, guilty, contemptuous, nostalgic, adoring, envious, ashamed, compassionate), drawing on emotional awareness and a range of vocabulary
- synthesising information from more than one aspect of an image (for example the setting, the objects in the setting, the other characters and their positions in relation to each other).

Things that made literary meaning-making easier included:

- only needing to provide one element of evidence to support their interpretation
- recognising and describing simple or straightforward feelings using simple vocabulary (e.g., happy, sad, angry)
- using information about place or time depicted literally in an image (compared to when depicted symbolically)
- identifying the role of a character rather than the *personality* of a character.

Several of the items used in the NMSSA English: viewing assessment were located above the cut-score associated with NZC Level 4 on the NMSSA scale. This could have been because students were unfamiliar with the meaning-making conventions used in some of the texts, or lacked the meta-knowledge and meta-language to talk about the text. Other research suggests that younger children can master the relevant aspects of capability, given sufficient opportunities to learn (see Report 3 of this series).

4. Disciplinary meaning-making in mathematics and statistics

The discipline of mathematics is introduced to students in terms of the formal, logical relations between numbers and quantities. Disciplinary inquiry in mathematics uses a range of conventions that mathematical and statistical communities have developed to aid their thinking and to communicate ideas, data and reasoning. Students need to learn these conventions and practice using them appropriately. For example, using symbols to represent numbers is a fundamental idea in mathematics. Students need to develop key ideas about how numbers can be represented before they can use these representations to support and represent their thinking, as well as interpret the thinking of others. Similarly, learning how to measure involves developing an understanding of what counts as a measure, the conventions involved in making a measurement, and developing an understanding of how to read a scale. Learning how to use graphs depend on internalizing a number of graphing conventions that standardize how we make sense of data presentations. (This is also applicable to meaning-making in the sciences.)

Students learn to make meaning from mathematical texts by developing an understanding of specific vocabulary, symbols, graphics and diagrams. Meaning-making conventions in mathematics are tightly bound up with the mathematical ideas they are representing and at times it is very difficult to separate the convention from the mathematics itself. Both, however, are essential to learners.

Things that made mathematical meaning-making harder included:

- Using fractions to express part-whole relationships in contexts where relationships between the parts and the whole are not readily apparent
- recognising that the equals sign signifies equality between two sides of an equation
- carrying out steps in a mathematical operation in the correct order, as determined by mathematical conventions (failing to adhere to the rules will most often result in different values for the same mathematical expression)
- finding an unnumbered point on a scale when a fraction or decimal is required to name the point
- reading a scale when the starting point of the measurement is not set at zero on the scale
- accurately describing a trend in a data display, or using an element of proportional reasoning to interpret a data display
- selecting the correct terminology for more advanced mathematical ideas (e.g. improper fractions, prime numbers, parts of a circle).

Things that made mathematical meaning-making easier included:

- expressing part-whole relationships in contexts where the parts could be readily counted and apportioned as equally sized pieces
- identifying symbols that correspond with arithmetic operations needed to solve simple number or word problems
- finding the correct measurement when the unnumbered point on a scale is a whole number half-way between two other whole numbers which are marked
- making sense of simple data presented in a common graphing format.

5. Why a focus on disciplinary meaning-making matters

This short report compares and contrasts our findings about Year 4 and Year 8 students' capabilities to use a range of meaning-making conventions and processes from three quite different knowledge building disciplines. Despite their differences, a common theme is apparent when looking across the three reports. This theme concerns the contribution of disciplinary meaning-making to NZC's high level vision of educating our young people to be "confident, connected, actively involved lifelong learners" (NZC, p.8) and good citizens.

Science makes an important contribution to students' growing capabilities for citizenship more generally by building their awareness of features of robust empirical inquiry and their dispositions to critically engage with science texts and arguments. Precision and clarity are hallmarks of meaning-making in science. For example, a number without a unit of measurement is meaningless. Students need to develop the disposition to ask about the unit of measurement and to ensure it is present whenever they work with a data set, however that idea is represented. If they do this often enough over the course of their science learning at school, they could be more likely to also ask this question of any data reported in media accounts of science issues when they are older, or if they need to make a personal decision that involves some aspect of measurement. It seems a small thing but actually can become critical if data are misused, misinterpreted, or misunderstood. NZC send a clear signal that meaning-making capabilities in science are a necessary part of a future-oriented education system:

By studying science, students use scientific knowledge and skills to make informed decisions about the communication, application, and implications of science as these relate to their own lives and cultures and to the sustainability of the environment. (NZC, p.28)

English equips students with the tools needed to explore the textual choices available when making meaning for different social purposes. They also explore the relationship between textual choices and social purposes, (i.e., how texts are constructed to elicit emotional, physical, and aesthetic experiences, as well as cognitive responses, in readers). English provides students with the tools needed to critique and second-guess texts, rather than take them at face value. It provides students with the tools to redesign or transform texts for their own purposes. Opportunities to build meaning-making capabilities through the discipline of English are therefore more important than ever before. NZC send a clear signal that such capabilities are a necessary part of a future-oriented education system:

English gives students access to the understanding, knowledge, and skills they need to participate fully in the social, cultural, political, and economic life of New Zealand and the wider world. To be successful participants, they need to be effective oral, written, and visual communicators who are able to think critically and in depth. (NZC, p.18)

According the NZC, **mathematics and statistics** "...equip students with effective means for investigating, interpreting, explaining and making sense of the world in which they live" (p.26). An essential part of this involves developing an understanding of the meaning-making conventions and processes that mathematical and statistical communities have developed to aid their thinking and to communicate ideas, data and reasoning.