VOLUME 2012/13 ISSUE 5

EXPANSIVE EDUCATION NETWORK Research digest
Integrating Habits of Mind and subject content

Summer 2013

Inside This Issue

2 Subject-specific HOM

2 Split-screen teaching

3 Mathematics HOM

5 Science HOM

7 Thinking like a Maker

8 HOM for Creativity

9 How could I use this research?

Message from the team

Welcome to the summer edition of the Expansive Education research digest. In this termly publication we aim to provide coverage of important themes for expansive educators.

Habits of Mind (HOM) is an expression coined by Art Costa and Bena Kallick to describe the characteristic ways that learners think and act, especially when confronted with challenging problems (Costa and Kallick, 2002). A core tenet of Expansive Education is that students learn both the content of a particular subject *and* certain habits of mind (HOM) or learning dispositions. These HOM can either help them as learners and citizens as they become, for example, more resilient or more collaborative, or hinder their development through becoming dependent or selfish. We also believe that these dispositions are not innate, but learned. Their cultivation therefore depends largely on the pedagogies adopted by teachers.

Art Costa and Bena Kallick (2009) provide plenty of examples of cultivating HOM through a wide range of subjects in their book 'Habits of Mind Across the Curriculum: Practical and Creative Strategies for Teachers' and similarly 'The Learning Powered School' by Guy Claxton, Bill Lucas and colleagues (2011), is full of practical BLP-inspired suggestions. In Australia, you can see an example of the way in which the new National Curriculum (2013) explicitly maps capabilities against subjects in the curriculum.

However, while it is possible to cultivate many different HOM in many different subjects, some content seems particularly aligned to specific HOM. We explore these connections between HOM and subjects in this digest and suggest ways in which this link can be practically useful.

Australian Curriculum Assessment and Reporting Authority (2013) *General capabilities in the Australian curriculum*. Available: www.australiancurriculum.edu.au [Accessed 22 July 2013]

Guy Claxton, Maryl Chambers, Graham Powell and Bill Lucas (2011) *The Learning Powered School.* Bristol: TLO.

Art Costa and Bena Kallick, (2002) *Discovering and exploring habits of mind.* Alexandria, Virginia: Association for Supervision and Curriculum Development.

Art Costa and Bena Kallick, eds. (2009) *Habits of mind across the curriculum: Practical and creative strategies for teachers.* Alexandria, VA: ASCD.

Bill Lucas, Guy Claxton, and Janet Hanson

Subject-specific HOM

The problem of what to include within the curriculum, and what to exclude, is common to all levels of education, and is one of the reasons why many educators suggest that building a curriculum around skills or HOM, rather than focusing solely on subject knowledge, is more useful and relevant to the world that the learner will join outside school, college or university. It is also important to ensure that the pedagogies adopted by educators are ones that will actually facilitate the development of the desired HOM.

Teachers interested in developing specific pedagogies for subjects frequently refer to the importance of getting learners to 'think like' a competent member of the learning community to which they are 'apprenticed' when they start to learn that subject. 'Thinking like a…' is a phrase frequently used in two books that explore signature pedagogies to develop disciplinary HOM (Chick, Haynie and Gurung, 2012; Gurung, Chick and Haynie, 2009). Most of the chapters in the books focus on pedagogies rather than HOM, but you might find it worth 'dipping in' to ones relevant to your own subject areas. For example, Joel Sipress and David Voelker (2009) explore how to change history teaching from a transmissive 'coverage' model to one that emphasises 'doing history'. This involves enabling students to engage with primary source documents, explore conflicting perspectives, make their own judgements and argue their case based on the evidence. They note that one of the main challenges to this approach is the assumption held by students that the past is 'given' and cannot be challenged. A practical example of how a history teacher might try to change this way of thinking is given in the next section on split-screen teaching.

Nancy Chick, Aeron Haynie and Regan Gurung, eds. (2012) *Exploring more signature pedagogies: approaches to teaching disciplinary habits of mind*. Sterling, Virginia: Stylus.

Regan Gurung, Nancy Chick and Aeron Haynie, eds. (2009) *Exploring signature pedagoges: approaches to teaching disciplinary habits of mind*. Sterling, Virginia: Stylus.

Joel L. Sipress and David J.Voelker (2009) From learning history to doing history: Beyond the coverage model. In N Chick, A Haynie and R Gurung, eds. *Exploring more signature pedagogies: approaches to teaching disciplinary habits of mind*. Sterling, Virginia: Stylus, pp.19-35.

Split-screen teaching

In the Building Learning Power framework, incorporating HOM into subject teaching is referred to as split-screen teaching and Bill and Guy's book 'New kinds of Smart' offers two examples of this technique.

A science teacher organises a circus of experiments in her Year 6 classroom and as the children circulate round the tasks in threes and complete the experiments, she encourages them to work on their 'questioning muscles' by thinking up 'questions that a scientist might want to ask next' (Lucas and Claxton 2010:28). She then encourages them to explain what makes a 'good' question and how you can distinguish 'good' evidence from false.

In a history class about the Tudors in Year 8, the teacher wants to develop students' empathy by asking them to write about a critical event through the eyes of three characters who hold radically different views about the event. She then asks them to think of a similar situation from their own lives. Both these examples demonstrate how teachers can incorporate HOM that develop 'thinking like a…' within their curriculum.

Bill Lucas and Guy Claxton (2010) *New Kinds of Smart*. Maidenhead: Open University Press and New York: McGraw Hill Education.

Mathematics Habits of Mind (MHOM)

Valuing subject knowledge and HOM in the modern curriculum

Updating the curriculum becomes even more challenging in science and technology subjects when knowledge rapidly becomes obsolete. This is the argument put forward by Al Cuoco and his colleagues, who suggest that much school mathematics teaching does not prepare high (secondary) school leavers for actually applying their mathematical knowledge outside school. They suggest that the approach to teaching mathematics has traditionally been more about demonstrating the solution of a problem to students and expecting them to solve problems by substituting one set of numbers for another. Instead, they suggest that it would be more useful if the curriculum was built around the habits of mind used by mathematicians when they think about problems and how they set about solving them. Up to date content is still important, but the tools to use this knowledge immediately and in the future are more important.

Teaching which specifically seeks to cultivate certain habits of mind can encourage students to take risks, to experiment, to track back over false starts, and sometimes even to fail. It is not about drilling students in particular methods for problem solving, is more about making clear the 'mental habits that allow students to develop a repertoire of general heuristics and approaches that can be applied in many different situations' by providing a genuine research experience (Cuoco et al., 1996: 378).

The researchers identify a generic set of mathematical habits of mind (MHOM) and more specific subsets for geometry and algebra. Students who think like mathematicians should be:

Pattern sniffers	Always on the lookout for patterns, finding hidden patterns, or using shortcuts arising from them when presented with maths problems, but also relevant to problem solving in daily life;
Experimenters	Performing though experiments so they can give evidence for their answers to questions such as 'what kind of number do you get if you square an odd number?' Students should also develop a healthy scepticism for experimental results;
Describers	Able to give precise descriptions of the steps in the process, invent notation, argue and write;
Tinkerers	Taking ideas apart and putting them back together again;
Inventors	Their inventions might be rules for a game, algorithms, explanations of how things work, or even axioms for a mathematical structure;
Visualisers	Being able to visualize things that are inherently visual such as working out how many windows there on the front of a house by imagining them, or using visualization to solve more theoretical tasks;
Conjecturers	Making plausible conjectures;
Guessers	Starting with a possible solution to a problem and working backward to achieve the answer.

Much more detail is given in the paper about the specific collections of MHOM that 'geometers' and 'algebraists' use.

The authors conclude by reminding us that in an advanced technological society almost every aspect of our daily lives is influenced by the thinking of scientists and mathematicians, and so we should be ensuring that young people leaving school are able to understand and contribute to the making of decisions about how new technology is deployed.

Some practical illustrations of mathematics teaching to incorporate MHOM are provided by Marshall Gordon in the next section.

AL Cuoco, E. Paul Goldenberg and June Mark (1996) Habits of Mind: An organizing principle for mathematics curricula. *Journal of Mathematical Behavior*, 15: 375-402. Available: http://nrich.maths.org/content/id/9968/Cuoco_etal-1996.pdf [Accessed 17 July 2013]

Thinking like a mathematician

Al Cuoco and his colleagues were researching HOM specific to mathematics over ten years ago, but as Marshall Gordon found more recently, mathematics educators still seem to be challenged to provide appropriate learning experiences for students that develop MHOM. Marshall argues for the mathematical inquiry process to be made more explicit in education 'so that the productive practices of a mathematically-inclined mind are considered as content' and therefore 'promoted as worthy of study' (Gordon 2011:457). This is particularly important in the curriculum for those who are training to become mathematics teachers, since he suggests that teachers need to be able to explain why the mathematics they are teaching makes sense. Marshall draws on the MHOM listed by Cuoco et al. (1996) to confirm that those who are successful at mathematical thinking are able to look for patterns, tinker, visualise, take things apart, conjecture, simplify the problem and change representations (Gordon 2011:461). He then illustrates how it is possible to design learning experiences that enable students not only to become successful problem solvers, but to think of themselves positively as such, thereby developing greater resilience for mathematics learning. He also demonstrates how students could have the opportunity of constructing, testing and discussing their own conjectures, thereby developing their self-confidence as 'doers' of mathematics.

Marshall Gordon is a member of the teaching team in the upper school math department of The Park School of Baltimore in Brooklandville, Maryland, USA, where the mathematics teachers have written a curriculum for 9th-11th grade (secondary level), based on mathematical habits of mind and the idea that learning mathematics should be about problem solving rather than learning rote procedures.

For example, in a lesson designed to develop the ability to tinker, or play around with numbers and figures in order to learn something about them, students are presented with problems and encouraged to try possibilities. In Book 1, Problem 10 is taken from the film 'Die Hard With A Vengeance'. The characters John McClane and Zeus Carver open a briefcase only to discover that in doing so they have armed a powerful bomb. It will explode in a matter of minutes unless they can disarm it. Inside the briefcase there is a scale. They have at their disposal two jugs — one holds exactly 5 liters and the other holds exactly 3 liters. To disarm the bomb, they have to fill the 5 liter jug with exactly four liters of water and place it on the scale. A few grams too much or too little will detonate the bomb. The water can be obtained from a nearby fountain. How can they disarm the bomb?

This problem and many more examples that encourage students to play around with numbers are available on the Park School website: http://parkmath.org/curriculum/

Marshall Gordon (2011) Mathematical habits of mind: Promoting students' thoughtful considerations. *Journal of Curriculum Studies*, 43 (4): 457–469.

Identifying mathematical HOM

If you are searching for a tool to identify your own students' MHOM, you may find the Quantitative Literacy assessment instrument tool developed by Stuart Boersma and Dominic Klyve helpful. This survey could also be useful as a tool for evaluating your action research interventions designed to enhance MHOM.

Quantitative literacy is described as 'a basic mathematical skill set, uniquely combined with reasoning abilities, critical thinking abilities and the habit of mind to purposefully engage with quantitative material' (Boersma and Klyve, 2013:1). In order to assess their students' propensity to adopt a quantitative literacy habit of mind, they devised an exercise to measure whether their students had the inclination to:

- glean, identify and report quantitative information in direct support of a thesis statement;
- invoke quantitative reasoning to critique a statement or opinion;
- check numerical information presented in text with any accompanying graphics; and
- critically evaluate information presented graphically.

They selected two newspaper articles containing appropriate quantitative information which they asked students to read in class and then answer questions that would demonstrate the extent to which they exhibited the skills above. The question prompts were designed to ensure that students were not led into focusing on the quantitative aspects of the article, although the researchers did admit that the timing of the use of the exercise within a quantitative reasoning course could have resulted in some bias. They claimed that their instrument did appear to successfully measure students' habits of mind. However, they also found that their course was less successful in actually changing these habits.

The exercise was conducted with college students but there is sufficient detail in the paper that should enable it to be adapted for other age groups, should you wish to develop a tool for evaluating an action research project focused on habits of mind in mathematics.

Stuart Boersma and Dominic Klyve (2013) Measuring Habits of Mind: Toward a prompt-less instrument for assessing quantitative literacy. *Numeracy*, 6 (1), Art6. Available: http://scholarcommons.usf.edu/numeracy/vol6/iss1/art6 [Accessed 17 July 2913]

Science Habits of Mind (SHOM)

Concerns are currently being expressed that individuals find it difficult to engage in informed discussion about scientific and technological innovations that are affecting their daily lives, for example vaccination programmes, food radiation or nuclear power. They lack the ability to judge whether their lives maybe enriched or harmed by these socio-scientific innovations (SSIs) and are therefore apprehensive about them. Even teachers who might be expected to introduce discussion in their classes about SSIs to link science teaching to real- world issues appear reluctant to do so, contributing to a climate of fear about the pace of scientific advances. These issues prompted Muammer Calik and Richard Coll to undertake research to discover whether the teaching of science based on incorporating SSI might benefit from a deeper understanding of how scientists think, or scientific habits of mind (SHOM), which are:

Open-mindedness	Being receptive to new ideas;
Scepticism	Adopting a critical appraisal approach;
Rationality	An appeal to good reason and making logical arguments;
Objectivity	Recognising the need to reduce the idiosyncratic contributions of the investigator to a minimum;
Mistrust of arguments from authority	Treating arguments sceptically irrespective of the status of the originator;
Suspension of belief	Not making immediate judgements if evidence is insufficient;
Curiosity	Demonstrating a desire to learn and inquisitiveness.

They developed a survey instrument designed to measure SHOM. Much of the article explains how they developed and validated the questions to ensure that the survey tool did accurately measure SHOM.

Muammer Çalik and Richard Kevin Coll (2012): Investigating socioscientific issues via scientific Habits of Mind: Development and validation of the Scientific Habits of Mind Survey. *International Journal of Science Education*, 34 (12):1909-1930. Available: http://dx.doi.org/10.1080/09500693.2012.685197 [Accessed: 17 July 2013]

Thinking like a scientist

Studies of children's perceptions of science and mathematics teaching often reveal that they find it difficult to engage with the topics because they seem remote from the world outside school. Richard Gott and his colleagues decided that one way to address this was to find out more about what practising scientists do and bring the teaching of those processes of 'thinking like a scientist' into the classroom (Gott, Duggan and Johnson, 1999). In addition to increasing children's motivation to engage with science, they also aimed to tackle employers' criticisms of the lack of relevance of science education, especially in vocational education programmes. They quite rightly claim that it is no use exhorting schools and colleges to teach specific scientific habits of mind, rather than general skills and competencies, without providing examples of how it might be done.

For their pilot study they interviewed employees within a small biotechnology company to identify the knowledge and skills they needed to fulfil the requirements of the job. They differentiated between conceptual understanding, ie knowledge of the science and procedural understanding, ie knowledge of the processes that employees used in their work when they applied their scientific knowledge. They found that employees made extensive use of procedures that required problem solving, accuracy, selecting the right instrument for the task, observation, and noting control variables. However, the employees did not regard these procedures as 'science' but referred to them as 'common sense', and suggested that they were habits they had learnt on the job rather than during their formal science education.

Sandra Duggan and Richard Gott continued this research in a further study in which they defined procedural understanding as 'the thinking behind the doing of science' (Duggan and Gott, 2002:664), suggesting that this was encapsulated in the disposition of collecting valid and reliable evidence. The aim of this second study was to investigate what science people used in their everyday lives on leaving education as well as in science-based employment and in which situations a disposition towards collecting valid and reliable evidence might be relevant. Based on their findings, they made a number of recommendations about including opportunities in the science curriculum for children to become confident at handling evidence. For example, at Key Stage 3, they suggest that pupils should be able to carry out investigations formulated as problems and collect, analyse and interpret their own evidence - procedures that would follow on well from the science example in the section above on split screen teaching.

Sandra Duggan and Richard Gott (2002) What sort of science education do we really need? *International Journal of Science Education*, 24 (7): 661-679. Available: http://dx.doi.org/10.1080/09500690110110133 [Accessed 17 July 2013]

Richard Gott, Sandra Duggan and P. Johnson (1999) What do practising applied scientists do and what are the implications for science education? *Research in Science & Technological Education,* 17 (1): 97-107.Available: http://dx.doi.org/10.1080/0263514990170108 [Accessed 17 July 2913]

Thinking like a Maker

The subjects discussed in the previous sections of this digest, science and mathematics, are often accorded a higher status than practical and vocational subjects. They are deemed to be more 'difficult' than, for example, hairdressing or plumbing and therefore requiring greater intelligence to learn. Bill and Guy have developed the 4-6-1 model (Claxton, Lucas and Webster 2010) to illustrate the core HOM involved in practical learning, see Figure 1. They have argued that both academic and practical learning draw upon four habits of mind and six frames of mind, which, when deployed in the right way at the right time, create presence of mind, or the ability to think, do, act, make or produce the right response.

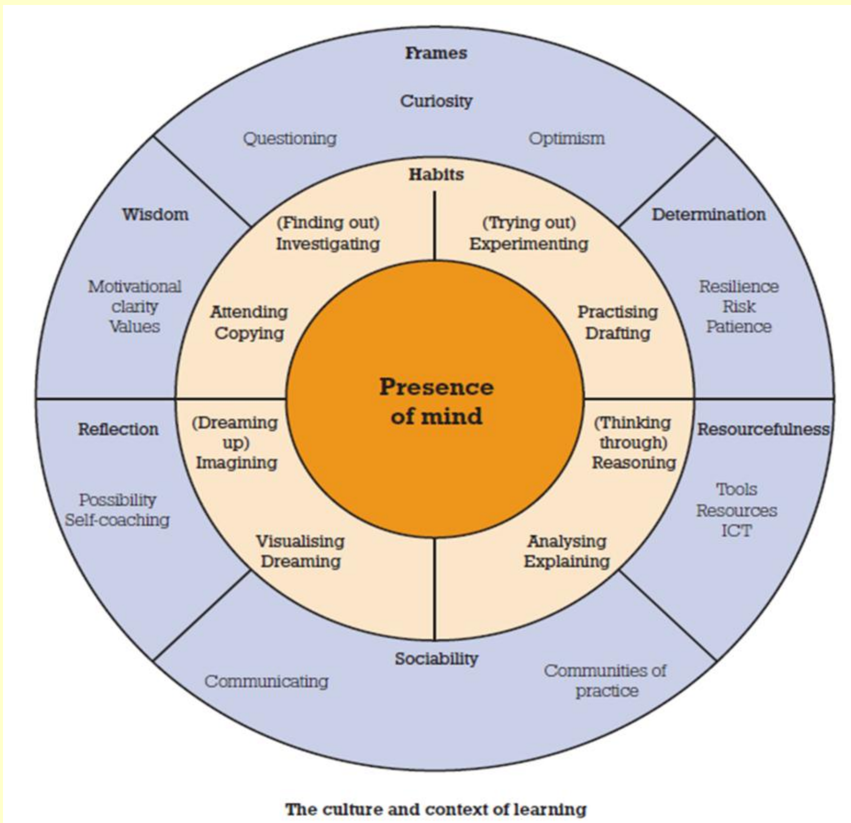

Figure 1 The 4-6-1 model (Claxton, Lucas and Webster, 2010:17)

The middle ring contains the four most important habits of mind. Learners need to be skilled at *finding out* about things using a range of resources and strategies; at actively *trying out* ideas; at *dreaming up* new ways of doing things; and at *thinking through* the consequences of what might happen in order to make the most appropriate choice of action. The outer ring contains generic attitudes that support successful learning in any subject. Beyond the outer ring is the context – hairdressing, or physics, furniture making or geography, for example. But any habit or frame of mind needs to be activated in the moment. This is what 'presence of mind' means, having the skill and being ready, able and willing to deploy it.

Claxton, G., Lucas, B. and Webster, R. (2010) *Bodies of knowledge: How the learning sciences could transform practical and vocational education.* London: Edge Foundation.

Habits of Mind for Creativity

Creativity is an important habit of mind for successful learning in many vocational and professional subjects although it is not always recognised as such. It is also widely accepted as an important outcome of schooling, but there is lack of clarity about how it should be taught and assessed. One of the reasons for this is a lack of precise understanding and articulation of what it is. However, colleagues from the CRL have recently published a paper that offers teachers and students a framework for developing and tracking students' creativity in schools (Lucas, Claxton and Spencer, 2013). Focusing on the dispositions that make up the creative individual, ie what the learner is doing when being creative, they produced the Five Creative Dispositions Model as a framework for teachers and students to trial in classrooms.

Figure 2 Creative dispositions model (Lucas, Claxton and Spencer, 2013:18)

Adopting the view that creativity is largely learnable rather than innate, the model explores five core dispositions of the creative mind, ie; being inquisitive, persistent, imaginative, collaborative and disciplined. Each of these five dispositions was expanded through sub-dispositions. A tool was developed to be trialled in schools and from the results, the team concluded that it was possible for both teachers and pupils to assess pupils' creativity, and that the five habits had face validity. The conception of creativity defined in the study supported teachers' understandings of the creative dispositions that they would wish their pupils to develop and teachers reported that they thought the framework encompassed a learnable set of dispositions.

Bill Lucas, Guy Claxton and Ellen Spencer (2013) *Progression in student creativity in school: First steps towards new forms of formative assessments*. OECD Education Working Papers, No. 86, OECD Publishing. Available: http://dx.doi.org/10.1787/5k4dp59msdwk-en
[Accessed 17 July 2013].

How could I use the ideas reported in this Research Digest?

As you read through the summaries of the research reported in this issue, take time to reflect on how you might incorporate their concepts, findings or tools into your own action research inquiries. Think of the rubric we suggest you use to develop your action research question - If I do x will y happen? - and consider if any of the ideas reported in this digest might help you decide what intervention to make, ie your x, or decide what HOM you want your students to develop, ie your y. We have provided some examples to get you started.

Mathematics

If I get my students to develop their own definitions of odd and even numbers will their ability to see patterns and solve mathematics problems increase?

If I provide my students with real world problems will they grasp mathematical concepts more effectively?

Science

If I share real world scientific challenges with my students will their curiosity increase?

If I teach my students different ways of expressing scepticism will their evidential skills become stronger?

Practical learning

If I praise my students' efforts consistently will they develop greater pride in their work and pay more attention to detail, eg take more time to correct errors before handing in work?

If I encourage my students to critique each other's work will their craftsmanship increase?

Creativity

If I use a creativity assessment tool with my students and discuss examples of creativity with them, will they become more confident at playing with numerical problems?

If I regularly ask my students to notice when other students are using their imagination, will they produce more ideas when asked?

Research summary compiled by Janet Hanson at the Centre for Real-World Learning