**Habits of Mind**

**Habits of mind in education**

‘Habits of mind’ (HoM) as an approach to teaching and learning is the specific creation of Art Costa and Bena Kallick (Costa, 1991; Costa and Kallick, 2002) who suggest that there are 16 habits of mind which define what humans do when they behave intelligently.

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| **16 Habits of Mind** |
| 1. Persisting  | 9. Thinking about thinking (metacognition)  |
| 2. Thinking and communicating with clarity and precision  | 10. Taking responsible risks |
| 3. Managing impulsivity  | 11. Striving for accuracy |
| 4. Gathering data through all senses  | 12. Finding humour  |
| 5. Listening with understanding and empathy  | 13. Questioning and posing problems  |
| 6. Creating, imagining, innovating  | 14. Thinking interdependently  |
| 7. Thinking flexibly  | 15. Applying past knowledge to new situations  |
| 8. Responding with wonderment and awe  | 16. Remaining open to continuous learning  |

At the same time, parallel thinking in the UK widely in use among primary and secondary educators is Guy Claxton’s Building Learning Power (Claxton, 2002) with its 17 HoM. In general education the phrase ‘habits of mind’ and associated phrases such as ‘dispositions for learning’ and ‘learning attributes’ have also been associated strongly with the work of Project Zero at Harvard University[[1]](#footnote-1).

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| **Building Learning Power** |
| *Resilience - Being ready, willing and able to lock on to learning*1. Absorption2. Managing distractions3. Noticing4. Perseverance | *Reflectiveness - Being ready, willing and able to become more strategic about learning*10. Planning11. Revising12. Distilling13. Meta-learning |
| *Resourcefulness - Being ready, willing and able to learn in different ways*5.Questioning6. Making links7. Imagining8. Reasoning9. Capitalising | *Reciprocity - Being ready, willing and able to learn alone and with others*14. Interdependence15. Collaboration16. Empathy and listening17. Imitation |

**Habits of Mind in Engineering Education**

In the USA a major review of engineering education within K-12 (primary and secondary) education (Katehi et al., 2009) established that the engineering curriculum should be underpinned by six Engineering Habits of Mind (EHoM) which represent the values, attitudes and thinking skills associated with engineering.

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| **USA - Engineering Habits of Mind** |
| 1. Systems thinking |
| 2. Creativity |
| 3. Optimism |
| 4. Collaboration |
| 5. Communication |
| 6. Attention to ethical considerations |

Two disciplines underpinning engineering have already have done much thinking in this area, mathematics (Cuoco et al., 1996; Gordon, 2011) and science (Çalik and Coll, 2012). Both disciplines shed direct light on EHoM.

Cuoco et al. (1996) proposed some Mathematical Habits of Mind (MHoM) exhibited by successful mathematical thinkers.

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| **Mathematical Habits of Mind** |
| 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 for doing things, 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. |

Çalik and Coll (2012) argued that that science teaching would be enhanced by a deeper understanding of how scientists think and worked with the following list of Science Habits of Mind (SHoM):

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| **Science Habits of Mind** |
| 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. |

**CRL’s Engineering Habits of Mind**

In our 2014 report for the Royal Academy of Engineering *Thinking like an engineer,* we synthesised these generic and discipline-specific habits of mind to generate our six Engineering Habits of Mind.

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| **Engineering Habits of Mind** |
| Systems thinking | Seeing whole systems and parts and how they connect, pattern-sniffing, recognising interdependencies, synthesising. |
| Problem finding | Clarifying needs, checking existing solutions, investigating contexts, verifying. |
| Visualizing | Being able to move from abstract to concrete, manipulating materials, mental rehearsal of physical space and of practical design solutions. |
| Improving | Relentlessly trying to make things better by experimenting, designing, sketching, guessing, conjecturing, thought-experimenting, prototyping. |
| Creative problem-solving | Applying techniques from different traditions, generating ideas and solutions with others, generous but rigorous critiquing, seeing engineering as a ‘team sport’. |
| Adapting | Testing, analysing, reflecting, rethinking, changing (both in a physical sense and in mentally). |

**References**

Çalik, M. and Coll, R.K. (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) pp1909-1930.

Claxton, G. (2002) *Building Learning Power*. Bristol: TLO Ltd.

Costa, A. (1991) The search for intelligent life. In Costa A. (Ed.), *Developing minds: A resource book for teaching thinking* (Rev. ed., Vol. 1, pp. 100–106). Alexandria, VA: ASCD.

Costa, A. and Kallick, B. (2002) *Discovering and Exploring Habits of Mind.* Alexandria, Virginia: Association for Supervision and Curriculum Development.

Cuoco, A., Goldenberg, E.P. and Mark, J. (1996) Habits of mind: an organizing principle for mathematics curricula. *Journal of Mathematical Behaviour* 15 pp375-402.

Gordon, M. (2011) Mathematical habits of mind: Promoting students' thoughtful considerations. ***Journal of Curriculum Studies***43(4) pp457-469.

Katehi, L., Pearson, G. and Feder, M. (2009) *Engineering in K12 Education. Understanding the status and improving the prospects*. (Committee on K-12 Engineering Education, National Academy of Engineering and National Research Council). Washington, DC: National Academies Press.

Royal Academy of Engineering (2014) *Thinking like an engineer.* London: Royal Academy of Engineering. Available: [www.raeng.org.uk/thinkinglikeanengineer](http://www.raeng.org.uk/thinkinglikeanengineer).

1. See for example <http://learnweb.harvard.edu/alps/thinking/docs/habits.pdf> which explores mathematics and science [↑](#footnote-ref-1)