



# **The Science Behind Macat's Thinking Skills Programme**

**August 2015**  
**Dr Sara Baker and Dr Lauren Bellaera**  
**Faculty of Education**  
**University of Cambridge**

## **Introduction**

Macat has been working in collaboration with the University of Cambridge since 2014. The company has adopted an empirical-based approach to the design of their resources, meaning that they rigorously test their resources in order to establish the impact on learning outcomes.

The role of the Cambridge research team based at the Faculty of Education is to empirically test the effectiveness of Macat's materials using scientific methods grounded in the principles of experimental psychology. The research team also provides recommendations for how Macat's resources can be developed, based on existing findings from the psychology and education literature. The project is led by Dr Sara Baker, who is the Principle Investigator, and managed by Dr Lauren Bellaera, who is a Research Associate at the University. Research outputs are in preparation to disseminate Macat's findings through peer-reviewed publications in psychology and education journals.

An initial study, carried out by Drs Baker and Bellaera, showed that, following an educational intervention with some of Macat's multimedia materials, undergraduate students significantly improved their comprehension of seminal texts, with many students also showing improvements in their ability to think critically about seminal texts.

The Cambridge research team has helped Macat to design the thinking skills features for their online learning platform, and there are plans to test the effectiveness of these materials on a large scale involving UK and US cohorts of students and life-long learners. In what follows, we present a short overview paper outlining the literature on thinking skills, with an emphasis on critical thinking, and explain how it relates to the research being carried out by the University of Cambridge in partnership with Macat.

## **What is critical thinking?**

The term 'critical thinking' has been related to a number of constructs, including intelligence, subject-specific expertise, problem-solving, reasoning and logical thinking (Bangert-Drowns & Bankert, 1990). However, because of its complexity, and because it is made up of a range of components, there is no general agreement as to how to define critical thinking (Bangert-Drowns & Bankert, 1990).

Over the decades, a number of definitions have been proposed (e.g. Facione, 1990; Fasko, 2003; McPeck, 1981; Paul, 1993). The skills that underpin critical thinking are similar irrespective of the definition given, and include the ability to make inferences, and to

interpret, analyse and evaluate arguments (Facione, 1990). As well as viewing critical thinking as comprised of cognitive skill-based functions (Baron, 1985; Ennis, 1962; Ku, 2009; McPeck, 1981), the skills themselves can also be viewed as dispositional traits (Facione, 1990; Ku, 2009; Perkins & Ritchhart, 2004; Taube, 1997). Critical thinking dispositions refer to a person's internal motivation to practice critical thinking, and include qualities such as open-mindedness, inquisitiveness, and flexibility (Facione, 1990; Facione, Facione, & Giancarlo, 1996; Perkins & Ritchhart, 2004).

Critical thinking skills can either be subject-specific or general (Ennis, 1989). *Subject-specific* critical thinking refers to the application of critical thinking within a subject (e.g. history, psychology or politics), whereas *general* critical thinking refers to the application of critical thinking separately from a subject (such as in real world problems; Ennis, 1989). Some studies have shown improvements in subject-specific critical thinking, but not general critical thinking, following educational interventions (e.g. Renaud & Murray, 2008).

### **Why does critical thinking matter?**

Critical thinking has been described as a 21<sup>st</sup> century skill (Pellegrino & Hilton, 2012); a skill which is prioritized as an important goal of higher education (Wyer, 2009); and a skill which is highly valued and sought after by employers (Deane & Borg, 2011). However, one cannot assume that the development of critical thinking skills is an automatic outcome of attending university. In fact, on the contrary, many students are leaving university without being proficient in these skills (Association of American Colleges and Universities, 2005). Research shows that critical thinking skills improve better when they are explicitly taught (Abrami et al., 2008; Bangert-Drowns & Bankert, 1990).

### **Macat's definition of thinking skills**

The focus of the Cambridge research team is to assess the impact of Macat's resources on both subject-specific and general critical thinking skills. As part of this programme, and drawing on the critical thinking literature (e.g. Facione, 1990; Facione, 2015), the team carried out a survey which asked UK and US academics in the humanities and social sciences to rank a range of thinking skills in terms of how important each skill was to their subject discipline.

The results of the survey showed that the most highly valued thinking skills were those of analysis, evaluation and interpretation. Macat has used the results from the survey to select six thinking skills to prioritize on their platform: problem solving, analysis, creative thinking, interpretation, evaluation and reasoning. A variety of activities and tests have been created in order to promote the development of these skills.

## **Testing critical thinking**

A number of tests exist for both general and subject-specific critical thinking skills using a range of response formats (Ku, 2009). For example, some general critical thinking tests use multiple-choice formats, such as the Watson-Glaser Critical Thinking Appraisal (Watson & Glaser, 1980). Other tests use open-ended questions which require a student to provide written responses (e.g. the Ennis–Weir Critical Thinking Essay Test; Ennis & Weir, 1985). Other tests of general critical thinking use a combination of multiple choice and open-ended questions (e.g. the Halpern Critical Thinking Assessment Using Everyday Situations; Halpern, 2007). In addition, subject-specific critical thinking tests have been developed for certain topics within subject disciplines. For instance, Lawson’s (1999) Psychological Critical Thinking test assesses students’ critical thinking skills in relation to psychological research methods.

We can measure critical thinking in tests, but also in people’s spoken and written language. Indeed, many studies have analyzed dialogue either in the classroom or online as a way to monitor the development of students’ critical thinking (e.g. Anderson, Howe, Soden, Halliday, & Low, 2001; Nussbaum, Winsor, Aqui, & Poliquin, 2007)

To evaluate critical thinking outcomes, the Cambridge research team has used the Watson-Glaser Critical Thinking Appraisal (Watson & Glaser, 1980) and developed subject-specific critical thinking tests for the Political Sciences. The next phase in the trial programme is to test ways of developing argumentation skills in an online environment, and to carry out content-analysis of online chat rooms as part of their scientific studies.

## **What types of instructions improve critical thinking?**

Research shows that it is possible to develop critical thinking skills through the use of effective instruction (for reviews see Abrami et al., 2008; Abrami et al., 2014), and the evidence shows that actively teaching critical thinking, as a separate skill, is the most effective approach to improve thinking skills (Abrami et al., 2008; Bangert-Drowns & Bankert). This can be done either by explicit teaching of critical thinking as a discrete subject, or by teaching it alongside material that promotes critical thinking within a subject lesson (Abrami et al., 2008).

A range of activities have been used to improve critical thinking. These include: asking higher-order questions (Renaud & Murray, 2008), using graphical organizers (Nussbaum et al., 2007), and prompting self-reflection (Austin, 2008). However, whether a particular activity improves critical thinking does not only depend solely on the effectiveness of the instructions and associated activities. It is also dependent on factors related to the

individual (academic ability, motivation) as well as the context (intervention length, type of subject; Niu, Behar-Horenstein, & Garvan, 2013).

The Cambridge research team has taken into account students' academic ability whilst assessing the impact of Macat's resources on critical thinking. The importance of individual variability is also taken into consideration in Macat's online learning platform.

### **Future directions**

Based on the research evidence outlined above, Macat is in the process of developing a bespoke suite of thinking skills activities and tests covering all six of the skills. Macat is working closely with the Cambridge team with the aim of producing a platform that is capable of accurately assessing a student's propensity to think critically and his or her study goals, and using that information to personalize their learning experiences.

## References

- Abrami, P. C., Bernard, R. M., Borokhovski, E., Waddington, D. I., Wade, C. A., & Persson, T. (2014). Strategies for Teaching Students to Think Critically: A Meta-Analysis. *Review of Educational Research, 85*, 275-314.
- Abrami, P. C., Bernard, R. M., Borokhovski, E., Wade, A., Surkes, M. A., Tamim, R., & Zhang, D. (2008). Instructional interventions affecting critical thinking skills and dispositions: A stage 1 meta-analysis. *Review of Educational Research, 78*, 1102-1134.
- Anderson, T., Howe, C., Soden, R., Halliday, J., & Low, J. (2001). Peer interaction and the learning of critical thinking skills in further education students. *Instructional Science, 29*, 1-32.
- Association of American Colleges and Universities. (2005). *Liberal education outcomes: A preliminary report on student achievement in college*. Washington, DC: AAC&U.
- Austin, Z., Gregory, P. A., & Chiu, S. (2008). Use of reflection-in-action and self-assessment to promote critical thinking among pharmacy students. *American Journal of Pharmaceutical Education, 72*, 1-8.
- Bangert-Drowns, R. L., & Bankert, E. (1990, April). *Meta-analysis of effects of explicit instruction for critical thinking*. Paper presented at the annual meeting of the American Educational Research Association, Boston.
- Baron, J. (1985). *Rationality and intelligence*. New York, NY: Cambridge University Press.
- Deane, M., & Borg, E. (2011). *Inside track: Critical thinking and analysis*. Essex, England: Pearson.
- Ennis, R. H. (1962). A concept of critical thinking. *Harvard Educational Review, 32*, 81-111.
- Ennis, R. H. (1989). Critical thinking and subject specificity: Clarification and needed research. *Educational Researcher, 18*, 4-10.
- Ennis, R. H., & Weir, E. (1985). *The Ennis-Weir critical thinking essay test*. Pacific Grove, CA: Midwest Publications.
- McPeck, J. (1981). *Critical thinking and education*. Oxford, UK: Martin Robertson.
- Facione, P. A. (1990). *Critical thinking: A statement of expert consensus for purposes of educational assessment and instruction. Research findings and recommendations*. Newark, DE: American Philosophical Association.
- Facione, P. (2015). *Critical thinking: What it is and why it counts*. Millbrae, CA: Insight Assessment, California Academic Press. Retrieved April 20, 2015, from <http://www.insightassessment.com/Resources/Critical-Thinking-What-It-Is-and-Why-It-Counts-DEXadobe.PDF>
- Facione, P. A., Facione, N. C., & Giancarlo, C. F. (1996). The motivation to think in working and learning. In E. Jones (Ed.), *Preparing competent college graduates: Setting new and higher expectations for student learning* (pp. 67-80). San Francisco, CA: Jossey Bass.
- Fasko, D. (2003). *Critical thinking and reasoning: Current research, theory, and practice*. Cresskill, NJ: Hampton Press.

- Halpern, D. F. (2007). *Halpern critical thinking assessment using everyday situations: Background and scoring standards*. Claremont, CA: Claremont McKenna College.
- Ku, K. Y. (2009). Assessing students' critical thinking performance: Urging for measurements using multi-response format. *Thinking Skills and Creativity, 4*, 70-76.
- Niu, L., Behar-Horenstein, L. S., & Garvan, C. W. (2013). Do instructional interventions influence college students' critical thinking skills? A meta-analysis. *Educational Research Review, 9*, 114-128.
- Nussbaum, E. M., Winsor, D. L., Aqai, Y. M., & Poliquin, A. M. (2007). Putting the pieces together: Online argumentation vee diagrams enhance thinking during discussions. *International Journal of Computer-Supported Collaborative Learning, 2*, 479-500.
- Lawson, T. J. (1999). Assessing psychological critical thinking as a learning outcome for psychology majors. *Teaching of Psychology, 26*, 207-209.
- Paul, R. (1993) *Critical thinking: How to prepare students for a rapidly changing world*. Santa Rosa, CA: Foundation for Critical Thinking.
- Pellegrino, J. W., & Hilton, M. L. (Eds.), (2012). *Education for life and work: Developing transferable knowledge and skills in the 21st century*, National Academies Press.
- Perkins, D. N., & Ritchhart, R. (2004). When is good thinking? In D. Y. Dai & R. J. Sternberg (Eds.), *Motivation, emotion, and cognition: Integrative perspectives on intellectual functioning and development*. Mahwah, NJ: Erlbaum.
- Renaud, R. D., & Murray, H. G. (2008). A comparison of a subject-specific and a general measure of critical thinking. *Thinking Skills and Creativity, 3*, 85-93.
- Taube, K. T. (1997). Critical thinking ability and disposition as factors of performance on a written critical thinking test. *The Journal of General Education, 46*, 129-164.
- Watson, G., & Glaser, E. M. (1980). *Watson-Glaser Critical Thinking Appraisal*. San Antonio, TX: PsychCorp.
- Wyer, K. (2009). *U.S. faculty: Civic engagement, diversity important goals for undergraduate education*. Retrieved August 26, 2015, from <http://www.heri.ucla.edu/PDFs/press/pr030509-08faculty.pdf>