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Skills for the 21st Century: teaching higher-order thinking

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It is hard to imagine a teacher or school leader who is not aware of the importance of teaching higher-order thinking skills to prepare young men and women to live in the 21st Century. However, the extent to which higher-order thinking skills are taught and assessed continues to be an area of debate, with many teachers and employers expressing concern that young people 'cannot think'.

What are we talking about when we talk about 'higher-order thinking'? Brookhart (2010) identifies definitions of higher-order thinking as falling into three categories: (1) those that define higher-order thinking in terms of *transfer*, (2) those that define it in terms of *critical thinking*, and (3) those that define it in terms of *problem solving*.

In the category of *transfer*, Anderson, Krathwohl et al (2001) define transfer in how it differs from retention: *Two of the most important educational goals are to promote retention and to promote transfer (which, when it occurs, indicates meaningful learning) … retention requires that students remember what they have learned, whereas transfer requires students not only to remember but also to make sense of and be able to use what they have learned*.

While learning for recall requires thinking, the higher-order thinking is in 'transfer'. That is, students not only acquire the knowledge and skills, but also can apply them to new situations. It is this kind of thinking, according to Brookhart (2010) that applies to life outside of school where thinking is characterised by 'a series of transfer opportunities (rather) than as a series of recall assignments to be done'.

The *critical thinking* category includes definitions that refer to 'reasonable, reflective thinking that is focused on deciding what to believe or do' (Norris & Ennis, 1989) and 'artful thinking', which includes reasoning, questioning and investigating, observing and describing, comparing and connecting, finding complexity, and exploring viewpoints (Barahal, 2008).

In critical thinking, being able ‘to think’ means students can apply wise judgment or produce a reasoned critique. The goal of teaching is then to equip students to be wise by guiding them towards how to make sound decisions and exercise reasoned judgment. The skills students need to be taught to do this include: the ability to judge the credibility of a source; identify assumptions, generalisation and bias; identify connotation in language use; understand the purpose of a written or spoken text; identify the audience; and to make critical judgments about the relative effectiveness of various strategies used to meet the purpose of the text.

In the *problem-solving* category Brookhart provides the following definition: *A student incurs a problem when the student wants to reach a specific outcome or goal but does not automatically recognize the proper path or solution to use to reach it. The problem to solve is how to reach the desired goal. Because a student cannot automatically recognize the proper way to reach the desired goal, she must use one or more higher-order thinking processes. These thinking processes are called problem solving* (Nitko & Brookhart, 2007). They may include remembering information, learning with understanding, critically evaluating ideas, formulating creative alternatives, and communicating effectively.

The broad definition of problem solving is that it is the skill that enables a person to find a solution for a problem that cannot be solved simply by memorising (ibid). While there are many closed problems–in maths for example–that require students to use memory to repeatedly practice a particular algorithm, many problems are open-ended and cannot be solved from memory alone. Or they may have more than one solution. Or they may be genuine problems where an answer is not yet known. Problems may also be open-ended in that solutions change as circumstances change. For example, living within a budget is an open-ended problem.

Bransford and Stein (1984) point out that problem solving is the general mechanism behind all thinking, including recall, critical thinking, creative thinking, and effective communication. They assert that to recall something, students have to identify it as a problem ("I need to memorise the planets, a poem, a list of capital cities. How can I do that?") and devise a solution that works for them. Similarly, critical thinking is a matter of problem solving–how well does Shakespeare develop this character?–and communication also involves problem solving–who is my audience? How do I need to best communicate with them? What words might I use to persuade?

Project Zero developed at Harvard University, provides an example of how teachers might help students to think by viewing works of art, using an ‘Artful Thinking Palette’ (Barahal, 2008). Students were asked to use six thinking dispositions to view art: exploring viewpoints, reasoning, questioning and investigating, observing and describing, comparing and connecting, and finding complexity. Teaching students these thinking skills is not only useful in art but in other disciplines, and in preparation for standardised tests such as the Queensland Core Skills Test.

Brookhart (2010) argues that if teachers think of higher-order thinking as problem solving they can set lesson goals to teach students how to identify and solve problems at school and in life. This, she says, involves not just solving problems set by the teacher but solving new problems that ‘they define themselves, creating something new as the solution’.

How do we teach higher-order thinking?

While Bloom’s Taxonomy is not the only framework for teaching thinking, it is the most widely used, and subsequent frameworks tend to be closely linked to Bloom’s work. A committee under the leadership of Dr Benjamin Bloom created the Taxonomy in 1956. Bloom’s aim was to promote higher forms of thinking in education, such as analysing and evaluating, rather than just teaching students to remember facts (rote learning). Learning was divided into three domains of educational activity:

- Cognitive: mental skills (*Knowledge*)
- Affective: growth in feelings or emotional areas (*Attitude or self*)
- Psychomotor: manual or physical skills (*Skills*)

While all three domains are important for a ‘rounded’ person, it is the first domain (Cognitive) that is the subject of this paper. The cognitive domain involves ‘knowledge and the development of intellectual skills’ (Bloom, 1956). The abilities and skills within the domain are listed in six major categories starting from the simplest thinking behaviour to the most complex (see Table 1). It is generally accepted that each behaviour needs to be mastered before the next one can take place. This is useful knowledge in assisting teachers in their lesson planning.

Table 1: Categories of The Cognitive Domain

Category	Example and Key Words
Knowledge: Recall data or information.	**Examples**: Recite a policy. Quote prices from memory to a customer. Know the safety rules. Define a term. **Key Words**: arranges, defines, describes, identifies, knows, labels, lists, matches, names, outlines, recalls, recognises, reproduces, selects, states.
Comprehension: Understand the meaning, translation, interpolation, and interpretation of instructions and problems. State a problem in one's own words.	**Examples**: Rewrite the principles of test writing. Explain in one's own words the steps for performing a complex task. Translate an equation into a computer spreadsheet. **Key Words**: comprehends, converts, defends, distinguishes, estimates, explains, extends, generalises, gives an example, infers, interprets, paraphrases, predicts, rewrites, summarises, translates.
Application: Use a concept in a new situation or unprompted use of an abstraction. Apply what was learned in the classroom into novel situations in the work place.	**Examples**: Use a manual to calculate an employee's vacation time. Apply laws of statistics to evaluate the reliability of a written test. **Key Words**: applies, changes, computes, constructs, demonstrates, discovers, manipulates, modifies, operates, predicts, prepares, produces, relates, shows, solves, uses.
Analysis: Separate material or concepts into component parts so that its organisational structure may be understood. Distinguish between facts and inferences.	**Examples**: Troubleshoot a piece of equipment by using logical deduction. Recognise logical fallacies in reasoning. Gather information from a department and select the required tasks for training. **Key Words**: analyses, breaks down, compares, contrasts, diagrams, deconstructs, differentiates, discriminates, distinguishes, identifies, illustrates, infers, outlines, relates, selects, separates.
Synthesis: Build a structure or pattern from diverse elements. Put parts together to form a whole, with emphasis on creating a new meaning or structure.	**Examples**: Write a company operations or process manual. Design a machine to perform a specific task. Integrate training from several sources to solve a problem. Revise and process to improve the outcome. **Key Words**: categorises, combines, compiles, composes, creates, devises, designs, explains, generates, modifies, organises, plans, rearranges, reconstructs, relates, reorganises, revises, rewrites, summarises, tells, writes.
Evaluation: Make judgments about the value of ideas or materials.	**Examples**: Select the most effective solution. Hire the most qualified candidate. Explain and justify a new budget. **Key Words**: appraises, compares, concludes, contrasts, criticises, critiques, defends, describes, discriminates, evaluates, explains, interprets, justifies, relates, summarises, supports.

In the mid-nineties, Lorin Anderson (2000), along with her colleagues, revisited the cognitive domain in the learning taxonomy and made two major changes. She changed the six categories from nouns to verbs; and slightly rearranged them so they became:

Table 2: Revised Categories of The Cognitive Domain

BLOOM	ANDERSON
Knowledge	**Remembering** **Examples:** Using memory to produce definitions, facts, or lists, or recite or retrieve material. **Key Words**: retrieving, recalling, recognising knowledge from memory.
Comprehension	**Understanding** **Examples:** Constructing meaning from different types of functions, be they written or graphic messages **Key Words:** interpreting, exemplifying, classifying, summarising, inferring, comparing, and explaining.
Application	**Applying** **Examples:** Applying related information and skills and referring to situations where learned material is used through products like models, presentations, interviews or simulations. **Key Words:** executing, implementing.
Analysis	**Analysing** **Examples:** Breaking material or concepts into parts, determining how the parts relate or interrelate to one another or to an overall structure or purpose. Creating spreadsheets, surveys, charts, diagrams, or graphic representations can represent analysing. **Key Words:** differentiating, organising, attributing, as well as being able to distinguish between the components or parts.
Synthesis	**Evaluating** **Examples:** Critiques, recommendations, and reports are some of the products that can be created to demonstrate the processes of evaluation. **Key Words:** checking, critiquing In Anderson's taxonomy evaluation comes before creating, as it is often a necessary part of the precursory behaviour before creating something.
Evaluation	**Creating** **Examples:** Creating requires users to put parts together in a new way or synthesise parts into something new and different to form a coherent or functional whole. **Key Words:** reorganising, generating, planning, producing Creating is 'synthesis' on Bloom's Taxonomy

Using the Taxonomy, teachers have a framework available to them that allows them to scaffold teaching thinking skills in a structured way. Teachers can do this through the following stages.

1. Specifically teaching the language and concepts of higher-order thinking

Teachers should not only teach the language and concepts but also tell students what they are doing and why higher-order thinking skills are necessary for them to problem-solve at school and in life. For example, by using a common language, students can recognise the skill they are exercising and the level of complexity of a question. When they see words like 'define', 'recognise', 'recall', 'identify', 'label', 'understand', 'examine', or 'collect', they know they are being asked to recall facts and demonstrate their knowledge of content. When they see words like, 'apply', 'solve', 'experiment', 'show', or 'predict', they understand they are being asked to demonstrate application. And when a question begins with 'appraise', 'judge', 'criticise', or 'decide', they understand the higher-order thinking skill they are practising is 'evaluation'. Teachers also have an instant checklist of whether or not the level of work they require from students is of sufficient complexity. Students should begin to practice higher-order thinking skills from primary school, but by the time they reach year 11 and 12 the bulk of class and assessment questions and discussion should be in the higher levels of the taxonomy.

2. Planning classroom questioning and discussion time to tap into particular higher-order thinking skills

The important word here is ‘plan’. Teachers, on the whole, are very good at ‘thinking on their feet’; however, without meticulous planning they are likely to ask recall questions rather than questions that require higher-order thinking. Similarly, discussions can be de-railed if they are not planned with a higher-order thinking learning objective in mind. While this does not mean every question or discussion has to be pitched at higher-order thinking, a good proportion should be. By carefully planning lessons and discussions, teachers can ensure the proportion is right. It is useful to ask a colleague to observe a class with a view to recording the percentage of higher-order thinking skills practiced in a lesson; or even to ask students to use the knowledge they have gained in learning the language of thinking to record the teacher's use of higher-order terms; or to observe and assess their classmates in planned activities. Teachers should also encourage students to reflect on their learning so they understand their thinking strengths and weaknesses.

3. Explicitly teaching subject concepts

The research is overwhelmingly in favour of explicit, direct instruction (Hattie, 2005; Marzano, 2011). This is particularly so in the teaching of concepts. Students need to understand the critical features that define what higher-order thinking skills they are practising. Once again, Bloom’s Taxonomy (or the Core Skills of the Queensland curriculum) is a useful place to start. In any subject area, students should be aware of the key concepts they must learn. They must be able to identify them and they must practice them. Teachers can help by alerting students when a key concept is being introduced, and identifying the explicit characteristics of the concept. Students need to understand whether the concept is concrete, abstract, verbal, nonverbal, or process.

For example, often students who perform poorly in mathematics have difficulty with nonverbal concepts. Simply working problems again and again with no verbal explanation will do little to help these students to understand maths concepts. Teachers have to spend time helping students to make strong connections between the manipulation of the symbols, the associated language and some form of concrete materials and images. By working through problems with students and verbalising the appropriate language, students begin to understand mathematical procedures.

Conversely, students who have difficulty with verbal concept formation need multiple examples with relatively less language, which may confuse them. That is, some students need to be *shown* how to solve a problem, some students *told*, and some need both.

In countries where attainment in maths is particularly high, it seems teachers ensure students have mastered basic concepts before proceeding to more sophisticated ones. Where students do not master basic concepts they are likely to attempt to memorise rather than to understand. While this works for them in the early years, it leads to misunderstanding and the inability to apply knowledge in the later years of schooling. It is also possibly the reason why many students ‘turn off’ maths.

Thomas and Thorne (2009) suggest a multi-step process for teaching and learning concepts, which includes:

1. name the critical (main) features of the concept
2. name some additional features of the concept
3. compare the new to the already known
4. name some false features of the concept
5. give the best examples or prototypes of the concept (what it is)
6. give some non-examples or non-prototypes (what the concept isn't)
7. identify other similar or connected concepts.

4. Providing scaffolding

Scaffolding involves giving students support at the beginning of a lesson and then gradually turning over responsibility to the students to operate on their own (Slavin, 1995). Without this limited temporary support students are unlikely to develop higher-order thinking skills; however too much scaffolding can be as detrimental as not enough. Kauchan and Eggen (1998) suggest teachers should provide ‘only enough support so that learners make progress on their own’. Too much or too little support can interfere with the development of higher-order thinking skills. Too little support, and students are left floundering; provide support even though students don’t ask for it, and they get the message they cannot do the task on their own.

Kauchan and Eggins (1998), propose the following guidelines:

1. Use scaffolding:

   - During initial learning, with a variety of examples to describe the thinking processes involved
   - Only when needed, by first checking for understanding and, if necessary, providing additional examples and explanations
   - To build on student strengths and accommodate weaknesses.

2. Provide structured representations and discussions of thinking tasks:

   - Visually represent and organise problems in concrete examples such as drawings, graphs, hierarchies, or tables
   - Demonstrate how to break up a thought problem into convenient steps, using a number of examples and encouraging students to suggest additional examples
   - Discuss examples of problems and solutions, explaining the nature of problems in detail and relating the worked-out solutions to the problems. This practice reduces the student's need for additional teacher assistance.

3. Provide opportunities for practice in solving problems

   - Provide teacher-directed practice before independent practice, spot-checking progress on practice and providing short responses of less than 30 seconds to any single request for assistance
   - Assign frequent, short homework assignments that are logical extensions of classroom work
   - Link practice in the content area to complex, real-life situations.

5. Consciously teach to encourage higher order thinking

In order to foster deep conceptual understanding, consider using the following strategies:

- Teach skills through real-world contexts
- Vary the context in which student use a newly taught skill
- Emphasise the building blocks of higher-order thinking
  - Build background knowledge
  - Classify things in categories
  - Arrange items along dimensions
  - Make hypotheses
  - Draw inferences
  - Analyse things into their components
  - Solve problems
- Encourage students to think about the thinking strategies they are using (more details available online: http://theonlinepd.files.wordpress.com/2008/03/teachinghigherorderthinking.pdf).

Using assignments and assessments that require intellectual work and critical thinking is associated with increased student achievement. These increases have been shown on a variety of achievement outcomes, including standardised test scores, classroom grades, and research instruments. The increases have been demonstrated in reading, mathematics, science, and social studies. And they have been documented particularly for low-achieving students. Evidence from both the National Assessment of Educational Progress (NAEP) and the Trends in International Mathematics and Science Study (TIMSS) report clear evidence that in mathematics and science instruction emphasising reasoning is associated with higher scores in all grade levels tested, while in reading, teaching for meaning (including thinking about main ideas, author's purpose, theme, and using real texts) is associated with higher NAEP performance, Wenglinsky (2004).

Higgins et al (2005), for example, did a meta-analysis of studies of thinking-skills interventions on student cognition, achievement, and attitudes. He and his colleagues found 29 studies, mostly from the United States and the United Kingdom that reported enough data to calculate effect sizes. They found very strong effects. The average effect of thinking-skills instruction was:

- 0.62 on cognitive outcomes (for example, verbal and nonverbal reasoning tests), over 29 studies.
- 0.62 on achievement of curricular outcomes (for example, reading, maths, or science tests), over 19 studies.
- 1.44 on affective outcomes (attitudes and motivation), over 6 studies.

Assessing higher-order thinking skills has also been shown to assist disadvantaged students. The 'Higher Order Thinking Skills' (HOTS) program designed by Pogrow (2005) specifically for educationally disadvantaged

students, is based on four kinds of thinking skills: (1) metacognition, or the ability to think about thinking; (2) making inferences; (3) transfer, or generalising ideas across contexts; and (4) synthesising information. The project is a pure thinking skills approach to assist disadvantaged students in grades 4–8 in the United States. It combines the use of Socratic dialogue, drama, and technology, and has been used in approximately 2,600 schools in 48 states. It produced student gains in standardised tests, on measures of metacognition, in writing, in problem solving, and in grade point average.

Furthermore, Pogrow found that in studies contrasting the efficacy of teaching higher-order thinking skills with teaching enhanced content instruction, the former was much better at setting up students to be flexible, allowing them to 'understand understanding' and to handle a variety of content.

Finally, research has shown that student motivation increases when teachers hold them accountable for higher-order thinking. This seems to be so, because teaching students higher-order thinking tasks forces them to engage in thinking about particular things, and undertaking assessment that requires intellectual work and critical thinking. Memorising, while it is useful in some cases, does not increase students' autonomy and, to a large extent, does not contribute to mastery, although it might be argued that knowing basic facts is essential in providing building blocks for understanding. Also, it should be noted that 'knowing things' for immediate recall is a relatively unimportant skill. In most things we do, it is not the facts that are important but how we apply knowledge. For example, knowing the times table is useful to save time, to help in estimating and because rote learning builds useful pathways in the brain, but it is only when we use our knowledge of tables to manage our finances, plan a budget, or make decisions about whether one item is more expensive than another, that we exercise problem solving and higher-order thinking.

Therefore, in order to assess so that students can demonstrate mastery, teachers need to plan assessment items that allow students to use all the skills of the Taxonomy: analysis, evaluation, and creation (the "top end" of Bloom's Taxonomy); logical reasoning; judgment and critical thinking; problem solving; and creativity and creative thinking.

There are countless resources online and on paper to assist in the teaching of higher-order thinking, and while these are useful, an effective teacher needs to make few changes to programs already in place in order to ensure that students are encouraged to think. The research suggests that constant awareness of the language teachers use, and reflection on how the skills might be incorporated in every lesson, are pivotal in making the difference.

Bibliography

Anderson, L., Krathwohl, D., Airasian, P. et al (2001), *A Taxonomy for Learning, Teaching, and Assessing: A revision of Bloom's Taxonomy of Educational Objectives*, New York: Pearson, Allyn & Bacon

Barahal, S. (2008), *Thinking about Thinking: Pre- Service Teachers Strengthen their Thinking Artfully*, Phi Delta Kappan 90 (4)

Bloom B. S. (1956), *Taxonomy of Educational Objectives, Handbook I: The Cognitive Domain*, New York: David McKay Co Inc.

Bransford, J., & Stein, B. (1984), *The IDEAL Problem Solver*, New York: W. H. Freeman

Brookhart, S. (2010), *How to Assess Higher Order Thinking Skills in Your Classroom*, ASCD, http://www.ascd.org/Publications/Books/Overview/How-to-Assess-Higher-Order-Thinking-Skills-in-Your-Classroom.aspx

Hattie, J. (2009), *Visible Learning: a Synthesis of Over 800 Meta-Analyses Relating to Achievement*, Oxon, OX: Routledge

Higgins, S., Hall, E., Baumfield V. & Moseley D. (2005), *A Meta-Analysis of the Impact of the Implementation of Thinking Skills Approaches on Pupils*, in Research in Education Library, London: EPPI-Centre, Social Science Research

Kauchak, D., & Eggen, P. (1998), *Learning and Teaching: Research-based Methods (3rd ed.)*, Boston: Allyn and Bacon

Marso, R., Pigge, F. (1992), *A Summary of Published Research: Classroom Teachers' Knowledge and Skills Related to the Development and Use of Teacher-Made Tests*, paper presented at the annual conference of the Midwestern Educational Research Association, Chicago, IL

Marzano, R. (2011), *The Art & Science of Teaching/ The Perils and Promises of Discovery Learning*, Educational Leadership, Volume 69, Number 1

Nitko, A. & Brookhart, S. (2007), *Educational Assessment of Students*, Pearson Merrill Prentice Hall

Norris, S. & Ennis, R. (1989), *Evaluating Critical Thinking*, Pacific Grove, CA: Midwest Publications

Pogrow, S. (2005), *HOTS Revisited: A Thinking Development Approach to Reducing the Learning Gap After Grade 3*, Phi Delta Kappan

Slavin, R. (1995), *A Model of Effective Instruction*, The Educational Forum, 59

Thomas, A., and Thorne, G. (2009), *How to Increase Higher Order Thinking*, Metarie, LA: Center for Development and Learning, http://www.readingrockets.org/article/34655
Wenglinsky, H. (2004), *Closing the Racial Achievement Gap: The Role of Reforming Instructional Practices*, Education Policy Analysis Archives, 12 (64)

Further Reading

Brookhart, S. (2010), *How to Assess Higher Order Thinking Skills in Your Classroom*, ASCD, http://www.ascd.org/Publications/Books/Overview/How-to-Assess-Higher-Order-Thinking-Skills-in-Your-Classroom.aspx
Teacher and author Susan M. Brookhart answers the questions: What does higher-order thinking look like? And how can teachers assess it across the disciplines?

Brookhart begins by laying out principles for assessment in general and for assessment of higher-order thinking in particular. She then defines and describes aspects of higher-order thinking according to the categories established in leading taxonomies, giving specific guidance on how to assess students in the following areas:

- Analysis, evaluation and creation
- Logic and reasoning
- Judgment
- Problem solving
- Creativity and creative thinking

The book covers how to use formative assessment to improve student work and then use summative assessment for grading or scoring.

Interesting sites:

http://theonlinepd.files.wordpress.com/2008/03/teachinghigherorderthinking.pdf

This site provides excellent information about why we should teach higher-order thinking skills and how to teach them.

Research in Action:

http://www.ascd.org/Publications/Books/Overview/How-to-Assess-Higher-Order-Thinking-Skills-in-Your-Classroom.aspx

This site includes a series of four short videos in which Dr Susan Brookhart describes, with examples, how best to assess higher order thinking skills in your classroom. The videos include: why higher order thinking is important, principles for designing assessment, assessing reasoning and assessing creativity. While the author regularly promotes her book in these videos, the contents of the videos are useful and worthwhile as simple and succinct summaries for teachers considering how to assess their students.

http://www.readingrockets.org/article/34655

Included on this site are specific conversations with students to test their thinking; examples of how to increase higher-order thinking; comments about evaluation; and recommended resources.

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Subject Heading

Subject Headings

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