Abstract

Critical thinking is a metacognitive process that, through purposeful, reflective judgement, increases the chances of producing a logical conclusion to an argument or solution to a problem. Instruction in critical thinking is becoming exceedingly important because it allows individuals to gain a more complex understanding of information they encounter and promotes good decision-making and problem-solving in real-world applications (Butler et al., 2012; Halpern, 2003; Ku, 2009). Due to what can be considered an exponential increase in the creation of new information every year (Darling-Hammond, 2008; Jukes & McCain, 2002), critical thinking skills are needed more than ever in order to aid individuals in becoming more adaptable, flexible and better able to cope with this rapidly evolving information. This review investigates existing theoretical frameworks of thinking skills and educational objectives, as well as cognitive models situated in empirical research; and aims to develop an integrated framework of learning outcomes based on the integration of these extant frameworks with recent conceptualisations of critical thinking.

Introduction

Critical thinking is often described as a metacognitive process, consisting of a number of sub-skills (e.g. analysis, evaluation and inference) that, when used appropriately, increases the chances of producing a logical conclusion to an argument or solution to a problem. The teaching of critical thinking (CT) skills has been identified as an area that needs to be developed (Association of American Colleges & Universities, 2010; Australian Council for Educational Research, 2002). CT skills are vital in educational settings because they allow individuals to go beyond simply retaining information, to actually gaining a more complex understanding of the information being presented to them (Dwyer, Hogan & Stewart, 2012; Halpern, 2003). CT skills are also important in social and interpersonal contexts where good decision-making and problem-solving are needed on a daily basis (Ku, 2009). Research suggests that good critical thinkers make better decisions and judgments in complex situations (Gambrill, 2006), engage less in cognitive bias and heuristic thinking (Facione & Facione, 2001; McGuinness, 2013) and are more likely to get better grades, become more informed and more active citizens, and are often more employable as well (Barton & McCully, 2007; Holmes and Clizbe, 1997; National Academy of Sciences, 2005).

CT courses have been taught at University in varying academic domains including law, philosophy, psychology, sociology and nursing, all with the goal of improving CT performance. Such CT courses have also been informed by varying conceptualisations of CT (e.g. Ennis, 1987; Facione, 1990b; Halpern, 2003; Paul, 1993). Though research indicates that CT can be improved in various academic domains (e.g. Abrami et al., 2008; Alvarez-Ortiz, 2007; Gadzella, Ginther & Bryant 1996; Hitchcock, 2004; Reed & Kromrey, 2001; Rimiene, 2002; Solon, 2007), these varying conceptualisations can make it difficult for researchers and teachers to understand or agree on the key components of good CT. These difficulties may impede the ability of researchers and teachers to construct an integrated theoretical account of not only how best to train CT skills but also how best to measure CT skills. Notably, the relationship between the concepts of CT that are taught and those that are assessed is often unclear; and a large majority of studies in this area include no theory to help elucidate these relationships (Dwyer, 2011).

Despite potential difficulties in assessing CT, both Abrami et al.'s (2008) and Alvarez-Ortiz's (2007) meta-analyses indicate that making CT learning objectives explicit to students is crucial in improving CT ability. That is, in order to improve CT ability, students must be aware of what it is they are supposed to be learning; and likewise; their teachers must also be aware what it is they are supposed to be teaching. Arguably, however, this is not often the case. According to one university lecturer interviewed in Lloyd and Bahr's (2010, p. 13) qualitative research, "we expect students to do it [think critically], but now you are questioning me on my understanding of it, I wonder if I actually understand it myself." Lloyd and Bahr's research further revealed that while 37% of academics instructing or assessing CT in university courses at least acknowledge the dispositional and self-regulatory aspects of CT, only 47% described CT in terms of involving processes or skills.

Although the development of CT skills is seen as increasingly important for successfully adapting to the modern world (Halpern, 2003), there has been limited agreement on how to define CT (e.g. Bensley, 1998; Ennis, 1987; Moseley et al., 2005; Paul, 1993) and its relationship with other cognitive processes such as memory and comprehension (Dwyer, 2011; Halpern, 2003). In this paper, we situate CT in a broad framework of thinking skills that identifies and organises six key learning outcomes (i.e. memory, comprehension, analysis, evaluation, inference and reflective judgment). We also describe how other metacognitive processes, including

self-regulatory skills and thinking dispositions are central to understanding CT in action, and we highlight the importance of this broad skill-set for adapting to today's ever-changing world.

Frameworks for Thinking & Learning Outcomes

Frameworks for thinking processes may be developed for a number of specific reasons, for example, to address educational objectives, instructional design, productive thinking, or cognitive development. In this context, a number of frameworks are considered because the processes they describe as being necessary in educational settings are also necessary for the successful application of critical thinking. Bloom's (1956, p.12) taxonomy of educational objectives was developed to classify "mental acts or thinking [resulting from] educational experiences", and was one of the first frameworks to characterise thinking as an array of both lower-order and higher-order thinking processes - consistent with many modern conceptualisations of critical thinking (e.g. Reeves, 1990). Bloom's taxonomy of educational objectives consists of six hierarchically arranged categories of thought (see Figure 1), which notably, are consistent with those identified in this review as comprising CT and processes associated with CT.

Romiszowski's (1981) framework for knowledge and skills, which was heavily influenced by Bloom's taxonomy, presents a skill-cycle that not only describes the cognitive processes necessary in educational settings, but also the way in which they interact and develop. For Romiszowski, skills act upon novel, incoming information as well as pre-existing knowledge. During the skill-cycle, an individual perceives, recalls, makes plans and performs based on knowledge of facts, procedures, concepts and principles.

Insert Figure 1 around here

Anderson and Krathwohl's (2001) taxonomy follows Romiszowski's general principle of describing thinking in terms of actions, specifically, by transforming Bloom's thinking processes from noun form to verb form (e.g., renaming evaluation as evaluating). Anderson and Krathwohl also place creation (formerly, synthesis in Bloom's taxonomy) as the pinnacle process in the hierarchy of learning outcomes, and similar to Romiszowski, Anderson and Krathwohl treat knowledge as a separate dimension and highlight a unique form of knowledge - metacognitive knowledge, which refers to strategic knowledge, knowledge about cognitive processes and tasks, and self-knowledge (Anderson & Krathwohl, 2001).

Similarly, Marzano's (2001) taxonomy includes a metacognitive system, which acts as an executive control system focused on goal and process specification, as well as process and disposition monitoring (Marzano, 1998). Marzano's taxonomy is similar to other frameworks in that it includes a knowledge domain and processes (under the broad category of the cognitive system) of knowledge retrieval (i.e. memory/recall), comprehension (i.e. knowledge representation), analysis (i.e. classifying, identifying errors, generalising, matching and specifying) and knowledge utilisation (i.e. decision-making, problem-solving, investigation and experimental enquiry). At the highest level in Marzano's taxonomy is the self-system in which goals are produced. It is in the self-system where motivation, attention, and beliefs help to determine whether or not any given task will be undertaken.

Though the taxonomies presented above are descriptive in terms of identifying thinking processes and the links among them, it is also important to consider the empirical, cognitive psychology research which has investigated key thinking processes. In addition, a possible weakness of the frameworks above is that they do not adequately elaborate on the manner in which one applies higher-order thinking processes (Krathwohl, 2002; Moseley et al., 2005). One feature of *application* that is pertinent in this context is the reflective judgment an individual brings to bear in the application of knowledge, which will also be elaborated upon below as a key feature of CT. Thus, the focus of this paper now turns to a more detailed discussion of each of the six key processes outlined above (i.e. memory, comprehension, analysis, evaluation, inference and reflective judgment).

Memory

Higher-order thinking skills, such as CT skills, are dependent upon memory, given that it is not possible for one to use higher-order thinking processes if one does not know, or cannot remember the information one is supposedly thinking about (Krathwohl, 2002). This is an important issue to consider given that it has been argued by researchers in the field of critical thinking that the ability to think critically about specific information (i.e. analyse, evaluate, and infer reasonable conclusions) is directly affected by one's ability to recall and understand (i.e. lower-order thinking skills) the information one is required to think about (Halpern, 2003, Maybery, Bain and Halford, 1986). In order for an individual to remember information (i.e. the foundation stone in Bloom's taxonomy), a number of processes are important. After it is actively attended to, information is held in limited capacity short-term storage, and through manipulation of that information within short-term storage, it can be encoded into permanent storage, where it is represented as knowledge and can be subsequently retrieved (Atkinson & Shiffrin, 1968; Broadbent, 1958; Baddeley, 2000; Baddeley & Hitch, 1974; Craik and Tulving, 1975). A large body of empirical research conducted by Alan Baddeley and colleagues (e.g. Baddeley 1986, 2000, 2002; Baddeley & Hitch, 1974; Baddeley & Wilson, 2002), suggests that this short-term storage is better described as a multiple component working memory system, which includes two slave systems (i.e. the phonological loop and the visuospatial sketchpad); a central executive (i.e. which has more recently been argued to be an attention focusing process associated with long-term memory, rather than a separate, governing component included in working memory; Dwyer, 2011; Sweller, 2005); and a storage centre known as the episodic buffer, which also integrates novel information from working memory with existing knowledge from long-term memory (Baddeley, 2000; 2002).

Whereas working memory can store a limited amount of information for a limited amount of time, long-term memory (LTM) is a region of memory that enables relatively permanent storage of information, for example, facts in semantic LTM, events in episodic LTM, and procedures in procedural LTM (Tulving, 1984). The likelihood of information being stored in LTM is increased when it is encoded into one's existing schemata/schemas (i.e. representations of knowledge that have been assembled from previous experience, which allow for treatment of multiple elements of information as a single element categorised according to the manner in which it will be used (Sweller, 1999). Schemas can be used to facilitate the assimilation of new information, through organising smaller, specific schemas (i.e. lower-order schemas) into a larger, more comprehensive and complex schema (i.e. a higher-order schema). However, for schemas to be constructed in a meaningful way that support subsequent memory, the information subject to schema construction must be understood, or comprehended (Pollock, Chandler & Sweller, 2002; Sweller, 2005; 2010).

Comprehension

By some accounts, schema-construction is essentially the same as building understanding, or comprehension (Pollock, Chandler & Sweller, 2002; Sweller, 2005). In Bloom's (1956) taxonomy, comprehension involves explaining, summarising, paraphrasing, or illustrating information based on prior learning (Huitt, 2011). Sweller (2005) explicitly links comprehension and memory processes, describing comprehension as changes in LTM, along with the effect of those changes on working memory - a perspective supported by research indicating a significant, positive correlation ($r = .31$, $p < .001$) between comprehension performance and recall performance (Dwyer, 2011). Without changes in LTM, nothing has been understood.

Sweller further describes comprehension as the ability to integrate schemas from LTM with novel information simultaneously in working memory. For a diagram of the relationships among working memory, LTM and comprehension in this context, see Figure 2. Sweller (1999) further simplifies his conceptualisation of comprehension by describing it as the ability to make required connections between new information and/or schemas. Making such connections allows individuals to gain understanding of novel information, create new levels of comprehension and, subsequently, solve problems. Consistent with the thinking frameworks reviewed above, the ability to apply knowledge and understanding, and also solve problems, often depends on an individual's metacognitive abilities.

Insert Figure 2 around here

Metacognition

Though the term metacognition was not used by Bloom, many modern conceptualizations of metacognition are related in important ways to the higher-order thinking skills described by Bloom (Wegerif, 2002). Metacognition was first described by Flavell (1976, p. 232) as "knowledge concerning one's own cognitive processes and products or anything related to them; and the active monitoring, consequent regulation and orchestration of these processes". According to Boekaerts and Simons (1993), Brown (1987) and Ku and Ho (2010), individuals think metacognitively in two ways: first, individuals must be aware of their own cognitive processes (i.e. self-regulation); second, individuals must be able to apply available cognitive processes for purposes of learning or devising solutions to problems. Together, these self-regulatory processes and specific high-level cognitive processes are central to our conceptualisation of CT (see Figure 3).

Self-Regulatory Functions of Metacognition

Though one may possess the cognitive skills necessary to conduct CT, the willingness to conduct these skills ultimately dictates how well they are performed (Ennis, 1998; Facione et al., 2002; Halpern, 2003, 2006). Along with the ability to perform CT skills, "a critical thinker must also have a strong intention to recognise the importance of good thinking and have the initiative to seek better judgment" (Ku, 2009, p. 71). This willingness to self-regulate can be described in terms of executive function, key dispositions towards thinking, the motivation to think and learn, and the perceived need to use specific cognitive processes when solving problems. Executive function refers to metacognitive processes (Gagne, 1985; Moseley et al., 2005), used to

self-regulate thought, such as attention (Banich, 2009; Miyake et al., 2000; Norman & Shallice, 1986), memory processes (Hofmann, Schmeichel & Baddleey, 2012; Miyake et al., 2000; Norman & Shallice, 1986) and higher-order thinking skills (Barkley, 1997; Miller & Cohen, 2001; Moseley et al., 2005; Zelazo et al., 1997). Possessing a disposition towards thinking refers to the extent to which an individual is inclined to perform a given thinking skill (Valenzuela, Nieto & Saiz, 2011). Specific dispositions have also been described, including truth-seeking, open-mindedness, analyticity, systematicity, confidence, inquisitiveness and maturity (Facione & Facione, 1992). A large body of research has demonstrated significant correlations between CT dispositions and CT ability (Colucciello, 1997; Dwyer, 2011; Facione, Facione & Sanchez, 1994; Facione, 2000; Profeto-McGrath, 2003; Rimiene, 2002).

Insert Figure 3 around here

A number of researchers also emphasise the importance of motivation as a process used to activate the cognitive and metacognitive resources necessary to conduct good CT (Ennis, 1996; Norris, 1994; Perkins, Jay & Tishman, 1993). Motivation towards thinking and learning includes, for example, the motivation to regulate effort, thinking processes and learning beliefs (Pintrich et al., 1991). Consistent with this position, research indicates that CT ability is often significantly correlated with motivation towards learning (e.g. Dwyer, 2011; Dwyer, Hogan & Stewart, 2012; Garcia, Pintrich & Paul, 1992; Valenzuela, Nieto & Saiz, 2011), as well as one's perceived need for such thinking processes (Dwyer, 2011; Dwyer, Hogan & Stewart, 2012; Halpern, 2006). Though the self-regulatory functions of thinking are important to consider as part of any effort to understand how an individual applies their CT skills, the skills of analysis, evaluation, inference and reflective judgment are the cognitive backbone of critical thinking.

Thinking Critically

Though debate is ongoing over the definition of CT and the core skills necessary to think critically, one definition and list of skills stands out as a reasonable consensus conceptualisation of CT. In 1988, a committee of 46 experts in the field of CT gathered in an effort to agree upon a definition of CT and the skills necessary to think critically. The report of the findings of this meeting, known as The Delphi Report, defined CT as:

> "…purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation, and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which that judgment is based" (Facione, 1990b, p. 3).

Furthermore, the Delphi panel overwhelmingly agreed (i.e. 95% consensus) that analysis, evaluation and inference were the core skills necessary for CT (Facione, 1990b). Notably, recent research indicates strong relationships among these skills, as analysis and evaluation ($r = .40$, $p < .001$), analysis and inference ($r = .36$, $p < .001$) and evaluation and inference ($r = .48$, $p < .001$) were all significantly, positively correlated (Dwyer, Hogan & Stewart, 2011).

Analysis

Analysis is a CT skill that is used in the context of argumentation to detect, examine and identify the propositions within an argument and the role they play; for example, the main conclusion, the premises and reasons provided to support the conclusion, objections to the conclusion and inferential relationships among propositions (Facione, 1990b). Notably, at the core of the Delphi definition of analysis is the ability to recognise the structure of an argument, which depends not only on one's knowledge and skill as a reader/listener, but also on the way in which an author/speaker uses relational cues, or signals, that guide the reader/listener (Meyer, Brandt & Bluth, 1980). For example, words like but, because and however can be used by the author/speaker to indicate that propositions that follow are objections, reasons, or rebuttals for propositions that have come before. Notably, the organisation of propositions within an argument is critical for the reader, as the resulting structure has been found to affect the reader's ability to recall and comprehend information within t he argument (e.g. Meyer, Brandt & Bluth, 1980; Munch, Boller & Swasy, 1993, Myers, 1974).

Evaluation

Evaluation is a CT skill that is used in the assessment of propositions and the conclusions they infer with respect to their credibility, relevance, logical strength and the potential for omissions, bias and imbalance in the argument; thus, deciding the overall strength or weakness of the argument (Facione, 1990b). Evaluating the credibility of claims and arguments involves progressing beyond merely identifying the source of propositions in an argument, to actually examining the credibility of those identified sources (e.g. personal experiences, common beliefs/opinions, expert/authority opinion and scientific evidence). Evaluation also implies deep consideration of the relevance of claims within an argument, which is accomplished by assessing the contextual relevance of claims and premises (i.e. the pertinence or applicability of one proposition to another). Evaluating the logical strength of an argument is accomplished by monitoring both the logical relationships amongst propositions and the claims they infer. Finally, evaluating the balance and bias in an argument allows for progression beyond identifying an argument's balance, bias and potential omissions, to being able to question and adequately address the motives behind such balance (or imbalance), bias and potential omissions.

Inference

Like Bloom's (1956) conceptualisation of synthesis, inference, involves the "gathering" of credible, relevant and logical evidence based on the previous analysis and evaluation of available evidence, for the purposes of "drawing a reasonable conclusion" (Facione, 1990b, p. 9). Drawing a conclusion always implies some act of synthesis. However, inference is a unique form of synthesis in that it involves the formulation of a set of consequences and conclusions that are derived from a set of arguments or a body of evidence. This may imply accepting a conclusion pointed to by an author in light of the evidence they present, o r "conjecturing an alternative", equally logical, conclusion or argument based on the available evidence (Facione, 1990b, p.9). According to the Delphi definition, another important aspect of inference is "querying the evidence" available, for example, by recognising the need for additional information or justification and by being able to gather such additional information or justification to draw a conclusion; and to judge the plausibility of utilising such additional information or justification for purposes of conjecturing an alternative conclusion. Notably, in the

context of querying evidence and conjecturing alternative conclusions, inference overlaps with evaluation to a certain degree in that both skills are used to judge the relevance and acceptability of a claim or argument. Nevertheless, it remains necessary to query and judge the inclusion of propositions within an argument, before gathering them to draw a conclusion.

The definition of CT provided by the Delphi Report was adopted by the America n Philosophical Association and as a result, became the accepted definition for good CT (Beckie, Lowry & Barnett, 2001; Sorensen & Yankech, 2008). Though the Delphi Report has shed some light on what CT is, how to conceptualise it and how to measure it, at the same time, it is often acknowledged that CT skills take time to develop (Dawson, 2008a; Halpern, 2003; King & Kitchener, 1994; Kuhn, 1999). In order for CT to develop to an optimal level, related metacognitive processes may be needed to support both CT skill development and the successful application of CT to real-world problems. Reflective judgment is one such metacognitive process that can aid in the support, development and application of CT, particularly in the context of real-world problems.

Reflective Judgment

The ability to conduct metacognition and apply CT skills to a particular problem implies a reflective sensibility and the capacity for reflective judgment (King & Kitchener, 1994). Reflective judgment (RJ) is an individuals' understanding of the nature, limits, and certainty of knowing and how this can affect how they defend their judgments and reasoning (King & Kitchener, 1994), especially in contexts where ill-structured problems are encountered (King, Wood & Mines, 1990). Moreover, RJ involves the ability of an individual to acknowledge that their views might be falsified by additional evidence obtained at a later time (King & Kitchener, 1994). Thus, it is not only the conclusion one reaches, but also the manner in which one arrives at the conclusion that is important in RJ.

RJ is often considered as a component of CT (Baril et al., 1998; Huffman et al., 1991), because RJ allows one to acknowledge that epistemic assumptions are vital to recognising and judging a situation in which CT may be required (King & Kitchener, 1994). RJ may also influence how well an individual applies each CT skill (King, Wood & Mines, 1990). Research suggests that like CT skills, child and adult development may see a progressive development of RJ ability toward greater levels of complexity and skill (Kitchener &King, 1981). Notably, RJ development is not a simple function of age or time, but more so a function of the amount of active engagement with topics that require CT (e.g. ill-structured problems), such that the development of higher levels of reasoning and RJ ability can emerge (Brabeck, 1981; Dawson, 2008a; Fischer & Bidell, 2006). In this context, the more developed one's RJ, the better able one is to present "a more complex and effective form of justification, providing more inclusive and better integrated assumptions for evaluating and defending a point of view" (King & Kitchener, 1994, p. 13).

The relationship between CT and RJ has been confirmed in a number of research studies and the suggestion has been made that CT and RJ develop in an interdependent, cyclical manner (Brabeck, 1981; Dawson, 2008a; Dwyer, 2011; King & Kitchener, 1994; King, Wood & Mines, 1990). For example, Brabeck (1981) assessed 119 university students on both CT and RJ ability. CT was measured using the Watson-Glaser Critical Thinking Appraisal (WGCTA, Watson & Glaser, 1980) and RJ was measured using the Reflective Judgment Interview (Kitchener & King, 1981). Results revealed a positive correlation between both measures (*r*

= .40, *p* < .001). There was also a significant difference between high-scoring and low-scoring critical thinkers on RJ performance.

Based on these findings, Brabeck (1981) suggested that there is an inextricable link between CT and RJ. This link was confirmed by further research conducted by King, Wood and Mines (1990), which examined the RJ and CT performance of both university undergraduate and graduate students. Results revealed a significant correlation between RJ (as measured by the Reflective Judgment Interview) and CT, measured using both the WGCTA and the Cornell Critical Thinking Test (Ennis, Millman & Tomko, 1985; *r* = .46, *p* < .01 for both). More recently, research by Dwyer (2011) revealed a similar, positive correlation (*r* = .43, *p* < .01) between RJ (as assessed by the Lectical Reflective Judgment Assessment; Dawson, 2008b) and CT (as assessed by the California Critical Thinking Skills Test; Facione, 1990a).

Though this research does indicate that RJ and CT are significantly correlated, it is less clear from the literature how the development of RJ might facilitate the development of CT and vice versa. While RJ models are traditionally developmental (e.g. Kitchener & King, 1981; King & Kitchener, 1994; 2002), models of CT do not provide a detailed account of how specific CT sub-skills of analysis, evaluation and inference develop (e.g. Ennis, 1998; Halpern, 2003a; Paul, 1993). For example, it may be that a certain level of RJ ability is needed before a student can begin to understand and apply certain CT sub-skills (e.g. evaluating logical strength and inferring plausible conclusions or alternatives). Thus, further research is necessary to provide more than correlational evidence alone in support of the link between RJ and CT development. Nevertheless, it is reasonable to assume that through the acknowledgment of uncertainty in decision-making and problem-solving, an individual with good RJ will be able to apply CT skills with caution and awareness of the alternative conclusions and/or solutions that may be drawn. This perspective is supported by recent research which indicates that RJ may be more closely aligned with dispositional factors associated with CT, rather than CT skills per se (Dwyer, Hogan & Stewart, in preparation). Also consistent with this view, it has been noted that those who show good RJ are more likely to exhibit greater care when *applying* CT skills (King & Kitchener, 2004).

An Integrative Framework

Cumulatively, the theoretical and research-based models described above are integrated into a cognitive framework of learning outcomes (see Figure 4 below). Similar to many existing frameworks, the proposed framework identifies memory/knowledge and comprehension as foundational processes necessary for the successful application of CT (i.e. analysis, evaluation and inference). The proposed framework also integrates reflective judgment, as well as the self-regulatory functions of metacognition, which both ultimately dictate how well each thinking process will be conducted. Such a framework is necessary in order to address the lack of impetus focused on training CT skills (Abrami et al., 2008; Dwyer, 2011; Ennis, 1998; Halpern, 2003) and at the same time, provide a framework for CT training that makes explicit the learning outcomes associated with critical thinking.

Insert Figure 4 around here

To reiterate, the teaching of CT skills has been identified as an area that needs to be developed in educational settings because they allow individuals to go beyond simply retaining information, to actually gaining a more complex understanding of the information being presented to them (Halpern, 2003). Consistent with Ennis' (1998) typology of CT instruction, research by Abrami and colleagues (2008) indicates that, for optimal CT instruction in the classroom, the CT element of instruction must be made explicit to students. That is, students must be aware that they are being taught CT and that they are expected to apply CT skills to whatever topic they are studying. In addition to this explicit mixing or infusing of CT into instruction, recent research suggests that the provision and construction of hierarchically structured argument maps increases CT ability in students (Dwyer, 2011; Dwyer, Hogan & Stewart, 2011).

It is important to acknowledge that, though CT may be best cultivated initially in an educational environment, for example, through explicit instruction (Abrami et al., 2008) and the use of hierarchical aids, such as argument mapping (Alvarez-Ortiz, 2007; Dwyer, Hogan & Stewart, 2012; Butchart et al., 2009; van Gelder, 2000; 2001), the importance of CT utilisation is not restricted to such settings (Butler et al., 2012; Ku & Ho, 2010; Halpern, 2003). Rather, CT should be endorsed and used in real-world scenarios, for example, when problem-solving, hypothesis testing, analysing arguments, and assessing risks and probabilities (Butler et al., 2012; Dwyer, Hogan & Stewart, 2012; Halpern, 2003; 2010). Given the rate at which new information is being produced (Darling-Hammond, 2008; Jukes & McCain, 2002; Varian & Lyman, 2003), it is important for individuals to have the ability and willingness to engage critically with new information, so that they can constructively solve problems, draw reasonable conclusions and make informed decisions. Moreover, CT training may ultimately help people to become more adaptable, flexible and better able to cope with the rapid development of ever-evolving information.

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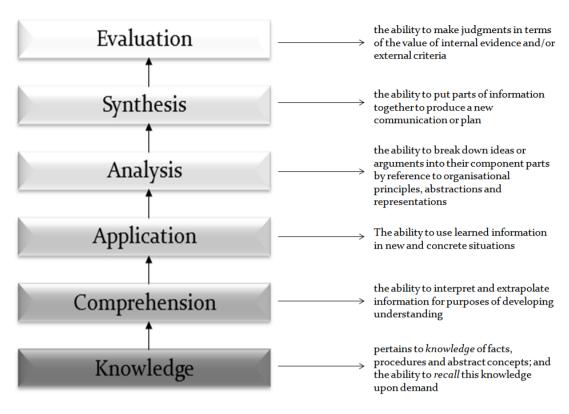
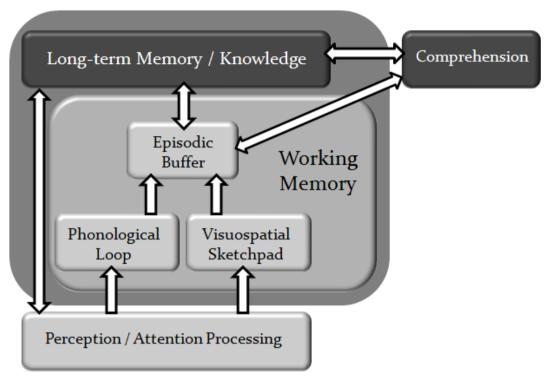Figure 1: Bloom's Taxonomy (1956)

Figure 2: Working Memory as a buffer between informational input and storage in LTM as knowledge
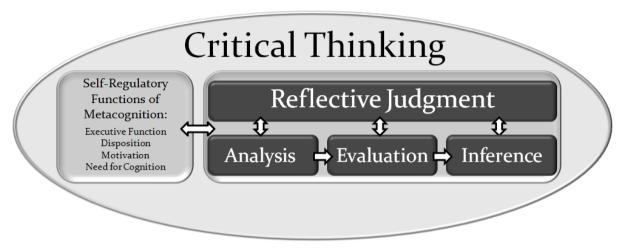
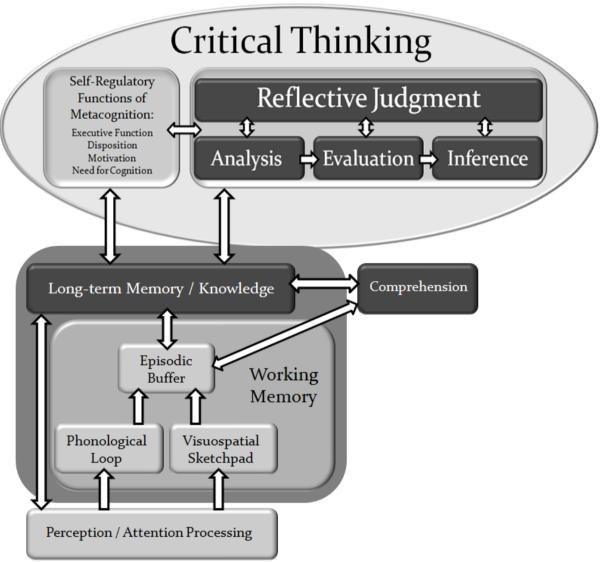Figure 3: The Interdependencies among the Self-Regulatory Functions of Metacognition, CT Skills and Reflective Judgment

Figure 4: An Integrative Framework of Critical Thinking