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Metacognition

Gloria Stillman
Faculty of Education, Australian Catholic University, Ballarat Campus (Aquinas), Ballarat, VIC, Australia

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Metamemory; Metacognitive knowledge; Metacognitive experiences; Metacognitive strategies

Definition

Any knowledge or cognitive activity that takes as its object, or monitors, or regulates any aspect of cognitive activity; that is, knowledge about, and thinking about, one's own thinking.

Characteristics

Although the construct, metacognition, is used quite widely and researched in various fields of psychology and education, its history is relatively short beginning with the early work of John Flavell on *metamemory* in the 1970s. Metamemory was a global concept encompassing a person's knowledge of "all possible aspects of information storage and retrieval" (Schneider and Artelt 2010). Flavell's (1979) model of metacognition and cognitive monitoring has underpinned much of the research on metacognition since he first articulated it. It was a revised version of his taxonomy of metamemory that he had developed with Wellman (Flavell and Wellman 1977). According to his model, a person's ability to control "a wide variety of cognitive enterprises occurs through the actions and interactions among four classes of phenomena: (a) metacognitive knowledge, (b) metacognitive experiences, (c) goals (or tasks), and (d) actions (or strategies)" (p. 906). *Metacognitive knowledge* incorporates three interacting categories of knowledge, namely, personal, task, and strategy knowledge. It involves one's (a) *sensitivity* to knowing how and when to apply selected forms and depths of cognitive processing appropriately to a given situation (similar to subsequent definitions of partly what is called *procedural metacognitive knowledge*), (b) intuitions about intra-individual and inter-individual differences in terms of beliefs, feelings, and ideas, (c) knowledge about task demands which govern the choice of processed information, and (d) a stored repertoire of the nature and utility of cognitive strategies for attaining cognitive goals. The first of these is mostly implicit knowledge, whereas the remaining three are explicit, conscious knowledge. *Metacognitive experiences* are any conscious cognitive or affective experiences which control or regulate cognitive activity. Achieving *metacognitive goals* are the objectives of any metacognitive activity. *Metacognitive strategies* are used to regulate and monitor cognitive processes and thus achieve metacognitive goals.

In the two decades that followed when Flavell and his colleagues had initiated research into metacognition (Flavell 1976, 1979, 1981), the use of the term became a buzzword resulting in an extensive array of constructs with subtle differences in meaning all referred to as metacognition (Weinert and Kluwe 1987). This work was primarily in the area of metacognitive research on reading; however, from the early 1980s, work in mathematics education had begun mainly related to problem solving (Lester and Garofalo 1982) particularly inspired by Schoenfeld (1983, 1985, 1987) and Garofalo and Lester (1985). Cognition and metacognition were often difficult to distinguish in practice, so Garofalo and Lester (1985) proposed an operational definition distinguishing cognition and metacognition which clearly demarcates the two, namely, cognition is "involved in doing," whereas metacognition is "involved in choosing and planning what to do and monitoring what is being done" (p. 164). This has been used subsequently by many researchers to be able to delineate the two.

Today, the majority of researchers in metacognitive research in mathematics education have returned to the roots of the term and share Flavell's early definition and elaborations (Desoete and Veenman 2006). The field has firmly established the foundations of the construct and by building on these foundations, several researchers have extended Flavell's work usefully and there is an expanding body of knowledge in the area. The elements of his model have been extended by others (e.g., elaborations of metacognitive experiences, see Efklides 2001, 2002) or are the subject of debate (e.g., motivational and emotional knowledge as a component of metacognitive knowledge, see Op 't Eynde et al. 2006). Subsequently, it has led to many theoretical elaborations, interventions, and ascertaining studies in mathematics education research (Schneider and Artelt 2010).

Flavell did not expect metacognition to be evident in students before Piaget's stage of formal operational thought, but more recent work by others has shown that preschool children already start to develop metacognitive awareness. Work in developmental and educational psychology as well as mathematics education has shown that metacognitive ability, that is, the ability to gainfully apply metacognitive knowledge and strategies, develops slowly over the years of schooling and there is room for improvement in both adolescence and adulthood. Furthermore, studying the developmental trajectory of metacognitive expertise in mathematics entails examining both frequency of use and the level of adequacy of utilization of metacognition. Higher frequency of use does not necessarily imply higher quality of application, with several researchers reporting such phenomena as *metacognitive vandalism*, *metacognitive mirage* and *metacognitive misdirection*. Metacognitive vandalism occurs when the response to a perceived metacognitive trigger ("red flag") involves taking drastic and destructive actions that not only fail to address the difficulty but also could change the nature of the task being undertaken. Metacognitive mirage results when unnecessary actions are engaged in, because a difficulty has been perceived, but in reality, it does not exist. Metacognitive misdirection is the relatively common situation where there is a potentially relevant but inappropriate response to a metacognitive trigger that is purely inadequacy on the part of the task solver not deliberate vandalism. Recent research shows that as metacognitive