Chapter 51
Using Metacognitive Strategies in the STEM Field

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ABSTRACT

Too often, we teach students what to think but not how to think. This quote embodies the concept of metacognition and its importance to student learning. Students frequently do not use learning techniques to truly learn information and develop long-term understanding of the curriculum at hand. Instead they memorize information for exams without understanding the depth of what they have studied. This in turn can create a pseudo-understanding of the curriculum. The metacognitive strategies we teach students allow them to become good learners. In this chapter we discuss the relationships between metacognition and critical thinking, problem solving, motivation, and academic performance. Specifically, the STEM area of mathematics is discussed. The chapter brings together multiple perspectives on metacognition and the importance of engaging students in metacognitive activities and strategies to improve learning outcomes.

INTRODUCTION

Too often, we teach students what to think but not how to think. This sentence embodies the concept of metacognition and its importance to student learning. The metacognitive strategies we teach students allow them to become *good learners*. In this chapter we discuss the relationship between metacognition and motivation, problem solving, critical thinking, and academic performance. Specifically, the area of

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mathematics is discussed. It brings together multiple perspectives on metacognition and the importance of engaging students in metacognitive activities and strategies to improve learning outcomes.

Often, students are not using learning techniques to truly learn information and develop long-term understanding of the curriculum at hand. Instead they memorize information for exams without understanding the depth of what they have studied. This in turn can create a pseudo-understanding of the material. In an educational environment, metacognitive learning requires students to cultivate a plan for the curriculum, monitor by reflecting on their learning process, and adapt their plan correspondingly in order to secure deeper, more robust, and more transferrable learning (Zhao, Wardeska, McGuire, & Cook, 2014).

The application of metacognitive strategies is important to improving student learning outcomes. Knowledge of cognition - understanding one's own way of learning, and regulation of cognition, the way one uses what he has learned, work together. These cognition concepts help individuals solve problems by allowing them to process information thoroughly and apply the processed information. By becoming aware of their own learning process, they can rearrange and improve their learning strategies. Not only does metacognition create good learners by helping the student understand their mental weaknesses and strengths, but also by helping the student become aware of anxiety and motivation factors that hinder them from learning thoroughly (Tok, 2013).

This chapter begins with discussions on critical thinking and motivation and the role they play in developing metacognition in students. The chapter then evolves into relevant areas that are related to metacognition, which include problem solving skills and academic performance. Next is a discussion on the use of metacognitive strategies in mathematics and how these strategies can be affected by math anxiety. The chapter includes an empirical study of metacognitive strategies in an undergraduate course. This pilot study was intended to add to the current understanding and use of metacognitive strategies in college students studying basic statistics.

This chapter concludes with a discussion regarding how metacognitive strategies can be infused into courses. Metacognition is important because it can increase student learning (Dean & Kuhn, 2003). In addition to learning the material, students must be aware of what they do or do not understand about the material. These learning strategies can help students to apply and transfer knowledge to all aspects of life whether it is in a professional, educational, or daily-life setting.

Metacognitive strategies can be used to help shape courses, thereby encouraging students to become active participants in their own learning. This chapter reviews current research on metacognition while highlighting ways to effectively use this information to help students improve critical thinking skills and academic performance. These learning strategies can be used by faculty in higher education to help improve student-learning outcomes.

BACKGROUND

The idea of metacognition has gained considerable attention in recent years. Metacognition put into the simplest of terms is "thinking about thinking" (Downing, Kwong, Chan, Lam, & Downing, 2008). In an educational environment, metacognitive learning requires students to cultivate a plan for the curriculum, monitor by reflecting on their learning process, and adapt their plan correspondingly in order to secure deeper, more robust, and more transferrable learning (Zhao, Wardeska, McGuire, & Cook, 2014). Metacognition is comprised of two areas: knowledge of cognition and regulation of cognition.