The issue of quality in higher education is an ongoing concern that has received considerable international attention. There are many different metrics that have been proposed, including preparation of faculty, selectivity, graduation rate, placement of graduates and so on in order to measure the quality of an educational institution. In this chapter we do not address the issue and difficulties associated with how to measure the quality of an educational institution. Rather, we start with the premise that important contributors to the quality of an educational institution are the instructional practices used by its faculty. Based on this perspective, we focus on strategies that have been shown to, and can be employed to, improve the instructional practices used in higher education.

We situate the discussion in this chapter in the disciplines of science, technology, engineering and mathematics (STEM). These are fields of study that have been the target of significant instructional improvement efforts. However, we believe that the arguments presented in this chapter are relevant and useful for understanding and promoting instructional improvements in a wide variety of disciplines.

1. What is STEM and what is wrong with STEM instruction?

As discussed in more detail below, improving instruction in STEM subjects has been an important focus of research and funding in the USA for over 50 years. This surge in interest is often traced to 1957 when the Soviet Union, then an intense cold war rival of the USA, successfully
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launched the first satellite to orbit the Earth (DeBoer, 1991). Since that time, calls for improvement in STEM instruction have been linked to the need to prepare STEM professionals who can work towards large-scale national goals such as national security, national prestige and economic development (Committee on Science Engineering and Public Policy, 2006; National Commission on Excellence in Education, 1983; National Science Board, 2007; National Science Foundation, 1996). More recently, dealing with current world issues has been added to this list. For example, in a 2009 speech, President Obama highlighted the need to address climate change, find cures for disease, and produce clean energy as pressing reasons to improve STEM education (The White House, 2009).

Although we focus here primarily on discussions within the USA, very similar discussions are occurring within European (European Commission, 2007) and broader international contexts (Fensham, 2007).

Prior researchers have identified a number of important concerns about teaching methods commonly used in STEM courses. In particular, there is concern that many college STEM courses: (1) do not help students develop meaningful understanding of the course content (Hake, 1998; Wandersee et al., 1994); (2) do not help students develop the skills necessary to solve real problems in a cooperative way (deJong and Ferguson-Hessler, 1986; Eylon and Reif, 1984; Reif, 1995); (3) turn away many capable students who find these courses dull and unwelcoming (National Science Foundation, 1996; Seymour and Hewitt, 1997; Tobias, 1990); and (4) misrepresent the processes of science (Halloun and Hestenes, 1998; Lawson, 1985; Millar, 1998; Redish et al., 1998).

To address these problems, it is commonly advocated that college science teachers stop using instructional styles based on lectures aimed at transmitting information to students and begin using instructional styles that encourage active student participation in the learning process (Handelsman et al., 2004). Although lectures focusing on the transmission of information have been used by colleges for hundreds of years, there are two basic reasons that make them no longer appropriate as the primary mode of instruction. One is that new knowledge is being created much faster today than it was even 10 or 20 years ago. A college graduate no longer can expect that a collection of facts acquired in college will be sufficient throughout their working life. This means that students must come away from college with the ability to find, apply and organize new information. The other is that a much larger percentage of the population is now attending college. For example, the US Census Bureau reports that currently 27 per cent of the US population aged 25 or older have a bachelor’s degree and 54 per cent have