The Teaching and Learning of Twenty-First Century Skills

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The need for a well-prepared workforce that is able to succeed in the 21st century has been acknowledged for more than a decade (Stuart, 1999). As technologies change and as modes of communication continue to develop, it is becoming increasingly important for today's students to become better prepared for life in a constantly changing world. Consequently, educators will need to adapt to these changes in order to equip students with the skills that will be necessary in order to be successful.

In the present paper, I critically examine how 21st century skills can be taught, and how they are best learned. Specifically, I focus on three domains of these skills: cognitive skills (i.e., problem-solving and critical thinking), interpersonal skills (i.e., communication skills, teamwork, and cultural sensitivity), and intra-personal skills (i.e., self-regulation, executive functioning, and self-management). In addition, I discuss domain-specificity verses domain-generality of the teaching and learning of these skills. Finally, I also examine contextual factors that facilitate and hinder the teaching and learning of these skills.

What are 21st Century Skills?

Much discussion about the need for twenty-first century skills has emerged out of conversations related to the changing global economy (Stuart, 1999). This has been exacerbated by popular books such as *The World is Flat: A Brief History of the Twenty-First Century* (Friedman, 2005), *Runaway World: How Globalization is Reshaping our Lives* (Giddens, 2003), and *Drive: The Surprising Truth About What Motivates Us* (Pink, 2009). In addition, the advent of the millennium was been well-publicized a decade ago, as the media has portrayed the 21st century often as a futuristic society that will necessitate the need for advanced cognitive skills.

Nevertheless, the term "twenty-first century" may be misleading, since the array of skill referred

to as twenty-first century skills actually was advocated for long ago, by scholars such as Socrates

and Dewey (Silva, 2009).

Twenty-first century skills have been defined and described in a number of ways. In a

recent review of 59 international documents related to 21st century skills, Voogt and Pareja-

Roblin summarized the recommended skills, describing them as "collaboration, communication,

ICT literacy, and social and/or cultural competencies" (p. i). In addition, they note that most of

the documents "mention creativity, critical thinking, and problem solving" (Voogt & Pareja-

Roblin, 2010, p. i).

The National Research Council has organized several workshops examining and

attempting to define and identify twenty-first century skills. In particular, some of these

workshops have focused on how 21st century skills can and should be taught within the domain

of science education (National Research Council, 2007, 2010). Several meetings were held, and

the following five domains of 21st century skills were identified (National Research Council,

2010):

(1) Adaptability

(2) Complex Communication/Social Skills

(3) Nonroutine Problem-Solving

(4) Self-Management/Self-Development

(5) Systems Thinking.

In summary, various categorizations have been used to identify twenty-first century

skills. Nevertheless, these varying classification systems all converge on the need to educate a

workforce and citizenry so that individuals can effectively think about complex issues, work

collaboratively with others in a technologically advanced society, and regulate their use of appropriate strategies in appropriate contexts. However, the implications of this for both teaching and learning are profound, and must be seriously considered and addressed by a variety of constituencies.

Domain-Specificity vs. Generalizable Skills

One of the most important implications of the need for teaching and learning twenty-first century skills is the issue of whether or not these skills are generalizable or domain-specific. In particular, when a particular skill is taught or learned, should the skill be taught as a general skill that can be adapted or transferred to other contexts, or as a specific skill within a specific domain? For example, VanderStoep and Pintrich (2003) have provided examples for methods of teaching students about the role of prior knowledge in learning and memory. However, since memories for different subject domains are constructed differently, an important question arises as to whether or not such methods should be taught as general skills, or within subject-specific examples and within specific courses.

There is evidence about the distinctions between domain-specificity verses domain generality in the learning of skills from research in educational and cognitive psychology on transfer of knowledge. Although many students and educators assume that learners readily transfer the skills that they have learned in one course to situations and problems that arise in another course, research on human learning suggests that such transfer seldom occurs naturally, particularly when there is a need for the learner to transfer complex cognitive strategies from one domain to another (Salomon & Perkins, 1989). Specifically, transfer is only likely to occur when care is taken to facilitate that transfer (i.e., to specifically utilize strategies that will facilitate the likely transfer of skills learned in one domain to another domain) (Gick & Holyoak, 1983). Thus

twenty-first century skills that are taught within one domain are not likely to naturally transfer to another domain, unless educators are thoughtfully instructed on how to facilitate this transfer. For example, eighth graders might be taught how to solve a mathematics problem involving the usage of percentages that must be multiplied; the students then might encounter a problem in their social studies courses that involves calculating compounded interest (related to an economics problem); however, although the same basic process might be necessary to solve both problems, it is unlikely that students will naturally transfer the skills learned in the math class to the problem encountered within the domain of social studies.

Mayer and Wittrock (1996) noted that the transfer of problem-solving skills from one domain to another is not automatic. Specifically, they noted that "Laboratory studies have shown that learning how to solve a problem often does not help students solve a subsequent problem that looks different but can be solved in the same way" (p. 51). In summarizing the literature on this topic, Mayer and Wittrock made several observations that have important implications for the teaching of twenty-first century skills. First, they noted that the use of general practices to improve students' thinking (e.g., teaching Latin or the computer language LOGO with the goal of improving students' ability to think) are not successful means of improving students' overall cognitive abilities; second, research indicates that it is useful to reinforce basic skills (e.g., basic arithmetic skills) so that these skills become automatic, since such basic skills are required for the successful learning of more complex cognitive skills; third, when general problem-solving strategies are taught, they should be taught within meaningful contexts, and not as simply rote algorithms to be memorized; and fourth, educators need to help students to recognize that the solution to one type of problem may be useful in solving a problem with similar structural features (Mayer & Wittrock, 1996).

Some scholars have addressed the issue of teaching complex cognitive skills in order to facilitate transfer. Halpern (1998) proposed a four-part model for the teaching of critical thinking skills so that transfer across domains and contexts would be enhanced. The four parts of Halpern's model include (a) an attitudinal component (i.e., having positive attitudes toward using necessary advanced cognitive skills), (b) providing both instruction and practice using these skills (including verbal reasoning skills, argument-analysis skills, hypothesis testing, thinking with probabilities, decision-making, and problem-solving), (c) providing activities to facilitate transfer of thinking skills, and (d) considering the assessment of thinking (i.e., metacognition). Particularly important is the fact that Halpern noted that instructors will need to work diligently in order to be able to incorporate such models into teaching. Thus, as will be discussed later, we should not assume that educators will be able to simply adapt to this kind of complex instruction, unless they are provided with sufficient training.

In summary, research indicates that instructing students in general problem-solving skills can be useful, but more elaborate scaffolding and domain-specific applications of these skills are often necessary. Whereas general problem-solving and critical-thinking strategies can be taught, research indicates that these skills will not automatically or naturally transfer to other domains. Rather, it is imperative for educators and trainers to recognize that twenty-first century skills should be taught within specific domains; if they are taught as general skills, then extreme care must be taken to facilitate the transfer of these skills from one domain to another.

Three Types of Twenty-First Century Skills

In the next section, I examine three distinct albeit related types of twenty-first century skills: cognitive skills, interpersonal skills, and intrapersonal skills. It is important to examine these three skill-types separately, since instruction in these skills can occur both in isolation (e.g.,

just teaching cognitive skills), or jointly (e.g., teaching students to use cognitive skills within interpersonal contexts). As I will argue later, although twenty-first century skills can be categorized into these three areas, the three are highly inter-related.

Cognitive Skills

The importance of higher-order cognitive skills has been acknowledged as important for many years. In an address presented at the annual meeting of the American Psychological Association in 1997, Diane Halpern noted that "critical thinking" is extremely important and should be emphasized in education; however, Halpern noted that many educated individuals continue to engage in logically flawed reasoning (e.g., believing in phenomena that are not scientifically supported) (Halpern, 1998). Halpern cited numerous studies that had been conducted in the 1990s that clearly indicated that higher order or "critical thinking" skills can be taught to students (Halpern, 1996). Thus evidence has existed for many years indicating that it is indeed possible to teach these skills.

There is ample evidence that students can be taught a variety of cognitive problem-solving skills across a wide array of domains, and that performance can be enhanced with the acquisition of such skills (Mayer & Wittrock, 2006; Scheiter, Gerjets, & Schuh, 2010; Seagull & Erdos, 1990; Sternberg & Grigorenko, 2000; VanderStoep & Pintrich, 2003; Watson & Kramer, 1995; Xin & Jitendra, 2006). Research indicates that even the simple use of higher-order questions in college courses can lead to improved levels of higher-order thinking in students (Renaud & Murray, 2007).

Although various cognitive skills can be taught, it is important to note that there are important individual differences in cognitive skills as well, and these must be taken into consideration when teaching 21st century skills to students. For example, research indicates that

in mathematics, younger learners are more likely to utilize a larger variety of strategies to solve problems than are older learners (Lemaire & Arnaud, 2008). In addition, research has documented differences in problem solving ability by gender (Kucian, Loenneker, Dietrich, Martin, & Von Aster, 2005; Moreno & Mayer, 1999), culture (Matsuda, 1992), and differing abilities related to intellectual disabilities (Numminen, Lehto, & Ruoppila, 2001). These individual differences are not limitations, but rather, provide useful information regarding how appropriate instruction can be developed to meet learners' diverse needs.

A variety of methods for instruction of cognitive problem-solving skills have been identified. Two methods include the aforementioned automaticity methods (wherein students are drilled on basic skills that should become automatic, in order to free-up working memory for more complex aspects of problem-solving), and constraint-removal methods (wherein complex parts of tasks are removed to make problem-solving simpler for learners) (Mayer & Wittrock, 2006).

Numerous materials exist that provide instructors with examples of how to teach complex cognitive skills to students. As I will discuss later, various universities have developed successful courses that teach college students how to use these skills. In addition, various books have been authored that provide educators with examples of strategies and techniques that can be used in classrooms to teach complex cognitive skills to students (Sternberg & Grigorenko, 2000; Trilling & Fadel, 2009; VanderStoep & Pintrich, 2003).

In summary, cognitive skills, such as problem-solving techniques and critical thinking skills, can be taught to students. Nevertheless, the aforementioned issue of domain-specificity verses the teaching of general cognitive skills remains extremely important. Whereas twenty-first century cognitive skills can be taught, it will be very important to train teachers to consistently

instruct students in these skills, across a variety of domains. Cognitive skills are highly situated, and do not occur in isolation (Perkins & Salomon, 1989). Therefore, in order to successfully instruct students in cognitive skills, it will be necessary to train educators to work consistently and collaboratively on these issues.

Interpersonal Skills

The importance of communication skills in the 21st century cannot be underestimated. Individuals in the workplace need to work together collaboratively on a large array of issues. Indeed, many prestigious schools and colleges of business administration use curricula that teach students how to work collaboratively (e.g., the Masters of Business Administration program at the Harvard Business School (Harvard University, 2011)) and to work in teams (e.g., the Masters of Business Administration program at the University of Michigan (University of Michigan, 2011)).

Although these skills are taught in graduate schools, America's public schools have the responsibility of teaching interpersonal skills to most students. Whereas standardized examinations tend not to focus on such skills, it is nevertheless important for educators, particularly during the elementary school years, to instruct students in these skills. The need for teachers to be able to both teach interpersonal skills to children and adolescents, as well as to be able to use these skills in consultation with colleagues and community members, has been recognized as being important by accrediting bodies, including the National Council for Accreditation of Teacher Education (NCATE). For example, NCATE Standard 1g (Professional Disposition for all Candidates) states the following target goals for teacher candidates:

"Candidates work with students, families, colleagues, and communities in ways

that reflect the professional dispositions expected of professional educators as

delineated in professional, state, and institutional standards. Candidates

demonstrate classroom behaviors that create caring and supportive learning

environments and encourage self-directed learning by all students. Candidates

recognize when their own professional dispositions may need to be adjusted and

are able to develop plans to do so." (NCATE, 2008, p. 20).

Thus the ability of educators to be able to both use and teach interpersonal skills is considered a

core component of the teaching profession.

Research results also indicate that instructing even very young children in interpersonal

skills is related to a host of beneficial outcomes. In addition, although most of us would not

argue with the notion that teachers primarily impact students' cognitive abilities, there is

evidence that teachers may even have a greater influence on interpersonal outcomes in children.

For example, results of a recent study from the Early-Childhood Longitudinal Study –

Kindergarten Cohort (ECLS-K) indicate that kindergarten teachers on average have larger effects

on their students' social and behavioral skills development than on academic achievement

(Jennings & DiPrete, 2010). In the next sections, research on two specific types of twenty-first

century interpersonal skills are discussed: cultural competence and working cooperatively.

Cultural Competence

One particularly important area in which individuals will need to be better prepared is in

the area of cultural competence. Given the ease of video-conferencing, conference calls, and

"Skyping" with collaborators across the globe, it is becoming increasingly important to prepare

individuals to interact appropriately with students, colleagues, teachers, and collaborators from a

diverse array of cultures.

Culture is a very broad term; this term can be used to refer to many differences between individuals. *Cultural competence* refers to being able to communicate effectively with individuals from different regions (e.g, urban, rural, and suburban), different nationalities, different socioeconomic statuses, different races, different religions, different sexual preferences, and numerous other varied backgrounds. There are large literatures both the teaching of cultural competence (Banks, 1995) as well as on instructing learners with culturally relevant pedagogical techniques (Boykin, Tyler, & Miller, 2005; Gay, 2000). These literatures indicate that is certainly possible to teach skills in cultural competence to others, and that it is also possible to adjust instructional methods to meet the cultural expectations of diverse learners.

One example of the need for the teaching and learning of cultural competence as a 21st century skill comes from the field of nursing. Nurse educators acknowledge that in order to effectively treat and serve patients, nurses must be able to understand patients' cultural backgrounds related to health beliefs (i.e., cultural-influenced beliefs related to how health care decisions are made, religious influences on health-related beliefs, linguistic differences of patients, etc.) (Calvillo, et al., 2009). The American Association of Colleges of Nursing (AACN) developed cultural competency skills that are recommended for inclusion in undergraduate nursing education programs. These skills include (a) the ability to apply social and cultural information across contexts, (b) the ability to use appropriate data and evidence in order to provide culturally competent patient care, (c) the ability to provide safe and high quality health outcomes for diverse populations, (d) the ability to advocate for social justice and the elimination of health disparities, and (e) the need to continue to participate in professional education to continue to develop cultural competence (Calvillo, et al., 2009). The identification of these competencies by a major organization such as AACN facilitates some consistent application of

the teaching of these principles to the emerging workforce in nursing; it also emphasizes the importance of this 21st century skill.

There is much debate regarding whether cultural competence skills should be taught in stand-alone courses, or as embedded within courses. This debate has been exemplified in recent editions of popular educational psychology textbooks, which at times integrate cultural competence into all chapters within the text (e.g., Ormrod, 2008) and at times treat this topic as a stand-alone chapter (e.g., Woolfolk, 2011). Optimal results likely will be obtained when such skills are taught as general communication strategies, and then reinforced throughout a wide range of contexts and courses.

Learning How to Work Cooperatively

Researchers in the field of educational psychology have acknowledged for many years that students can be taught to work effectively with one another in cooperative groups. Indeed, a large literature exists on *cooperative learning* (Gillies, 2007; Johnson, Johnson, & Smith, 2007; Kane & Kane, 2004; Slavin, 1991, 1983). Research indicates that the effective use of cooperative learning groups with students can lead to increases in achievement (Slavin & Karweit, 1984). In addition, studies have indicated that children can be taught to use complex cognitive skills, particularly when these skills are taught in collaborative settings (Burke & Williams, 2008). Gay (2000) has noted that minority students (particularly Native American, Latino American, African American and Asian American students) may benefit from cooperative learning, since cooperation is salient in many of these students' cultures.

There are many reviews of cooperative learning techniques. Nevertheless, teaching cooperative skills to students needs to occur systematically. Simply putting students into groups and asking them to work together is insufficient. Rather, educators should use techniques that

have been empirically validated, including Student Teams Achievement Divisions (STAD)
(Slavin, 1991), JIGSAW (Aronson, Blaney, Stephan, Sikes, & Snapp, 1978), and Cooperative
Integrated Reading and Instruction (CIRC) (Slavin, 1991).

The benefits of students working cooperatively and collaboratively are many. Hattie
(2009) estimates effect sizes for cooperative learning's relation to achievement as $d = 0.41$ when
compared to heterogenous classes, as $d = 0.59$ when compared to individualistic learning, and as
$d = .54$ when compared to competitive learning. Some research indicates that students ask for
and receive more and more effective assistance from their peers when they work in cooperative
groups (Webb, 1982, 1992). Other studies indicate that when students are taught to work
collaboratively, they become more accepting of individuals from diverse cultural backgrounds
(Slavin & Cooper, 1999) and of students with various disabilities (Madden & Slavin, 1983)

There are many ways in which technology also can be used to teach interpersonal skills.
Jaen and Basanta (2009) argue that the use of rather simple technologies such as DVDs can
facilitate instruction of various interpersonal skills. DVDs can be used to bring situations from
the workplace or from outside of the classroom directly to students who are learning specific
skills. One particularly inexpensive way of doing this is through the use of film clips, which can
be adapted (with appropriate copyright approvals) for use in teaching a variety of interpersonal
communication skills. Another intriguing potential method of teaching about social skills could
involve the use of avatars in virtual environments such as "Second Life" (Gottschalk, 2010).

In summary, it is possible to teach interpersonal skills to others. There are numerous
ways to accomplish this type of instruction. Again, one of the most important implications is that
instruction in interpersonal skills should not occur in isolation; rather, such skills need to be

introduced, reinforced, and emphasized as being important. As I will discuss later, it will be particularly important for assessment methods to facilitate students' valuing of these skills.

Intra-Personal Skills

Intrapersonal skills include an array of abilities. Paramount among these are self-regulation and self-management. Much research conducted over the past three decades indicates that these skills can be taught. Further, when these skills are learned, students benefit in a number of related ways (Boekaerts, Pintrich, & Zeidner, 2000; P.R. Pintrich & de Groot, 1990; P.R. Pintrich & Garcia, 1991; Zimmerman & Moylan, 2009).

Self-regulation refers to the ways that learners activate and control cognitions, emotions, and academic behaviors that are related to learning (Zimmerman, 1989, 1990, 2000, 2002). Research has documented that students can be self-regulatory, and can learn to adjust their levels of self-regulation, in a variety of different domains. Some of these domains include motivation (Meece, 1994; Wolters, 1998), mathematics (Cleary & Chen, 2009; Malpass, O'Neil, & Hocevar, 1999), science (Schraw, Crippen, & Hartley, 2006), and reading and writing (Graham, Harris, & Troia, 1998; Schunk & Zimmerman, 2007).

Zimmerman notes that self-regulation includes the processes of forethought (before a task is undertaken), performance/volitional control (monitoring of progress while engaging with a task), and self-reflection (evaluating one's performance on a task) (Schunk & Zimmerman, 2006; Zimmerman, 2000, 2001). Pintrich has proposed a different model consisting of four phases: (a) forethought, planning, and activation, (b) monitoring, (c) control, and (d) reaction and reflection (P. R. Pintrich, 2000).

Research indicates that self-regulatory beliefs do differ by subject domains. In a large-scale study of college students across three disciplines and three institutions, Vanderstoep et al.

found that measures of knowledge, motivation, and self-regulation distinguished low achievers from high achievers in social science and natural science courses, but not in humanities courses (VanderStoep, Pintrich, & Fagerlin, 1996). Vanderstoep et al. suggest that models of self-regulated learning in particular may need to be studied separately and perhaps adjusted within the humanities.

Self-regulatory skills are important in terms of twenty-first century skills, because students need to understand when and how to use various skills. There are many examples in the educational psychology literature of ways to teach self-regulatory skills to students. For example, Connor and her colleagues conducted a large-scale randomized control trial comparing literacy instruction for first-graders using either an intervention in which teachers were traained to focus on self-regulatory skill development, compared to a control group. Teachers in the intervention condition both used specialized software that helped them to plan individualized instruction for students, and received professional development. Results indicated that gains in self-regulatory skills were particularly prominent for children who displayed the lowest initial levels of self-regulation (prior to the intervention) (Connor, et al., 2010). Other studies indicate that self-regulatory strategies can be taught to older students as well (Rosario, et al., 2010; Tuckman, 2003).

In summary, research indicates that students can be taught various self-regulatory and self-management skills. These strategies are particularly important, because they allow students to regulate their use of cognitive and interpersonal strategies. Similar to issues discussed with cognitive and interpersonal skills, it is equally important to train teachers in effective methods of teaching these skills to their students, both in school and work-related settings.

DISCUSSION

In the present paper, I have reviewed research indicating that there is much research indicating that cognitive, interpersonal, and intrapersonal twenty-first century skills can be taught. Research indicates that these skills are important, and can be taught to young children, to adolescents, and to adults. Nevertheless, one of the clear and important themes that emerges from this research is that these skills should not be taught in isolation. Human learners do not easily and naturally transfer problem-solving strategies from one domain to another; consequently, instruction in twenty-first century skills must be carefully scaffolded and reinforced across a variety of educational contexts.

Nevertheless, it also is important to note that instruction in 21st century skills may not be equally accessible for all individuals. Indeed, it is important to recognize that instruction in and the development of twenty-first century skills may be stratified, with children, adolescents, and adults from certain social classes having greater access to such instruction (Farkas, 2003; Willis, 1981). This is obviously an issue that must be taken seriously, particularly so that access to jobs that require twenty-first century skills is not limited to a small privileged group of individuals.

Twenty-first century skills also are influenced by what is valued by society and by those who define these skills. Inevitably, the skills that are valued in the United States may differ from the skills that are valued in Peru or Ethiopia. In addition, definitions of twenty-first century skills also will be affected by values and definitions from diverse fields of knowledge (Yanchar, Slife, & Warne, 2008). For example, the skills that are valued by physicists may not be the same as those that are valued by journalists; whereas many of these skills may transcend these disciplines, the aforementioned research clearly indicates that transfer of these skills will not be automatic and natural; this can be exacerbated by disciplinary differences, wherein scholars in

some fields (e.g., physics) disagree with the definitions of twenty-first century skills provided by scholars in other disciplines (e.g., journalism).

College Courses Design to Teach Cognitive and Motivational Skills

Fortunately, many universities have developed impressive and effective courses and programs that are designed to teach various cognitive and motivational skills to college students. These courses can be used as models for the instruction of twenty-first century skills to both younger and older learners, as long as developmental differences are considered. These courses have in particular been designed to help students to become successful learners in college (Mayer & Wittrock, 1996; P.R. Pintrich, Brown, & Weinstein, 1994; P.R. Pintrich, McKeachie, & Lin, 1987). Specifically, students who participate in these courses learn cognitive, interpersonal, and intrapersonal skills that help them to be successful students during college. In some cases, students who are determined to be at-risk for college failure are advised to enroll in these courses. Research has determined that these courses are quite effective, and can lead to long-term improved achievement for many students (McKeachie, Pintrich, & Lin, 1985; Tuckman, 1996, 2003; Weinstein, 1994). However, Mayer and Wittrock (1996) caution that such courses often succeed in teaching students to transfer problem-solving skills to similar types of problems, but not to problems that differ in structure.

Mayer (1989; Mayer & Wittrock, 1996) suggests that courses such as those described above are most successful at teaching various cognitive skills when the curriculum

> "focuses on a collection of component skills, such as how to represent problems, rather than on impoving the mind in general; the methods emphasize problem-voling processes such as modeling the processes of experts rather then solely gitting the right answer; and the expectations for transfer are modest, such as

students being able to solve similar kinds of problems rather than being able to

solve problems in different subject domains." (Mayer & Wittrock, 1996, p. 57)

Successful programs exist at several universities. These programs can be used as models

for the teaching of 21st century skills, and can be adapted for use with younger students. Several

well known programs include those at the University of Michigan, The Ohio State University,

and the University of Texas at Austin.

How Should Twenty-First Century Skills Be Taught?

Twenty-first century skills can be taught in a variety of manners and across numerous

contexts. Throughout history, various job-related skills have been taught successfully through

various forms of apprenticeships (Collins, Brown, & Newman, 1989; Rogoff, 1990), and such

models may prove useful in the future as well. However, most likely, these skills will be taught

in traditional school settings.

Strategies can be effectively taught within sociocultural contexts. Numerous researchers

have argued that Vygotsky's notion of the zone of proximal development (ZPD) can be used as a

theoretical framework for teaching various cognitive and social strategies to students. In a classic

study, Palincsar and Brown (1984) developed a technique called reciprocal teaching; this

technique was designed to improve the reading skills of at-risk adolescent readers. Students

learned four strategies (summarizing texts, asking questions about texts, clarifying difficult

sections of texts, and predicting what will come next in texts) with the guided assistance of a

teacher. Students learned to use these strategies within the context of reading, with many

positive benefits for the students (Palincsar & Brown, 1984). Reciprocal teaching is highly

effective, with effect sizes in the range of $d = 0.74$ (Hattie, 2009). Techniques such as reciprocal

teaching can be used as models for instruction in various twenty-first century skills.

Unfortunately, there is no secret formula for successful instruction. Nevertheless, in the present paper, I have reviewed studies that indicate that twenty-first century skills can be successfully taught to and learned by students. I present the following recommendations based on this review.

Recommendation #1. Whereas it is appropriate to teach general twenty-first century skills (e.g., general problem-solving skills, general heuristics, general strategies for critical thinking), it is important for educators to realize that general instruction is necessary but not sufficient for effective learning of these strategies (i.e., it isn't sufficient to just teach general skills in isolation).

Recommendation #2: When general skills are taught, focus in particular on making basic skills become automatic. Whereas there is a tendency in education to avoid teaching basic skills (in favor of more complex skills), research indicates that students will be able to more efficiently learn and use twenty-first century skills if they have mastered and automated basic, rudimentary skills (Mayer & Wittrock, 1996).

Recommendation #3: Teach applications of general twenty-first century skills within domain-specific (subject-specific) courses. Mayer (2004) has noted that there is much available scientific data concerning both how to teach students thinking skills within specific subject domains. Thus the general skills that may be taught must be reinforced in subject-specific courses.

Recommendation #4: Teach metacognitive strategies as well as cognitive, interpersonal, and intrapersonal strategies Metacognition involves thinking about one's thinking (Salatas Waters & Schneider, 2010). Learners need to know when and how to use these skills (Mayer & Wittrock, 1996; Salatas Waters & Schneider, 2010). Whereas metacognition appears similar to

intrapersonal skills, students can be metacognitive in relation to all three types of twenty-first century skills.

Recommendation #5: When problem-solving skills are taught, we should not assume that they will easily generalize to a broad array of problems; rather, we should expect that they will apply only to similar types of problems (Mayer & Wittrock, 2006). If we want these skills to transfer to problems with different structures, we must train teachers to show students how to transfer these skills.

Recommendation #6: Recognize that the use of 21st century skills involves both cognitive/social skills *and* the motivation to use those skills. Researchers have recognized that the use of complex cognitive and social skills will not occur if individuals are not sufficiently motivated to use those skills; indeed, the use of such skills requires both "skill" and "will" (Corno, 2008; VanderStoep & Pintrich, 2003). Thus twenty-first century skills should not be taught in isolation; rather, it is important to recognize that students need to be motivated to use these strategies.

Recommendation #7: Twenty-first century skills should be taught in an interdisciplinary manner. It is extremely important for teachers in schools to be trained simultaneously about this topic. In particular, if effective transfer is to occur, teachers in one subject domain (e.g., science) must be able to identify the same types of twenty-first century strategies as do teachers in another domain (e.g., social studies). If teachers use common language to describe and teach these skills, then they will be better able to help students to transfer these skills and apply them across diverse domains.

Potential Roadblocks to the Teaching of Twenty-First Century Skills

As a final note, it is important to note that there are certain factors that may impede the successful teaching of twenty-first century skills. These impediments may be particularly salient in public schools. Whereas many educators may agree with the goal of teaching these skills to students, the nature of the educational system in the United States may impede progress in this area.

Of particular concern is the focus on standardized testing in the United States. Indeed, federal legislation such as *No Child Left Behind*, as well as numerous local and state-level policies, force teachers to emphasize the importance of standardized tests (Berliner & Nichols, 2007). If teachers feel compelled to prepare students for these examinations, then instruction in twenty-first century skills may be neglected, particularly if these skills are not emphasized on the tests. This is not a trivial point, as classroom practices are often strongly influenced by assessment policies (Berliner & Nichols, 2007; Nichols & Berliner, 2005).

Conclusion

In summary, it is both necessary and possible to teach twenty-first century skills. If the United States is going to excel in education and technology, it is important to nurture the development of these skills in the population. In order to accomplish this, we will need to train teachers to effectively instruct students in these strategies, across a variety of disciplines. Indeed, research indicates that teachers can be trained through professional development to teach such skills to students (Sailors & Price, 2010). One particularly useful venue for providing this instruction for teachers is through introductory educational psychology courses, which are required in many teacher education programs. Nevertheless, given the development of alternative certification programs such as Teach for America, and tensions between faculties in various areas of teacher education (e.g., Patrick, Anderman, Bruening, & Duffin, 2011), it will be

important to loudly and actively advocate for the consistent training of future and practicing

teachers in these important skills.

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