Chapter 2

Motivational Challenges Experienced in Highly Complex Learning Environments

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Introduction

One of the greatest challenges facing education today is to find more effective and efficient ways to support the learning of highly complex knowledge. As Richard Snow described the issue: "... learning to learn, learning to reason, learning to find and solve problems, learning to be interested and industrious, to persevere, to achieve in the face of novelty, complexity, adversity, and change ... increasingly becomes the principal goal of education" (Snow, 1996, p. 536). Snow goes on to define general ability as the capacity to deal effectively with novelty and complexity. "Intelligence is ... an organization of aptitudes for learning and problem solving, particularly in situations involving novel or complex meaningful information and incomplete instruction about it" (p. 537). To advance the goal of understanding how to support the learning of complex knowledge, most discussions emphasize the use of structured teaching strategies or the design, development and delivery of strongly guided instruction and other educational services (for example, Kirschner, Sweller, & Clark, 2006; Mayer, 2004). This chapter will describe the various ways that motivation to learn is influenced by complexity and a few of the special motivational challenges students experience as they attempt to learn complex knowledge in challenging environments. Motivation has been found to make a highly significant contribution to learning from instruction, accounting for approximately 20 percent of the variance in achievement and about 29 percent of the variance in transfer of knowledge (Colquitt, LePine, & Noe, 2000). Considering that instructional strategies account for about the same proportion of learning variance (Snow, 1996), motivational processes may deserve more attention from researchers concerned with complex learning. Our discussion begins with a definition of complexity and a description of current motivation theory. We then go on to describe five different research areas where task complexity may interfere with the motivational processes that support learning. Where possible, we will also describe the evidence for ways to overcome motivational problems.

Handling Complexity in Learning Environments: Theory and Research

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Defining and Measuring Complexity and Novelty

Current attempts to provide a cognitive definition of learning complexity (Salomon, 1983, 1984; Lohman, 1989; Snow, 1996) have focused on the number of non-automated cognitive operations or strategies that students must implement to achieve a specific learning goal. Thus as learning tasks require more non-automated operations, cognitive complexity increases. Sweller (this volume, Chapter 1) refers to this process as element "interactivity" and provides examples from mathematics tasks where more complex learning requires the mastery of many related steps in an operation.

While it is possible to measure the explicit cognitive steps or strategies required to achieve well-defined tasks such as a mathematics problem, it has been a challenge to measure the extent to which student prior experience has led to automated cognitive strategies that can be applied without placing a load on working memory (Anderson, 1983, 1990). Students with more prior knowledge learn more quickly in part because they do not experience as much complexity as students with less prior knowledge. When poorly defined tasks or problems are tackled, cognitive load is a significant factor for most students (Singley & Anderson, 1989). Lohman (1989) described the problem of estimating the amount of complexity that confronts any learner in any task situation very well when he cautioned that: "What is novel for one person may not be novel for another person or even for the same person at a different time ... [thus] ... inferences about how subjects solve items that require higher level processing must be probabilistic, since the novelty of each [item] varies for each person" (p. 348).

In addition to the number of non-automated operations, individual assessments of complexity must also consider the amount of processing space available in working memory for each learner. While the availability of working memory space appears to be very limited (Cowan, 2001), the actual space available to any learner varies considerably due to both motivational and learning processes (Bandura, 1997).

Recognizing that complexity must be defined by reference both to the prior knowledge and to the motivational processes a learner brings to bear on a task, is a necessary step in understanding how to support learning. Lohman (1989) made a compelling, research-based argument that for learners with diverse cultural backgrounds and different levels of prior knowledge, any given learning goal could be excessively complex for some but routine for others. Historically, reviews of research on motivational processes that support (or fail to support) learning suggest that as complexity increases, a learner's motivation becomes a much more significant predictor of learning (Pintrich & Schunk, 2002). It seems important, therefore, to examine some of the most important motivational challenges posed by complexity. After defining motivation and its role in learning, the chapter will describe five motivational challenges students face when pursuing complex learning goals.

Defining and Measuring Motivation

Motivation is most often defined as "... the process whereby goal-directed activity is instigated and sustained" (Pintrich & Schunk, 2002, p. 4), and, in addition, as the amount and quality of the "mental effort" people invest in achieving learning and performance goals (Salomon, 1984). Mental effort is defined as "the number of non-automatic elaborations

necessary to learn or solve a problem" (Salomon, 1984, p. 785) or "interactivity" (Sweller, this volume, Chapter 1). Thus, motivational research and theory tends to focus on three primary dependent variables or "indexes": (1) starting (instigating) new behaviors; (2) persisting (sustaining) in the face of distractions once started on a goal and; (3) investing mental effort in order to accomplish goals that are novel and complex (Pintrich & Schunk, 2002) since routine goals can be achieved with a minimum of mental effort. It is useful to view motivation research and theory as an attempt to understand the precursors of one or more of these three "index" variables or their contribution to learning and problem solving. There are variables that influence starting, persisting or investing mental effort (Clark, 1999a) during learning. Presumably, learners with high ability will not learn unless they start, persist and invest adequate mental effort during learning. All other motivational variables are presumed to influence one or more of these three indexes.

Current motivational theories and models The theoretical models in current educational use derive, in part, from an early analysis of motivation research by Salomon (1983, 1984), more recent reviews by Pintrich and Schunk (2002); and the model building effort of Martin Ford's (1992) Motivational Systems Theory (MST) as well as the more familiar Social Cognitive Theory proposed by Bandura (1997). Some of these efforts have been summarized by Clark (1999a, 2003, 2004, 2005, in press; Clark & Estes, 2002), who has described a theory called CaNE (Commitment and Necessary Effort) where commitment is a joint function of starting and persisting at a task, and effort reflects the number of novel cognitive operations needed to achieve a goal. Evidence for the theory comes from various sources including meta-analytic reviews of motivation studies (e.g., Colquitt et al., 2000) and direct tests (e.g., Condly, 1999; Gimino, 2000; Flad, 2002; Yildir, 2004).

Until recently, motivation research has tended to be fragmented and motivation theories seem often to overlap and researchers seem to examine similar constructs with different names and different constructs with similar names. Ford's (1992) review of motivation research and theory identified over 30 different theories of motivation. Pintrich and Schunk (2002) describe six different motivation research groups who were investigating very similar goal-orientation variables but using different construct names. Efforts by theory builders such as Ford (1992), Pintrich and Schunk (2002) and Bandura (1997) to integrate diverse yet overlapping theories has recently made it possible to better understand the motivational processes that occur during learning and problem solving. One model that attempts to integrate many of the variables in a number of current theories is presented in Figure 2.1.

The motivational challenge of complexity Routine, well-learned tasks when practiced in a familiar environment, apparently do not place heavy demands on motivation (Bandura, 1997). What is clear from studies that support many motivation theories is that when we learn successfully, motivation has provided the initiation and energy that led us to start pursuing a goal, persist in the face of distractions and competing goals and invest adequate mental effort to master the range of complex cognitive operations needed to achieve the goal. Thus, hypothesizing a motivational origin of failure to learn seems reasonable when otherwise able students fail to achieve learning goals. What aspects of motivational processes are challenged when learning tasks grow increasingly complex? Are some learners more vulnerable to motivationally based learning problems? The

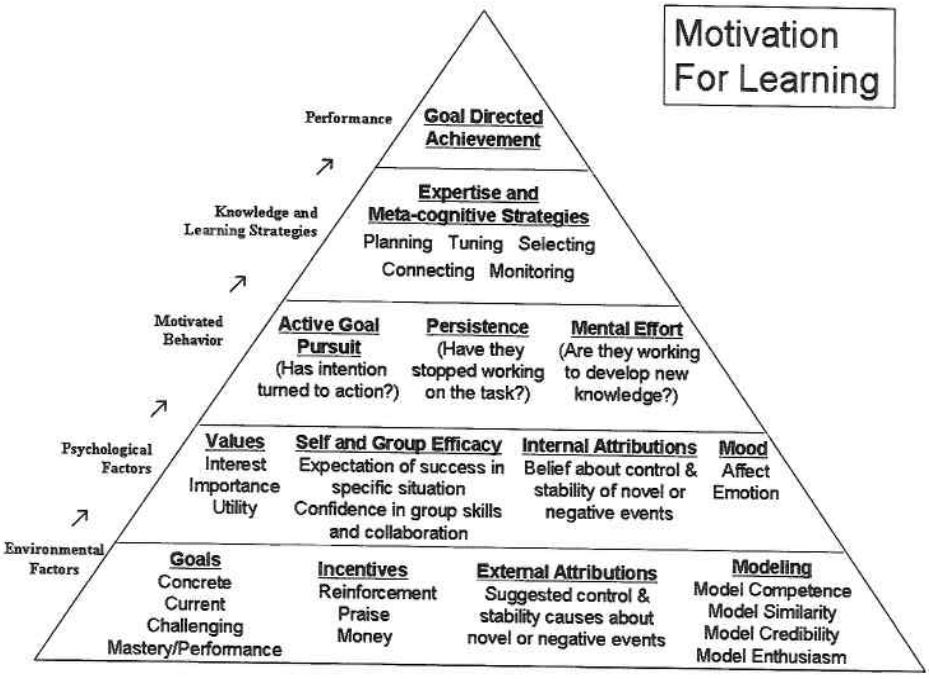

Figure 2.1: Integrated model of motivation variables.

discussion turns next to five areas where motivation seems to account for a great deal of learning variance.

Task Complexity and Motivation

The first issue to be discussed draws on the cognitive load theory of Sweller and colleagues (Sweller, this volume, Chapter 1), and on theory generated and research conducted in psychotherapy settings on automated "ironic" processes in cognition (e.g., Clark, 1999b; Wegner, 1997) to highlight research on automated and unconscious cognitive processes that may inhibit motivation and learning when working memory is overloaded by the learning environment.

> As task complexity increases, excessive working memory load may cause cognitive "defaults" that are automated, largely unnoticed and destructive to learning

Wegner (1997) has provided evidence for a process he calls "Ironic" mechanisms in mental control. He presents evidence that when working memory is overloaded by complex tasks, anxiety about performance and/or a number of conflicting goals, the result is that a hypothesized "ironic monitoring system" causes an automated cognitive default in working

memory. These defaults are often experienced as gaps in attention, "day dreaming" or inappropriate "off task" behaviors. Examples of default behaviors are sitting with a book one intends to study and turning pages but recognizing at some point that the content of pages cannot be recalled because our mind has "wandered" to thinking about problems or other distractions. Wegner (1997) presents evidence that overload defaults are due to an unconscious, uninterruptible, cognitive process that "... searches for mental content signaling a failure to create the intended state of mind" and introduces "... different, unwelcome and unintended behavior" (p. 148). Shoham and Rohrbaugh (1997) draw on cognitive expectancy-control motivation theory and attribute the ironic process to a perceived loss of control. They describe the downward spiral of control loss that afflicts many people who seek psychological help because they cannot learn to control intrusive thoughts, fears, or test anxiety. They note that expressing these fears often leads helpful friends to urge the person to "stop thinking about it". Yet the more a person tries not to think or worry about something negative, the more that cognitive overload occurs and unwelcome, intrusive thoughts occur in working memory. The more that these thoughts are experienced, the greater the perceived loss of control which lowers our self-efficacy for control of our own thinking. The result is that intrusive thoughts actually increase.

The ironic monitoring system is contrasted with an opposing, "intentional monitoring system", that is "... conscious, effortful and interruptible ... [and] searches for mental content consistent with the intended state of mind" (Wegner, 1997, p. 148). This system is the one that we hope is operating when learning is taking place. It focuses attention on assigned learning goals and activities and encourages the retrieval and reorganization of appropriate prior knowledge schemas. In order to maintain the intentional system, students must believe that they are experiencing a personally manageable level of complexity in instructional displays (Clark, 1999b).

Another motivational area where belief plays an important role in the amount and type of motivation available to support complex learning is described in social cognitive theories concerning the influence of self-efficacy on persistence and mental effort during learning.

> As task complexity increases, students with inappropriately high or low task self-efficacy tend not to persist and reduce their mental effort

As task complexity increases during learning, persistence and mental effort also increase (Pintrich & Schunk, 2002). Yet Bandura (1997) and Salomon (1984) provide evidence that when tasks are highly complex and yet perceived as familiar, mental effort decreases. This implies that the relationship between perceived self-efficacy and mental effort is negative when highly complex tasks are perceived as familiar and easy. At inappropriately high self-efficacy levels, overconfident learners apparently stop investing effort because they perceive tasks as familiar and so use inappropriate previously acquired learning strategies. Weiner's (1985, 1986) attribution theory provides evidence that unexpected and negative events provoke attempts to explain why failure occurred. His theory could be interpreted to suggest that people who make overconfident mistakes may be difficult to help since they generally can be expected to avoid taking responsibility for their use of inappropriate knowledge. They may project the blame for their mistakes to teachers, instructional materials, tests or other aspects of the learning environment. Heckhausen and Schultz's (1995)

developmental theory of motivation points to reliable age differences in the way students can be expected to react to learning problems caused by overconfidence. They offer evidence that younger learners tend to choose "primary" or external projection strategies when faced with negative feedback about their performance under conditions of excessive challenge or conflict, whereas adults tend to select more "secondary" and internal projection strategies in the same context. Their theory predicts an interaction between age and the locus of causal attributions after overconfident failures.

Sarbin (1997) describes research on five types of strategic action that are deployed by most people to handle threats to efficacy: (1) Instrumental acts that seek to change the external environment such as appeals to others for help. (2) Tranquilizing and releasing acts that attempt to change internal states through acts such as the use of tranquilizing drugs, physical exercise and meditation. (3) Attention redirection that focuses attention on consistent input (to balance the conflict) through neurotic behaviors such as conversion reactions, imaginary worlds, hypochondriasis, or external projection of blame. (4) Changing beliefs and values that attempt to modify perceptions of the event so that the new perception disconfirms the threat or conflict such as "reframing" or "reinterpreting" the event. (5) Finally, escape behaviors such as depression, helplessness and quitting or dropping out. Each of these reaction strategies provide alternatives that are helpful (reframing the event) and those that are potentially harmful and destructive (addiction to tranquilizing drugs). Additional research on the use of reframing information during feedback about errors may be beneficial.

In addition to self-efficacy, the current emotional state of an individual or group is also hypothesized to influence task persistence and mental effort when task complexity increases (Bower, 1995; Ford, 1992; Helmke, 1987; Weiner, 1985).

> As task complexity increases, more learners experience negative emotional reactions and those who lack emotional self-regulatory skill tend to become angry or depressed and distracted from learning goals

The general hypothesis resulting from research on emotion suggests that as mood becomes more positive, both starting and persisting become more likely, frequent and stronger in the face of increasing complexity (Boekaerts, 1993; Bower, 1995; Ford, 1992). Negative moods are characterized as sadness, fear, depression and anger (Ford, 1992). These negative mood states inhibit persistence and mental effort (Bower, 1995). Positive moods are characterized by happiness, joy, contentment and optimism. Positive emotions have been found to foster persistence and mental effort (Bower, 1995; Ford, 1992). In research, mood states are indicated by people's memory for information congruent with their self-reported mood state; ratings of the enjoyableness of mood-congruent information or commitments; affiliation preferences for associating with people who are also experiencing positive mood states; and social comparisons with mood-congruent people in social and educational contexts (Bower, 1995). Expectancy-control theories (Eccles & Wigfield, 1995, 2002) suggest that negative mood states reduce value for learning goals; lead to lowered expectations that success or control will be achieved in complex environments, and negative moods focus people on past errors and failures

(Boekaerts, 1993; Bower, 1995). In fact, there are suggestions (e.g., Shapiro, Schwartz, & Austin, 1996; Weiner, 1986) that one of the origins of negative emotions is the perception that we are denied adequate control in specific situations. For example, Weiner (1986) suggests that depression sometimes results from the self-perception that we are lacking in, critical skills or ability to achieve a necessary goal, and that anger is the emotional product of the cognitive belief that some external agent has threatened our self-control.

Izard (1993) has presented evidence of four separate mechanisms that generate the same emotion in any individual. Only one of those systems is cognitive and under the control of the individual. Other, non-cognitive emotion activation systems include habitual or automated emotional reactions to events (Anderson, 1990, 1983) plus neural, biochemical and hormonal processes (Izard, 1993). Izard's research suggests that the origins of emotions are not always under our direct control. Yet, Bower (1995) makes the point that emotions can be influenced by environmental and cognitive events even when their origins are biological or neurological. This claim seems to be supported by recent evidence concerning the extent of the placebo effect in mood disorders such as depression. For example, Enserink (1999) reviews the meta-analyses of antidepressant drug trials and concludes that as much as 75 percent of the effects of new drugs such as Prozac are due to expectancy beliefs and not due to biological factors.

Interventions that have been found to change negative mood states have included listening to music that is perceived to be positive; writing or telling about a positive mood-related experience; watching a movie or listening to stories that emphasize positive mood states (Bower, 1995); and emotion control training through "environmental control strategies" including the choice of learning context and "positive self talk" (Corno & Kanfer, 1993). There are also indications that trusted enthusiastic, positive, energetic teachers and learner "models" encourage positive emotions in others and support learning goal persistence (Bandura, 1997).

In addition to beliefs about our capabilities and positive emotions, beliefs about the causes of our errors and failures also have been found to have a major impact on learning in complex environments.

> As task complexity increases, those who have learned to attribute mistakes and other learning difficulties to fixed and uncontrollable causes (e.g., inadequate intelligence) reduce their effort

Weiner (1985, 1986) described a system for understanding the ways in which learners responded to successes and failures in complex learning environments "... in the hope of modifying instructional practice to improve achievement" (1985, p. 567). Weiner's (1985) attribution theory responded to prior motivational theories, expectancy-value theory in particular, by locating the attribution within the individual, in a temporal context, and under the control of affective responses to success or failure. According to attribution theory, each attempt at task completion occurs within an individualized context of expectations (for success or failure) and values (importance of irrelevance). These expectancy values are confirmed or disaffirmed by perceived task outcomes which in turn trigger affective responses such as joy, exuberance or contentment for successes, or guilt, shame, frustration or anger for failures. The affective response in turn leads to a search for causality by

the individual. Weiner theorizes that three conditions are most likely to lead to a spontaneous effort to find a cause or reason (attribution) for events that are classified as when events are unexpected, negative and/or novels. Events that are classified as unexpected, negative and/or novel are very common in highly complex learning environments. In the tradition of social psychology, attribution searches for causes of events are conscious, and rational attempts to explain perceptions that are located simultaneously in three attribution dimensions: locus (internal/external – "Was the cause internal or 'in me' or external and 'in my environment'?"), stability (stable/unstable – "Was the cause stable or reliable or was it unstable and unreliable?"), and controllability (controllable/uncontrollable – "Was the cause under my control, or not?").

Attribution Bias in Complex Settings

Weiner (1985) provided evidence that during socialization most people learn causal beliefs or attribution biases about common experiences to protect their self-image. Multiple forms of attribution bias are hypothesized including: fundamental error bias and self-serving or positivity bias. Attributions that contain fundamental errors are those that incorrectly ascribe positive events to the self, while discounting other possible causes that might have contributed. Self-serving bias forgives our own errors as situational and temporary while attributing other people's errors to durable, reliable and negative traits. Recent meta-analyses of the effect size of self-serving bias (also referred to in the literature as the hedonistic bias), by Mezulis, Abramson, Hyde, and Hankin (2004) found that its mean weighted effect is 0.96 SD across large and diverse samples. It is reasonable to hypothesize that an effect so large may indicate that this bias may be highly automated in human cognitive processing architecture. This meta-analysis is one part of an increasingly large body of research summaries that documents the connections between particular types of attributions and subsequent performance on learning tasks. These reviews also contain strong indications that the more complex the learning task and environment, the more likely that inaccurate and damaging attribution biases will be used to explain mistakes and failures.

Mezulis' summary of so many studies provides considerable evidence to support the hypothesis that students who make external, stable, uncontrollable attributions for failures (for example, "This teacher always gives impossible mathematics tests") are significantly less likely to start or persist at subsequent tasks in that context or invest mental effort in a way that leads to success. Alternatively, students who make internal, unstable, and controllable attributions for their failures (for example, "I did not invest enough time and effort studying for the test") are more likely to increase their effort for similar, subsequent tasks; a strategy that often leads to increased success. This is not to say that all internal, unstable, controllable attributions lead to success. Linnenbrink and Pintrich (2002) describe evidence of situations where unstable, internal attributions that discount other significant causes of failure (for example poor instruction, distracting or disruptive task contexts, hunger or illness) can lead to future learning problems. Linnenbrink and Pintrich suggest that attributions related to effortful strategy use are particularly effective in increasing motivation and task engagement because they "help dispel the inappropriate belief that effort always leads to success, but still helps to convey the ideas that success is possible"

(2002, p. 317). Wilson and Linville (1985) demonstrated that giving college students information about the instability of the sources of poor performance created both short- and long-term improvements in achievement outcomes including grade point average and reduced dropout rates. In addition to supporting adaptive attributions through structured discussions with students, Cleary and Zimmerman (2004) and Hall, Hladkyj, Perry, and Ruthig (2004) document the important role that more structured attribution retraining programs can have in increasing student success.

Attribution Retraining

In attribution retraining programs, student are generally given specific information about attribution processes, shown videotaped simulations of attributions using actors, and subsequently engaged in discussion about the ways in which they might make attributions in a variety of situations (Hall et al., 2004). The content provided by videotaped simulation could be delivered by live actors, or trained volunteers with the same results (Clark, 2001). In other programs, causal attributions are one phase within a larger cycle of self-aware analysis of learning strategies and outcomes (Cleary & Zimmerman, 2004). In all cases, however, attribution retraining has been shown to have significant positive effect sizes across multiple aspects of performance and achievement. Although not examined in the current body of research on attribution, we hypothesize that as the conscious cognitive processes related to making adaptive attributions become automated, their effects would stabilize in a positive direction across multiple performance domains. However, there are complex task domains where the suggestion of negative attributions can cause performance difficulties for the most capable learners. This appears to be the case when negative stereotypes about test taking are communicated to learners who have been the target of prejudice in educational settings.

> As task complexity and saliency increases students who are victims of prejudice in diverse educational settings are more susceptible to "stereotype threat" in complex learning environments

It appears that negative cultural, national and racial stereotypes, when they are made salient in testing situations, can harm the test motivation and performance of socially stigmatized groups (Steele & Aronson, 1995). The so-called "stereotype threat" is activated when an individual runs the risk of confirming an unflattering or negative stereotype generally held about the social group to which he or she belongs (Steele, 1997).

Experimental manipulations of stereotypes in experiments reported by a number of researchers (e.g., Spencer, Steele, & Quinn, 1999; Steele, 1997; Steele & Aronson, 1995) have consistently documented decreases in academic test performance that result when individuals are faced with potentially confirming negative stereotypes that might apply to themselves. In the typical experiment, very capable students who are members of a race, gender or national culture that has been stereotyped as weak performers in the area being tested are taking a "high stakes" test in a setting where a majority of students are members of a race, gender or culture commonly perceived as more capable. When an authority in the test environment points out the negative stereotype, measured test performance by

minority students is often significantly reduced. The finding seems to occur even when an attempt is made to argue against the negative stereotype. Most troubling about these studies is the fact that stereotype threat seems to have a greater impact on the most motivated and capable students (Steele, 1997).

Although this area of research started with the examination of the test performance of African-Americans in North America, subsequent research has documented the stereotype threat effect with students of both African and Latin origins in academic performance (Aronson, 2002; Steele, 2003), females in mathematics (Brown & Josephs, 1999; Spencer et al., 1999), low socioeconomic groups in academic tasks (Croizet & Claire, 1998), and white males in math performance when compared with Asian students (Aronson et al., 1999). Simply having test-takers identify their race on a pretest questionnaire has been found to result in lower test performance when race membership is associated with lower test performance (Steele & Aronson, 1995).

How is Stereotype Threat Related to the Testing Environment?

At first glance, these results may suggest that by not making race, nationality or gender salient in a testing environment, the problem would be solved. However, the impaired performances do not appear to be the result of only mentioning stereotypes. Similar results are observed when researchers manipulate the manner in which an assessment is presented to test-takers. Informing African-American subjects that a test is a measure of intelligence results in adverse effects on performance, whereas presenting the same test as an information-gathering instrument does not (Steele & Aronson, 1995). It may very well be that a stereotype of African-American intellectual inferiority creates a threat for a test-taker that he or she might confirm the stereotype. Similar results have been obtained by informing female test-takers that a math test has historically resulted in lower performances by females (as compared to men) which results in females performing significantly worse than equally qualified men (Spencer et al., 1999). But when told that the same test has not resulted in gender-related differences, females perform equal to their male colleagues. This suggests that by presenting a test in a different manner, the threat of confirming a negative stereotype can be removed and performance apparently does not suffer.

The fact that this phenomenon has been observed in populations for which there are fairly well-known negative stereotypes raises the question as to the specific motivational process is at work. Is the effect due to situational anxiety and/or symptomatic of some internal feelings of inferiority or low self-esteem on the part of the test-takers? It is interesting to note that the same type of performance impairments are observed with highly math identified, Caucasian male test-takers when given pre-test information that white males historically perform worse in math than Asian students (Aronson et al., 1999). This suggests that situational pressures alone can create the effect, since this population (White males) is not presumed to have general low self-esteem or feelings of intellectual inferiority.

Research on stereotype consciousness in middle childhood (McKown & Weinstein, 2003) suggests that in North America, African-Americans and Latinos (traditionally academically stigmatized groups) are aware of these stereotypes even as early as ages 6–10. Stereotype threat effects have been observed in girls aged 11–14 in math performance (Ambady, Shih, Kim, & Pittinsky, 2001). The fact that stereotypes may be so well known at such an early age

suggests that the stereotype threat phenomenon might be an important but hidden process that operates when complex knowledge is tested at all levels of education.

Hypotheses About the Causes of Stereotype Threat in Complex Testing Situations

Different theories as to the underlying processes or mechanisms that lead to stereotype threat have emerged. The role of anxiety has been examined (Osborne, 2001; Spencer et al., 1999; Steele & Aronson, 1995), as well as the possible combined roles of anxiety and diminished working memory (Schmader & Johns, 2003), but exactly how the two interact to affect performance has yet to be fully explicated. Anxiety as a trigger seems to have the most significant support for being at least a contributor to the observed effects, though its exact role in the process continues to be investigated.

Expectancy has been suggested as perhaps playing a role in these threat situations (Stangor, Carr, & Kiang, 1998). It is plausible that when a test-taker is given a seemingly credible reason why they might not perform well, their self-efficacy may decrease along with their expectancy for success. This reduced expectancy may result in lower performance. However, further research on examining the role of expectancy in stereotype threat has been met with mixed results (Cadino, Maass, Frigerio, Impagliazzo, & Latinotti, 2003).

Although some critics have challenged some of the underpinnings of stereotype threat theory, the effect has been demonstrated in robust fashion in several studies for almost a decade. Yet some of the issues mentioned by critics warrant further investigation. Just how large a part stereotype threat plays in the overall performance of poor and minority students has yet to be clarified. Whether it operates alone, or in concert with the myriad of other factors that contribute to the underperformance of this segment of the student population is still an open question. For example, it is reasonable to hypothesize that student's who have minimal motivation to succeed on high-stakes tests as a result of early academic failures would presumably not be affected, since they no longer identify with the academic domain.

The most important potential outcome of stereotype threat research would undoubtedly be to find ways to prevent stereotype threat from affecting test performance. In order to do so, it will be necessary to clarify the mechanism or mechanisms responsible for the reduction in performance of affected individuals. Research into anxiety is appealing and somewhat promising, given the established research that links anxiety to hampered academic performance. Insofar as anxiety is generated by uneasiness about some future outcome, research into how expectancies might play a role in the process would also be in order.

How can Tests be Structured to Counter the Effects of Stereotype Threat?

The apparent situational nature of the effect suggests that by altering the manner in which assessments are presented, test facilitators might better enable students to perform up to their capabilities. Stereotype threat research on athletic tasks suggests one way that outcomes might be improved by way of test presentation. Black and White elite athletes showed opposite patterns of performance on a laboratory miniature golf course, depending on which of the two groups was put under stereotype threat (Stone, Lynch, Sjomeling, & Darley, 1999). When the task (ten holes of golf) was presented as a measure of "natural athletic ability", Blacks outperformed Whites. When the same task was presented as a

measure of "strategic sport intelligence", Whites outperformed Blacks. In addition to demonstrating that this phenomenon may apply in settings other than academic performance, this research suggests that presenting material in a way that emphasizes a group's perceived strengths can improve that group's performance.

As the stakes continue to be raised for testing results, and the emphasis on testing outcomes continues to increase, researchers interested in complex learning environments must examine contributing factors to the underperformance for different subgroups of students. Stereotype threat appears to be one of those potential factors, and solving its mystery might contribute to reducing error in high-stakes tests.

Conclusion

Complex learning tasks and environments present a significant challenge to both cognitive learning ability and learner motivation to persist at the task and invest adequate mental effort to learn. While considerably less developed than cognitive learning research, the testing of motivation theories and the design of systematic research on motivational variables have increased dramatically in the past two decades. As a result of these studies, it appears that in most learning environments, motivation accounts for almost as much learning variance as cognitive aptitude, and thus requires more consideration in both educational research and practice.

Studies of the cognitive processes that underlie learning have provided strong evidence that learners risk cognitive overload and failure in their attempts to assemble novel strategies to support their own learning. Yet it appears that the problem is confounded by motivation issues that accompany cognitive challenges. For example, there is compelling evidence that for some students, cognitive overload causes unconscious, automated motivational "defaults" that reduce their persistence at a learning task and reduce their mental effort by switching their attention to less demanding and irrelevant stimuli. These defaults appear to happen without conscious awareness and may have a negative impact on learning. Evidence also suggests that complexity may lead students with inappropriately high or low self-efficacy to reduce their mental effort and either attempt to find an "excuse" to withdraw from learning and/or refuse to accept responsibility for mistakes.

Other areas of motivation research suggest that some learners experience strong negative emotions during cognitive overload, and when their emotional self-regulatory skill is low, negative emotions reduce task persistence and mental effort. Negative emotions are more likely for students who have learned to attribute mistakes and failures to stable and uncontrollable causes (such as a lack of intelligence). These students interpret learning difficulties as evidence that they cannot succeed and reduce their persistence and effort. A very damaging variety of this belief is explored by researchers concerned with "stereotype threat", In this research, the most capable and motivated students appear to experience anxiety, and increase their level of concern in high-stakes testing situations when they are reminded that their race, gender, or culture is expected to perform poorly on the test they are taking. This increased and perhaps distracting concern leads to significantly reduced performance.

Many motivational studies have explored treatments that help to overcome motivational deficits on complex tasks when complexity cannot be reduced to a more manageable level. Many of these interventions focus on self-regulatory skills such as the reattribution of beliefs about failure to more controllable causes or the management of strong negative emotions and/or adjustments in inappropriately high or low self-efficacy. Future research in this area would benefit from attempts at building and validating more comprehensive theories of motivation to learn with particular reference to the learning of complex tasks.

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