Creative Paradoxical Thinking and Its Implications for Teaching and Learning Motor Skills

Article · November 2011

DOI: 10.1080/07303084.2011.10598688

1 author:

David D Chen
California State University, Fullerton

Creative Paradoxical Thinking and Its Implications for Teaching and Learning Motor Skills

DAVID CHEN

Understanding paradoxes such as "less is more" can improve teaching effectiveness.

In my 20 years of teaching and research in the area of motor skill acquisition and performance, I have encountered many phenomena (either research findings or anecdotes) that first puzzled and then fascinated me. I would like to introduce three fictitious scenarios to illustrate my point.

• Mary, a novice teacher, coaches tennis at a high school. She is frustrated with one of the students she is trying to help by correcting a flaw in his backhand stroke. The more she talks, the less the student progresses. The young teacher does not realize that when presenting feedback to a student, less is more. Feedback is more effective when it is brief and focuses on a key point, than when it is excessive.

• In another case of coaching tennis, Mary finds that her students retain more of what she teaches if she introduces multiple skills (e.g., service, forehand, backhand, and volley) in a random order, even though they may not progress fast initially.

• She also observes that during an important game, one of her best players chokes up due to an obsession with avoiding the mistake she fears most. Ironically, she does exactly what she was trying to avoid.

Each of these occurrences seems counterintuitive and irrational because they have some contradictory elements. My understanding of these phenomena was greatly enhanced when I started to employ the concept of paradox and paradoxical thinking. Paradoxical thinking allows me to combine the rational, linear, left-brain approach with the creative, nonlinear, right-brain approach in understanding many previously confusing phenomena. I have also discovered that most of the effective learning and teaching strategies involve paradoxes. In this article, I will attempt to (1) define the concept of paradox, (2) propose the concept of creative paradoxical thinking and its benefits for theorists and practitioners, (3) identify six paradoxes by going through research findings of motor learning and performance, and (4) offer suggestions for applying the paradoxical-thinking process in solving problems encountered in learning and teaching motor skills.

What Is Creative Paradoxical Thinking?

A paradox is defined as a statement or situation that contains two or more logically opposing elements, but that may actually be true (Fletcher & Olwyler, 1997; Quinn & Cameron, 1988). In other words, in a paradox, contradictory and mutually exclusive elements are present and operate at the same time. In one of the above examples (less is more) "less" and "more" are juxtaposed to create an illogical statement, but a closer examination of the facts reveals its wisdom: less information

All photos by Lenny Wiersma

Developing great skill requires practice, but orderly drills are not necessarily the most effective form of practice.

contained in a sharply focused message is more conducive to learning than a verbose message that contains several ideas. People tend to dismiss paradoxes as coincidences or nonsense because they think in a more linear and logical way, without realizing that effectiveness in learning or teaching is often associated with paradoxes.

Gannon (2008) points out that there are three methods for us to understand paradoxes. The first method is to accept both elements as true despite their contradictory nature. The second method is to reframe the paradox. Reframing permits examinations of the paradox in different contexts and at different levels of analysis. The third method accepts the paradox but looks for a "higher unifying principle to understand it" (p. 6). The concept of creative paradoxical thinking is based on these three methods, but it is not limited to these methods. The core of creative paradoxical thinking suggests that practitioners should identify new paradoxes in their teaching and learning experiences and create new strategies for achieving outstanding results.

Motor-Learning Paradoxes

The process of teaching and learning motor skills is very complex, as it involves interactions between two or more people. The dynamics of the individual and in the environment make the process of teaching and learning very complex and unpredictable. One method of teaching will be hugely successful in one situation and fail terribly in another. A student may produce great results one day and experience choking on another. The relationship between teaching and learning and between effort and results is not linear or predictable. Paradoxical phenomena are the product of these dynamics. They may appear counterintuitive and confusing, yet they may serve as a source of creative energy once identified, understood, and harnessed. Paradoxical phenomena have been documented across several lines of research. The complex process of acquiring a new motor skill requires the engagement of the whole brain circuitry, and the path to mastery seems to be quite jerky sometimes. Research in human motor learning offers some clues as to the complexity of the mental process in overcoming the obstacles to acquire a skill. I will identify six paradoxical phenomena in motor-learning literature and adopt the creative paradoxical-thinking process to clarify them. I will walk you through the entire paradoxical-thinking process for the first paradox. For the remaining paradoxes I will emphasize the identification and application components.

Paradox 1: Order Out of Chaos

This paradox portrays phenomena where increased confusion introduced during practice sessions produces slow improvement and inferior performance at first, but leads to superior long-term retention or learning; while orderly drills may generate the opposite pattern. Two established research findings related to this type of paradox are the contextual interference effect and the variability effect. To increase the amount of contextual interference or chaos, the practitioner may increase the degree of unpredictability in presenting multiple skills during practice (i.e., random practice). To lower contextual interference, the practitioner can use a blocked practice schedule in which only one skill is drilled over and over until it is mastered before moving on to another skill. Random practice increases the difficulty level of performance, thus producing a temporary setback in performance, but it may increase long-term retention rates (Lin, Fisher, Winstein, Wu, & Gordon, 2008; Lin et. al., 2009; Shea & Morgan, 1979). Research findings also show that less variability produces better short-term benefits while more variability is often associated with better long-term retention and transfer effects (Edwards & Lee, 1985; Proteau, Blandin, Alain, & Dorion, 1994). Now let us apply the three-step, creative paradoxical-thinking approach to the above results for the purpose of obtaining insight into the nature of effective practice.

Step 1: Accepting the Contradictory Sides as True. There exist two opposing arguments in the above paradoxical phenomena. One argument states that increased contextual interference or variability decreases initial performance. The second, opposing argument states that increased contextual interference or variability increases lasting retention. These counterintuitive findings are perplexing to many of us who are used to linear thinking patterns, such as "what starts well ends well." To overcome this perplexity, we need to move on to the next step.

Step 2: Reframing the Paradox. Reframing paradoxical phenomena allows us to understand the seemingly contradictory arguments in the paradox by looking at them from a different perspective, which takes into account such factors as skill level, task difficulty, practice setting, time (i.e., time allotted for memory consolidation), mental effort (i.e., amount of mental work demanded), and instructional resources (i.e., quality and availability of instruction). For example, blocked practice may be instrumental for beginners to develop a stable pattern of movement, but it may also prevent students from moving to the next stage of expertise. Random practice is difficult for beginners who have not mastered the mechanics of basic skills, but it may promote specificity of training for highly skilled athletes. What is initially appealing to the student and teacher may not yield satisfactory long-term results. What is upsetting in the short-term may produce better results in the long run. Knowing the pros and cons of each argument in the paradox allows the student and teacher to move to the next stage of resolving the paradox.

Step 3: Creating and Applying a Paradoxical Insight. Based on motor-learning research, the first paradoxical principle states that *interference and variability embedded in the practice environment may facilitate lasting learning even though they may create setbacks for initial learning*. To apply this principle in teaching, it is important to remember that the level of interference and variability should be compatible with age, skill level, time allotted for practice, and instructional resources. High contextual interference resulting from introducing multiple tasks and placing high variability demands on students for quick reactions tend to favor older, more skilled students who are provided with a lot of support.

Paradox 2: Less Is More

The main responsibility of teachers and coaches is to provide guidance for students and athletes in the form of verbal instructions, feedback about the results of their performances, and skill demonstrations. Guidance normally conjures up positive connotations, for it is associated with improvement. "More is better" is often the motto. However, motor-learning research has proven that excessive guidance harms long-term learning, while reduced guidance can facilitate it (Salmoni, Schmidt, & Walter, 1984). The guidance hypothesis, which has been empirically supported, states that providing external feedback too frequently may lead to a student's dependence on the feedback, resulting in failure to process his or her own internal feedback. Therefore, it is recommended that instructors reduce the amount of guidance as learning progresses. The benefits of reducing guidance for motor learning have been empirically verified and can take the following forms: (1) decrease the frequency of feedback, (2) delay the time interval between performance and feedback, and (3) provide more autonomy for students to solve problems. The decreased guidance forces students to tune in to their internal feedback and develop more effective strategies for coping with emerging problems in the learning environment.

In this paradox "more guidance" and "less guidance" are polarized. This introduces the second paradoxical principle, which states that *learners may benefit from reduced amounts of guidance that is strategically timed.* Teachers love to help students learn by offering as much guidance as they can.

Excessive guidance harms long-term motor learning, so when giving feedback, sometimes "less is more."

Yet it is important to realize that too much guidance can backfire. Students need more guidance at the beginning of a learning session, because beginners need to know what they are learning, how they should perform a skill, and what the indicators of a satisfactory performance are. As the students progress to more advanced levels, it is better to gradually withdraw guidance so that they can become self-reliant. When teachers provide too much guidance, they may reduce the students' level of mental effort to understand and process information they garner from more internal sources. As research shows, mental effort corresponds to the amount of neurological correlation in the brain. Instead of withdrawing guidance completely, the teacher can reduce the amount and frequency of feedback provided, delay the time before offering any feedback or modeling, and/or encourage students to evaluate their own performance more often.

Paradox 3: Learning from the Less Skilled

It is conventional wisdom that you learn from an expert, but observational learning research shows you can also learn from someone who has not yet mastered the skill (Adams, 1986; McCullagh & Meyer, 1997). Mechanically copying a flawless movement demonstrated by an expert may not naturally lead to mastery (Druckman & Swets, 1988) because passively watching a person perform does not always encourage students to problem solve. Researchers have demonstrated that the use of correct models may not be the most effective means of conveying movement-skill information during the early stages of skill acquisition. They also found that watching a learning model (i.e., a peer model) better engaged the observer in problem solving and other cognitive activities leading to a permanent understanding of the skills (Lee & White, 1990). McCullagh and Caird (1990) have also demonstrated the effectiveness of watching a learning model. They found that participants who watched the learning model were more accurate in developing their skills for the timing task than those who watched the expert model. They were also able to transfer more of the skills they learned when

Teachers need to know when to intervene and when to stay away, in order to allow students the opportunity to solve motor problems on their own.

asked to complete a different task. Even though there still exist some inconsistent research findings, Lee, Swinnen, and Serrien (1994) believe that "observing a learning model will be no less effective than observing an expert model" due to the fact that "a learning model more actively engages the observer in the problem-solving processes that characterize learning" (p. 331).

This third paradoxical principle states that *learners may learn from both expert and novice peers*. Teachers should demonstrate the correct way of performing a skill during the early stages of learning. In addition, the teacher can use student learners to demonstrate to the class what they believe to be the best performances. Students can relate better to their peers, and an image of their peers performing the skill well is more motivating. Peer models who are still in the process of improving their skills can help others correct mistakes and increase the amount of awareness of the technique aspect being learned. Teachers can also use cooperative and collaborative learning assignments to augment learning. For example, have students work in groups to come up with the best way to learn how to bunt in baseball.

Paradox 4: Guided Discovery Learning

This paradox involves two opposite ideas: actively seeking the answer to a problem and waiting to be given an answer. Students are more likely to develop problem-solving skills and spontaneous strategies when given more control over their learning environment compared to those who are closely supervised (Wulf & Shea, 2004). Discovery learning, characterized by the withholding of explicit instructions, is an alternative technique for constructing a learning environment. It encourages the student to solve a problem independently, thereby leading to equivalent or better retention (van Emmerik, den Brinker, Vereijken, & Whiting, 1989; Vereijken & Whiting, 1989, 1990; Whiting, Bijlard, & den Brinker, 1987).

Various hypotheses have been proposed to account for the benefits of the discovery-learning effect. Green and Flowers (1991) suggested that providing students with instructions or rules may lead to an increased processing load and high attentional demands during acquisition, which is subsequently harmful to learning. Hodges and Lee (1999) postulated that discovery learning enables the individual to demonstrate a more exploratory learning strategy in which he or she becomes more familiar with the dynamics of the task and variations in intrinsic information sources.

The discovery-learning effect is surprising and counterintuitive. The use of explicit instructions coupled with physical demonstrations is commonplace and has been widely used to help students acquire new skills and knowledge (Hodges & Lee, 1999; McCullagh & Caird, 1990). However, this traditional form of instruction actually produces worse or equivalent learning effects when compared with the discovery-learning technique. Discovery learners benefit from the withholding of information because they are able to figure things out on their own, whereas traditional learners are "punished" with less progress because they are overloaded with information.

This fourth paradoxical principle states that *learning is a process of self-discovery as well as a process of accumulating knowledge and skills from external sources*. Real learning will never occur until the student feels that he or she has discovered the solution by him or herself. Yet, all learners know how important it is for someone to provide that extra push or edge in terms of instructional tips or emotional encouragement. Real learning is about combining these two seemingly contradictory sides to serve the needs of the student. This principle echoes the concept of "zone of proximal development" by Vygotsky (1978). Teachers need to know when to intervene and when to stay away so that students can become more independent problem solvers.

Paradox 5: Learning Without Awareness

The techniques of implicit learning and explicit learning seem to be counteractive and their coexistence creates a paradox. In implicit learning the individual is not informed about the precise nature or goal of the task, and yet may acquire abstract knowledge about the inherent rules and regularities in a task even without being aware of them (Reber, 1989; Shea, Wulf, Whitacre, & Park, 2001; Wulf & Schmidt, 1997). Implicit learning does not rely heavily on working memory, and yet it is resistant to psychological stress and the effects of aging. Examples of implicit-learning tasks are the ability to walk without the ability to describe how walking is done biomechanically, or learning to speak your mother tongue without having learned grammatical rules. On the contrary, explicit learning involves clear objectives and a dependence on working memory, yet its performance is subjugated by psychological stress and the presence of secondary tasks. Examples of explicit learning include taking an exam that requires recalling a poem, or remembering how to hold a tennis racket under the instruction of a teacher. Motor-learning research shows that implicit learning favors the learning of complex skills where the information processing load is high, while explicit learning favors the learning of simple tasks (e.g., Shea et al., 2001).

This fifth paradoxical principle states that *educators should use explicit- and implicit-learning strategies to maximize learning effects*. Learners depend heavily on explicit learning to learn about the nature of tasks and basic play strategies. Through effort and discipline, the basics of a sport are driven deeply into the neurological circuits of the brain. Explicit learning works well with simple tasks where information-processing needs are low. At higher levels of performance, motor skills are performed at a more automatic, subconscious level, which is made possible by the process of implicit learning. Great learners and performers know how to access two kinds of processes. Recent research shows that teachers can help students acquire complex motor skills by encouraging them to discover the regulatory features of the skills by themselves in an unconscious way so that this new knowledge will not interfere with the execution of the movement (which is typical in implicit learning). The irony here is that not telling is more informative.

Paradox 6: The Ironic Processes

In athletic performance, the more you want to suppress some negative thoughts that might disrupt a smooth performance, the more likely the thoughts will pop up and cause you to do exactly what you wanted to avoid (Beilock, Afremow, Rabe, & Carr, 2001; Janelle, 1999; Wegner, 1994). The paradoxical phenomenon of getting the opposite of what you want can be explained by the theory of ironic processes of mental control (Wegner, 1994). According to this theory, humans use two processes to control the mind in order to gain what is desirable and avoid what is undesirable. The intentional, conscious, and effortful operating process searches for whatever mental contents are available to help in the achievement of goals. But the unconscious and automatic monitoring process looks for mental contents that may indicate failure. The cooperation between the operating system and monitoring process works well when the monitoring process remains in the background. However, when excessive stress (e.g., emotional arousal, distractions) causes the monitoring process to take over and excessively influence the mind, the operating process carries out what is supposed to be avoided.

This sixth paradoxical principle states that *to avoid being a victim of the ironic processes, students need to be clear about what they want and learn to manage their stress*. When students are clear about their goals, their effort can be expended effectively to reach those goals. It is also important to manage their emotions and stress when performing under pressure. Ironic processes occur when the individuals are overloaded. Sometimes, acknowledging negative thoughts results in emotional calmness, while unyielding mental resistance creates mental disturbance.

Conclusions

In this article I have reexamined some of the major findings in motor learning and performance by using the framework of creative paradoxical thinking. Paradoxes are subjective and result from our perceptions. People may not agree on the definition of paradox as discussed in this article, but I hope there are at least three benefits from this endeavor. First, creative paradoxical thinking allows us to look at the established findings in motor-learning literature from a different angle, thus offering us a unique perspective of the connections among otherwise disconnected areas of research. Second, we can encourage teachers to identify more paradoxes in learning and teaching than those identified in this article so that they can offer proper instructional tips to their students. Third, practitioners can use paradoxical thinking to deal with difficult situations in their teaching and research. Paradoxical thinking encourages individuals to identify the pros and cons of each situation and to benefit from apparent contradictions encountered in learning and teaching motor skills.

Reflection can help to clarify goals, manage stress, and control emotions.

Understanding the dialectical nature of learning offers practitioners the following four important tips for instruction and consulting in daily activities.

1. Teachers and coaches should encourage learners to be unafraid to make mistakes and to learn from those mistakes. The coach or teacher must recognize that students develop error-correction mechanisms and self-regulation strategies through lots of experience of self-management and trial-and-error.

2. Coaches and teachers should conduct practice with competition in mind. In other words, it is important to match the practice conditions with those of the performance.

3. Coaches and teachers should persevere in the face of difficulties. Students will experience a temporary slide back or plateau in their progress when learning under difficult conditions. Coaches and teachers must be patient and never let up until breakthroughs occur.

4. Teachers and coaches should encourage each student to develop metacognitive strategies so they can monitor their own progress and problems during learning. Students should be challenged. The rule of forced efficiency means that only

Continues on page 49

science education professors: Comparisons with teachers: Uses and the current versus desired technology knowledge gap. *Contemporary Issues in Technology and Teacher Education, 4*(3), 299-312.

Shulman, L. S. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review, 57*(1), 1-22.

Smerdon, B., Cronen, S., Lanahan, L., Anderson, J., Iannottie, N., & Angeles, J. (2000). *Teachers' tools for the 21st century: A report on teachers' use of technology*. Washington, DC: National Center for Education Statistics.

So, H. J., & Kim, B. (2009). Learning about problem-based learning: Student teachers integrating technology, pedagogy and content knowledge. *Australasian Journal of Educational Technology, 25*(1), 101-116.

Velasquez, A. (2009). *The design of a blended approach for reaching the TPCK framework in a technology integrated course.* Unpublished master's thesis, Brigham Young University, Provo, UT.

Woods, M., Karp, G., Miao, H., & Perlman, D. (2008). Physical educators' technology competencies and usage. *Physical Educator, 65*(2), 82-99.

Susana Juniu (junius@mail.montclair.edu) is a professor in the Department of Exercise Science and Physical Education at Montclair State University, in Montclair, NJ 07043.

Chen

Continued from page 23

under challenging conditions can we really tap into our potential for learning. While challenging students, the coach or teacher should also be sensitive to the age, skill level, and special needs of the student, and remember to encourage enjoyment in both practice and performance.

References

Adams, J. A. (1986). Use of the model's knowledge of results to increase the observer's performance. *Journal of Human Movement Studies, 12*, 89-98.

Beilock, S. L., Afremow, J. A., Rabe, A. L., & Carr, T. H. (2001). "Don't miss!" The debilitating effects of suppressive imagery on golf putting performance. *Journal of Sport and Exercise Psychology, 23*, 200-221

Druckman, D., & Swets, J. (1988). *Enhancing human performance.* Washington, DC: National Academy.

Edwards, R. V., & Lee. T. D. (1985). The relationship of cognitive style and instructional strategy to learning and transfer of motor skills. *Research Quarterly for Exercise and Sport, 56*, 286-290.

Fletcher, J., & Olwyler, K. (1997). *Paradoxical thinking: How to profit from your contradictions*. San Francisco: Berrett-Koehler.

Gannon, M. J. (2008). *Paradoxes of culture and globalization*. Los Angeles: Sage.

Green, T. D., & Flowers, J. H. (1991). Implicit versus explicit learning processes in a probabilistic, continuous fine-motor catching task. *Journal of Motor Behavior, 23*, 293-300.

Hodges, N. J., & Lee, T. D. (1999). The role of augmented information prior to learning a bimanual visual-motor coordination task: Do instructions of the movement pattern facilitate learning relative to discovery learning? *British Journal of Psychology, 90*, 389-397.

Janelle, C. M. (1999). Ironic mental processes in sport: Implications for sport psychologists. *The Sport Psychologist, 13*, 201-220.

Lee, T. D., Swinnen, S. P., & Serrien, D. J. (1994). Cognitive effort and motor learning. *Quest, 46*, 328-344.

Lee, T. D., & White, M. A. (1990). Influence of an unskilled model's practice schedule on observational motor learning. *Human Movement Science, 9*, 349-367.

Lin, C. H., Fisher, B. E., Winstein, C. J., Wu, A. D., & Gordon, J. (2008). Contextual interference effect: Elaborative processing or forgetting-reconstruction? A post hoc analysis of transcranial magnetic stimulation-induced effects on motor learning. *Journal of Motor Behavior, 40*(6), 578-586.

Lin, C. H., Fisher, B. E., Wu, A. D., Ko, Y. A., Lee, L. Y., & Winstein, C. J. (2009). Neural correlate of the contextual interference effect in motor learning: A kinematic analysis. *Journal of Motor Behavior, 41*, 232-242.

McCullagh, P., & Caird, J. K. (1990). Correct and learning models and the use of model knowledge of results in the acquisition and retention of a motor skill. *Journal of Human Movement Studies, 18*, 107-116

McCullagh, P., & Meyer, K. N. (1997). Learning versus correct models: Influence of model type on learning of a free weight squat lift. *Research Quarterly for Exercise and Sport, 68*(1), 56-61.

Proteau, L., Blandin, Y., Alain, C., & Dorion, A. (1994). The effects of the amount and variability of practice on the learning of a multi-segmented motor task. *Acta Psychologica, 85*, 61-74.

Quinn, R. E., & Cameron, K. S. (1988). *Paradox and transformation: Toward a theory of change in organization and management*. Cambridge, MA: Ballinger.

Reber, A. S. (1989). Implicit learning and tacit knowledge. *Journal of Experimental Psychology: General, 118*, 219-235.

Salmoni, A. W., Schmidt, R. A., & Walter, C. B. (1984). Knowledge of results and motor learning: A review and critical appraisal. *Psychological Bulletin, 95*, 355-386.

Shea, J. B., & Morgan, R. L. (1979). Contextual interference effects on the acquisition, retention, and transfer of a motor skill. *Journal of Experimental Psychology: Human Learning and Memory, 5*, 179-187.

Shea, C. H., Wulf, G., Whitacre, C. A., & Park, J.-H. (2001). Surfing the implicit wave. *Quarterly Journal of Experimental Psychology, 54A*, 841–862.

van Emmerick, R. E. A., den Brinker, B. P. L. M., Vereijken, B., & Whiting, H. T. A. (1989). Preferred tempo in the learning of a gross cyclical action. *The Quarterly Journal of Experimental Psychology, 41*, 251-262.

Vereijken, B., & Whiting, H. T. A. (1989). In defense of discovery learning. In P. C. W. van Wieringen & R. J. Bootsma (Eds.), *Catching up: Selected essays of H. T. A. Whiting* (pp. 155-169). Amsterdam, Netherlands: Free University Press.

Vereijken, B., & Whiting, H. T. A. (1990). In defense of discovery learning. *Canadian Journal of Sport Science, 15*, 99-106.

Vygotsky, L. S. (1978). *Mind in society*. Cambridge, MA: Harvard University Press.

Wegner, D. M. (1994) Ironic processes of mental control. *Psychological Review, 101*, 34-52.

Whiting, H. T. A., Bijlard, M. J., den Brinker, B. P. L. M. (1987). The effect of the availability of a dynamic model on the acquisition of a complex cyclical action. *The Quarterly Journal of Experimental Psychology, 39*, 43-59.