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*Un homenaje al legado de investigación del Dr. Gregory Schraw: La teoría del aprendizaje autorregulado**

Antonio P. Gutiérrez de Blume**

* This article is a tribute to the life and research legacy of Dr. Gregory Schraw, a being who inspired so many others to pursue their dreams, become lifelong learners, and achieve success.

** Ph.D. in Educational Psychology, University of Nevada, Las Vegas, Department of Educational Psychology and Higher Education. Associate Professor at Georgia Southern University, Department of Curriculum, Foundations, and Reading, United States. ORCID: https://orcid.org/0000-0001-6809-1728 Correspondence: agutierrez@georgiasouthern.edu

*An homage to the research legacy of Dr. Gregory Schraw: The theory of self-regulated learning**

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ABSTRACT

Gregory "Gregg" Schraw was an international scholar interested in investigating psychological phenomena related to self-regulated learning theory. This reflection article summarizes Gregg's research trajectory about the three main components of self-regulated learning: cognition, motivation, and metacognition, while presenting the impact of his trajectory regarding some of the most relevant works of his legacy, and his contributions to the development of self-regulated learning theory and metacognition. The contributions of Gregg's work to theoretical and applied contexts in his field of research are discussed. The reflection concludes with some implications on Gregg's work and legacy and with the presentation of some of the gaps or gaps that he, as a visionary, considered for the field of study and that in his research program he wanted to pursue in his future work.

Keywords: self-regulated learning theory, metacognition, motivation, cognition, learning, learning processes.

RESUMEN

Gregory "Gregg" Schraw fue un académico internacional interesado en investigar los fenómenos psicológicos relacionados con la teoría del aprendizaje autorregulado. Este artículo de reflexión resume la trayectoria de investigación de Gregg en los tres componentes principales del aprendizaje autorregulado: cognición, motivación y metacognición, a la vez que presenta algunos de los trabajos más relevantes de su obra, el impacto de su trayectoria y sus aportes para el desarrollo de la teoría del aprendizaje autorregulado y la metacognición. Se discuten las contribuciones del trabajo del Doctor Schraw al desarrollo teórico y aplicado en su campo de investigación. La reflexión concluye con algunas implicaciones sobre su obra y su legado, así como con la presentación de algunas de los vacíos que él, de manera visionaria, consideró para el campo de estudio y que en su programa de investigación deseaba perseguir en su trabajo futuro.

Palabras clave: teoría del aprendizaje autorregulado, metacognición, motivación, cognición, aprendizaje, proceso de aprendizaje.

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Introduction

Gregory Schraw (henceforth, "Gregg", as he preferred to be called) could best be described in one statement: An eminently intelligent being who was strong, curious, creative, exceedingly productive, brave, compassionate, and kind. It is said that those who are truly creative thinkers see the world in a fundamentally different way than the rest of humanity (Runco & Albert, 2010). Gregg exemplified this quintessence of curiosity and creativity because he was not ashamed to ask deep questions and ponder the many possible answers to those questions. He was also an adept problem solver who transformed the anger and frustration most people feel when faced with a complex problem into a mind game that was even enjoyable to decipher and solve. Gregg was also an avid reader, prolific writer, and a voracious, critical consumer of information. His ability to think of novel research ideas, readily transform them to experiments, write the results, and publish these works was uncanny. Beyond his intellect, curiosity, and productivity, however, Gregg was also a deeply compassionate individual.

The British philosopher Thomas Hobbes was well known for his pessimistic view of human nature (others may disagree and claim Hobbes was simply a realist). Hobbes believed that humanity would be in a constant State of War, and that the main role of government (preferably a potent central government) was to ensure the rights of all and to keep the more savage parts of human nature at bay (Finn, 2006). Gregg exemplified a strong counterargument to Hobbes' premise. I have never experienced another being express anger as Gregg did, with calm and serenity. Gregg very much preferred dialogue and diplomacy over aggression and violence, even during discussions. Above all, however, Gregg was a kind and compassionate being who taught others that seeking tolerance and understanding of others' differences, in whichever form they manifest, was a superior approach to hate and divisiveness. Gregg's many students know him best by this aspect of himself, as a compassionate, kind, and benevolent mentor.

Gregg approached mentoring students by providing them autonomy and self-regulation. He achieved this by offering students information and advice so that they could make the most informed decision (Wang, 2021). Nevertheless, he never told students what to do or what choice to make; that was left to the students themselves. This allowed students to make their own choices to see what consequences derived from those choices. This benefitted students greatly because they were able to learn on their own that the best choices were guided by higher-quality information whereas poorer choices were driven by faulty information. Gregg was also never one to shower his students with much praise; however, this was intentional. When Gregg praised students, they knew that he meant in genuinely and sincerely because it was reserved for extraordinary occasions in which students went above and beyond what was typically expected. Consequently, his students model this behavior with their own students, thereby inspiring future generations of scholars. In the following sections, Gregg's work is summarized by first introducing the theory that guided his research then organizing his research by theme. Finally, this tribute ends with implications, recommendations and future research paths, and concluding thoughts.

Self-regulated learning theory

Self-regulated learning (SRL) theory posits that SRL encompasses cognition, metacognition, and motivation. Several theoretical accounts of SRL have been proposed in the literature (see Panadero, 2017, for a review). For instance, Zimmerman's Cyclical Phases Model (CPM)

(Zimmerman & Moylan, 2009) describes SRL as a cyclical process involving three parts: (1) forethought (e.g., goal setting, strategic planning, self-efficacy beliefs, and intrinsic motivation); (2) performance and volitional control (e.g., attention focusing, self-instruction, and self-monitoring); and (3) self-reflection (e.g., self-evaluation, attributions, and self-reactions). Boekaerts (1999), on the other hand, proposed a three-layer Adaptable Learning Model (ALM) of SRL, including: (1) regulation of the self-choice of goals and resources; (2) monitoring of processing methods (i.e., the use of metacognitive knowledge and skills to direct one's learning); and (3) regulation of processing modes (i.e., the choice of cognitive strategies).

Similarly, Winne and Hadwin (1998) developed a Metacognitive Perspective Model (MPM) of SRL in which metacognitive processes play a central role. According to the tenets of this model, learners are perceived as being active, involved self-regulated individuals who control their own learning through the implementation of metacognitive monitoring and strategy use. The model was subsequently expanded to include self-regulatory actions and the role of motivation (Winne & Hadwin, 2008). Along a similar vein, Efklides (2011) devised the Metacognitive and Affective Model of Self-Regulated Learning (MASRL) in which metacognitive and motivational processes are also key, centered on task, person, and a combination of or interaction between task and person levels. Even though all these models vary regarding labels and what aspects to include, they all agree that learning is regulated by a variety of dynamic interacting and cyclical cognitive, metacognitive, and motivational factors (Butler & Winne, 1995; Panadero, 2017). As his many works reveal, Gregg conducted research that is best captured by the three main components of SRL theory, cognition, metacognition, and motivation, but his research also led to theoretical advancement.

Gregg's research legacy

The summary of Gregg's research trajectory is displayed in Table 1.

Table 1. Summary of research by Dr. Gregg Schraw organized temporally

Author/s (Publication Year)	Relation to Self-Regulated Learning Theory
Schraw, Wade, & Kardash (1993)	Metacognition (Applied)
Schraw & Dennison (1994)	Theoretical Advancement
Schraw & Moshman (1995)	Theoretical Advancement
Schraw (1996)	Metacognition (Applied)
Schraw (1998)	Cognition
Schraw & Aplin (1998)	Motivation
Schraw, Flowerday, & Reisetter (1998)	Motivation
Schraw & Nietfeld (1998)	Metacognition (Measurement)
Flowerday & Schraw (2000)	Motivation
Schraw (2001)	Theoretical Advancement
Schraw, Flowerday, & Lehman (2001)	Motivation
Schraw & Lehman (2001)	Motivation
Lehman & Schraw (2002)	Metacognition (Applied)
Nietfeld & Schraw (2002)	Metacognition (Applied)
Finney & Schraw (2003)	Motivation
Flowerday & Schraw (2003)	Motivation
Flowerday, Schraw, & Stevens (2004)	Motivation
McCrudden *et al.* (2004)	Metacognition (Applied)
McCrudden, Schraw, & Kambe (2005)	Cognition
McCrudden, Schraw, & Hartley (2006)	Metacognition (Applied)
Lehman *et al.* (2007)	Cognition
McCrudden *et al.* (2007)	Metacognition (Applied)
Nussbaum & Schraw (2007)	Cognition
Schraw, Wadkins, & Olafson (2007)	Cognition
Hoffman & Schraw (2009)	Motivation
McCrudden & Schraw (2009)	Metacognition (Applied)
McCrudden, Magliano, & Schraw (2010)	Metacognition (Applied)

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Author/s (Publication Year)	Relation to Self-Regulated Learning Theory
Schraw (2010)	Theoretical Advancement
Bubb *et al.* (2013)	Theoretical Advancement
Olafson *et al.* (2013)	Cognition
Paik & Schraw (2013)	Cognition
Robinson *et al.* (2013)	Theoretical Advancement
Schraw, Kuch, & Gutierrez (2013)	Metacognition (Measurement)
Schraw & Patall (2013)	Cognition
Olafson, Schraw, & Kehrwald (2014)	Cognition
Gutierrez & Schraw (2015)	Metacognition (Applied)
James, Schraw, & Kuch (2015)	Theoretical Advancement
Gutierrez *et al.* (2016)	Metacognition (Measurement)
Feucht, Lunn Brownlee, & Schraw (2017)	Cognition
Gutierrez de Blume *et al.* (2021)	Metacognition (Measurement)

Source: author

Research on cognition

Gregg contributed much to the role of cognition, such as the relation between learning strategies and performance, in students' self-regulated learning. One such contribution, for example, was epistemology and epistemic beliefs. Epistemology refers to the sources of knowledge and knowing of individuals, and it has been shown to significantly influence the way learners engage not only learning outcomes, but the process of learning as well (Feucht *et al.*, 2017). One study examined how epistemic reflexivity, as a form of personal epistemology, could benefit teachers in the classroom. Findings provided practical guidelines for teachers to strengthen their epistemic reflection, and thus, become more reflective practitioners (Feucht *et al.*, 2017). On a similar vein, another study investigated the relation between argumentation and defending one's perspective in writing. They proposed that promoting adaptive argumentative skills (e.g., preparing strong, cogent arguments for one's perspective, critically evaluating others' perspective, etc.) in students' writing would improve their reasoning skills (Nussbaum & Schraw, 2007).

Gregg demonstrated his passion for teaching and learning in this and other research. For example, one study explored the importance of evidence-based practice (EBP), especially among educational practitioners. Findings suggested that, to develop high-quality EBPs, individuals should use research-to-practice methods and empirical data to make appropriate prescriptive recommendations in practice (Schraw & Patall, 2013). The relevance of instructions given to learners also plays a central role. A separate study found that students were able to perform better when the information and instructions were directly related and more specific, both diminishing the time students spend on reading and reading comprehension performance (McCrudden, Schraw, & Kambe, 2005).

Gregg also contributed to research on some of the adaptive and maladaptive behaviors in learning. In a series of studies, he and his colleagues investigated the role of academic dishonesty, procrastination, and seductive details. A series of studies investigated academic dishonesty in students (Olafson *et al.*, 2013; Olafson *et al.*, 2014). The first study examined the behaviors of students who were caught cheating, students who cheated but did not get caught, and students who claimed never to have cheated. Findings indicated that academic dishonesty behaviors were consistent across the groups, and that only those who were previously found to have cheated were less likely to do so again (Olafson *et al.*, 2013). Findings from this study were supported by evidence from a different study that extended these findings by providing explanations of why students cheat rather than simply the tasks in which they do it. Results revealed that students cheat most often because they feel tremendous external pressure from parents, friends, and society to perform at consistently high levels (Olafson *et al.*, 2014).

Likewise, procrastination, or the tendency to delay tasks presumably because they are unpleasant, is another topic Gregg explored. He and his colleagues argued that, although procrastination is often deleterious to learning, it can at times be positive for highly self-regulated individuals have unique strategies to complete assignments, albeit at the last moment (Schraw *et al.*, 2007).

Finally, Gregg was deeply interested in the influence of seductive details and students' illusions of knowing. Seductive details refer to a phenomenon in which students focus on irrelevant information of expository text and tend to ignore relevant information about the topic (Lehman *et al.*, 2007; Schraw, 1998), and illusions of knowing refer to learners' tendency to overestimate what they actually know about a topic (Paik & Schraw, 2013). In a series of studies, Gregg and his colleagues found that students recalled irrelevant information in expository text much more frequently and readily that relevant information about the topic (Schraw, 1998) and that this dilemma was exacerbated in scientific texts about phenomena, especially as the irrelevant information was more interesting to students (Lehman *et al.*, 2007). Similarly, Paik and Schraw (2013) examined the effects of teaching with animation in multimedia presentations. They discovered that while animation in multimedia presentations was beneficial to students' learning, it was moderated by the emergence of illusions of knowing. Thus, animation should be used judiciously when using multimedia for learning because it leads some students to overestimate what they actually learned.

Research on metacognition

Gregg is, perhaps, best known for his research in metacognition, which is the area of SLR theory with which he was most passionate. The next two sections focus on his work in metacognition, separating his research as applied and measurement-related.

Applied research

The main thread that links all these research studies together is Gregg's desire to enhance students' monitoring and control of their own learning, and hence, subsequently improve their self-regulated learning skills. In a series of three studies, he and his colleagues examined the impact of relevance instructions on key learning outcomes. One study, for example, explored readers' meaningful reading experiences. Results demonstrated that setting specific, manageable goals improved students' text recall and reading comprehension (McCrudden, Schraw, & Hartley, 2006). A follow up study found that students' verbal ability mediated the relation between relevance of instructions and goals and reading comprehension, such that students with higher verbal ability set more concrete, specific goals, understood instructions more deeply, and exhibited superior reading comprehension (McCrudden & Schraw, 2009). Finally, in a third mixed method study, results indicated that relevance instructions influenced readers' goals and the strategies they used to meet those goals insofar as more relevant instructions led students to develop more concrete, manageable goals and to employ deeper learning strategies than more general instructions (McCrudden *et al.*, 2010). As is evident from this line of inquiry, Gregg was deeply interested in text comprehension and what factors may influence it.

In four additional studies, Gregg and colleagues investigated the relation between various factors and text processing. The first study reported findings of three experiments that explored the interactive effects of text-based importance (i.e., intrinsically important information such as main ideas) and task-based importance (i.e., information made important by a task) on recall for text. Experiment 1 indicated that information relevant to an encoding task was recalled better than was task-irrelevant information.

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Experiment two found that information that was relevant to a task was recalled well regardless of its text-based importance. Information that was not relevant was recalled better if it was of high text-based rather than of low text-based importance. Finally, Experiment 3 supported the conclusion that readers used flexible, compensatory strategies that reflected a trade-off between text-based and task-based importance and that the use of multiple strategies occurred spontaneously without explicit prompting (Schraw *et al.*, 1993). In the second study, two experiments investigated shallow and deep text processing. In Experiment 1, they found that breaks in local coherence had no effect on any outcome measures, whereas relevance enhanced deeper processing. In Experiment 2, they found that breaks in global coherence interfered with shallow processing, whereas relevance enhanced deeper processing. In addition, relevance compensates for breaks in global coherence on measures of deeper processing, which supports the compensation hypothesis. Presumably, relevance enables readers to focus on salient information, which in turn can be used to repair serious coherence breaks (Lehman & Schraw, 2002).

A related follow up study compared high-load and low-load versions of a text by manipulating text presentation, text organization, and example context on measures of fact and concept learning. Findings indicated that low-load text presentation enhanced fact and concept learning and post-reading ease of comprehension ratings and that ease of comprehension was related significantly to fact and concept learning (McCrudden *et al.*, 2004). The fourth study examined how students process scientific texts, results revealed that the more diagrams that are present in the text, the more students were able to learn, especially difficult concepts, and the more they were able to hold onto and recall information (McCrudden *et al.*, 2007).

Beyond research on text comprehension, Gregg was also quite interested in factors that contributed to gains in metacognitive monitoring skill. Gregg's seminal article that began his measurement work on the domain generality or specificity of metacognitive monitoring described later was published in 1993. Here, he investigated the source of students' confidence in their answers to test items. The domain-specific hypothesis predicts that confidence judgments should be related to performance on a particular test, but not to confidence judgments or performance on unrelated tests. Conversely, the domain-general hypothesis predicts that confidence judgments should be related not only to performance on a particular test but also to confidence judgments and performance on unrelated tests. Results supported the domain-general hypothesis, and that the domain-general nature of confidence judgments may be attributable to generalized metacognitive knowledge (Schraw, 1996). Subsequently, a series of studies found that students who received learning strategy instruction showed superior learning and more accurate monitoring (Gutierrez & Schraw, 2015; Nietfeld & Schraw, 2002). In the first study, which involved performance on probabilities, participants received an instructional sequence of five learning strategies discussed during instruction (Nietfeld & Schraw, 2002). While these strategies were domain-specific (probabilities), the second study sought to transform these strategies into domain-general ones to maximize the transfer factor of the strategies across learning domains, and thus, further disentangle to mystery behind the domain-general versus domain-specific nature of metacognitive monitoring (Gutierrez & Schraw, 2015).

Measurement research

Besides contributing to the burgeoning body of work on metacognition in applied settings,

Gregg was also internationally renowned for his measurement work in metacognition. In 1994, Schraw and Dennison proposed a new theoretical conceptualization and measurement of self-reported metacognitive awareness. The study supported a two-factor solution in which knowledge of cognition was comprised of declarative, procedural, and conditional knowledge while regulation of cognition captured the sub-components of planning, information management, debugging, comprehension monitoring, and evaluation of learning. The resulting measure, the Metacognitive Awareness Inventory, continues to be employed widely today, and it has been translated into many languages, including Spanish, Japanese, and Chinese (Mandarin). Schraw and Nietfeld (1998) further investigated the general monitoring skill hypothesis. Students completed eight tests of fluid and crystallized ability. The eight tests yielded three performance components, whereas measures of monitoring yielded two principal components. The study supported two main conclusions: 1) monitoring skill is related across multiple domains, and 2) individuals may possess separate general monitoring skills for fluid and crystallized tasks. Of special significance, the general monitoring skill hypothesis appeared to provide the best explanation of the findings.

Subsequently, Schraw, Kuch, and Gutierrez (2013) examined the dimensionality of 10 different monitoring measures using confirmatory factor analysis (CFA). The 10 measures were representative of five interpretative families of measures used to assess monitoring accuracy based on a 2 (performance) × 2 (monitoring judgment) contingency table. The authors predicted that the two-factor solution corresponding to measures of specificity and sensitivity used to assess diagnostic efficiency would provide the best solution, which was confirmed by the data. The two-factor solution showed that that either metacognitive monitoring may utilize two different types of processes that rely on separate judgments of correct and incorrect performance or it may be sufficiently complex that a single measurement statistic fails to capture all the variance in the monitoring process.

These conclusions were further supported by two additional studies which found that monitoring occurs through two different, albeit inversely related, processes of metacomprehension accuracy and error, and that individuals develop metacognitive learning judgments in different ways based on correct and incorrect performance. According to this framework, the processes related to the development of accurate monitoring judgments are different from those related to erroneous judgments and, as an equally important aspect, errors in performance judgments are not unidimensional, but rather are divided into discordant judgments in relation to actual performance that lead to overconfidence and those that lead to underconfidence (Gutierrez *et al.*, 2016; Gutierrez de Blume *et al.*, 2021). Evidently, Gregg contributed extensively to metacognitive research not only in applied settings, but in measurement as well.

Research on motivation

Motivation is arguably the most complicated concept withing the theory of self-regulated learning. This is the case because it is an umbrella term that subsumes a variety of constructs, each with their own rich theoretical traditions, including self-efficacy, affect/emotion, expectancy value of tasks, goal orientation, and self-determination, among others. It is because of this that Gregg pursued motivational concepts and to better understand how it influenced metacognitive monitoring. Gregg's research on motivation spanned the roles choice, self-efficacy, situational interest, and goal orientation played in learning outcomes.

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Choice

In four distinct studies, Gregg and colleagues evaluated the effect of various choices on learning. Schraw *et al.* (1998) investigated the effect of choice on cognitive and affective engagement during reading in two experiments. Both experiments compared college students who either selected what they read or were assigned the same story without being allowed to choose. Experiment 1 found that unrestricted choice heightened favorable affective perceptions of the reading experience compared with denied-choice and control groups, but it had no effect on cognitive measures of engagement. Experiment 2 replicated these findings when individuals within a single group were offered choice or were denied choice. Employing qualitative phenomenology to examine what, when, where, and to whom teachers offer choice, one study showed that teachers believe that choice promotes learning and motivation, but that teachers imposed limits on classroom choice based on characteristics such as students' age, cognitive ability, and prior knowledge (Flowerday & Schraw, 2000).

A follow up study also incorporating multiple experiments examined the effect of choice on cognitive task performance and affective engagement, and proffered two predictions (Flowerday & Schraw, 2003). The enhanced cognitive engagement hypothesis (ECE) predicted that choice would increase cognitive engagement as measured by performance on a cognitive task such as solving a crossword puzzle or writing an essay. The enhanced affective engagement hypothesis (EAE) predicted that choice would have a positive effect on attitude and effort. Experiment 1 indicated that choice had no positive effect on cognitive engagement, but it had a positive effect on attitude and effort. Experiment 2 demonstrated that self-paced readers who were given a choice of how long to study spent less time and performed more poorly on cognitive measures than researcher-paced readers who did not have a choice. Further, positive affective engagement was associated with choice of study time. Thus, findings from both experiments supported the EAE hypothesis (Flowerday & Schraw, 2003). A related study explored the effects of choice and topic interest on reading engagement, attitude, and learning. Experiment 1 showed a small negative effect for choice on the writing of content essays, such that students in the control group, who were not given choice, wrote better content essays. In Experiment 2, no effects were found for choice or topic interest (Flowerday *et al.*, 2004).

Self-efficacy

Another area in which Gregg worked within motivation was self-efficacy beliefs. Self-efficacy is defined as individuals' self-assessments regarding their own competence or ability to perform in a task. In two separate pieces, Gregg and his colleagues tackle the influence of self-efficacy in students' ability to self-regulate their learning. The first study included two measures, current statistics self-efficacy (CSSE) and self-efficacy to learn statistics (SELS), to address whether statistics self-efficacy is related to statistics performance, and whether self-efficacy for statistics increases during the semester. Self-efficacy scores, as captured by both measures, were related positively to each other and to two measures of statistics performance (i.e., specific statistics problems and overall course performance). The CSSE and SELS also were related positively to math self-efficacy and attitudes towards statistics, but they were related negatively to anxiety. Interestingly, results revealed that statistics self-efficacy increased almost two standard deviations within an academic semester (Finney & Schraw, 2003).

In addition, Hoffman and Schraw (2009) examined the influence of self-efficacy beliefs and working memory capacity on mathematical problem-solving performance, response time,

and efficiency. Two separate experiments evaluated the viability of the motivational efficiency hypothesis, which predicted that motivational beliefs, such as self-efficacy, increase problem-solving efficiency through focused effort and strategy use. Both Experiments reported a significant effect for self-efficacy on problem-solving performance and efficiency, but limited effects for time. Within experiments, Experiment 1 suggested that self-efficacy is beneficial as demands on working memory increase. Further, self-efficacy increased problem-solving efficiency through strategic performance rather than faster solution times, which is consistent with the motivational efficiency hypothesis.

Situational interest

Situational interest refers to interest that is spontaneously evoked by elements of the task itself such as task instructions or an engaging text. This implies that interest in the task may not have been high in the first place, if present at all. Research indicates that situational interest can be divided into initial interest (interest initially sparked by some element of the task), interest that catches an individual to continue with the task (this entails continued task-involvement beyond initial interest), and sustained interest (this implies an enduring interest in the task by individuals; Schraw & Lehman, 2001; Schraw *et al.*, 2001). In two studies, Gregg and his colleagues investigated the relation of situational interest and learning. Schraw and Lehman (2001), for instance, conducted a systematic review of theoretical and empirical research on situational interest. They distinguished between situational and personal interest. Situational interest involves spontaneous and context-specific task engagement, whereas personal interest is enduring and context-general. They identified five emergent themes such as examining the effect of relevance on the relation between interest and learning, that focus on relations among situational interest, information processing, and affective engagement. Taking this advice to heart, Schraw, Flowerday, and Lehman (2001) evaluated several approaches to increase situational interest in the classroom. These included offering meaningful choices to students, selecting well-organized texts that promote spontaneous interest, and providing the background knowledge needed to fully understand a topic.

Goal orientation

A final area of motivation addressed by Gregg was students' goal orientation. Goal orientation refers to students' approach to learning, and they are generally divided into a 2 (mastery, performance) x 2 (approach, avoidance) array. This produces four types of goal orientations: mastery approach (individuals who seek to master content for mastery itself and/or because they find it intrinsically motivating), mastery avoidance (individuals who avoid activities because they fear they cannot master them), performance approach (individuals who prefer high performance because they seek to be the best performer relative to others), and performance avoidance (individuals who seek to avoid situations of incompetence or underperformance relative to others; Schraw & Aplin, 1998). In a study published in 1998, Schraw and Aplin studied the relation between students' goal orientations and teachers' subjective ratings of students. Findings showed a strong relation between mastery goals and teacher ratings, but no relation among goals, grades, and an objective measure of critical thinking.

Theoretical advancement

Besides his many contributions to research, Gregg was also a theorist. His theoretical contributions were aimed at improving not only conceptual definitions of constructs, but also the quality of the data derived from them, and the validity of the inferences and conclusions

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about them. In another of his seminal articles that continues to be highly cited today, Schraw and Moshman (1995) discuss individuals' theories about their own cognition. They defined these "metacognitive theories" as systematic frameworks individuals employ to explain and direct their cognition, metacognitive knowledge, and regulatory skills. Moreover, they distinguished between tacit, informal, and formal metacognitive theories and discuss critical differences among them using criteria borrowed from cognitive developmental research. In 2001, Schraw also systematized theoretical work in epistemology, in which he summarized research on epistemological beliefs (i.e., beliefs about knowledge and knowing). He identified four emergent themes pertaining to the number relation among, development, and measurement of epistemological beliefs. Moreover, he uncovered four educational implications regarding epistemological beliefs: understanding teachers' beliefs, understanding students' beliefs, promoting critical thinking, and attempting to change teachers' and students' beliefs to more adaptive ones (Schraw, 2001).

Gregg was also concerned with educational policy and accountability by way of the use of data from assessments. In 2010, Gregg served as the Guest Editor to a special issue on "Schooling in the Age of Accountability", in which his emphasis was the relation between school accountability and school improvement, professional development, assessment, and student motivation. In addition, the research from the special issue helped him develop a conceptual framework that links standards–based education to assessment, accountability, and school variables such as improvement, professional development, and motivation. A related study provided revised guidelines to combat a growing research-reporting concern. Findings proposed that peer-review educational research journals modify their editorial policies regarding the content of primary research articles such as that authors should restrict their discussion and conclusions to their data and not offer recommendations for educational practice nor speculate about the educational policy implications of their research. It was argued that these modified editorial policies should lead to enhanced validity and utility of the inferences and conclusions of published research (Robinson *et al.*, 2013).

Gregg was also quite interested in how to improve the theory and measurement of students' ratings of instructional effectiveness. He firmly believed that if personnel decisions for faculty members (e.g., tenure and promotion) were going to be based, however minimally, on students' evaluations of instructional effectiveness that they should be based on sound data. One study found that while faculty were encouraged to adhere to credible student feedback on improving instruction because it led to appreciable gains in learning, they cautioned that course evaluations should serve as only one component of gauging faculty members' teaching effectiveness (Bubb *et al.*, 2013). A follow up study derived an equation from standard statistical theory that can be used to estimate sampling margin of error for student evaluations of teaching (SETs). This equation was employed to examine the effect of sample size, response rates, and sample variability on the estimated sampling margin of error and the interpretative validity (IV) of a SET score. It was found that a small margin of error (e.g., 3% of the range), suggests a greater precision, or IV in a score, whereas a large margin of error (e.g., 10% of the range) suggests a lower IV (James, Schraw, & Kuch, 2015). Thus, like Bubb *et al.* (2013), student evaluations should be only one source of instructors' teaching skill.

Epilogue

As is evident, Gregg was an eminent scholar and deep thinker who impacted research and

advanced theory in the areas of self-regulated learning and educational psychology. On the practical side, Gregg's research contributed to our understanding of self-regulated learning generally and to the three main components of SRL theory more specifically, cognition, metacognition, and motivation. Gregg's pursuit of a much deeper understanding of SRL theory is what made him both an applied researcher and a theoretician. Indeed, he exemplified that one could not call oneself a "scientist" if one did not pursue both research in practice and theoretical development.

Another key takeaway from Gregg's research trajectory was his penchant for developing "concept-rich" and methodologically-sound studies. He not only conducted research with multiple experiments often, but he also planned his works by intentionally including multiple related concepts rather than more simplistic approaches. This best captured his constant drive to understand concepts more deeply by asking multiple questions in several experiments. Thus, he was engaging in multi-experiment studies well before it became a fad. From a methodological standpoint, Gregg also exemplified depth of understanding by engaging in research through multiple research designs. He was, of course, best known for his prolific quantitative research; however, he also understood the need to conduct qualitative and mixed method research if researchers truly sought to understand phenomena more holistically.

Next steps: where Gregg saw himself next[1]

Gregg was a "restless soul" insofar as he never truly felt comfortable discussing or accepting the concept of retirement. In my capacity as a Ph.D. student at the University of Nevada, Las Vegas during the years 2008-2012, and as one of the last three students in which Gregg served as dissertation Chair, I feel honored to have been able to be his student and to have been able to learn so much from his work and legacy.

During our conversations, I remember Gregg once commented that his goal was to work well beyond his 75th birthday. In fact, he considered an intellectual challenge, remarking that he would only stop working when his "mind gave up on him", an event he was not expecting until past 80 years of age. This is one of the most memorable aspects of Gregg, his tireless pursuit of answers to the deep questions of psychological phenomena that were still incubating in his brilliant mind. Before his untimely death at 62, Gregg left much work undone, a task he left to those who knew him best and to the scientific community at large. Following are some of Gregg's next steps in research.

One area that Gregg left unexplored as of the time of his passing was in measurement of metacognition. Gregg was deeply committed to developing a much richer theoretical framework than that proposed by Nelson and Narens (1990). To this end, one of his last great works was in advancing the measurement of metacognitive monitoring and developing a more comprehensive view of monitoring (e.g., Gutierrez *et al.*, 2016; Gutierrez de Blume *et al.*, 2021). However, the puzzle is yet incomplete. Gregg was interested in more conclusively examining the developmental trajectory of metacognition across the lifespan. He was also interested in continuing to investigate the domain-specificity or domain-generality of metacognition. Finally, he was interested in exploring the influence of within-person characteristics such as personality, personal preferences, and other social and familial characteristics on metacognition and self-regulated learning more generally,

1 Ideas derived from my scholarly conversations with Dr. Gregg Schraw during the years he was my mentor (2007-2015)

and metacognitive monitoring more specifically. These are certainly no easy tasks; then again, if they were, Gregg would never have been interested in pursuing them in the first place. These research avenues are ones which Dr. Fred Kuch and I, two of his three final students, continue to ponder today.

Conclusion

Gregg was an internationally-renowned scholar who was best known for his research under the tenets of self-regulated learning theory. His works in cognition, motivation, and metacognition led not only to appreciable contributions to research-in-practice, but also to major theoretical advancements. Besides his many scientific accomplishments, Gregg was also known to be a great mentor, guide, and friend to those who knew him best. The many students who have the honor of having worked with him continue to model his many positive behaviors for future generations of scholars. Thus, even though Gregg is no longer here in body, his spirit and legacy live on.

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