

Recent Research in Science Teaching and Learning

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ABSTRACT

The *Current Insights* feature is designed to introduce life science educators and researchers to current articles of interest in other social science and education journals. In this installment, I highlight three recent studies from the fields of psychology and science, technology, engineering, and mathematics education that can inform life science education. The first assesses the impact of a novel study strategy: having students deliberately make mistakes and correct them. The second encourages educators to think more carefully about the impact of different types of interest on student learning. The third reminds us of the impact of personal beliefs in diversity, equity, and inclusion efforts.

NOVEL STUDY STRATEGY: STUDENT'S CORRECTING INTENTIONAL ERRORS INCREASES LEARNING

Wong, S. S. H., & Lim, S. W. H. (2021). Deliberate errors promote meaningful learning. *Journal of Educational Psychology*. Advance online publication. <https://doi.org/10.1037/edu0000720>

Many instructors are focused on helping students get things right, but studies in both education and the workplace demonstrate that mistakes, paired with corrective feedback, can be valuable for long-term learning (for an overview, see the introduction of this paper). In this study, Wong and Lim explore one strategy for introducing mistakes into the learning process: inducing deliberate errors. This strategy involves students intentionally writing statements that have mistakes and then immediately correcting the statement. For example, a student might write: "Whales are (mammals) that live in the ocean." The authors propose several advantages of deliberate errors over naturally occurring errors. First, this method avoids any negative emotions students can experience from natural mistakes (e.g., if they attribute the mistake to low ability). With deliberate errors, they can attribute the mistake to the activity. This difference may help them more successfully absorb corrective feedback. In addition, it is a structured activity, so instructors can plan for it instead of waiting for a spontaneous mistake to occur in class.

Wong and Kim tested the efficacy of deliberate errors for learning at both lower and higher levels of learning across two studies. Their controls in these studies were three common study strategies: underlining (study 1), concepts maps (study 1), and elaboration (study 2). Published evidence documents that all three strategies support learning at the knowledge and comprehension levels. Concept maps and elaboration also support higher-order learning. Of the three strategies, elaboration was the most like the deliberate error condition. In the elaboration condition, students wrote a statement and then explained the meaning of one of the concepts in the statement. For example, a student might write: "Whales are mammals (warm-blooded vertebrates who give live birth) that live in the ocean." The procedures for both studies were the same: Participants first had a practice phase where they tried out whichever study strategy they were assigned to. Then they were given one of two novel texts to read and 25 minutes to employ their assigned study strategy. Participants then completed a brief survey about their perception of their learning and

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a distraction activity (study 1) or break (study 2). They then completed a recall test and an application test in which they applied knowledge from the text they read to explain a novel scenario. The recall test asked them to write down everything they could remember from the text. Students were assigned points for every idea they correctly applied or recalled. The biggest difference between the studies was that study 1 employed a between-person design (i.e., each participant was assigned to one of three study strategy conditions) and study 2 employed a within-person design (i.e., each participant was assigned to both the deliberate error and elaboration conditions). In study 2, the order of the tasks was randomly assigned for each participant.

The deliberate errors approach outperformed all three study strategies on both the application and the recall assessments. For example, participants in the concept map and underlining conditions correctly applied approximately seven ideas from the original texts, and those in the deliberate error condition applied ~10 (a 30% increase). Even more stringently, the same participant in the deliberate error condition versus elaboration condition correctly applied approximately two additional ideas (a 45% increase) and recalled three additional ideas (38% increase).

Interestingly, the participants did not perceive any differences in the effectiveness of the study methods as they were studying or even after they took the exams. This may mean that students inadvertently choose study strategies that do not assist them as much as deliberate errors, so instructors using this strategy may need to provide framing that introduces students to the value of this strategy.

Thus, Wong and Lim demonstrated the potential of deliberate errors as a learning tool and study strategy. It outperformed three study strategies that did not involve making mistakes on both higher- and lower-order assessments. However, this study focused only on short-term gains, so studies demonstrating the impact on long-term learning, as well as studies on more complex tasks in authentic learning environments, are still needed.

CAN TRIGGERING INTEREST SOMETIMES REDUCE LEARNING?

Senko, C., Perry, A. H., & Greiser, M. (2021). Does triggering learners' interest make them overconfident? *Journal of Educational Psychology*, 114, 482–497.

Interest is widely leveraged in biology education to increase student engagement and persistence. However, what different researchers mean by “interest” can vary (Rowland *et al.*, 2019), and a widely used framework for characterizing interest identifies multiple types of interest that lie on a spectrum based on their stability over time (Hidi and Renninger, 2006). In this paper, Senko and colleagues posit that some of these types of interest may have an unintended consequence: a reduction in learning.

Drawing on Hidi and Renninger's model, the authors focus on two types of interest: personal interest, which is characterized an enduring affinity for a topic, and situational interest, a short-term interest that is triggered by features of the learning environment or learning task rather than the topic *per se*. Of the two, situational interest is easier for an instructor to cultivate and so is often the one leveraged in the classroom. Both types of interest have been shown to be

helpful for capturing students' attention and helping them enjoy a topic. However, Senko and colleagues argue that situational interest may also lead to a harm by making students overconfident in their knowledge, which could lead to them to reduce their study time on those interesting topics. Their hypothesis is based on previous studies, reviewed in the paper's introduction, that reveal a correlation between situational interest and confidence even on novel tasks. Further, research demonstrates that affect is one of the cues individuals use to assess their ability at a task. So positive feelings like enjoyment that occur due to interest may also trigger confidence when it is not warranted.

There are two common ways that situational interest is triggered. The first is called “seductive details.” In this method, the interesting components of a text or lesson are only tangentially related to the actual topic (e.g., components like pop culture references or humor). Research has shown this method of triggering situational interest does not help with retention of the core topic, but the relationship to topic confidence has not been explored. A second way to induce situational interest is the make the core topic itself more interesting. Senko and colleagues explore the role of overconfidence in mediating the impact of situational interest on learning under both of these conditions.

The setup for this study is similar to the previous article reviewed in this installment of *Current Insights*. In study 1, two groups of students ($n = 201$) read a passage on the same topic. One group received a passage with seductive details to trigger their situational interest, and the other received a control passage without those details. Study 2 ($n = 196$) employed a within-person design wherein one student was exposed to both treatments: “relatively dull” passages (e.g., the methods of performing a religious chant) and passages in which the core topics were connected to topics college students broadly enjoy (e.g., how a particular religious movement was influenced by rock music). In both studies, students then self-reported interest in the passages as well as their confidence in understanding the topics they read about. In addition, researchers were interested in how potential overconfidence might impact study decisions, so in the second study, students were also asked which passage they would be mostly likely to study if they had limited time to study for a quiz. Students were then quizzed over the content of the passages. Researchers used mediation analysis to understand whether overconfidence could explain the relationship between situated interest and quiz performance.

The results from study 1 supported their overconfidence hypothesis. The seductive details treatment elicited more situational interest and made students more confident in the amount learned from the passage, yet these students recalled less about the topic than students in the dull condition. Study 2 showed slightly mixed results. Making core content more interesting led to slightly higher learning compared with the dull passages. However, the authors argue that this difference was small and that the overconfidence that was also elicited by more interesting content would be more damaging. They demonstrated this by asking students which passages they would prioritize studying: Students chose the dull passages, even though they only learned slightly less from those passages than from the interesting passages.

Overall, this paper is a cautionary tale for interest. It is a reminder that not all interest is equally valuable for learning. It is worth noting that this study was conducted in a lab without distractors. In the noisy world of a classroom, might getting student attention be worth the risk of overconfidence? This article cautions instructors who choose to leverage situational interest that they should avoid the addition of interesting tangential material and instead focus on making core content more interesting.

INSTRUCTOR BELIEFS INFLUENCE WHERE INSTRUCTORS PUT THEIR EFFORTS RELATED TO DIVERSITY, EQUITY AND INCLUSION

Russo-Tait, T. (2022). Color-blind or racially conscious? How college science faculty make sense of racial/ethnic underrepresentation in STEM. *Journal of Research in Science Teaching*. Advanced online publication. <https://doi.org/10.1002/tea.21775>

Black and Latinx science, technology, engineering, and mathematics (STEM) majors are more likely to switch to non-STEM majors or leave college than their White peers even after controlling for socioeconomic status (Riegle-Crumb and King, 2010; Riegle-Crumb *et al.*, 2019; Chang *et al.*, 2014; Xie *et al.*, 2015). These observations suggest there is something unique to the culture in STEM that is driving these students away. In this study, author Russo-Tait identifies one factor that may influence students' experiences in STEM classrooms: where instructors place responsibility for Black and Latinx underrepresentation in STEM and how that relates to their explanations for why this underrepresentation exists.

As reviewed in the paper's introduction, a common reaction to continuing disparities in U.S. society is "color-blindness." Color-blind explanations allow people to explain racial disparities in ways that do not acknowledge racism and further obfuscate systemic racism (racism embedded in society or organizations through policies and structures). There are multiple ways color-blindness can manifest, and Russo-Tait explores these manifestations, as well as how a contrasting belief, race consciousness, manifests in college STEM education, through interviews with 42 STEM faculty at a research-intensive historically white institution. The majority of faculty who participated in the interviews were white (74%) men (62%) who were also continuing generation (81%). In addition, 60% were faculty in the life sciences.

Russo-Tait found that 71% of interviewed faculty employed color-blindness in their explanations of continued racial disparities in STEM participation. Many of these explanations may feel familiar to readers. For example, some faculty connected racial underrepresentation to a lack of interest in STEM or lack of confidence that reduces student persistence when they encounter challenge. In these explanations, faculty failed to connect student personal behaviors or choices to the larger culture of STEM that may make it hard for them to reach out for help. Thus, faculty effectively put the burden of their underrepresentation on the students themselves. In addition, some faculty blamed underrepresentation on cultural aspects such as a lack of family or community support for attending college. For example, some faculty described how students were expected to assist with family responsibilities while in college, and these responsibilities

made completing course work challenging. Explanations like these again place responsibility for disparities in retention outside the university and falsely suggest that Black and Latinx cultures do not prioritize STEM. A third way color-blindness manifested in faculty explanations was in minimizing the role of race in underrepresentation. Some faculty did this by emphasizing that socioeconomic status was the primary issue, focusing on lack of exposure, opportunity, and educational resources available in low-income communities to explain underrepresentation.

What unites all three of these explanations is that they place the responsibility for ending underrepresentation outside the university: For instance, they emphasize insufficient precollege STEM experiences or perceived unsupportive cultures of Black and Latinx students. Many of the faculty who employed color-blind explanations were engaged in activities to increase the representation of Latinx and Black STEM majors, such as outreach to schools or participating in STEM summer camps. Their involvement in such programs aligns with the belief that underrepresentation stems from issues outside the university. They were not examining or challenging their own classroom practices or the norms of their departments.

Faculty who used race-conscious explanations for underrepresentation described some of the same patterns but related them back to systemic racism in STEM contexts. For example, faculty described lower confidence leading Black and Latinx students to leave STEM, but they related this to exclusionary practices and microaggressions occurring in STEM classrooms rather than cultural or experiential background. Faculty using race-conscious explanations placed the responsibility for underrepresentation on university STEM culture and in their own classrooms. This impacted where they put their effort to increase representation: They focused on practices in their classes and departments. Some of the practices these instructors changed to support their students of color included adding active learning, creating a code of conduct that discourages racism and sexism in the classroom, and supporting students of color as they apply for professional schools.

The faculty in this study were concerned about their students' success, but how that care was manifested as action varied based on their explanations for the challenges faced in STEM classes for Latinx and Black students. Faculty with color-blind beliefs seemed to focus on student experiences with STEM before college, whereas faculty with color-conscious beliefs were more likely to work on students' current experiences with STEM. It is important to note that color-blindness is a dominant cultural narrative in the United States; in the absence of specific training to counter color-blindness, it is not surprising that many faculty hold this belief. However, this study suggests that this belief may hamper efforts to change the culture in college STEM classrooms and departments even when held by faculty who want to create change.

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