

Evidence-Based Change Practices

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Four years ago, I (Geoffrey is the first-person source of the stories in this editorial) thought I had a perfect pitch to reform how gateway courses were taught in a top-ranked department: I had the enthusiastic endorsement from the college deans, I had resources to offer the department, I had incentives for the faculty, and I had the research data to support a plan for moving to evidence-based instructional practices. The pitch failed. The support from the dean was shrugged off; the department felt it knew what was best for itself. The resources were minimized; what could a couple million dollars really do anyway? The research was rejected; the current system was working just fine; they were a top-ranked program after all.

Stories of defeated change efforts are all too common in the engineering education research community. While our community has been making calls for change, our collective experiences have been that change is slow and hard (Borrego & Henderson, 2014). We chafe as we seek to promote “evidence-based instructional practices” (broadly defined in this editorial to include improving learning and climate, admissions policies, and curricular design), only to find our colleagues continue to use ineffective instructional practices or perpetuate practices that alienate groups of students. We ask ourselves, Why do they resist evidence-based practices? The irony is that while chafing at their rejection of the evidence, we do the same thing as we try to bring about change in ways that are not supported by evidence. Thus, despite our good intentions and sincere desire for change, we are destined to continue on this path of frustration as long as we fail to consider and use evidence-based change practices.

This past year, awardees of National Science Foundation (NSF) institutional change grants gathered to discuss their efforts. A common theme emerged: We each struggled to synthesize and apply the change research literature to guide our efforts (Herman & Pembridge, in press). In the same way that faculty intuitively teach the way they were taught, we intuitively seek to create change in the ways we have seen others try to create it. To spur progress, this editorial examines how we can apply evidence-based change practices to promote evidence-based instructional practices.

Specifically, this editorial reframes intuitive narratives about the role that administrative support, data, and incentives play in creating change. While these tools can play an important role in change, we often misunderstand how and when they apply. As will be shown, the change research literature indicates that change agents are better served by engaging the values and interests of those involved (Gagné, Koestner, & Zuckerman, 2000; Hornung & Rousseau, 2007), listening and telling stories (Vaara, Sonenshein, & Boje, 2016), and creating just systems (Kickul, Lester, & Finkl, 2002; Novelli, Kirkman, & Shapiro, 1995). In concert with these approaches, power, data, and incentives can become productive tools for creating sustainable change. But without them, these tools are unlikely to be effective.

Starting with Power Fails

At a recent NSF conference, a plenary speaker made her case for why and how we should improve STEM education. She noted that the president of the United States had mandated increasing the number and quality of STEM graduates and that the research data on active learning was in our favor. We had a “moral imperative” then, she argued, to increase the use of active learning in STEM, and we should use presidential mandates and data to push our cause forward (Handelsman, 2016).

When senior administrators or even presidents are on our side, it feels good. It might make us feel as if we can exert power, indeed that we are charged with the right and the need to apply power to make change happen. But using power to force change is counter-productive. Using power to influence others implies that the tasks they are being told to do are tasks they would not choose to do. It implies that it is probably in their best interests to resist and to stop once the power is no longer present (Gagné & Deci, 2005; Rains, 2013). Moreover, by seeking to control others (and that is what we are doing when we appeal to power to force change), we are diminishing their sense of autonomy and indicating that we know better. Thus, using power threatens our colleagues’ identities as competent professionals and indicates a lack of respect. Sometimes their resistance is passive, such as ignoring us or brushing us off. Sometimes their resistance is active, in the form of asserting their own dominance over us (Ford, Ford, & D’Amelio, 2008; Hirschman, 1970).

For example, when I tried to engage the top-ranked department as an expert in engineering education research with the backing of the dean, my goal of improving the department’s gateway courses represented an attack on their department’s identity. They prided themselves as the most rigorous of the engineering departments. From their perspective, in what sense was I an engineering education expert anyway? I had little experience teaching the courses we were discussing. The sense of power, the feeling that I knew better, despite whatever good intentions I had, led to an interaction that quickly generated the perception that I was an out-of-touch meddler to be resisted or even put in his place.

The perils of power in creating change mirror the perils of coercing students with grades to promote learning. Leveraging power undermines motivation. Motivation theories like self-determination theory (see Gagné and Deci, 2005, for a review), underscore that we should treat others as if they are motivated to preserve their autonomy, doing what they want and think is right to do. Just as promoting students’ intrinsic motivation to learn leads to deeper and better learning strategies, most people reliably perform effectively, remain committed, and go above and beyond for those around them when they feel that the motivation for their actions is internal – that they believe it is what they should do and are choosing to do it themselves.

Interest and Values, Then Power

The challenge of efficiently and effectively generating enduring change is not primarily about exerting power. Instead, it is about identifying, raising, and shaping the interests and values of those involved so that they can come to see new actions as being what they want to do (Conger, 1998; Ury, 1992). This is why some changes can feel so positive and go so well. Occasionally, faculty members realize that adopting a new teaching practice is in their

own interests. Notably, these interests are often different from our interests as engineering education researchers.

Consider Professor Smith, a pseudonym. Smith is a tenured engineering research faculty member who is skeptical of “touchy-feely” education research. While co-teaching a course, she unintentionally learned how to use evidence-based, collaborative learning practices. She found that she liked this particular teaching practice because it limited the possibility that underprepared graduate teaching assistants (GTAs) could present erroneous content during discussion sections and because students seemed to like it. At the same time, a colleague invited her to join an effort to revitalize their department’s introductory course sequence. Having been frustrated by students’ lack of preparation for her upper-level courses and figuring that she could do better than previous instructors, she agreed to join the team. Since she liked the collaborative learning practices, she quickly incorporated the technique into the introductory course sequence. While the students initially hated the changes (a response to an exertion of power), the students eventually came around and found that the collaborative learning exercises were a favorite part of the course.

Enjoying increased quality control and students’ support for the collaborative learning practices, Professor Smith’s team soon became supporters of these evidence-based practices as well. Within two years, Professor Smith’s team successfully lobbied for the creation of collaborative learning spaces and the incorporation of collaborative learning into over a dozen introductory courses in several departments. To be clear, no power was exerted on Professor Smith to change or prompt change in others. Instead, Professor Smith became a change agent for collaborative teaching practices because those practices solved her problem: complaints from students about unprepared GTAs and underprepared students for her upper-level courses. Solving her problem represented an advance for Professor Smith’s own interests. Her interests led her, because of her values, to advocate for broader adoption of these changes elsewhere.

The contrast between how easily the top-ranked department four years ago shrugged off millions of dollars and how much Professor Smith accomplished without the same resources is important. Faculty change is not largely driven by money. It is driven by interests and values. However, a common objection, at this point, is that tenure and promotion – not money – are the most relevant incentives driving faculty behavior. Certainly many faculty careers are driven by and organized around research. Without a research record there is often no tenure case for a teaching record to influence. In contrast, some institutions will support tenure cases for those with poor teaching records. This imbalance can create cynicism about the prospects for making lasting instructional changes. We hear statements roughly along the lines of “they do not need to teach well to get tenure, and once they have tenure, there is little way to force them to become better teachers.”

The danger of these sentiments lies in their assumption that power drives change and behavior. While faculty members may not use evidence-based practices, most still care about teaching, identify as teachers, and invest time and effort in teaching. They argue about the right content. They seek to guard “rigor.” They want interesting interactions with students rather than frustrating ones. They want students to be interested in topics they find so fascinating. Thus, as faculty commit extensive resources to teaching, we need to consider how we can make their teaching experiences rewarding instead of “monotonous” or “tolerable” or “an energy sink.” Professor Smith had a problem with unreliable GTAs, which spurred change that yielded a course with more excited and challenged students and fewer complaints. The GTAs were happier, the students were happier, and Professor Smith found teaching to be more rewarding.

As we design student-centric pedagogies that address the challenges that students face during learning, are we also considering the challenges that faculty face during teaching and their careers? Can we more robustly study faculty interests? Can we better identify and clarify the problems that stand in the way of those interests? Rather than use power to force our solutions on others, we should use our power to help faculty notice and articulate their own problems in a way that will lead them to seek to implement evidence-based instructional practices and seek our help in implementing them.

Four years ago, I felt defeated after I left my pitch with the top-ranked department. I reported my failures to the rest of my team, and they decided to give it one more go. Their pitch began with our institution's research culture. They talked about how we all intuitively know that good research collaborations live or die by regular meetings and that collaborations lead to innovation and cutting-edge research ideas. They talked about the looming challenges of teaching with rapidly growing enrollments and how getting that wrong, or doing poorly there, would affect all of us negatively, all the time. They also pointed out that no one had solved that challenge of teaching at scale yet, so our institution could be a pioneer in solving it. Within a half hour, the department signed up a team of six faculty members who would work together to collaboratively redesign the department's gateway courses. At that point, the power, resources, and data we offered were no longer useless. The deans supported *their* change effort, the resources backed *their* change effort, and the data informed *their* change effort.

Listen, Tell Stories, Then Provide Data

"Look, you can show me all the data you want, but it won't convince me that this is worth doing." With that comment, the associate head of a department ended our conversation about creating an integrated engineering-mathematics course. We were trying to create this course based on the data that showed that it could improve students' ability to transfer mathematics knowledge into engineering courses (Klingbeil & Bourne, 2013). Our colleagues dismissed these concerns, arguing that the prerequisite chains were there simply to delay students' entrance into engineering courses until they had "matured." With that rationale, changing the prerequisite structure was too painful with no benefit. We thought we had a great solution and the data to show it was a great solution, but they disagreed that there was even a problem – and consequently rejected the data.

We as educational researchers frequently seek to instigate change by presenting data (Handelsman et al., 2004). We are convinced by our data and believe that because our colleagues are good scientists they will be persuaded by our data too. The problem is that data are not credible and persuasive in themselves Kahan (2012). We respond to data differently depending on whether the data confirm or conflict with a story that we have already started to believe and an identity we hold dear. Confirming data are usually believed with little scrutiny. Conflicting data are dismissed, marginalized, critiqued, or held in abeyance (Chinn & Brewer, 1993). Conflicting data rarely prompts us to reconsider our beliefs and can even strengthen contrary beliefs (Kahan, 2012).

To lead people to notice problems, to believe problems are important, and to encourage attention to particular solutions, it is helpful to put data last. We mean this not in terms of the importance of data, but rather in the order in which to deploy it. The first step is listening.

Consider a noteworthy parallel, “design thinking.” A core insight of design thinking is to start from the perspective of the end user rather than the technology. What do users want? What challenges are they experiencing? Then, organize design efforts around those interests and problems. A colleague running a new product design course for engineers recently mentioned that the most startling revelation to the students was that they could consider not just what was a technically interesting question or technically feasible contraption, but what people would actually want to use. It might sound like an obvious message. Yet, just like how engineering students focus on technologies and neglect end users, educational researchers easily focus on what is pedagogically effective and neglect to consider what faculty might be interested in doing and the problems faculty are facing. If we approach our colleagues with solutions already in mind, we are not actually listening. If instead, our colleagues feel that we are actually and openly listening, we can motivate change (Kluger & Nir, 2010; Quaquebeke & Felps, 2016). Once we know what their problems really are, what their interests really are, we can bring the right data to bear.

We are still not ready to present data though. Instead, we should start our communications with stories rather than data (Heath & Heath, 2007). Stories help people understand the problem and indicate the kinds of solutions that are needed. Data then provides credibility for believing what the stories establish. If you read the news, you will realize that many journalists start by telling the story of a single person who represents the larger pattern or problem that the rest of the article is about. The data come after the story. This is not an accident.

A properly framed story can help our listeners reinterpret their understanding of the world and come to appreciate a problem or opportunity. The genesis for my co-PIs’ pitch to the top-ranked department began with a story. Around 20 years ago, the engineering departments threatened to take students out of the introductory physics sequence because the courses were taught so poorly. This threat placed the physics department in an existential crisis, because the department depended on the revenue from these courses to fund graduate students. A group of high energy physicists (a massively collaborative discipline) convened to design a system for the joint ownership for these courses. Innovations were owned by the team, and all team members needed to agree on which innovations should be made. The physics department went on to invent clickers (personal response systems) and other evidence-based instructional practices, receiving national and international awards for the quality of their teaching and leadership in physics education, while remaining a top-ranked research department. This story led our team to revisit the idea “teach like we do research.” Research is more than simply methods and data; it is a culture. At our institution, that culture is collaborative. This story simplified our message. Our call to departments was for them to create collaborative, joint ownership of courses. The story appealed to their existing belief systems and best practices. This story has stimulated faculty to incorporate multiple, evidence-based instructional practices into dozens of large, introductory-level courses in several departments.

Stories do many things simultaneously. Stories are concrete, they are relatable, they help our faculty audience feel the problem and not just understand it, they are existence proofs, they can grab attention and create interest, they are memorable. Critically, all of these features of stories help our audience change their perspective, help them identify problems or opportunities, and help them to see a proposed solution as sensible in light of this new perspective. Stories help people connect their interests to new actions. At this point, data can play a powerful confirming role for the new beliefs that have just formed. The data are no

longer something to be resisted because they conflict with the interests of the audience. After a story, the data justify what the audience wants to do.

Make Change in a Just and Fair Way

As the budget for our center for teaching and learning came under scrutiny, it became necessary to perform annual reviews of its programs to determine which would be cut. The director of the center considered making funding decisions by herself. However, because these programs were conceived by the faculty, a top-down decision by the director could easily have been seen as capricious, burning good will between the center and the faculty. This decision would have rendered the center considerably less effective going forwards. Instead, she convened a panel of faculty. To ensure that all programs felt that the process was fair, she shared a review rubric and assigned each member of the review committee to be a mentor for each program. This mentor was to be the advocate for that program during the review process, clarifying questions about the review criteria and championing that program during the review process. By the end of the review process, many of the faculty-run programs voluntarily relinquished some or all of their funding, committed to maintain their programs partly if not entirely through their own energy and funds, and continued to grant the center partial credit for their outcomes.

The process we go through to generate change matters. Thus far, we have been describing change as if it resulted from pairwise or small group discussions with faculty. We did so because faculty engagement and ownership are crucial. But faculty engagement is not enough. Students and graduate assistants in the changing courses matter. One course is linked to others: one faculty member's changes influence others. New instructional practices can lead to new requests for administrative support, instructional resources, space, and more. Because change happens within a system, we need to be thoughtful about the processes we are undertaking. Specifically, we need to think about three aspects of the change process to ensure that the process is just and fair. We need to think about treating people with respect and consideration (interactional justice), about providing explanations about what is happening and why it is happening (informational justice), and about being clear and consistent in how and why decisions are made (procedural justice; e.g., Colquitt et al., 2013). These three aspects of the change process are vital to people's willingness to go through change.

It may seem self-evident that we should treat people with respect, provide explanations, and use fair processes, but these practices are frequently neglected (Brockner, Wiesenfeld, Siegel, Bobocel, & Liu, 2015). These practices require effort and time that department heads, education researchers, and others trying to make change frequently rationalize away as being unnecessary. What seemed professional and respectful to one can seem cold and even hostile to another. As leaders and committees often generate plans for change in months of meetings, it is easy for them to forget that others do not know about the changes or the reasons why changes are necessary. It takes time and care to make decisions in clear and principled ways. For example, the center for teaching and learning's new review process consumed several weeks of many people's time. The center's director could have made the decisions herself in an afternoon. Making executive decisions can feel justified because it seems efficient. We can tell ourselves that "everyone will dislike whatever decision is made anyway." We can become so enamored with the changes that we seek to create that we avoid involving others who might disagree with us. We can rationalize making decisions

with “reasonable people” and feel justified in sidelining the “unreasonable people” rather than confronting different viewpoints and leveraging conflicting perspectives to generate higher quality solutions. In short, there are numerous reasons we seek shortcuts rather than operate in just ways. The center for teaching and learning’s director could certainly have taken what seemed to be the more expedient path. Of course, she would never have gotten the outcomes she obtained in that way though.

An additional challenge to working in just and fair ways is that when we think about justice and fairness, we are often thinking about outcomes rather than processes (Brockner et al., 2015). Did everyone get what they deserved? Did everyone get what they wanted? While just and fair outcomes are important, people are more likely to perceive outcomes to be just and fair if the process for bringing about the outcomes is effective on the three aspects just noted: people are treated with respect, explanations are provided, and processes are fair with clear and consistent bases for making decisions. Indeed, a good process typically enables people to accept a poor outcome, and a bad process often negates what might otherwise have been perceived as a reasonable outcome. For example, the faculty members who voluntarily relinquished funds that had been supporting their efforts to improve instruction (a bad outcome) were willing to accept the loss of those funds because the conversations that led to deciding to reduce funding were done fairly (a good process). More generally, we can alienate our colleagues and undermine our change efforts if we fail to apply a fair and just process. We briefly discuss each of these three contributions to a just and fair process.

Treat people with respect From an individualistic perspective, using power to create change undermines motivation and leads to resistance. From a justice perspective, using power goes against respectful treatment (Skarlicki & Folger, 1997). When we assert power over those with whom we disagree, we are likely to alienate them because we are asserting that our methods and beliefs are better than theirs. In contrast, listening to others fosters a feeling of being respected. These feelings of mutual respect can maintain motivation and engagement in change efforts even when changes go in directions that are not favorable to everyone.

Provide explanations We do not want to leave people in the dark (Kernan & Hanges, 2002). Changes without explanations generate anxiety and lead people to fear the worst. For example, when Professor Smith introduced collaborative learning into her course, students revolted, in part, because she had not provided adequate information. The students panicked and resisted. More generally, change efforts are often resisted simply because the stories that explain the problem or opportunity are not shared. When people do not understand the change goals and how they align with their interests, they are more likely to resist the process. A lack of information generates fear and distrust. Open and frequent information sharing engenders trust in the change process.

Use fair processes We want to engage people in the change process (Lind, Kanfer, & Earley, 1990). We want to get their views, hear their concerns, and take those contributions into consideration to the extent possible. What is not integrated needs to be explained. People do not expect or necessarily even want to make the decision. They do want to be heard and taken into consideration. They want to feel as if decisions are being made in principled ways rather than in arbitrary or self-serving ways. If departments are run in arbitrary or self-serving ways, people are more likely to be selfish, to

form coalitions, or to withdraw. In contrast, if people perceive that departments are run using sensible and clear rules and that those rules are consistently applied, then they are more likely to work to support the department.

Each of these types of justice suggests the critical need to spend considerable time listening and dialoguing with stakeholders before and during change processes. It can feel as if having all these conversations makes the change process unbearably slow. However, when colleagues and students feel that change processes are just, they will go beyond our expectations, improving and sustaining outcomes (Organ & Konovsky, 1989). The quality of the outcomes of our change efforts will always be bound by the quality of our change processes.

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Just as we have come to learn that our intuitive models of education are not always effective, we need to recognize that our intuitive models of leading change efforts are not always effective either. The discussion of change in this editorial is just a beginning. As engineering educators, we are in a good position to go much further. Our knowledge of evidence-based instructional practices dovetails nicely with evidence-based change practices. We know that power and control undermine students' motivation to learn, just like it can for faculty. We know that students desperately cling to misconceptions despite the evidence, just like faculty may. We know that students recoil at unfair practices and unmet expectations, just like our colleagues.

If we continue to emphasize the primacy of incentives, data, and power in our change efforts, we will continue to see the stagnant systems and ineffective instructional practices that frustrate us. Are we ready to listen?

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