Common Instructional Practices Grounded in Evidence

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ABSTRACT: Effective teaching is a complex process because it requires that faculty understand how learning actually works: how does information become knowledge and skills that students "own" and can use fluently and flexibly in other contexts beyond our particular course, and what strategies facilitate this deep and long-lasting learning? This paper provides examples of strategies that are based in research on learning, with the premise that we can design courses and pedagogy to enhance learning by creating the conditions that prompt students to engage in the behaviors we know lead to learning.

Keywords: evidence-based, instructional strategies

1 Introduction

Many faculty members, through experience, have identified and used successful pedagogical strategies that have resulted in deep student learning, and yet they cannot always articulate why those strategies have been successful. Some faculty have also recognized that certain strategies work with some cohorts of students and not others, and again they do not necessarily know why. This paper, based on *How Learning Works: 7 Research-Based Principles for Smart Teaching* (Ambrose et al., 2010), focuses on a set of common instructional practices and provides the underlying evidence for why these practices are effective.

2 Diagnostic Learning Assessments: The Importance of Prior Knowledge

Professor X begins his course by asking students the following question: by show of hands, how many of you know what permeability is? Porosity? Compressibility? Shear strength? To his delight, the vast majority of students raise their hands, and off they go into the new semester. Professor Y begins her course with a few problems that will allow students to demonstrate their understanding of permeability, porosity, compressibility, and shear strength. These problems are not graded and are administered solely for the purpose of helping the professor gain a sense of the knowledge her students possess.

Which of these approaches will provide accurate information about students' prior knowledge and, most likely, lead to a better result, e.g., better student performance, less faculty frustration? If you chose the second scenario, you are correct. What we know from research is that novices (someone without a lot of experience in the area) often overestimate what they know and often define "knowing" very differently from the faculty. For example, students in the first scenario might define "know" as "I've heard of it" or "I remember seeing it in the text in the last course" or "I could define it", while we, as educators, define "know" as the ability to define a term or concept, and also know both *how* to use it and, most importantly, *when* to use it. In other words, *knowing what* is very different from *knowing how* which is very different from *knowing when*. It's not that the students in the first scenario are deceitful, it's often that they don't know what they don't know. The second scenario takes the students' own view of their knowledge and skills out of the equation by simply requiring that they demonstrate what they know.

Why is this important? Because prior knowledge is the lens through which we take in all new information as we build our understanding and knowledge base. This lens influences how students filter and interpret

incoming information, and if and how they connect it to existing knowledge. If information in that knowledge base is inaccurate, incomplete, insufficient or inactive, then the foundation is shaky, making it difficult for students to integrate new knowledge, thus impeding their learning (Ambrose et al., 2010). Students learn more readily and deeply when they can connect what they are learning to what they already know. As a result, knowing what students actually know, or think they know, is vital to their success in our courses, allowing us to build from reality instead of our hopes or expectations (which may often be inaccurate).

In order for prior knowledge assessments – like the one in the second scenario – to be effective and successful, we have to be flexible and adaptable enough to fill the gaps identified, correct misconceptions, show students conditions of applicability (i.e., when to use the facts, concepts, models, etc. they have acquired), etc., which may mean deviations from the course plan we prepared. The good news, however, is that the assessment can also confirm what students actually do know and enable us to leverage and build on that knowledge and those skills.

3 Graphic Syllabi and Concept Maps: The Value of Organizational Structures

The first page of Professor A's syllabus is a graphic depiction of the course, while Professor B presents students with a concept map she developed to represent her view of the content. Why are these effective learning strategies? In both cases, these strategies provide a visual representation of organization: the graphic syllabus shows the organizational structure of the course, while the concept map shows the organizational structure of the content.

A graphic syllabus enables students to clearly see the overarching structure of the course and to continually situate what they are learning within that overall structure, as well as where they are headed. Why is that important? As experts in our field, we walk around with "pictures" (some call them schemas, knowledge structures, organizational structures) which we have unconsciously created: these organizational structures represent complex networks of facts, concepts, principles, procedures, etc. that are organized around meaningful features. These rich and meaningful knowledge structures allow us to access what we need when we need it; in fact, part of what makes us experts in our field is that we not only have a vast amount of knowledge, but that we have organized it in a way that makes it easy to retrieve and use (Ambrose et al., 2010). Depending on the level of students you are teaching, they may have sparse and superficial knowledge structures (think first year undergraduates) or partially accurate but incomplete knowledge structures (think third year undergraduates), neither of which will serve them well in the future. A graphic syllabus can provide students with the big picture view that presents key concepts or topics in the course and highlights their interrelationships.

A concept map illustrates the central principles and key features around which you, as an expert, organize your knowledge (Novak & Canas, 2008). They are typically "drawn as nodes and links in a network structure in which nodes represent concepts, usually enclosed in circles or boxes, and links represent relationships, usually indicated by lines drawn between two associate nodes. Words on the line, referred to as linking words or linking phrases, specify the relationship between the two concepts (Ambrose et al., p. 228)."

Both graphic syllabi and concept maps model for students the importance of intentionally organizing information to guide further learning, retrieval and use across situations. It really is true: a picture is worth a thousand words!

4 Authentic, Real World Assignments: Value as a Key to Motivation

Professor G goes out of his way to tap industry colleagues for examples of authentic, real world challenges and problems, as well as using his current consulting experience, to provide examples and design assignments for students in his courses. Why is this important?

Motivation is the personal investment an individual has in reaching a desired state or outcome (Maehr & Meyer, 1997), and in academe it influences the direction, intensity, persistence and quality of the learning behaviors in which students engage. In our courses, we hope that the desired state or outcome is the learning, although too often it's the grade! In either case, the question is why students would invest time and energy in our course given all the other things going on in their lives, e.g., other courses, co-

curricular activities, work, family demands, romances. One key element of the answer is value; students will be more motivated to pursue a goal that has high value to them (Ambrose et al., 2010). Lucky for us, there are three sources of value: the first is attainment value, which represents the satisfaction that one gets from accomplishing a goal; the second is intrinsic value, the satisfaction one gets from simply doing the task; and the third is instrumental value (also called extrinsic rewards), which represents the degree to which an activity or goal helps one to accomplish other important goals, like securing a high status job, recognition, a good salary (all longer-term goals). The example of authentic, real world problems falls into the final category, as this strategy enables students to see the relevance to future work in the tasks they are assigned, and provides a context for understanding concepts and theories and their applicability in the real world. In other words, these examples reinforce *knowing when* to apply their knowledge (which is different from *knowing what* and *knowing how*, as discussed in the section on diagnostic learning assessments). Without these connections to reality, course content often seems abstract to students, and given competing demands for their time and attention, they may focus on other courses where they clearly see value in accomplishing their short-term or longer-term goals.

5 Identifying the Strategy, Not Solving the Problem: The Rationale behind Isolated Practice in Gaining Mastery

Midway through her course, Professor M gives students a homework assignment, and then a quiz, in which she asks them to identify the statistical test they would use (e.g., one sample t-test, binomial test, chi-square goodness of fit, one-way ANOVA, paired t-test) to solve a set of problems, *without actually solving the problems*. Why does she do this, it's solving the problem that is most important, isn't it?

As experts in our field, tasks that seem easy to us can hide complex combinations of component knowledge and skills. Think about the many steps (e.g., turn ignition, adjust mirrors, put car in reverse, apply brakes), facts (e.g., traffic laws, street signs) and skills (e.g., parallel parking, performing a three-point turn) you engage on a daily basis when you drive your car. Actually, chances are you NEVER think about those things because they have become effortless and second nature to you given how long you probably have been driving. But all of those component parts are often overwhelming to someone just learning to drive. In order to become a safe driver, you need to practice many of these steps and skills in both isolation (e.g., balancing the gas and brake pedals in a standard transmission car) and in an integrated way (using your mirror and turn signal when switching lanes). The same is true in problem solving: in order to be effective, you need to first identify the nature of the problem, understand the end state needed, decide on a strategy to get there, execute the strategy, adapt execution based on continual monitoring or difficulties encountered, and evaluate the outcome. In solving a statistics problem, one of the most important decisions a student will make is identifying the appropriate test to use in analyzing the data. If they get this wrong, there is no recovery. In order to both help students understand the importance of choosing the most appropriate statistical test, and to give them practice doing so, Professor M focuses them on this one component part of solving problems.

Mastery requires that students first gain the component knowledge and skills they need, practice integrating them, and know when to apply what they have learned (Ambrose et al., 2010). In order for us to teach effectively, we need to be able to deconstruct or unpack complex tasks (that we often don't "see" as complex) so that we can clearly model for students the steps involved and the knowledge and skills needed to complete the task.

6 Polling in the Classroom: The Significance of Timely and Constructive Feedback

Professor S uses interactive technology in his classroom: he poses a question to students and asks them to respond; if a large enough proportion of students answer incorrectly, he then asks them to discuss the question in small groups, and then polls them again. This seems to take a lot of precious classroom time, is it worth it?

Absolutely! This strategy facilitates a number of key elements in the learning process. First, it enables the instructor to gather real-time feedback on students' understanding and intercede in the learning process as learning is happening, as opposed to giving feedback on a misconception in a problem set, three days after a student has handed it in (Ambrose et al., 2010). For example, if, after the second

polling, a significant number of students still respond incorrectly, the professor can provide further explanation of the concept and alternative examples. In other words, timing and the nature of feedback is most effective when students can make the most use of it; for example, addressing misconceptions, identifying missteps, determining lack of conceptual understanding versus mathematical errors, etc., promotes learning best, when the learning is occurring. This is true because the timely and constructive feedback helps students to stay on track and addresses their errors before they become entrenched.

Second, this strategy facilitates student discussion of content and peer-to-peer learning, as students explain their respective rationales for their response and "teach" each other. This does not happen if students are working alone on problem sets in the library or their dorm room. This strategy also bolsters other useful skills such as working in groups and communicating effectively.

7 Multiple and Diverse Examples: Contributing to a Positive Course Climate

Professor T spends a lot of time searching for examples, problem sets and projects that will "speak" to all of her students, as opposed to simply using the examples from the book and problem sets provided by the publisher. How does this extra effort pay off?

Examples help students to better understand theories, concepts, etc., and problems sets and projects provide students with the opportunity to apply what they have learned; all three help students learn how concepts and skills operate in a variety of contexts and conditions. However, if the nature of the examples, problems and projects are alienating to students – e.g., they don't feel connected to the content, they don't feel they belong in the course/field – then learning can be impeded. Given the diversity within college classrooms in 2020 (e.g., gender, cultural, socio-economic, age), an example that works to solidify a concept for one group may not do the same for another. For example, referencing the 2008 recession in the U.S. does not serve to elucidate concepts for either younger students who were children at the time or for those from countries not affected by it. Or using a cultural example from a famous "failure" in construction (e.g., Leaning Tower of Pisa, Tacoma Narrows Bridge, Lotus Riverside Complex) may illustrate a misconception to students from that region but not illuminate it for others from around the world. In all of these cases, multiple and diverse examples that connect with various members of the student population validate that they all belong.

Why is this sense of belonging important to learning? Because students are not only intellectual beings, but also social-emotional beings, and they bring their whole self into the classroom. As a result, these dimensions interact within the classroom climate to impact learning (Ambrose et al., 2010). While human beings continue to develop throughout their lives, it is important to remember that emotional and social processes are particularly salient during the college students' phase of life (circa 18 – 24). This is the time that young people are beginning to think about their professional identity; question their purpose, values, beliefs; exert independence and autonomy; establish new social networks; negotiate differences, etc., all of which intersect their intellectual, social and emotional selves (Chickering, 1969). Something as seemingly innocuous as using textbook examples that are gendered and culturally biased can create an environment where certain students feel unwelcome, or where they feel the pressure of "representing" their gender or ethnic identity. Intellectual pursuits interface with socio-emotional issues, and the emotions these examples may invoke can overwhelm the cognitive capacity to engage with the content, hence hindering learning. In other words, we need to remember that we teach students (who, like us, are complex human beings), not just content, and that we can create a climate in our course to enable or hinder learning for all of our students.

8 Reflection: A Requirement for Becoming a Self-Directed Learner

Professor Q requires every student, for every major assignment, to write a paragraph or two on what they found to be difficult about the assignment, what they would do differently (e.g., would they make different assumptions or take a different approach), what knowledge they need a better grasp on, and what skills they need to work on. What purpose does this serve?

The world in which we live today, and our graduates' future professional success, requires that they have the ability to continue to learn throughout their lives. Some will have multiple jobs and even careers, and others will find themselves continually upskilling, as their work roles and responsibilities change because of automation and globalization. Becoming a self-directed learner with strong metacognitive

skills (defined as the process of reflecting on and directing one's own thinking [National Research Council, 2001, p. 78)] entails graduates being able to assess new tasks (including the goals and constraints), evaluate their own strengths and weaknesses (per knowledge and skills), plan their approach to completing the task, apply the strategies identified and monitor their own performance, adjust approach and/or strategies if necessary, and finally reflect on the experience (Ambrose et al., 2010). It is the final component of this process that Professor Q is asking students to engage in.

As professionals and experts in our respective fields, we engage in this process continually, often without consciously recognizing that we do so. To illustrate the reflection stage of the metacognitive process, think about how many times you have hit the button to submit a proposal, journal article or book manuscript, and then immediately thought about a different way you could have structured the document, or a research study you should have cited, or a statistical test you could have done to strengthen the data analysis section. We do this all the time! Now think about your students: do you believe they engage in that same reflective process once they submit a project or problem set? Typically, they are looking forward and thinking about all of the other assignments they have to submit, not ruminating on what they could have done differently. And yet that is a vital part of the learning process, particularly one that can impact future learning and performance.

Because this doesn't come naturally to students, we can build this (the entire metacognitive process, not just the reflection piece) into our assignments and facilitate their ability to become self-directed, lifelong learners.

9 Conclusion

The above examples illustrate the learning principles from *How Learning Works: Seven Research-Based Principles for Smart Teaching*. While there are many more strategies that connect with the principles, the point of this paper is that we, as educators, should understand the underlying reasons that strategies we use work to enhance student learning. In other words, there is power in understanding how learning actually happens, so that we can design educational experiences (e.g., courses, in-class exercises, labs, projects) to fully engage students in the learning process. Cognitive psychologist and Nobel Laureate Herbert A. Simon (and a mentor to this author) was often heard saying that "Learning results from what the student does and thinks and only from what the student does and thinks. The teacher can advance learning only by influencing what the student does to learn." This quote sums it up succinctly: we can better facilitate deep and long-lasting learning if we utilize what we know about learning in our design and teaching processes.

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