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Towards evidence-based teaching, problem-based learning and metacognitive assessment cycles

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Abstract

A college education is still recognized as important for individual success and society more generally but recent scrutiny of higher education as a societal institution has not been entirely favorable. Universities and their faculty are being called upon to not just to impart knowledge but to prepare students for modern careers and to do so with demonstrable effectiveness. Developing critical thinkers that can analyze, evaluate and synthesize information to construct solutions for new, novel problems is paramount. This paper reviews the concepts of evidence-based teaching, problem-based learning and metacognitive assessment cycles as important to these efforts. Specific techniques such as testing, spaced learning, writing to learn, interteaching, problem-based learning, formative and summative assessment are detailed. Then, examples of efforts by the authors to consider and incorporate these items into their courses is described.

Keywords: Evidence-based teaching, Metacognition, Problem-based learning, Assessment, Constructivism

1. INTRODUCTION

In many circles, questions are being raised whether colleges are properly preparing students for modern society and careers and if the whole college endeavor is worth the cost.

Organizations such as the National Association of Colleges and Employers (NACE) (www.nace.org) conduct wide-ranging reports on institutional and student performance while those at the Delta Cost Project at American Institutes for Research provide detailed analysis on labor costs and distributions in higher education (Desrochers & Kirshstein, 2014). Research by the Council for Aid to Education (CAE) (www.cae.org), meanwhile, claims that 40 percent of college graduates lack proficiency in skills needed for white-collar jobs. If even remotely accurate, this is an alarming statistic. According to cla+ National Results, 2014-15 (2016), their Collegiate Learning Assessment (CLA) has "offered institutions a valuable measure of their contributions—or value added—to students' attainment of higher-order thinking skills" (p. 2). The expectations of the CLA "requires students to analyze, evaluate, and synthesize information as they demonstrate their ability to think critically and solve problems" (p. 2).

Another group, The Lumina Foundation (www.luminafundtation.org) is also very active in pursuing research into outcomes-based funding for higher education. This includes whether or not

a college education leads to better lives for graduates, and if so, what factors during school are important to success after graduating. The Gallup-Purdue Index, according to Great Jobs | Great Lives (2014), will "uncover which college experiences and perceptions are related to greater gains in the workplace and in well-being" (p. 5), since "students spend a significant amount of resources preparing for life outside of college, it is crucial to gauge whether the experiences they had in college have promoted a well-lived life" (p. 5). Students attest, via the G-P Index, "if they perceive that the college was a great fit for them, having professors who cared and made learning exciting, and, most importantly, feeling that their school prepared them well for life outside of college" (p. 5). As educators, we find it encouraging that caring faculty who are engaged with students are identified by alumni as a top factor in their success. So, while higher education can certainly get better, instructors must help lead the way.

From a financial investment standpoint, it is reassuring that two studies by researchers at the Federal Reserve conclude that it is still worth going to college and the benefits, monetarily, still outweigh the costs. Able and Deitz (2014) conclude that completing a bachelor's or associate's degree earn a return on their investment of about 15 percent while the research of Daly and Bengali (2014) claims college graduates can recoup their costs by age 40, and over the course of a career, "would have made about $830,800 more than the high school graduate" (pg. 4).

In summary, institutions of higher education are being called upon deliver not just a liberal arts education, nor simply to have a purely vocational focus, but rather to deliver aspects of both. We must develop graduates who not only know and appreciate important concepts and theories but who can use that foundation to construct a new understanding in solving the novel problems they will face. It is important for students to not only know what they have learned but to be conscious of their understanding, how they developed it, and yes, what they may still need to learn for their continued success after graduation.

While the problems facing higher education are bigger than any individual instructor, it is clear that faculty will play a central role in answering these challenges. Indeed, classroom instructors through their sound pedagogical choices and continuing effort to better measure and demonstrate their teaching efficacy can show that the resources allotted to them and trust placed in them are well deserved. And, while every educator is not going to be a world-renowned teaching researcher, we should all be, at some level, students of teaching and pedagogy. Furthermore, we should all be concerned with how to better craft instruments that can adequately measure our impact while gathering the evidence necessary to exemplify our efficacy.

This paper seeks to communicate our pedagogical understanding and teaching efforts as we strive to improve our own instruction. The next section contains an overview of some concepts integral to these efforts, including, constructivist learning theory, evidence-based and problem-based teaching, and metacognitive assessment cycles. Then, we discuss ideas and efforts we are making in our courses to implement these concepts. We are admittedly in the early stages of this journey, and measuring the impact of our efforts is an ongoing concern and active area of research. However, making pedagogical choices and experimenting based upon the evidence of others' success has expedited our experimentation, is certainly reasonable, experience indicates is well received and appreciated by students.

2. LITERATURE REVIEW

Constructivist learning theory

One criticism of higher education is that graduates might be "book smart" but they cannot translate that into real-world solutions. This may be because students principally have studied under an objectivist learning model, where lecture is the primary mode of transferring knowledge. Objectivism might be efficient but not always effective for life outside the classroom.

The constructivist teaching approach makes central the need for a student to be able to take what they have learned and "construct" new solutions and understanding through active participation and experimentation in the learning process.

While lecture and objectivist approaches have their role, and we still utilize them at times such as with interteaching described below, we spend more time in class actively working to solve problems and apply material to current student interests and concerns. From semester-long projects with external partners to modeling problem-based solutions where the solution process is deconstructed and then reassembled to illustrate how the process works to writing application and reflection papers based upon their

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work experience, integrating theory to practice permeates our efforts.

Evidence-based Teaching

Evidence-based teaching "refers to pedagogical tools and techniques that have shown through rigorous experimentation to promote learning" (Dunn, Saville, Baker, and Marek, 2013, pg. 5). While this definition seems straightforward, over the next several paragraphs it will be seen how complex, and even confusing, the approach/concept can be, especially for individual instructors looking to operationalize it in their teaching. Later in the paper, examples from the authors' experience will be provided for implementation and technique guidance.

Research into the efficacy of teaching and learning is actually a complex endeavor that can lead to conflicting results and educational movements that may later prove to be ineffectual or even harmful to learning. As Biesta (2007) points out, "education is at heart a moral practice more than a technological enterprise" (p. 10) because "in education means and ends are not linked in a technological or external way but that they are related internally or constitutively" (p. 10). So, where in a science like physics, factors and conditions can be well-controlled, research in education is much more complex because of the human factor and ever changing conditions.

Goodman and O'Brien (2012), claim that "[m]any common teaching strategies contradict scientific evidence about how people learn, to the detriment of student learning" (p. 903), and that instructors often assume that what they do in simplifying content/tasks; designing projects that are fun but that do not promote cognition or salient assessment of the course learning objectives; and/or saturating a student with feedback (i.e. above what is appropriate), could impair rather than foster student learning. Goodman and O'Brien (2012) provide extensive evidence to support their claims that these "strategies are actually counterproductive to learning," (p. 903) and that evidence-based teaching strategies "are more likely to benefit [student] learning," (p. 903).

These concerns and issues are not new. Rousseau (2006), suggests that since the 1930s, proponents of evidence-based practices "have struggled to connect science and practice without a vision or model to do so' (p. 260). It is Rousseau's (2006), opinion then that evidence-based management, "provides the needed model to guide the closing of the research-practice gap" (p. 260), and outlines her reasons why it is not only apt, but also pragmatic.

Rousseau (2006), is an advocate of promoting the active and purposeful search for and application of reputable evidence, since doing so "necessitates a balance between teaching principles—that is, cause-effect knowledge—and practices—that is, solutions to organizational problems" (p. 266). More so, she claims that using evidence requires a metaskill, i.e. "the ability to turn evidence-based principles into solutions" (p. 266). It should be noted that this is a constructivist view of learning.

Davies (1999), cautions that evidence-based education, "is not a panacea, a quick fix, cookbook practice or the provider of ready- made solutions to the demands of modern education" (p. 118), but rather a "set of principles and practices which can alter the way people think about education, the way they go about educational policy and practice, and the basis upon which they make professional judgements and deploy their expertise" (p. 118).

To simplify, it can be useful to think of evidence-based teaching in similar terms to evidenced-based medicine. Sackett, Richardson, Rosenberg and Haynes (1997 in Biesta, 2007), define evidence-based medicine as "the conscientious, explicit and judicious use of current best evidence in making decisions about the care of individual patients. This practice means integrating individual clinical experience with the best available external clinical evidence from systematic research" (p. 12), affirming that research evidence must be considered as only one of the many factors in the "process of clinical decision making, rather than the only factor to drive clinical practice" (p. 12). Sackett, et al. (1997 in Biesta, 2007), go on to posit that "[g]ood doctors use both individual clinical expertise and the best available evidence, and neither alone is enough" (p. 12).

We would suggest then that, by extension, smart teachers are those who willingly integrate both their expertise and that of their peers, with tried and tested teaching/learning evidence of what works in enabling students to not only master learning objectives but also to be able to employ the same in their own professional successes. As Biesta (2007), posits the "link between research, policy, and practice, [are achieved] using notions such as ''evidence-informed,'' ''evidence-influenced,'' and ''evidence-aware'' practice (p. 5).

This advice is reassuring because many instructors are subject matter experts and have curricular, institutional, or external pressures on them that makes developing a full research agenda for every course or change contemplated simply impractical. In other words, do not get overwhelmed trying to develop a full teaching research agenda, but rather get started by making choices that are evidence informed, influenced, or aware and build out the research components from there.

In this spirit, we find some relevant methods we are currently using and exploring in our teaching to be practical and useful, especially those which are suggested by Dunn et al. (2013). These include:

The testing effect—Giving exams and quizzes over the material is a common, basic way to measure learning. Dunn et al. (2013) provide a litany of studies on the topic about methods and techniques used in testing. Dunn et al. (2013) note "[r]ecent research has also highlighted the effectiveness of repeated testing in promoting the transfer of learning to new contexts" (pg. 6) and domains. Where "the preponderance of evidence shows strong support for test-enhanced learning and remembering, particularly when instructors provide feedback and adequate time for processing it" (pg. 6).

Roediger, McDaniel and McDermott (2006), claim the key principle of their research, is that "frequent classroom testing (and student self-testing) can greatly improve education from kindergarten through university" (para. 1). Tests include "both learning and final assessment […] in both recognition and recall formats" (p. 6).

The benefits of testing tend to center on underlying processes involving memory retrieval, where "studied information strengthens existing associative memory links between related cues and the targeted information" (p. 6). Dunn et al. (2013), conclude that the effectiveness of this effect will depend largely on how instructors design their courses, and the many factors that play into assessing the real learning outcomes that students achieve from the learning objectives that were designed into the various instruments of assessment applied in each course. "Nevertheless, the available evidence for the testing effect should encourage instructors to consider integrating more frequent testing or other activities that require retrieval into their courses" (p. 7). So while testing can be completed in-class or out, formative or summative, paper based or using technology like clickers, it should not simply be a "one and done" proposition.

Spaced learning—"[O]ver a century of research has revealed that studying information or practicing skills in multiple short sessions yields greater long-term retention than…a single long session" (Dunn et al, 2013, pg. 7). Thalheimer (2006), identifies the spacing effect, inferring "spacing repetitions of learning points over time […] [and] occurs when we present learners with a concept to learn, wait some amount of time, and then present the same concept again" (p. 6).

Dunn et al. (2013), suggest introducing "the same key concepts systematically at multiple points in the semester [or] including more frequent quizzes (either formative or summative) to promote more frequent study and simultaneously allowing students to accrue benefits from the testing effect" (p. 8). While there is no settled opinion on how many sessions to have, and whether spacing should be immediately after initial coverage, a few days, or on the order of weeks apart, research by Verkoeijen, Rikers and Ozsoy (2008), suggest days apart as the most effective spacing. An easy way for instructors to control spaced learning, for example, is to release review material on a schedule they determine using learning management system controls, etc. In our program, we have extended the spaced learning concept to include multiple replication across courses.

Metacognition: Thoughts about thinking—Dunn et al. (2013) also identify metacognition, or thinking about thinking, knowing about what one knows and how well it is known, etc. as another evidence-based learning concept that impacts learning. Dunn et al. (2013) note that teaching procedural learning methods to students (e.g. outlining of notes, rewriting and reflecting on notes, etc.) and that teaching and modeling the "self-talk" process of talking oneself through a solution, and assessments (formative and summative) can all play roles.

Ibabe and Jauregizar (2010), claim metacognition as "a person's knowledge about his or her own cognition and about the control he or she has over it" (Metacognition and self-assessment, para. 1), and consider it as an "essential element in the study of the teaching–learning process, because it is seen as the 'control centre' of the cognitive system" (Metacognition and self-assessment, para. 1). Key to metacognition in learning is assessment at the start and during the learning

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process (formative) and upon completion (summative).

Ibabe and Jauregizar (2010), draw distinction, claiming that "[s]ummative assessment takes place at the end of the educational program, with measurement as its principal goal" (Introduction, para. 2), whereas "[f] ormative assessment […] is carried out throughout the teaching-learning process, with the objective of monitoring the process and making any necessary improvements to the teaching program" (Introduction, para. 2). Boston (2002), qualifies that a broad interpretation of formative assessment should encompass purposeful endeavors that instructors employ to determine the current status of students' knowledge in order to diagnostically and meaningfully match their [the instructor's] pedagogical approach, course design, and teaching style to create an environment that effects optimum learning by students. Stull, Varnum, Ducette & Schiller (2011), posit "[a]ssessments should define in measurable terms what instructors should teach and students should learn" (p. 30), and continue stating "both formative and summative assessment need[s] to be incorporated into a total learning process" (p. 30).

Ibabe and Jauregizar (2010), assert that a mechanism for "teacher–student interaction and dialogue" (Introduction, para. 2), must be established and maintained, to create an environment where instructors can manage/coordinate activities that encourage students to continuously adapt their behavior to promote their learning. Boston (2002), qualifies the goal of formative assessment, as gaining an "understanding of what students know (and don't know) in order to make responsive changes in teaching and learning, techniques such as teacher observation and classroom discussion have an important place alongside analysis of tests and homework" (p. 3). In designing the Assessment instrument, the advice offered is to ensure questions are thoughtful and reflective "rather than simple, factual ones and then give students adequate time to respond" (p. 3).

William and Black (2003, in Stull, et al., 2011), "argue that formative assessment is the only way for which a strong prima facie case can be made for improving learning" (p. 31), and Stull, et al., 2011), repeat the claims shared above, stating "formative assessment informs both instructors and their students as to the degree to which the students have mastered the material" (p. 30), and that timely and complete feedback serves two student-learning functions: (1) identifying problem areas that need imminent attention and (2) reinforcing those elements in the teaching process that proved successful in fostering learning and achievement. Alternatively, the feedback available to the instructor "serves to identify the degree to which instruction was successful and to identify needed changes in instruction" (p. 30).

Ibabe and Jauregizar (2010), recount research where the quality and timeliness that both formative and "interactive self-assessment tests can help to improve learning when students receive feedback about the results" (Online self-assessment with feedback, para. 3), in enabling them to minimize their knowledge gaps and manage/control their learning agenda, in an environment that is both permissive and minimally punitive. They conclude that self-assessment and metacognition should be "closely bound up with one another, since the ultimate goal of self-assessment is that students learn to self-assess their knowledge and to self-regulate their learning process, thus increasing their autonomy and intrinsic motivation" (Metacognition and self-assessment, para. 5).

Metacognition and self-assessment are not just academic concepts devoid of practical implication, they get to the heart of preparing students for successful careers and lives. Händel, Artelt and Weinert (2013), assert that "[m]etacognition and self-regulation are considered key competencies in the 21st century" (p. 179), insisting that both apply equally to enduring learning, whether in the classroom or the world-of-work.

Writing to learn

"The writing to learn approach is based on the conception that writing about a topic can help students identify areas of confusion or lack of knowledge, reason through problems, and bring concepts together in new ways (Dunn et al, 2013, pg. 8). While there are a plethora of ways writing to learn can be employed, "[a] hallmark of all writing to learn activities…use targeted writing assignments that require students to apply, integrate, or reflect on some content knowledge (Dunn et al., 2013, pg. 8).

Writing to learn is a constructivist approach and can be used in highly technical courses as readily in qualitative ones. For example, industry whitepapers of consultant group articles can be used to drive home theories in courses like project management as well as principles of management.

Interteaching—For interteaching, an instructor often provides a guide for students that contains questions related to a reading assignment. Students answer these questions before class, then the get together in small groups to discuss during class while the instructor circulates. These discussions inform the instructor as to what should be covered in more detail via lecture or guided discussion, which often will be the lead off to the next class meeting, before beginning the cycle again.

Interteaching has links to behavior analysis. Boyce & Hineline (2002), describe the concept of *interteaching*, as "a technology of classroom instruction based on the principles of behavior analysis" (p. 215). They further note that "a behavior analyst sees learning [as] […] something a person does, not something that happens to him or her" (p. 215), and when they exhibit behaviors that they could not before, i.e. represent a reasonable change in purposeful behavior from before, they are understood to have then learned from doing. Or more succinctly put, learning is "a relatively permanent change in behavior" (Catania, 1998, p. 395). Interteaching, therefore, gets students actively and purposely involved in the instruction and lecture process.

Problem-based Teaching and Learning—Problem-based learning (PBL) is a pedagogical choice that has its roots in medical education and has evolved over the years to encompass a wide array of approaches. Solving a problem relevant to the course or situation at hand is at the heart of PBL approach. PBL can range from completely unstructured discovery learning, where students must figure out what issues, concepts, and questions to ask that are relevant to identifying the problem and then constructing a solution.

At the undergraduate level, though, guided problem-based learning is often employed as a means to model solution processes and prepare them for the unstructured and ill-defined problems they will encounter later in their studies and careers. Hundreds of articles have been written on PBL and Albanese and Mitchell (1993) and Savery (2006) provide useful reviews and definitions. Strobel and van Barneveld (2009) and Walker and Leary (2009) look at evidence of effectiveness for more than 230 previous studies.

Hung (2011) notes that the breadth of approaches and factors involved with PBL research might be part of the problem with researching its effectiveness. Mayer (2004), for example, notes pure discovery learning, as utilized in some problem-based learning implementations may not be effective or may even hinder learning and hence some guidance in the learning process is useful. Woods (2013), meanwhile, provides a conceptual map that provides direction on nearly three dozen learning environments and which PBL variation to use.

PBL has been utilized in our undergraduate courses, where developing computer/software skills are first necessary and once that is mastered, analysis and decision making can begin. Hence, a guided PBL approach is used where the problems are deconstructed for students, software techniques modeled and explained, then analysis and decision processes explored.

3. APPLICATION EFFORTS FOR CONCEPTS NOTED/DISCUSSED ABOVE

This section describes efforts to include the learning concepts detailed above in our teaching.

Constructivist learning theory
Constructivism requires teaching approaches that challenge students to apply what they are learning to their (professional) interests or lives more generally. In all our courses—even technical ones like Using Information Systems to Solve Business Problems or Project Management, students have writing or presentation projects.

Students may be charged with investigating how or what vendors and consulting organizations (e.g., Gartner, Oracle, SAP) are touting via whitepapers, websites, brochures, or videos and how that aligns (or does not) with our textbook material and theories. Alternatively, students may conduct more fact-based research via predominantly peer-reviewed and refereed publications.

Students then discuss their findings/observations at the next face-to-face session [or via a Blackboard Discussion Forum for fully online students]. Discussions are led by the assigned groups, which each choose a Leader, a scribe and a narrator. The groups facilitate the discussion, while the instructor assumes the role of observer, bringing the discussion back on track or returning it to common ground, where necessary.

Alternatively, presentations may be conducted by having students create a Panopto (lecture-capture system) video. These are made available

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via Blackboard for the other students to review and assess using a Qualtrics survey form.

The testing effect

Giving exams, tests, and quizzes over material is a time-honored tradition where the research shows a higher frequency of opportunity with feedback from the instructor along with reflection by the student leads to improved retention.

In most courses we offer, the traditional mid-term and final exams have been forgone in favor of multiple points of assessment. For example, the project management course now has 13 quizzes, five graded MS Project-based assignments, two comprehensive projects using MS Project, and a writing assignment focusing on vendor/consultant evaluation. The software and writing assignments include pre-grading opportunities where students can ask questions about their work and get feedback for correcting mistakes. The assignments and comprehensive projects require correction for use going forward. Multiple choice quizzes are still utilized to assess retention and provide the instantaneous feedback the students crave, particularly when these quizzes are offered online.

In the Using Information Systems to Solve Business Problems course, developmental lessons on using software (e.g. MS Access) are presented in a succinct, sequence-oriented manner. These are coupled closely with more comprehensive end-of-lesson assessments, which provide a quick turnaround in feedback, thereby guiding students to remedy issues without delay. For these end-of-lesson assessments, students record themselves using the Panopto lecture capture software and these recordings serve not only as reminders of their progress but also as an instrument for the instructor to troubleshoot their problems.

Spaced learning

Presenting learning opportunities as a series of measured phases, spaced out over time, is shown to improve student learning. Spaced learning across courses requires a purposeful, coordinated effort.

Cooperation amongst faculty throughout our program has been especially notable in developing student spreadsheet skills. In the past, students might have used spreadsheets in computer applications and then not again until two years later in operations management. Now, though, the core microeconomics course includes eight spreadsheet-based activities focusing on graphing skills and analysis. In addition, students learn how to use the Scenario Manager in Excel. The core statistics course is now heavily focused on Excel, with a particular emphasis on using the built-in statistics tools and functions. This is followed-up in operations management, also a core course, where the focus is on leveraging these skills to understand how to design a spreadsheet decision model to be efficient and error-free. In addition, focusing students on how to model the logic of a problem so sensitivity analysis and what-if scenarios can be completed is now possible. Operations management also introduces advanced Excel functions and the Solver optimizer. From operations management, many students now choose the elective Using Information Systems to Solve Business Problems, which further explores Excel use and gets students into intermediate Access database functionality.

Metacognition: Thoughts about thinking

While technical skills are important, white-collar jobs require higher-order thinking skills that many employers are saying graduates lack (cla+ National Results, 2016). Helping students to learn how to think is as relevant to IS majors as it is to business students, future engineers, or even teachers.

To us, cognition or self-assessment is a thinking-doing-reflection helix that in each iteration, brings one closer to the underlying motivation for the event or issue at hand and facilitates finding the most satisficing solution, given ruling constraints. Metacognition—thoughts about thinking—coupled to self-assessment, integrates students into the process and gives them perspective on how good they really are and how/where to improve themselves. Creating appropriate formative [and summative assessments] where students not only reflect on what the implicit task at hand is—while getting the simultaneous opportunity to see what their peer students are doing, how well, and to provide feedback on it—is important here.

Peer and self-assessments have been implemented in several courses using the Qualtrics survey system. Students provide feedback to others on their work or presentation, using Qualtrics-administered forms. The feedback is both quantitative and qualitative in nature, which is aggregated into a report and given to the author/presenter for improvement consideration. Each student functions several times during the semester as author/presenter and reviewer, so each has repeated opportunities to consider their own work and that of others, and then to

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implement changes. These multiple assessments provide the constructivist building blocks for learning and achieving the expected outcomes from a student-driven perspective. In addition, each student sees exactly where they stand and why, which is valuable in itself.

Writing to learn
Extended writing assignments are required in nearly every class, from lower to upper division and from concepts courses to technical ones.

For a lower division course, article applications are used with instructor provided articles that students use to connect practice to course theory. In an upper division course, students may use technical whitepapers from consulting organizations, for example, to show how course theories are being used in practice.

Students, especially those with significant work experience, are encouraged to write about how the theories in class are seen at work. Students are charged with identifying not only good practice but how improvements might be made using what they are learning in class.

Interteaching
Interteaching has been utilized a principles of management course by one of the authors though the technique is readily applicable to any concepts course regardless of domain.

In this implementation, students not only must read a chapter, but are given short cases or vignettes to consider. They answer questions for the vignettes that include important concepts in terms of applying the theory. In class, students get in small groups to discuss their responses then a class discussion ensues. The instructor extends the discussion, including short lectures as needed, to cover misunderstood material or to draw out other important theories and considerations.

Problem-based Teaching and Learning
Courses that use spreadsheets and project management software to are now taught in a guided problem-based learning fashion. Students may have spreadsheet mechanics down but often do not understand how to use a spreadsheet to model problem logic for what-if scenarios and sensitivity analysis. Project management software is normally new to them and complex. Early in the semester, problems are deconstructed and the solution process and logic modelled for them as they build their skills. As the semester progresses, support is lessened and the focus moves to analysis and decision making. For many students, these are transformative experiences as they begin to see how these tools can be used for all kinds of applications and decisions important to them.

4. CONCLUSION

It is always the hope, indeed the prime accountability of instructors, to continuously improve their pedagogies and related methodologies. At the same time, educators are under pressure to improve their impact and increasingly aware that competitive alternatives are becoming available for students to choose, which increases the pressure to get it right when teaching. While we may not always have the time or resources to conduct full experimental studies of our teaching choices, we remain committed to active experimentation in course design and delivery, making informed choices by leveraging our own experience with those of our peers and educational researchers.

This paper provides a review of specific, evidence-based teaching techniques such as testing, spaced learning, writing to learn, interteaching, problem-based learning, formative and summative assessment that we have found useful as we experiment with our pedagogy. Then, examples of our efforts by the authors to incorporate these approaches into our courses is described with the hope of inspiring others to consider how they might experiment themselves. Some of these methods are readily able to be implemented and scaled, while others admittedly require more effort and planning or cooperation amongst faculty members. Collecting evidence of impact is an active area of work in these efforts and the focus of forthcoming works.

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