An evidence-informed guided problem-based learning approach to teaching operations management

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Evidence of learning and student growth is a prized goal for programs and instructors, but is often difficult to measure with precision, especially for concepts like problem solving or critical thinking. This paper presents an experience teaching a core business course, operations management, at a Midwest (USA) regional campus that focuses on problem solving where the instructional choices are informed by theory, evidence in the literature, and author experiences. A guided problem-based learning (PBL) approach to teaching is employed using Excel exercises that are presented using interrelated narratives or dialogs. A conceptual narrative conveys why the problem being solved is important to organizations and the students' careers. A technical narrative presents theories, tools and techniques used to solve the problems in an accessible dialog, emphasizing the how and why the problem is solved a certain way, and how those techniques/tools can be used to solve other problems. The dialogs encourage student metacognition of what they are learning, why it is important, and how it can be used more generally. The course is offered both fully online and in-person using a flipped approach, i.e. lectures are presented via videos and classroom time is spent solving problems in workshop fashion. Results show students appreciate the guided PBL approach, find the class worthwhile and realistic, find they have a better understanding of how to solve problems generally, and how the concepts fit into their careers. Improvements are indicated for achieving meaningful student interaction for learning and for gaining improved confidence in their own specific problem-solving abilities.

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Introduction

Employers and critics of higher education are increasingly calling on universities to go beyond simply conveying subject matter knowledge and to develop in students higher-order concerns such as decision making and problem-solving abilities, technical proficiency, and communication skills (Career preparation: How wide is the divide? 2017). According to a survey by Hart Research Associates (2013), most employers strongly identify with a graduate's need for both knowledge and competency in a range of applied skills. Indeed, the link between students' educational development and their career advancement/long-term success in the workplace has employers advocating for a sharper focus on authentic learning outcomes via real-world scenarios. This means instructors must evolve course pedagogy, structure, and delivery to meet changing employer and societal expectations.

Evidence of learning and student growth is a prized goal for programs and instructors, but it is often difficult to measure with precision, especially for concepts like problem solving or critical thinking. This difficulty is magnified when focusing on course-level impacts where the normal teaching environment entails smaller class sizes, a limited number of section offerings, and a curriculum filled with content coverage requirements. Well-designed studies with scale and controls may be desired, but in practice are not always feasible. What is an instructor to do who, as a scholarly teacher, is interested in investigating his/her teaching choices, efficacy, and student perceptions but who is facing such practical limitations?

Davies (1999, p. 109) provides some guidance noting "evidence-based education operates at two levels. The first is to utilize existing evidence from worldwide research and literature on education and associated subjects…while the second level is to *establish* sound evidence where existing evidence is lacking…". In other words, scholarly teachers can operate from an evidence-based standpoint by incorporating research into what works in their pedagogical choices. Biesta (2007, p. 5), reinforces this notion suggesting, the "link between research, policy, and practice, [are achieved] using notions such as ''evidence-informed,'' ''evidence-influenced,'' and ''evidence-aware'' practice". Instructors should be encouraged to experiment in such evidence-informed or evidence-influenced manners focusing on the important objectives for the course, especially those valued by employers and society.

This paper presents an experience teaching a core business course, operations management (OM), at a Midwest regional campus. This course is one of only two upper division core courses—those required by all majors in the college—that is quantitatively focused. It is also the only one with prerequisites of statistics and computer applications, which are key components in contemporary decision-making and analysis. Many of the course delivery characteristics have evolved to modernize the development of student computer skills, decision-making ability, and problem solving and to emphasize the role the course plays in the curriculum. Instructor experience, student, alumni, and employer feedback all indicate these are important for graduates to know, appreciate, and be able to do.

Currently, students learn how to develop the decision models themselves; primarily using spreadsheet activities termed Excel exercises. Through these Excel exercises—and the similarly structured exams—students learn about not just spreadsheet mechanics but how to model the logic or mathematics of a decision setting more generally, so additional analyses and insights are possible. The progression of student development through the semester has been refined over time and progresses from being highly structured and guided to being much less so by the end of the course. At the beginning of the semester, the focus is on basic spreadsheet mechanics and layouts for efficiency, understanding, and error trapping as applied to OM problems. By the end of the semester, students are challenged to take a problem setting and to work in situations where data may not be readily available or where intermediate calculations and assumptions are required, to identify the appropriate mathematics to solve it, and then to build the model, test it, and make decisions.

In past years, the course was taught only via a traditional delivery mode with lectures in class and problems worked by students on their own time. More recently, the course is taught in two modes: an in-person section that utilizes a hybrid or flipped classroom approach and as a fully online course. All students still complete reading assignments outside of class but they now watch lecture videos on their own too. The in-person flipped class students then meet in a computer lab where the focus is on problem-based learning by applying the material in a workshop-like format. The learning approach integrates insights or lessons on spreadsheet design considerations, advanced solution techniques, and decision-making practice examples into solving the problems via narratives, which are related application and technical dialogs/stories to help students appreciate the problem settings, the solution nuances, and the problem-based learning approach itself. Online students differ in that the workshop portion of the class is delivered asynchronously via interactive solution videos that periodically pause during the narrative, allowing students to consider a concept and to build their spreadsheet model. The student then restarts the video to check his or her work and understanding.

The course evolution did not occur in a vacuum but rather was supported by the campus administration and fellow faculty members. A few years ago, it was possible for a student to complete the prerequisite computer applications class and not use spreadsheets again for several semesters before entering OM. To help remedy this, the statistics course, also an OM prerequisite, is now taught with a focus on using Excel. In addition, the core microeconomics course now has eight Excel activities integrated. Many graphical economics concepts are investigated using spreadsheets with extra items, such as how to change graph and axis formatting, using the Scenario Manager, and what-if analyses now covered. Other faculty have followed suit with smaller contributions. Campus administrators have also provided significant support. Our campus has become a certified testing center for Microsoft Office applications and we subscribe to the Microsoft Imagine program to gain access to specialized software for campus computer labs and for students to download. Computer labs for teaching are now widely available for instructors to use and video recording software is available for creating the flipped course materials. The college and campus strategic plans were instrumental in helping to justify these investments.

The instructional choices for the course are informed by theory, evidence in the literature, student feedback/performance, and author experiences. The remainder of this paper will review some pertinent concepts in this endeavor and delve into student perceptions of their learning experience. First, the notions of evidence-based and evidence-informed teaching are explored. Then, the concept of metacognition—which relates to one's understanding about the learning process, why what is being learned is important, and in recognizing one's own role and responsibility in it—is introduced. The course delivery employs a dialog or narrative technique to make the material more pertinent and interesting to students, which is discussed next. Then, the flipped classroom approach, where video lectures are completed outside of class time and problem solving is moved into class workshops is explored. These workshops utilize a guided problem-based learning approach, which is reviewed next. Finally, results from a survey instrument used to obtain student perceptions of the relevancy of the course structure and components to their learning experience, along with their gain in knowledge, spreadsheet skills and problem-solving ability is reviewed. While students overwhelmingly report positive results, limitations and areas for improvement in course design and delivery, and research structure are considered.

Literature and Concept Review

Evidence-Based and Evidence-Informed 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, p. 5). While this definition seems straightforward, research into the efficacy of teaching and learning is a complex endeavor. As Biesta (2007, p. 10) points out, "education is at heart a moral practice more than a technological enterprise," because "in education means and ends are not linked in a technological or external way but that they are related internally or constitutively". 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.

It can be useful to think of evidence-based teaching in similar terms to evidenced-based medicine or management. Biesta (2007, p. 12) defines 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." emphasizing that research evidence must be considered as just one of the many factors in the "process of clinical decision making, rather than the only factor to drive clinical practice." Biesta (2007, p. 12), goes on to state that "[g]ood doctors use both individual clinical expertise and the best available evidence, and neither alone is enough". By extension, good educators should operate similarly, integrating research evidence, their own experiences, and context-specific considerations into their pedagogical choices and implementation.

Rousseau (2006) notes that a goal in business education, is to develop students who become evidence-based decision makers in their careers and that it is essential for educators to model this in the curriculum and their teaching pedagogy. In this pursuit, Rousseau (2006, p. 266) proposes that there is a mix of practice and principles that need to be taught, and while there is no set rule on what the right balance is, it is important to "mak[e] the course tell a story student can understand and participate in". Students need to see themselves in the journey from novice to expert manager as represented by the course itself and the curriculum more generally. Educators should expose students to approaches used by evidence-based managers, explain what is being done and why, and to have students actively practice and self-reflect on these approaches (Rousseau, 2006). Opining further, Rousseau (2006) notes that stimulating courses and active learning are good pedagogy and should be core to teaching. In other words, engaging students by managing their perceptions and expectations is important. Students must understand that the development sought via a specific course, for example, is to leverage the subject matter to teach the principles and skills essential to solving problems more generally in their careers and not simply to train them on a limited set of practices for solving specific problems that they may never encounter outside the classroom.

Metacognition

It is no surprise, then, that a common theme in effective teaching is to make the material relevant to the students' lives and careers. Kreijnsa, Kirschner and Jochem (2003, p. 335) claim "[t]here is ample empirical evidence that cognitive processes necessary for deep learning and information retention occur in dialogues". Tanner (2012, p. 113) goes on to postulate "we learn more from reflecting on our experiences than from the actual experiences themselves," and acknowledges the contemporary "coining of the term "metacognition" and that the emergence of a metacognition research field in the last four decades," has been extensive. Formally, metacognition is, in the words of Flavell (1979, p. 113), "one's knowledge concerning one's own cognitive processes, or anything related to them, e.g., the learning-relevant properties of information or data" (p. 113). According to Händel, Artelt and Weinert (2013, p. 164), "metacognition is divided into *knowledge about* and *control over/regulation of* one's own cognitive system," meaning students must develop a cognitive presence and be responsible, intentional learners.
Bloch and Spataro (2014, p. 250) state "the question of how best to prepare business students to capably apply critical-thinking skills after they graduate remains open." Not that critical-thinking skills are unteachable—many scholars have evidenced they can be taught—instead, they argue the problem teaching critical-thinking skills at the university level rather "rests in *how* it is taught." It is important for students to not only know about what they are learning and why it is important but also to appreciate the processes, techniques, and approaches undertaken to achieve this. When a student makes the connection between what is currently being learned and how it applies to their experience—especially how it could have solved a problem or led to a better outcome—an "ah-ha" moment can occur. It should be noted that Tanner (2012) claims metacognition, as it is important to and in the process of learning, is not new and its notion can be inferred back to the Socratic questioning methods, through John Dewey's (1938; 1916) "thinking and doing" a century ago, and to the evolution of (social) constructivist theories more generally. For more on metacognition, its application and assessment, interested readers can see Ibabe and Jauregizar (2010); Israel, Bauserman and Block (2005); Israel, Block, Bauserman and Kinnucan-Welsch (2008); Iwai (2016).

A Role for Dialogs in Teaching

Barr and Tagg (1995, p. 13) proclaimed that a paradigm shift was underway in higher education. Institutions must change from being one "that exists to provide instruction," to one that "exists to produce learning." This is potentially a profound and difficult change, especially for institutions that have focused on the prior rather than the latter. Transitioning to a teaching style or methodology that encourages student metacognition and involvement in the learning process can be difficult for instructors who often were not taught this way themselves and who face time pressures inherent in a content-packed curriculum. Weaving cogent and meaningful dialogs or narratives and explanations throughout a course can benefit students but seem time consuming or even risky to instructors. Achieving an impact on student learning and development in a way that facilitates transferal of those knowledge and skills to solve important organizational and societal problems is highly prized, though, and arguably worth the (educated) risk.

The OM course in this study has evolved from being a lecture-focused class to one that uses dialogs for teaching problem solving via two, integrated narrative approaches. A *conceptual narrative* position the operations management concerns and situations as pertinent to the organization and to the students personally. This is where the problem setting is described, and examples given to show how the issue pertains not only to operations managers but also to marketing, accounting, finance or other areas of the organization as appropriate. The conceptual narratives help students to understand why what they are learning is important to their careers and how to communicate this to future employers or current managers. A *technical narrative* is interweaved with the conceptual narrative to emphasize the tools, techniques, and/or the mathematics and statistical theories implemented. Sometimes, pertinent conceptual and technical issues are initiated via mini lecture, while at other times it is via a questioning dialog or even through encouraging a trial-and-error approach. In each case, though, it is performed in phases to reveal conceptual and technical insights and concerns as the problem(s) are solved. This can happen within a single problem setting or spread across the semester's activities. The approach, and its implementation, has been developed from a research-informed view as well as from instructor experience and style, student feedback, and (quite frankly) mistakes.

Student Learning Interactions

Developing a social presence that gets students actively involved in the learning process, and indeed working together to solve problems and to learn the approaches, can be important for metacognition. Tu (28, p. 28), identifies that the "[c]haracteristics of the medium and user's perception determine the degree of social presence [which] is a dynamic variable [where participants] discern different degrees of social presence in different media." Tanner (2012) notes that reflection as part of metacognition has been a learning concern for decades, while Davies (1999) further emphasizes that involvement, interaction, and reflection have long been derived/advocated/applied by social constructivist proponents (e.g., Knowles, Piaget, Bruner, Vygotsky, Ausubel), especially those who favor learning from direct application to real-world problems. Bandura (1977, 2001, 2002) posits in social cognitive theory that observational learning and modelling by students enables them to mimic the observed behavior of others, in a social context, and in so doing, they gather data and experience that ultimately informs their own cognitive development. Bahn (2001, p. 111) agrees, stating that "from observing others, one forms an idea of how new behaviours are performed, and on later occasions this coded information serves as a guide for action." Indeed, Vrasidas (2000, p. 1), citing Dewey (1938) and Vygotsky (1978), asserts that student "[i]nteraction is one of the most important components of any learning experience." In short, by interacting together, observing, debating and explaining things to each other, trouble-shooting together, etc. students build a social presence where significant learning can occur.

Instructors can play a crucial role in this sharing of evidence-based practices, and then supporting, supervising and teaching students how to unpack, analyze, and interpret their modelled observations so they can use them in the future to solve novel problems. Kathpalia (2011, para. 6) claim there are "three overlapping and recursive elements of cognitive presence, social presence, and teaching presence," where "teaching presence is the glue that holds the other two elements together by facilitating and directing the communication to achieve learning outcomes and educational goals." In this case, the narratives form the basis for developing the teaching presence to drive student cognitive and social presence.

Student interaction, discussion, and working together is encouraged and often naturally occurs in the workshop format of the flipped OM class. In the fully online version, though, students work independently and asynchronously. This means online students differ in the intrinsic student-student interaction and the social presence they experience. While this may simply be a fact of taking a fully online, asynchronous class, it is important to monitor how this may affect the students' perceived learning experience. Indeed, if the in-person workshops are well managed in this respect, one might expect face-to-face students will obtain and recognize a peer interaction benefit that online students miss out upon.

Friesen and Kuskis (2012, p. 353) suggest that while the literature on higher education online courses has focused on the student-student and student-faculty interaction, perhaps student-content interactions should figure more prominently because "the mediated context of distance education has compelled distance educators to consider more seriously interactions between students and diverse educational media (in Moore's (1995) words 'the content')." For the online students, instructor created videos provide the primary contact with course content, especially for the Excel exercises. Students watch pre-recorded interactive solution videos specifically designed to simulate dynamics of the in-person workshop but tailored for the fact online students are completing the work asynchronously and usually on their own. Videos, therefore, play a central role in the student-content interaction for the course, albeit a different (and arguably more important) one for online students versus face-to-face students. So, how each group perceives the value of videos in addition to the student-student interaction in their learning experience are factors monitored. The flipped classroom technique, utilized to enable this workshop approach, is particularly important to the evolution of the course and elaborated upon next.

The Flipped Classroom

To realize the applied workshop-like course approach, it became necessary to flip the in-person classroom. Typically, a flipped course is a hybrid or blended approach where a significant amount of instruction and content, but not all, is online rather than face-to-face. Picciano and Dziuban (2007) identify that a course with at least 30 percent and less than 80 percent of the instruction/content occurring online, as hybrid or blended. Strict percentages are arguably less important than making sure the integrated online component is as meaningful as if it were face-to-face because time traditionally spent in the classroom, usually is reduced though not eliminated. Ideally, then, a hybrid course combines the best of traditional face-to-face and online learning to create something entirely new irrespective of modality.

A common flipped class approach moves theory or lecture material to outside of the traditional class meeting and instead uses class time to work on problems or projects that apply the theory. Pardo, Sanagustin, Parada and Leony (2012), advocate for a flipped course [or reverse course] structure with two or more sessions on the same or similar topic. The first session is the traditional lecture "attended" online as homework, and the second or ensuing sessions are face-to-face incorporating inquiry-based learning via discussions and practical application of concepts learned online. Essentially the hook is thoughtful fusion of the two, where work outside of class (e.g. online) is a supplement to the class work and not simply repeated or reiterated. To achieve a successful balance, one can reverse engineer the course by starting with expected learning outcomes, and then create the assignments and associated learning sequences.

In the OM course, for example, developing students to be better problem solvers, with the understanding of how decision models are developed and the technical skills to do so, is important. By starting with this final goal, it became clear the traditional pencil-and-paper approach was insufficient because it ignored how these problems are solved in practice. Hence, the workshop approach was adopted. In the flipped approach, students complete the textbook readings and foundation lectures outside of class, using videos and associated multiple-choice quizzes. Class time, meanwhile, focuses on building models via spreadsheets. This frees up time to go beyond just the basic mechanics of, for example, the forecasting calculations to building spreadsheet models from scratch; demonstrating how to employ the forecasting process in practice to make predictions and decisions; how to analyze performance of the methods overall and relative to each other; and then how to explain it to others.

While the flipped classroom is not necessarily a new pedagogical model, it has gained considerable attention in recent years as technology has facilitated greater capability and iterations. The Higher Education Academy (Flipped learning, 2017) presents an excellent overview on flipped learning with implementation ideas and support materials. Interested readers also may see Brame (2013); Pardo, Sanagustin, Parada and Leony (2012); Picciano and Dziuban (2007); Roach (2014); and 7 things you should know about…™ (2012) for more information and insights.

Problem-Based Learning

OM, is a quantitative course that entails developing computerized decision models, making a problem-based learning (PBL) approach a natural fit. Problem-based learning originated from McMaster's University in the 1960s (Albanese and Mitchell, 1993), where a concern existed that much of the medical training and education at the time was centered on lecture and memorization. As clinicians, though, the doctors would be working in a less structured diagnostic environment requiring much more critical thinking and unstructured discovery learning. PBL has been the subject of hundreds of studies representing a myriad of implementation tactics, objectives, and applications areas (e.g., Albanese and Mitchell, 1993; Delaney, Pattinson and Beecham (2017); Norman and Schmidt, 2016; Savery, 2006; Servant and Schmidt, 2016; Strobel and van Barneveld, 2009; Walker and Leary, 2009).

While often an intuitively appealing approach, PBL is not a panacea or found to be universally beneficial for learning. Student readiness for an unstructured environment may make a pure discovery PBL approach appropriate for advanced medical students but harmful for less capable learners (Mayer, 2004). Walker and Leary (2009) note that a key to success is often to provide students with appropriate and variable support or guidance (i.e. scaffolding) throughout the learning experience. Hung (2011) reinforces this idea noting that matching the PBL approach, support, and providing motivation through encouragement and explaining what is being done and why, is important.

Problem-Based Learning Approaches: Choosing appropriate PBL approach(es) for the students and material is important to success. Wood (2013) investigates the use of PBL in nearly three dozen learning scenarios—from pure discovery learning to traditional lecture—that differ based upon the intensity of knowledge acquisition and/or skill development, the learning technique employed, and assessment instrument(s) used. Wood (2013) provides useful guidance on how to approach problem-based learning via a comprehensive implementation identification framework.

For the OM course purposes, a prescribed amount of knowledge acquisition is required per college curriculum guidelines. At the same time, computer applications and statistics are course prerequisites, so students are expected to have fundamental spreadsheet mechanics and a statistical foundation. As a result, the focus can be on advancing student skill development, decision-making, and problem-solving capabilities. For knowledge acquisition, Wood (2013) recommends a problem-initiated teaching approach where the instructor creates subject-oriented problems and learning objectives, and then floats around the room as facilitator and observer of individual and small group efforts. For skill development, problem-centered and problem-sequence approaches are primary methods according to Wood (2013). A short case setup may be used for problem initiation, with information on solution development and design also provided. The activities then are designed to vary through the semester to address a problem-sequence skill focus approach (Wood, 2013).

Integrating knowledge acquisition and skill development encompasses the problem-based lecture-learn approach of Wood (2013). In this OM course, (mini) lectures are interspersed with spreadsheet implementation and analysis work; the emphasis on skill development, analysis, and interpretation changes purposefully both within a specific topic and throughout the semester. For example, the instructor poses a problem setting or short case and then challenges students to solve it (or part of it) while circling the room to provide support, to ask leading questions, or simply to cajole students. Periodically, the instructor returns to the front and interactively models the solution process while peppering students with questions, asking for interpretations, conclusions drawn, extending the problem beyond what was asked or to new areas, etc. From a skills standpoint, the focus of the Excel exercise activities progress from basic spreadsheet mechanics to advanced spreadsheet design and the use of sophisticated tools, such as the Solver and regression tools. Content-wise, knowledge application begins the semester with considerable structure and evolves to the end of the term where more traditional case material is presented, and students must work with less guidance and indirect or even incomplete information.

For assessment, in addition to multiple-choice quizzes, there are exams, structured similarly to the Excel exercises, and an individual investigation writing assignment. Exams challenge students to solve a problem holistically where a problem setting is described from a work perspective and overall expectations and decisions to be made communicated. Exams often mix elements from different Excel exercise problems and may or may not include specific data for the student to use. When this is the case, students must "make up" data as a placeholder for when the actual values are obtained as a way to model the realities of work. The other major course component, the individual investigation, is flexible and allows for application of personal experience or for reading and applying information from whitepapers and articles to the course concepts. Individual investigation submissions typically encompass 9-12 written pages.

Student Readiness for PBL Approaches: How much guidance to provide is a balancing act between providing too much support, making the process pedantic or irrelevant, and providing too little, thereby overwhelming students who are not able to even begin the solution process. Goodman and O'Brien (2012, p. 903) claim that "[m]any common teaching strategies contradict scientific evidence about how people learn, to the detriment of student learning." 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, p. 903) provide extensive evidence to support their claims that these "strategies are actually counterproductive to learning," and that evidence-based teaching strategies "are more likely to benefit [student] learning." On the other end of the spectrum, Mayer (2004) notes that too little support is harmful too.

Therefore, finding the appropriate guidance and support for PBL depends in large part on the capability of the students. A survey of OM students shows that most students are lower on the scales for operations management experience and initial knowledge. Figure 1 contains student self-reported knowledge and work experience in operations management at the beginning of the course.

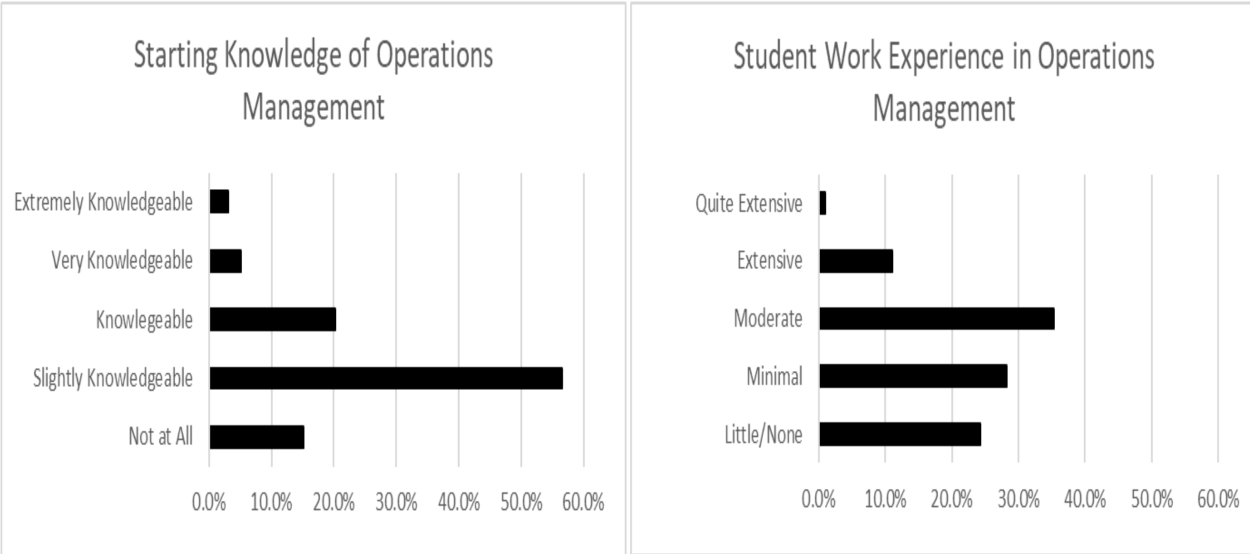

Figure 1. Student self-reported work experience and starting knowledge in operations management.

More than seven-in-ten (71.7 percent) students report being only slightly knowledgeable or possessing no knowledge at all of operations at the beginning of the semester, while just one-in-twelve (8.1 percent) report being very or extremely knowledgeable. For work experience in operations management, more than half (52.5 percent) of students report minimal to no experience whereas only about one-in-eight (12.1 percent) report having at least extensive OM work experience. Hence, the student profile seen in the course further reinforces the appropriateness of the guided problem-based lecture-learn approach (Wood, 2013). Comparing the online students to the face-to-face students shows no significant difference in either work experience (p = .233) or starting knowledge (p = .941). This indicates online and face-to-face students come from similar starting points rather than being distinct populations. This is reassuring given that the course delivery method, fully online versus flipped, is a factor of interest. Consider next, an example summary from the course before delving into the detailed student perceptions, results and insights, followed by limitations identified.

An Operations Management Example

Forecasting is a major OM concept covered extensively using Excel exercises and narratives. Students are positioned as an intern who has been charged with forecasting sales of a product so staffing decisions can be made, materials ordered, or promotional activities planned. This often leads to students discussing examples from their work experience. The instructor leads the students to consider the general approaches to forecasting, such as time series and associative forecasts, and then challenges them to perform forecasts using several different methods. Students are required to consider spreadsheet layout issues and to use appropriate built-in functions, such as =average () or =sumproduct () as they setup worksheets for each method. Once several forecasting methods are introduced and implemented, students are asked which method performs the best. This leads to a discussion and mini-lecture on error measures and on how each error measure gives a different perspective on forecast performance.

Students are then shown how using multiple spreadsheets within a workbook, if structured properly, can make a development like this much more efficient and less error prone because formulas can be entered once and then copied from sheet-to-sheet. A connection is made about how this multi-sheet structure is useful in organizations with multiple locations where each location has a worksheet within a workbook and the common structure facilitates aggregation and analysis. Next, students are introduced to the Solver tool in Excel, exposing them to optimization and how it is not just an abstract mathematical concept from their calculus class, but it can apply to forecasting and other practical areas. Finally, the forecasting problem is expanded to include regression where product sales are related to advertising expenditures, which leads to mini lectures on regression theory, its implementation in Excel, and regression output interpretation. This statistical theory discussion is reinforced later in the semester—with specific connections back to regression forecasting—as inventory models and process control and capability topics are covered.

Technical narratives, focusing on the tools and techniques being implemented and why, are reinforced and revisited at different points in the course. For example, a useful function, such as =sumproduct () is used in two different Excel exercises: forecasting and location analysis. This encourages students to consider that while the application may be different, the solution structure might resemble something they have worked on in the past. Similarly, another technical issue, decision sensitivity analysis, is investigated early in the semester using "what-if" scenarios to show the impact changes in assumptions or input values have on the decision made. Students are introduced to the What-If Scenario Manager capability in Excel and how it can be useful here. At the end of the semester, sensitivity analysis is revisited from a mathematical standpoint where once a system has been modeled mathematically, such as for inventory, students make predictions based upon the formulas and then test their predictions by making spreadsheet changes and observing if the result is consistent with their prediction or not. This serves as a meaningful way to tie together the semester's worth of work as the sensitivity analysis concept used in the first weeks of class is applied again, in a different manner, at semester's end.

Procedures and Methodology

Developing students to be better problem solvers, with the understanding of how decision models are developed, and the technical skills to do so, are important OM course goals. A survey was distributed to students to measure their perceptions on the impact and effectiveness of the teaching strategies used. The number of students surveyed for this study totaled 99 (55 students in the traditional in-class sections and 44 enrolled on-line) over two semesters.

The survey instrument included questions with both Likert and rank-order scales depending upon question intent. The beginning questions of the survey asked students about their work experience and how knowledgeable they were regarding the concepts of OM from both the pre-course and post-course perspectives. The next series of questions focused on student perceptions on the impact of different course components (e.g. Excel exercises, videos, individual investigation) had on their learning experience and skills development. The remaining survey questions focused on what impact, if any, interaction with others had on the learning experience; if students felt the course structure and teaching approach helped to prepare them for a future business career and improved their real-world problem-solving skills/abilities; and whether the course was realistic and relevant to them. Students responded by signaling agreement (strong/moderate), disagreement (strong/moderate) or neutrality towards given statements. These questions seek to discern if students are gaining value from the course, the methods and components used to deliver it, and if they recognize it as so, which are important for metacognition.

Results and Discussion

As seen in Figure 1 above, most students reported they had only a slight knowledge of OM subject matter. The self-reported knowledge for all students starting the semester averaged 2.24, where a score of two represents slightly knowledgeable. Indeed, 71.7 percent of student's report being only slightly knowledgeable or having no knowledge at all of OM. Figure 2 shows how student-reported knowledge changed over the semester.

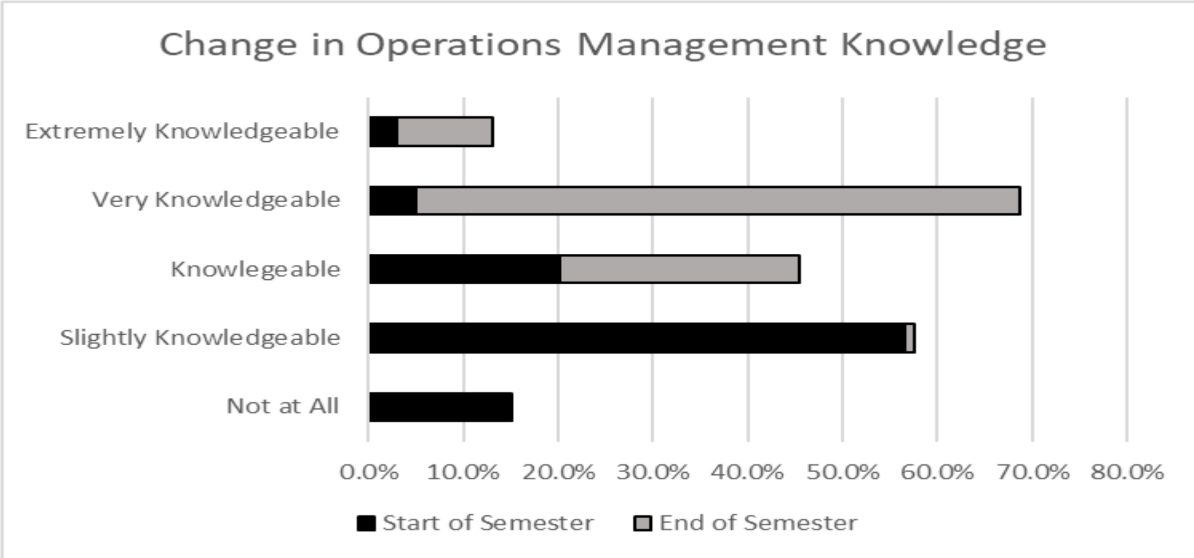

Figure 2. Student reported operations management knowledge at start and end of the semester.

At semester's end, 59 percent of students reported a knowledge increase of at least two categories, for an overall average of 3.83 (where 4 represents very knowledgeable). This increase in perceived knowledge of 1.59 categories, represents not only a statistically significant improvement (p = .000) but arguably a practically significant one too. At semester's end, zero students reported having no knowledge of OM and only one student out of 99 reported being merely slightly knowledgeable. Furthermore, nearly three quarters (73.7 percent) of students reported being very or extremely knowledgeable.

Next, students evaluated the course components—readings, videos, Excel/computer exercises, quizzes and the individual investigation—to determine the value they received from each regarding the overall learning experience and skill development. As detailed earlier, these course component choices were based in theory and evidence in the literature with the results presented in Table 1.

Overall, 95.96 percent of students reported the Excel/computer exercises were extremely or mostly impactful on their learning experience with no significant difference between online and in-person students. Both types of students ranked the Excel/computer exercises, presented in narrative fashion, as the most important course component. Indeed, 100 percent of in-person students identified these exercises as extremely or mostly impactful. This shows that students appreciate and value the guided problem-based approach used and indicates they find the exercises engaging, genuine, and relevant aspects of the course design and their learning experience. This is consistent with the PBL literature, especially as Hung (2011) notes that providing motivation through encouragement, explaining what is being done, and why, as important for PBL success.

Videos were rated as the second most important component overall for impact on the learning experience with 80.61 percent of all students reporting the videos as extremely or mostly useful. In this case, online students ranked the impact of the videos significantly higher than in-person students (p <.05). While 70.91 percent of in-person students felt the videos were extremely or mostly useful, 93.18 percent of online students did so. This is reasonable since online students rely solely on videos to deliver vignettes of theory and problem-solving application while in-person students can get much of this during class meetings. For online students, this reinforces Moore's (2012) contention that interaction between the student and contextual media should figure prominently in the design of fully online courses. The care and consideration used in developing the videos, and making them interactive, appears appreciated by students.

Multiple-choice quizzes related to the textbook readings and lecture content ranked third overall on learning impact with no significant difference between online and in-person students. About 60 percent of students found the quizzes extremely or mostly impactful. This was surprising, as anecdotally, students seem to complain most about the quizzes.

The individual investigation writing assignment, meanwhile, ranked fourth overall. Only 44.44 percent of all students believed the assignment was extremely or mostly useful with no statistical difference between online and in-person students. While this result needs additional investigation and data to know for sure, perhaps this is due to students' dislike of having to write a ten-page paper in a course that is mostly quantitative. Alternatively, the low level of student experience in operations management, coupled with the fact that OM is a core business course required of all business majors, might mean students would rather put this effort into papers and projects in their other courses.

Finally, textbook readings ranked last in impact with just 42.42 percent of students judging them as extremely or mostly helpful for learning. Online students found the readings more impactful than in-person students did (p <.05) with twice as many online students (59.09 percent) as in-person students (29.09 percent) rating the readings highly. The low rating may be because students find textbooks old fashioned and they prefer more modern tools, such as videos. Perhaps, though, maybe the readings simply need to be better aligned with the quizzes and activities, which Hoeft (2012) notes is important.

Regarding skill development, Table 1 shows nearly identical patterns for all the course components as the overall learning experience just discussed. The Excel/computer exercises rank first with an overall score of 4.79, where a score of 5 represents extremely useful/impactful. Videos ranked second and are significantly (p < .05) more important to online students. The multiple-choice quizzes ranked third while the individual investigation ranked fourth, with no difference between online and in-person students for either of these components. Finally, the readings ranked fifth with online students giving a significantly higher (p < .05) score to their importance than in-person students.

	Impact on Overall Learning Experience				
	Readings	Videos	Excel/Computer Exercises	Individual Investigation	Multiple Choice Quizzes
In-Person	2.87** *(5)*	3.84** *(2)*	4.89 *(1)*	3.04 *(4)*	3.53 *(3)*
	29.09%	70.91%	100.00%	34.55%	61.82%
Online	3.66** *(3)*	4.66** *(1)*	4.66 *(1)*	3.48 *(5)*	3.64 *(4)*
	59.09%	93.18%	90.91%	56.82%	56.82%
All	**3.22 *(5)***	**4.20 *(2)***	**4.79 *(1)***	**3.23 *(4)***	**3.58 *(3)***
	42.42%	80.81%	95.96%	44.44%	59.60%

	Impact on Skill Development				
	Readings	Videos	Excel/Computer Exercises	Individual Investigation	Multiple Choice Quizzes
In-Person	2.73** *(5)*	3.67** *(2)*	4.85 *(1)*	3.00 *(4)*	3.38 *(3)*
	20.00%	65.45%	98.18%	35.19%	50.91%
Online	3.61** *(3)*	4.55** *(2)*	4.70 *(1)*	3.33 *(5)*	3.41 *(4)*
	54.55%	93.18%	90.91%	51.16%	52.27%
All	**3.12 *(5)***	**4.06 *(2)***	**4.79 *(1)***	**3.14 *(4)***	**3.39 *(3)***
	35.35%	**77.78%**	**94.95%**	**42.27%**	**51.52%**

Table 1. The impact of course components on learning experience and skills development.

*Number in top row is the avg. score from students in each class type where 5 = Extremely useful/impactful, 4 = Mostly useful/impactful, 3 = Useful with some impact, 2 = Little use/impact, and 1 = Not useful. The ** means significant difference (p < 0.05) between the in-person and online sections. The number in parentheses is the rank for that component. Line two is the percentage of students responding extremely or mostly useful and impactful.*

The survey results presented in Table 2 focus on student perceptions of how well the course prepared them for their careers, reflected real-world situations, affected their problem-solving skills and abilities, and if student interactions were valuable to their experience. These concerns are important to achieving course relevancy and value and for developing intentional, cognizant learners.

The results show that students overwhelmingly report that the course structure and teaching approach made them better prepared for their career. Nearly eighty-five percent (84.85 percent) of students surveyed agreed that the course structure and design prepared them well for their future, with online and in-person students showing no significant difference (p = 0.814). Nine-out-of-ten students (89.90 percent) felt the course was realistic and reflected real-world situations, while 86.87 percent believed the course prepared them for solving real-world business problems. In both these cases, there is no significant differences between online and in-person students (p = .772 and p = .394, respectively).

Interestingly, though, when directly asked if they themselves were a much better problem solver because of the course, 88.64 percent of online students agreed while only 70.91 percent of in-person students did, a statistically significant difference (p = .025). Therefore, while online students responded consistent with the preceding questions, in-person students were not so confident in their own, specific problem-solving capabilities. Perhaps online students appreciated the course approach when compared to other fully online classes. Or, maybe, as Israel, Block, Bauserman and Kinnucan-Welsch (2008, p. 102) remind us "[t]o comprehends, learners need to use a variety of strategies deliberately and independently." Online students, by the nature of asynchronous delivery, must take more control of their learning but also have increased flexibility and choice regarding where, when and even how they decide to learn. In-person students learn in a group setting that might place constraints on learning independence and experimentation. Certainly, more data is needed here. One idea to improve in this regard, though, is to experiment with decreased guidance earlier in the semester than currently is happening. This might force more learning independence and experimentation.

Four-out-of-five (79.80 percent) students also reported that they learned about being an actual operations manager, with only about 5 percent disagreeing. Online and in-person students responded similarly (p = .593). For student confidence in the development of skills needed more generally for a business career, nearly nine-in-ten (88.89 percent) of all students strongly or moderately agreed. Considering course delivery mode, 87.27 percent of in-person and 90.91 percent of online students believed the course helped in this regard, which is a statistically significant difference (p = .033). Much of difference is due to a higher percentage of online students who strongly agree, rather than just agreeing, that the course helped them.

Survey Question	All Students	In-Person	Online	*p-value*
The course structure and teaching approach made me better prepared for my career.	**4.273** *84.85%*	**4.255** *85.45%*	**4.295** *84.09%*	*0.814*
Course was realistic and reflected real-world situations.	**4.455** *89.90%*	**4.436** *89.09%*	**4.477** *90.91%*	*0.772*
Course prepared me for solving real-world business problems.	**4.313** *86.87%*	**4.255** *81.82%*	**4.386** *93.18%*	*0.394*
I am a much better problem solver as a result of this course.	**4.010** *78.79%*	**3.855** *70.91%*	**4.205** *88.64%*	*0.025 ** *
I learned about being an actual operations manager as a result of this course.	**4.020** *79.80%*	**3.982** *78.18%*	**4.068** *81.82%*	*0.593*
I am more confident in the development of my skills that I need for a successful business career.	**4.313** *88.89%*	**4.164** *87.27%*	**4.500** *90.91%*	*0.033 ** *
Interaction with other students enhanced learning experience.	**3.141** *33.33%*	**3.491** *52.73%*	**2.705** *9.09%*	*0.025 ** *

Table 2. Student perceptions of course effectiveness and utility in preparing them for careers, solving problems, and in developing their skills.
*(Strongly Agree = 5, Moderately Agree = 4, Neutral = 3, Moderately Disagree = 2, and Strongly Disagree = 1). Significant difference between online and in-person students at the 0.05 p-value level denoted by **. Line two is the percentage of students strongly or moderately agreeing.*

Finally, students identified the value they found through interaction with other students regarding their overall learning experience. More than half (52.73 percent) of the in-person students rated this experience to be impactful on their overall learning experience while only one-in-eleven (9.09 percent) of fully online students did so. While the impact of student interaction for online students is understandably low and not a prominent concern—given that the fully online section is delivered asynchronously—there is opportunity for improvement here for in-person students. Again, perhaps this reinforces the need to improve the learning independence and experimentation of the in-person workshops per Israel et al. (2008).

Future Considerations

Though much was learned from of this study, it is recognized that limitations exist. As just noted, peer-to-peer interactions did not prove to be as valuable to the learning experience as had been surmised. In-person students, at least, should have much to gain from interaction with their peers, whether it be through observation, explanation, or trouble shooting. As Bahn (2001) notes, getting students to interact meaningfully as a resource for their knowledge and learning can yield significant benefits. In the future, greater emphasis will be placed on figuring out how to make peer interaction in class more of a priority, while still achieving content coverage requirements. Relatedly, encouraging in-person students to be more independent in their learning, by reducing guidance earlier in the semester, may help students develop better problem-solving confidence.

The value of reading materials also was not realized during this study. Many instructors have identified a similar issue in their courses and it seems that this may be a consequence of both technological and generational changes. To improve students' value perceptions of reading assignments, quiz content will be re-evaluated for better alignment with specific reading requirements or class exercises in an attempt to increase the importance level of and connection to student interests (Hoeft, 2012).

Integration of real-world problem solving is vital to the success of the problem-based learning approach. To take this concept a step further, establishing a corporate partner or launching a student-run business (Jacobs, Robinson and DePaolo, 2016), would provide students the opportunity to apply learned course concepts to actual business situations. As von Konsky, Miller and Jones (2016) note, students can find greater value in experiential opportunities designed to develop critical thinking when working with external partners. Gackowski (2003) emphasizes further that working externally broadens students' overall abilities to create actual business solutions through direct application of the concepts of the course and potentially affects students' professional careers longer-term.

To enhance future analysis of studying the OM course, in addition to perceptions, evaluation needs to perform based on specific pre-test and post-test instruments of demonstrated skills and problem-solving. Finding time to include a skill, problem-solving, and decision-making abilities test at the beginning of the semester to be repeated at the end should be investigated. Additionally, the survey instrument did not ask students about traits as gender or age, only OM experience and knowledge. With a split of about 60/40 female to male students, and a predominance of students under 25, understanding gender and age response differences could be useful.

Conclusion

University programs are under increasing scrutiny to develop students capable of contributing to solving modern organizational and societal problems. Rote learning and simple knowledge transfer are no longer enough as graduates are expected to have analytical, technical, and problem-solving skills, along with the ability to communicate implications and results to a wide array of audiences.

This paper details a guided problem-based learning approach to teaching operations management on a Midwest (USA) regional college campus. The course has been designed based upon evidence in the teaching and learning literature and refined through instructor experience and student feedback. The problem settings and solution processes used are presented in a narrative fashion using a workshop-like structure. Problem-based learning encompasses a plethora of implementation approaches designed to prepare students for the environments they may face beyond academia. Because students entering the class have little operations experience and knowledge, more guidance is provided at the start of the semester and tapered off over time. Conceptual narratives are dialogs and stories that provide the business context in which the problems reside. These illustrate why the problems being solved are relevant to their careers and lives, which is important for metacognition. The technical narratives, meanwhile, emphasize the tools and techniques employed in solving the problems and are used to bring to life how to discuss and explain the methods and issues to others so they can understand and appreciate them too.

The course is delivered in both online and in-person formats, with the in-person sections employing a flipped classroom approach. The flipped approach uses videos for lecture material, freeing up class time to work on related problems in class called Excel exercises. In addition to videos and the Excel exercises, significant course components include readings, an individual investigation, and multiple-choice quizzes. A survey asks students how important these components were to their learning experience in addition to their perceptions of how effective the course is in preparing them for their careers, solving problems, and in developing their skills.

The results show that students overwhelmingly recognize and support the value of the course and approach. The reality of smaller sample sizes, though, means that not all pertinent issues are going to be settled in a semester or two of monitoring. This seems fitting in the sense that true student performance will be determined well in the future, perhaps even several years after graduating. So, measuring a student's current confidence and consideration may form an opportunity for future engagement and reflection. Will students think better of us two to five years after graduation or not? Something to ponder.

References

7 things you should know about…™ | Flipped Classrooms (2012). Retrieved from

https://library.educause.edu/~/media/files/library/2012/2/eli7081-pdf.pdf
Bandura, A. (1977). *Social learning theory*. Englewood Cliffs, NJ: Prentice-Hall.
Bandura, A. (2001). Social cognitive theory: An agentic perspective. *Annual Review of Psychology,* vol. 52, pp. 1–26.
Bandura, A. (2002). Social cognitive theory in cultural context. *Applied Psychology,* vol. 51 (2), 269–290. DOI: 10.1111/14640597.00092
Bahn, D. (2001). Social Learning Theory: its application in the context of nurse education. *Nurse Education Today,* vol. 21, pp. 110–117.
Barr, R. & Tagg, J. (1995). From teaching to learning: A new paradigm for undergraduate education. *Change,* vol. 27 (6), pp. 13-25.
Biesta, G. (2007). Why "What Works" won't work: Evidence-based practice and the democratic deficit in educational research. *Educational Theory*, vol. 57 (1), pp. 1–22. DOI: 10.1111/j.1741-5446.2006. 00241.x
Bloch, J. & Spataro, S. E. (2014). Cultivating critical-thinking dispositions throughout the business curriculum. *Business and Professional Communication Quarterly,* vol. 77 (3), pp. 249–265.
Brame, C. J. (2013). 'Flipping the classroom'. Retrieved from https://s3.amazonaws.com/vu-wp0/wpcontent/uploads/sites/59/2017/06/08123735/Flipping-the-Classroom1.pdf
Career preparation: How wide is the divide? [Infographic] (2017, June 9). *The Chronicle of Higher Education.* Retrieved from http://images.results.chronicle.com/Web/TheChronicleofHigherEducation/%7B2db11846-d155-40a2-a894-2cbbedc8afd3%7D_2016_CollegeToCareer_Infographic_v6.pdf
Davies, P. (1999). What Is evidence-based education? *British Journal of Educational Studies,* vol. 47 (2), pp. 108-121.
Delaney, Y., Pattinson, B. & Beecham, S. (2017). Transitioning from traditional to problem-based learning in management education: the case of a frontline manager skills development programme. Retrieved from
http://srhe.tandfonline.com/doi/full/10.1080/14703297.2015.1077156?scroll=top&needAccess=true
Dewey, J. (1938). *Experience and education*. New York: Collier Macmillan Publishers.
Dewey, J. (1916). *Democracy and Education*. New York, NY: The Macmillan Company.
Dunn, D. S., Saville, B. K., Baker, S. C. & Marek, P. (2013). Evidence-based teaching: Tools and techniques that promote learning in the psychology classroom. *Australian Journal of Psychology,* vol. 65, pp. 5–13. doi: 10.1111/ajpy.12004
Flavell J. H. (1979). Metacognition and cognitive monitoring: a new area of psychological inquiry. *American Psychology,* vol. 34, pp. 906–911.
Flipped learning (2017). Retrieved from https://www.heacademy.ac.uk/knowledge-hub/flipped-learning-0
Friesen, N. & Kuskis, A. (2012). Modes of Interaction. In M. Moore, Handbook of distance education (pp. 351-371). Mahwah, NJ: Lawrence Erlbaum Associates.
Gackowski, Z. J. (2003). Case/Real-life problem-based learning with information system projects. *Journal of Information Technology Education,* vol. 2, pp. 357-365.
Händel, M., Artelt, C. & Weinert, S. (2013). Assessing metacognitive knowledge: Development and evaluation of a test instrument. *Journal for Educational Research Online,* vol. 5 (2), pp. 162–188.
Hart Research Associates (2013). It takes more than a major: Employer priorities for college learning and student success. *Employer Survey & Economic Trend Research - Association of American Colleges and Universities*, pp. 5-14.
Hoeft, M. E. (2012). Why university students don't read: What professors can do to increase compliance. *International Journal for the Scholarship of Teaching and Learning,* vol. 6 (2), pp. 1-19.
DOI: https://doi.org/10.20429/ijsotl.2012.060212
Ibabe, I. & Jauregizar, J. (2010). Online self-assessment with feedback and metacognitive knowledge. *Higher Education,* vol. 59 (2), pp. 243–258.
Israel, S. E., Bauserman, K. L. & Block, C. C. (2005). Metacognitive assessment strategies. *Thinking Classroom*, vol. 6 (2), pp. 21-28.
Israel, S. E., Block, C. C., Bauserman, K. L. & Kinnucan-Welsch, K. (Eds.) (2008). *Metacognition in literacy learning: Theory, assessment, instruction, and professional developmen*t. Mahwah, NJ: Lawrence Erlbaum Associates, Inc.
Iwai, Y. (2016). The effect of explicit instruction on strategic reading in a literacy methods course. *International Journal of Teaching and Learning in Higher Education,* vol. 28 (1), pp. 110-118.

Jacobs, A., Robinson, D. F., & DePaolo, C. A. (2016). Teaching Case: Using Excel to Make Strategic Managerial Decisions. *Journal of Information Systems Education,* vol. 27 (2), pp. 93-98.

Kathpalia, S. (2011, April 10). Blended e-learning-The way to go? *English Language Teaching World Online*. Retrieved from http://blog.nus.edu.sg/eltwo/2011/04/10/blended-e-learning-the-way-to-go/

Kirschner, P. A. (2001). Using integrated electronic environments for collaborative teaching/learning. *Research Dialogue in Learning and Instruction,* vol. 2 (1), pp. 1–10.

Kreijnsa, K., Kirschner, P. A. & Jochems, W. (2003). Identifying the pitfalls for social interaction in computer-supported collaborative learning environments: a review of the research. *Computers in Human Behavior,* vol. 19, pp. 335–353.

Norman, G. R. & Schmidt, H. G. (2016). Revisiting 'Effectiveness of problem-based learning curricula: theory, practice and paper darts' *Medical Education,* vol. 50 (8), pp. 793–797.

Pardo, A., Sanagustin, M., Parada, H. & Leony, D. (2012). Flip with care. SoLAR Southern Flare Conference, Aerial Function Centre, University of Technology Sydney November 29 – 30, 2012. Retrieved from https://www.researchgate.net/publication/232906379_Flip_with_care

Picciano, A. & Dziuban, C. (Eds.) (2007). *Blended Learning: Research Perspectives*. Needham, MA: Sloan-C.

Roach, T. (2014). Student perceptions toward flipped learning: New methods to increase interaction and active learning in economics. *International Review of Economics Education,* vol. 17, pp. 74–84

Rousseau, D. (2006). Is there such a thing as "evidence-based management"? [2005 Presidential Address]. *Academy of Management Review,* vol. 31 (2), pp. 256–269.

Servant, V. F. C. & Schmidt, H. G. (2016). Revisiting 'Foundations of problem-based learning: some explanatory notes'. *Medical Education,* vol. 50 (7), pp. 698–701.

Tanner, K. (2012). Promoting student metacognition. *CBE Life Science Education,* vol. 11 (2), pp. 113–120. doi: 10.1187/cbe.12-03-0033.

Tu, C-H (2000). On-line learning migration: from social learning theory to social presence theory in a CMC environment. *Journal of Network and Computer Applications,* vol. 23, 27–37. doi:10.1006/jnca.1999.0099

von Konsky, B. R., Miller, C., & Jones, A. (2016). The Skills Framework for the Information Age: Engaging Stakeholders in Curriculum Design. J*ournal of Information Systems Education,* vol. 27 (1), pp. 37-50.

Vrasidas, C. (2000). Constructivism versus objectivism: Implications for interaction, course design, and evaluation in distance education. *International Journal of Educational Telecommunications,* vol. 6 (4), pp. 339-362.

Vygotsky, L. (1978). *Mind in Society*. Cambridge, MA: Harvard University Press.