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## Guest Editors' Introduction: Special Issue on Problem-based Learning in Health Professions Education/Toward Advancement of Problem-Based Learning Research and Practice in Health Professions Education: Motivating Learners, Facilitating Processes, and Supporting with Technology

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# THE INTERDISCIPLINARY JOURNAL OF PROBLEM-BASED LEARNING

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## GUEST EDITORS' INTRODUCTION

### Toward Advancement of Problem-Based Learning Research and Practice in Health Professions Education: Motivating Learners, Facilitating Processes, and Supporting with Technology

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#### Introduction

Over a half century ago, problem-based learning (PBL) was introduced and implemented in medical education. Since then, PBL has been adapted and researched in health professions education throughout the world (Barrows, 1988; Hmelo-Silver, 2004; Schmidt, 1989). In reflecting on why PBL works in health professions education, Schmidt, Rotgans, and Yew (2011) attributed its success to the following factors: the activation of prior knowledge in small group settings, opportunities for elaboration on this knowledge, the arousal of situational interest that drives learning, and the flexible scaffolding provided by “cognitively and socially congruent” tutors (p. 792). Many systematic reviews on PBL in health professions education found PBL to be equivalent or superior to more traditional curricula (e.g., Hartling, Spooner, Tjosvold, & Oswald, 2010; Neville, 2009). PBL appears to be particularly beneficial to clinical competencies (Koh, Khoo, Wong, & Koh, 2008; Neville, 2009). In a systematic review that examined the effects of PBL during medical school on physician competencies after graduation, PBL was found to have moderate to strong effects on competencies related to coping with uncertainty, appreciation of legal and ethical aspects of health care, communication skills, and self-directed continued learning (Koh et al., 2008).

The past few decades have witnessed significant changes in education, health care, and technology. The educational paradigm has gradually shifted toward one that is more student-centered and constructivist-oriented. Advanced technologies have provided additional means to enhance health care delivery, learning, and instruction. Interprofessional education, which was designed to prepare students from different health professions to collaborate in a team environment to provide patient-centered care, has become increasingly common in health professions education (Interprofessional Education Collaborative Expert Panel, 2011). Health professionals in this era are expected to work as a team with individuals from other professions (Greiner & Knebel, 2003; Thompson, 2010; World Health Organization, 2010), to perform critical thinking and problem solving in their daily practices (Profetto-McGrath, 2005), and to utilize technology to deliver quality health care (e.g., electronic medical records, mobile technology) (Institute of Medicine, 2011). In the meantime, there are also needs for finding optimal ways to implement PBL in health professions education. Some of the noted issues include the need for more qualified facilitators to carry out PBL and the need for reliable and valid measures to assess student learning outcomes. All of these changes, challenges, and needs have prompted us to review the latest development of PBL in health professions education, including PBL practice (e.g., strategies and techniques) and research methods.

## Purpose and Overview

In the spring of 2014, we issued a call for contributions to an IJPBL special issue on PBL in health professions education. By health professions education, we refer broadly to undergraduate, graduate, and clinical education in various health-related professions. In light of the development of a new paradigm in education that exemplifies the original principles of PBL (Barrows & Tamblyn, 1980), we have expanded the concept of PBL to include educational approaches that give problems a central place in learning activities (Bereiter & Scardamalia, 2000). The purpose of this special issue is to provide a platform for health professions educators, researchers, and curriculum designers to discuss issues and share experiences on current practices of PBL. We took particular interest in contributions related to health professions education in the twenty-first century, which are characterized by interprofessional collaboration, rich integration with technology, and an emphasis on problem solving, critical thinking, and other twenty-first-century learning outcomes.

We received a total of 36 proposals from six countries representing various areas of health professions education. Upon rigorous editorial reviews, we invited 20 authors to submit full manuscripts. After two rounds of reviews by a team of experts in PBL and health professions education, eight manuscripts were accepted to be published in this special issue. These articles represent a wide spectrum of health professions, including medicine, nursing, dentistry, optometry, pharmacy, physical therapy, speech and hearing, and surgery, and are contributed by educators and researchers from Australia, Hong Kong, Ireland, and the United States. In addition, one article was the result of cross-country collaboration (see Skinner, Braunack-Mayer, & Winning, 2015). We are pleased to see that all these articles demonstrate an effort to move away from *if* to *how* as we look forward to a new generation of PBL research (Ravitz, 2009), that is, from investigating if PBL works to exploring ways to design effective PBL curricula and experiences, motivate and help students to learn in the PBL environment, prepare faculty for successful PBL implementation, assess diverse learning processes and outcomes, and augment PBL with learning technologies. Furthermore, we are impressed by a variety of theoretical lenses (e.g., motivation, critical theory) and research methods (e.g., structural equation modeling, case study, interactional ethnography) represented in this special issue. Five main themes emerge from this collection of articles, which we discuss specifically in the following section.

## Emerging Themes

To better understand the issues of design and facilitation in PBL, it is necessary that we review the essential characteristics of a PBL environment. PBL starts with an ill-structured problem or question as a stimulus to drive learning (Hmelo-Silver & Barrows, 2006). Ill-structured problems are complex problems that have multiple goals, some of them vague, and they often do not have a single correct answer; they can have multiple solutions or no solution at all, which requires learners to consider alternatives, select the most viable solution, and provide a reasoned argument to support their solution (Hmelo-Silver & Barrows, 2006; Jonassen, 1997). In addition, the problems should be multifaceted, which require students to synthesize information and apply knowledge from different domains. Furthermore, it also requires learners to develop adaptive expertise to solve complex and ill-structured problems (Bransford, Brown, & Cocking, 2000; Feltovich, Spiro, Coulson, & Feltovich, 1996). PBL is an iterative problem-solving process, in which learners work in groups to engage in the processes of knowledge construction and social negotiation of meaning. Therefore, group work and collaborative problem solving become salient characteristics of PBL. The most important value of PBL is that students take responsibility for their own learning and become self-directed and reflective learners. The role of a tutor, facilitator, or instructor is to scaffold learning through modeling, coaching, and eventually fading some of the support (Hmelo-Silver & Barrows, 2006). With a common understanding of PBL, we present and discuss the five themes that emerged from this special issue: (a) interprofessional and multidisciplinary research and practice; (b) small group learning; (c) learner motivation; (d) designing and facilitating PBL; and (e) supporting PBL with emerging technologies.

### **Interprofessional and Multidisciplinary PBL Research and Practice**

In the recent decade, interprofessional collaborative practice has become an important skill set across health professions. Many educators have found PBL a useful pedagogical tool to develop students' interprofessional collaboration skills because PBL requires students to apply knowledge from different fields of expertise to solve multifaceted problems (Kumar & Natarajan, 2007). Therefore, one of the timely themes to address interprofessional education is to investigate what PBL research has been done in this context, and what has been found to contribute to the literature of PBL research.

L'Ecuyer, Pole, and Leander (2015), in this issue, suggest that PBL is a feasible means to achieve important learning

objectives for interprofessional education. Through analysis of written reflections among nursing students involved in an interprofessional seminar, the authors conclude that the students commented on attributes of teamwork, communication, roles and responsibilities of other professions, confidence to engage other professions, and connecting PBL to interprofessional practice. The use of relevant patient cases encouraged critical thinking among nursing student participants and was essential to the use of PBL in interprofessional education.

Multidisciplinary approaches to case writing and facilitator training within the professions of dentistry and pharmacy, respectively, are included in this special issue. Doubleday et al. (2015) specify a model for case writing for an integrated dentistry curriculum, which incorporates coordinated input from multiple disciplines (e.g., biomedical, clinical, and educational sciences). The implications of social constructivism to the integrated case writing process are highlighted. Salintri, Wilhelm, and Crabtree (2015), in this issue, propose a theoretical framework for a structured facilitator training program in a college of pharmacy that uses constructivism as a guiding philosophy. Facilitators came from multiple disciplines within academic pharmacy, such as basic, clinical, and social/administrative sciences, and also include practicing pharmacists.

### **Small Group Learning: Knowledge Co-Construction or Information Gathering?**

Whether in the original PBL or in similar approaches, small group learning and collaboration are essential (Savery, 2006). To solve problems, students work in small groups to elaborate and negotiate ideas, and construct joint explanations (Hmelo-Silver, 2004; Schmidt et al., 2011). From an instructional design perspective, small group learning can achieve several important goals of PBL, for instance, constructing an extensive and flexible knowledge base, developing effective problem-solving skills, and becoming effective collaborators (Hmelo-Silver, 2004). Yet, educational implementation is often at odds with what was planned. In the literature of health professions education, students' perceptions of PBL group learning have been extensively studied (e.g., de Grave, Dolmans, & van der Vleuten, 2002; Visschers-Pleijers, Dolmans, de Leng, Wolfhagen, & van der Vleuten, 2006). Yet, until recently, most studies reported anecdotal findings or used self-report surveys to study students' perceptions. Ethnographic methods such as observations and interviews in naturalistic settings are needed to yield rich findings that can inform PBL researchers and practitioners in health professions education.

In this issue, Skinner et al. (2015) conducted ethnographic observations and interviews in two PBL programs in different countries to reconstruct for the reader beginning dentistry students' perceptions of and experiences with small groups

throughout the PBL life cycle. A salient theme from this study is that students viewed group processes as mechanical, orderly information gathering and exchange, rather than as means to resolve uncertainties, issues, or conflicting ideas. In fact, the authors observed that an effort to bring up uncertainties in group meetings was considered a deviation that was unproductive and would cause confusion. To quote the interview with a student, who was considered an outlier compared with the majority of students, the group process has come down to "get . . . information and cut and paste and make your two pages to send off," which "takes away the idea of PBL" (p. 27). Skinner et al.'s (2015) findings are not single occurrences. Similar findings are corroborated in two other studies conducted in Hong Kong, which are published in this issue. Both Chan et al. (2015) and Jin, Bridges, Botelho, and Chan (2015) observed that during group processes, students spent more time on superficial tasks such as information searching and gathering, which hindered meaningful interaction with peers that could have led to better understanding of the problem and deeper learning. Clearly, in all these cases, students' behaviors deviated from the ideal of PBL group processes, which could have prevented them from reaping the full benefits of PBL.

While these studies reveal what happens during PBL group collaboration and how students perceive their group experience, other studies, which are discussed in the next theme, lead us to uncover some underlying causes of these issues.

### **Learner Motivation: Antecedents of PBL**

Beginning in the 1980s, the field of education has seen increasing interest in examining how learners' motivational beliefs, values, and goals shape both learning processes and outcomes (Eccles & Wigfield, 2002). Instead of treating learners as a homogeneous group, educational research started to recognize the substantial role individual differences play in learning. Motivational constructs have been extensively studied in the educational context, for example, self-efficacy beliefs (Bandura, 1997), achievement goal orientations (Ames, 1992; Elliott & Dweck, 1988), intrinsic motivation (Sansone & Harackiewicz, 2000), and epistemic beliefs (Hofer & Pintrich, 1997; Schommer, 1990). These constructs, on the other hand, have received much less attention in the literature on health professions education, particularly in PBL. In fact, in a recent study on PBL in medical education, Schaubert, Hecht, Nouns, Kuhlmeier, and Dettmer (2015) argued that the process of learning cannot be adequately understood unless environmental, social, and psychological antecedents are integrated.

We are pleased that two studies in this issue have chosen to examine the *how* question from motivational perspectives. In pondering students' extensive focus on information

gathering and exchange while lacking quality discourse and deep learning in small groups, Skinner et al. (2015) show us, through observations and quotes from interviews, the connections among students' surface behaviors, value beliefs, and their deeper conceptions of learning. In Skinner et al.'s account, students often believed learning to be the increase of knowledge by taking in information. Accordingly, throughout the PBL process, the students tended to perceive group functions as pooling information during the problem analysis stage, as gathering information during the research stage, and as exchanging information during the stage of applying research to problems. The study shares with us a few interesting observations, for instance, students favored known facts over uncertainties (questions and issues), which points to students' deeply ingrained epistemic beliefs about the certainty of knowledge (Hofer & Pintrich, 1997; Schommer, 1990).

Coming from another motivational perspective, Abercrombie, Parkes, and McCarty (2015), in this issue, examine how students' achievement goal orientations affect their perceived fairness of peer evaluation, perceived learning, and the accuracy of their assessment of self and peers' problem solutions. The researchers found that the more performance-oriented a student was, that is, the more the individual focused on demonstrating his or her performance in comparison with that of others, the more likely he or she would perceive peer assessment to be unfair, and the less accurate was this individual's actual assessment of self and peers' problem solutions.

Both studies confirm that PBL in health professions education does not have a universal effect on learners. Rather, individual characteristics (e.g., beliefs, values, goals) interact with the learning environment to affect learning behaviors, perceptions, and outcomes. With more fine-grained knowledge about PBL beyond a comparison with "traditional" teaching methods, PBL educators and researchers in health professions education are able to carefully engineer the PBL learning environment to maximize its potential. In the next section, we discuss another evident theme related to the design of a PBL environment and the facilitation of the PBL processes.

### **Design and Facilitation of PBL**

Several contributions in this special issue focus on the design and facilitation of PBL, which are integral components of a PBL environment. Central to PBL is the problem (Hmelo-Silver & Barrows, 2006). As such, the success of PBL can largely hinge on the quality of the problem. A good problem should be sufficiently comprehensive to cover all the important objectives and to relate various concepts from different domains (Hmelo-Silver, 2013). In health professions education, problems are often presented in the form of cases. Moreover, as health professions education moves

from discipline-based (e.g., physiology, pharmacology) to organ system-based (e.g., pulmonary, cardiovascular) and team-taught approaches, case development can no longer rely on the expertise of one or two instructors. Doubleday et al. (2015) in this issue share an integrated case development model at a Doctor of Dental Medicine program that enabled a multidisciplinary team of biomedical scientists, clinicians, and education specialists to collaborate on case writing. Uniquely, the authors examined the case writing process from the perspectives of the case writers. The collaborative case writing, a PBL process itself, helped faculty to project their writing experience and reflections in the design of PBL for students.

A good problem would not lead to PBL success without skillful facilitation (Hmelo-Silver, 2004). Facilitator training is another critical aspect of PBL. Salinitri et al. (2015) advance a PBL facilitator training model implemented at a college of pharmacy. Similar to Doubleday et al. (2015), Salinitri et al. faced the challenge of training facilitators from different disciplines. Their facilitator training model took a particular emphasis on the assessment of students. In the training sessions, facilitators individually used an objective checklist to assess students' performance in recorded PBL sessions. Observing that many facilitator training programs evaluate their effectiveness by way of participants' subjective perceptions, Salinitri et al. (2015) propose a novel idea to objectively evaluate facilitator training by collecting facilitators' ratings of student performance at multiple time points during training and examining the improvement of inter-rater reliability.

While also focusing on instructor facilitation of learning, Kammer, Schreiner, Kim, and Denial (2015) developed an instrument named "Active Learning in Health Professions Scale" (ALPHS) to measure students' perceptions of the frequency with which they experience active learning pedagogy. Kammer et al. (2015) identified two factors in the instrument that predicted students' engagement in learning, which in turn predicted critical thinking. Although not specifically geared toward PBL, we believe that the instrument can nonetheless provide a window to examine PBL tutors' facilitation strategies. Measuring tutors' use of active learning strategies can inform us how to design effective interventions that will help to engage students and foster their critical thinking in PBL.

### **Supporting PBL with Emerging Technologies**

With the development of technology, PBL has evolved from working on paper-based problems in a face-to-face setting to integrating a rich variety of emerging technologies to augment problem presentation, analysis and solution, small group collaboration, tutor facilitation, and assessment of learning (Jin & Bridges, 2014). In their review of emerging technologies

used in PBL curricula in health sciences education, Jin and Bridges (2014) found a number of positive outcomes afforded by technology-rich PBL environments, including providing rich, authentic problems and/or case contexts for learning; supporting student development of medical expertise through the accessing and structuring of expert knowledge and skills; making disciplinary thinking and strategies explicit; providing a platform to elicit articulation, collaboration and reflection; and reducing perceived cognitive load.

PBL researchers and educators have explored the possibility of conducting PBL online (Rounds & Rappaport, 2008; Savin-Baden & Wilkie, 2006; Valaitis, Sword, Jones, & Hodges, 2005). In this issue, Abercrombie et al. examine the use of an innovative online platform, *Calibrated Peer Review*, to provide instructor scaffolding and feedback, and support peer and self-assessment in an online environment. Other researchers have been exploring the use of mobile devices in PBL environments as mobile learning has become an emerging trend in education. Just like any emerging technology, mobile learning brings issues and challenges along with opportunities (Hamm, Saltman, Jones, Baldrige, & Perkins, 2013). Two studies in this special issue (Chan et al., 2015; Jin et al., 2015) integrate mobile devices to support PBL activities. While mobile devices provide instant access to online information, both studies observe that if not implemented properly, mobile devices may promote superficial processing of information without in-depth learning. Moreover, Jin et al. (2015) found that students lacked the ability to map the information they found from online searches to particular problem scenarios, which points to additional scaffolding needs in technology-supported PBL. By sharing these studies, the authors of these two articles offer guidelines for effective use of mobile devices in PBL. The studies communicate the need to examine issues related to the use of technology in PBL, such as how technologies are used to scaffold learners' PBL experience, what process they support, and how technologies can be used effectively to transform students and instructors in a PBL environment (Hamm et al., 2013).

## Discussion

In summary, this special issue reflects a general interest in identifying factors that influence successful PBL implementation and experience, exploring ways to improve PBL strategies, addressing the needs of facilitator training, and examining how emerging technologies can be used effectively to enhance learners' PBL experience. The investigations on factors influencing PBL focus on both students and facilitators. The factors associated with the students include student perceptions, experiences, epistemic beliefs, motivation, and skills; the factors associated with the facilitators include their

beliefs, skills, and experiences in conducting PBL. Some of the articles discuss ways to improve students' learning experience and tutors' facilitation experience through designing effective strategies or applying tools to enhance PBL experience. This collection of articles also shows the evolution of PBL research from *if* PBL works to *how* it would work more effectively.

Regarding methodology, we are pleased to note that the researchers have used a variety of research methods to investigate PBL. However, most of the studies have only addressed students' or facilitator's perceptions and experiences. There remains a lack of research that directly assesses students' learning outcomes and progress. Other researchers (e.g., Bolland, French, & Ertmer, 2009; Harling, Spooner, Tjosvold, & Oswald, 2010) have shared similar concerns about the quality of measures.

Looking forward, we need more research that looks deeper into the *self-process*, *group process*, and *facilitation process* of PBL. The self-process includes students' and facilitators' epistemic beliefs, motivation, goal orientations, perceived values, and self-regulation. The group process includes inter-professional communication, team collaboration, and co-regulation. The facilitation process involves facilitation strategies (e.g., what to facilitate and how to facilitate), tools, and resources needed to mediate or support PBL.

Regarding self-process, it is necessary to expand beyond traditional learning outcomes to incorporate outcomes that are situated in a broader professional and social context. Interprofessional education, for example, entails four domains of essential behaviors and skills: (a) values and ethics, (b) roles and responsibilities, (c) interprofessional communication, and (d) teams and teamwork (Interprofessional Education Collaborative Expert Panel, 2011). More research should examine PBL's role in facilitating the various processes and outcomes. Further, we would like to see more research using a variety of research methods and measurement techniques that are not limited to self-reports. Moreover, PBL research in health professions education should also look into antecedents of PBL, such as learners' beliefs, goals, and values, and examine how these variables interact or mediate the effects of PBL.

Regarding group process, it will be interesting to examine the relationship between individuals' knowledge construction and knowledge co-construction, and between self-regulation and co-regulation among group members during the social interaction process in PBL (Lu, Lajoie, & Wiseman, 2010; Volet, Summers, & Thurman, 2009). In addition, we need more research about providing effective scaffolding strategies, including scaffolding group processes, facilitating information searching for problem representation, and developing collaborative problem-solving skills. In terms

of facilitation process, there is a strong need to investigate the influence of facilitators' skills in facilitating PBL. Additionally, we need to conduct more research on the effects of sophisticated technologies on students' PBL experience and supporting their skill development to meet the challenges of the twenty-first century skills in health professions, particularly examining the functions and effects of various kinds of scaffolding afforded by various technologies. Above all, it is critically important to focus on the goal of PBL and understand what to scaffold, what to facilitate, and what to support as we consider the questions on how to scaffold, how to facilitate, and how to support. Hmelo-Silver's (2013) conceptual framework on a problem space and a larger learning space sheds some light as we ponder on these issues for future PBL research.

## Conclusion

We would like to thank all the contributors from various areas of health professions education and from different parts of the world for their active response to the call and their original scholarly work. Their research has expanded our knowledge on how PBL is implemented, adapted, and researched in their specific contexts. It is definitely an important contribution to the PBL research. We appreciate the generous help and expertise from all the reviewers. We would also like to thank both editors of IJPBL, Dr. Michael Grant and Dr. Krista Glazewski, as well as the IJPBL editorial assistant, Jiyeon Jung, for their valuable support and continuous assistance in the publication of this issue. Last but not least, we appreciate the opportunity to be the guest editors of this special issue. We have learned tremendously from this editorial and publication process, which has been truly an inter-professional collaboration experience for ourselves.

## References

- Abercrombie, S., Parkes, J., & McCarty, T. (2015). Motivational influences of using peer evaluation in problem-based learning in medical education. *Interdisciplinary Journal of Problem-Based Learning*, 9(1), 33–43.
- Ames, C. (1992). Classrooms: Goals, structures, and student motivation. *Journal of Educational Psychology*, 84(3), 261–271. <http://dx.doi.org/10.1037/0022-0663.84.3.261>
- Bandura, A. (1997). *Self-efficacy: The exercise of control*. New York, NY: W. H. Freeman and Company.
- Barrows, H. S. (1988). *The tutorial process*. Springfield, IL: Southern Illinois University School of Medicine.
- Barrows, H. S., & Tamblyn, R. M. (1980). *Problem-based learning: An approach to medical education*. New York, NY: Springer.
- Belland, B., French, B., & Ertmer, P. (2009). Validity and problem-based learning research: A review of instruments used to assess intended learning outcomes. *Interdisciplinary Journal of Problem-Based Learning*, 3(1), 59–89. <http://dx.doi.org/10.7771/1541-5015.1059>
- Bereiter, C., & Scardamalia, M. (2000). Process and product in problem-based learning (PBL) research. In D. H. Evensen & C. E. Hmelo (Eds.), *Problem-based learning: A research perspective on learning interactions* (pp. 185–195). Mahwah, NJ: Lawrence Erlbaum Associates.
- Bransford, J. D., Brown, A. L., & Cocking, R. R. (2000). *How people learn: Brain, mind, experience, and school*. Washington, DC: The National Academies Press.
- Chan, L. K., Bridges, S. M., Doherty, I., Ng, M., Jin, J., Sharma, N., & Lai, H. Y. Y. (2015). A qualitative study on how health professional students and their PBL facilitators perceive the use of mobile devices during PBL. *Interdisciplinary Journal of Problem-Based Learning*, 9(1), 83–95.
- de Grave, W. S., Dolmans, D. H., & van der Vleuten, C. P. (2002). Student perspectives on critical incidents in the tutorial group. *Advances in Health Sciences Education*, 7(3), 201–209. <http://dx.doi.org/10.1023/A:1021104201303>
- Doubleday, A. F., Koerber, A., Strotman, M. D., Haley, C. M., Jurgens-Toepke, P., Knight, G. W., & Brown, B. P. (2015). Social constructivism and case-writing for an integrated curriculum. *Interdisciplinary Journal of Problem-based Learning*, 9(1), 44–57.
- Eccles, J., & Wigfield, A. (2002). Motivational beliefs, values, and goals. *Annual Review of Psychology*, 53, 109–132. <http://dx.doi.org/10.1146/annurev.psych.53.100901.135153>
- Elliott, E. S., & Dweck, C. S. (1988). Goals: An approach to motivation and achievement. *Journal of Personality and Social Psychology*, 54(1), 5–12.
- Feltovich, P. J., Spiro, R. J., Coulson, R. L., & Feltovich, J. (1996). Collaboration within and among minds: Mastering complexity, individuality and in groups. In T. Koschmann (Ed.), *CSCL: Theory and practice of an emerging paradigm* (pp. 25–44). Mahwah, NJ: Lawrence Erlbaum Associates.
- Greiner, A. C., & Knebel, E. (2003). *Health professions education: A bridge to quality*. Washington, DC: The National Academies Press.
- Hamm, S., Saltman, G., Jones, B., Baldrige, S., & Perkins, S. (2013). A mobile pedagogy approach for transforming learners and faculty. In Z. L. Berge & L. Muilenburg (Eds.), *Handbook of mobile learning* (pp. 176–182). New York, NY: Routledge.
- Hartling, L., Spooner, C., Tjosvold, L., & Oswald, A. (2010). Problem-based learning in pre-clinical medical education: 22 years of outcome research. *Medical Teacher*, 32(1), 28–35. <http://dx.doi.org/10.3109/01421590903200789>

- Hmelo-Silver, C. E. (2004). Problem-based learning: What and how do students learn? *Educational Psychology Review*, 16(3), 235–266. <http://dx.doi.org/10.1023/B:EDPR.0000034022.16470.f3>
- Hmelo-Silver, C. E. (2013). Creating a learning space in problem-based learning. *Interdisciplinary Journal of Problem-Based Learning*, 7(1), 24–39. <http://dx.doi.org/10.7771/1541-5015.1334>
- Hmelo-Silver, C. E., & Barrows, H. S. (2006). Goals and strategies of a problem-based learning facilitator. *Interdisciplinary Journal of Problem-Based Learning*, 1(1), 21–39. <http://dx.doi.org/10.7771/1541-5015.1004>
- Hofer, B., & Pintrich, P. (1997). The development of epistemological theories: Beliefs about knowledge and knowing and their relation to learning. *Review of Educational Research*, 67(1), 88–140. <http://dx.doi.org/10.3102/00346543067001088>
- Institute of Medicine. (2011). *Health IT and patient safety: Building safer systems for better care*. Washington, DC: National Academies Press.
- Interprofessional Education Collaborative Expert Panel. (2011). *Core competencies for interprofessional collaborative practice: Report of an expert panel*. Washington, DC: Interprofessional Education Collaborative.
- Jin, J., & Bridges, S. M. (2014). Educational technologies in problem-based learning in health sciences education: A systematic review. *Journal of Medical Internet Research*, 16(12), e251. <http://dx.doi.org/10.2196/jmir.3240>
- Jin, J., Bridges, S. M., Botelho, M. G., & Chan, L. K. (2015). Online searching in PBL tutorials. *Interdisciplinary Journal of Problem-Based Learning*, 9(1), 96–108.
- Jonassen, D. H. (1997). Instructional design models for well-structured and ill-structured problem-solving learning outcomes. *Educational Technology Research & Development*, 45(1), 65–94. <http://dx.doi.org/10.1007/BF02299613>
- Kammer, R., Schreiner, L.A., Kim, Y. K., & Denial, A. (2015). The validation of the Active Learning in Health Professions Scale. *Interdisciplinary Journal of Problem-Based Learning*, 9(1), 58–72.
- Koh, G. C., Khoo, H. E., Wong, M. L., & Koh, D. (2008). The effects of problem-based learning during medical school on physician competency: A systematic review. *Canadian Medical Association Journal*, 178(1), 34–41. <http://dx.doi.org/10.1503/cmaj.070565>
- Kumar, M., & Natarajan, U. (2007). A problem-based learning model: Showcasing educational paradigm shift. *Curriculum Journal*, 18(1), 89–102. <http://dx.doi.org/10.1080/09585170701292216>
- L'Ecuyer, K., Pole, D., & Leander, S. (2015). The use of PBL in an interprofessional education course for health-care professional students. *Interdisciplinary Journal of Problem-Based Learning*, 9(1), 9–18.
- Lu, J., Lajoie, S., & Wiseman, J. (2010). Scaffolding problem-based learning with CSCL tools. *International Journal of Computer-Supported Collaborative Learning*, 5(3), 283–298. <http://dx.doi.org/10.1007/s11412-010-9092-6>
- Neville, A. J. (2009). Problem-based learning and medical education forty years on: A review of its effects on knowledge and clinical performance. *Medical Principles and Practice*, 18(1), 1–9. <http://dx.doi.org/10.1159/000163038>
- Profetto-McGrath, J. (2005). Critical thinking and evidence-based practice. *Journal of Professional Nursing*, 21(6), 364–371. <http://dx.doi.org/10.1016/j.profnurs.2005.10.002>
- Ravitz, J. (2009). Introduction: Summarizing findings and looking ahead to a new generation of PBL research. *Interdisciplinary Journal of Problem-Based Learning*, 3(1), 4–11. <http://dx.doi.org/10.7771/1541-5015.1088>
- Rounds, L. A., & Rappaport, B. A. (2008). The successful use of problem-based learning in an online nurse practitioner course. *Nursing Education Perspectives*, 29(1), 12–16. [http://dx.doi.org/10.1043/1536-5026\(2008\)029\[0012:TSUOPL\]2.0.CO;2](http://dx.doi.org/10.1043/1536-5026(2008)029[0012:TSUOPL]2.0.CO;2)
- Salinitri, F. D., Wilhelm, S. M., & Crabtree, B. (2015). Facilitating facilitators: Enhancing PBL through a structured facilitator development program. *Interdisciplinary Journal of Problem-Based Learning*, 9(1), 73–82.
- Sansone, C., & Harackiewicz, J. M. (2000). *Intrinsic and extrinsic motivation: The search for optimal motivation and performance*. New York, NY: Academic Press.
- Savery, J. R. (2006). Overview of problem-based learning: Definitions and distinctions. *Interdisciplinary Journal of Problem-Based Learning*, 1(1). <http://dx.doi.org/10.7771/1541-5015.1002>
- Savin-Baden, M., & Wilkie, K. (2006). *Problem-based learning online*. New York, NY: Open University Press.
- Schauber, S. K., Hecht, M., Nouns, Z. M., & Kuhlmeier, A. K., & Dettmer, S. (2015). The role of environmental and individual characteristics in the development of student achievement: A comparison between a traditional and a problem-based-learning curriculum. *Advances in Health Sciences Education*. <http://dx.doi.org/10.1007/s10459-015-9584-2>
- Schmidt, H. G. (1989). The rationale behind problem-based learning. In H. G. Schmidt, M. Lipkin, M.W. de Vries, & J. M. Greep. (Eds.), *New directions for medical education* (pp. 105–111). New York, NY: Springer.
- Schmidt, H. G., Rotgans, J. I., & Yew, E. H. J. (2011). The process of problem-based learning: What works and why. *Medical Education*, 45(8), 792–806. <http://dx.doi.org/10.1111/j.1365-2923.2011.04035.x>
- Schommer, M. (1990). Effects of beliefs about the nature of knowledge on comprehension. *Journal of Educational Psychology*, 82(3), 498–504.

- Skinner, V., Braunack-Mayer, A., Winning, T. (2015). The purpose and value for students of PBL groups for learning. *Interdisciplinary Journal of Problem-Based Learning*, 9(1), 19–32.
- Thompson, C. (2010). Do interprofessional education and problem-based learning work together? *The Clinical Teacher*, 7(3), 197–201. <http://dx.doi.org/10.1111/j.1743-498X.2010.00381.x>
- Valaitis, R. K., Sword, W. A., Jones, B., & Hodges, A. (2005). Problem-based learning online: Perceptions of health science students. *Advances in Health Sciences Education*, 10(3), 231–252. <http://dx.doi.org/10.1007/s10459-005-6705-3>
- Visschers-Pleijers, A. J., Dolmans, D. H., de Leng, B. A., Wolfhagen, I. H., & van der Vleuten, C. P. (2006). Analysis of verbal interactions in tutorial groups: A process study. *Medical Education*, 40(2), 129–137. <http://dx.doi.org/10.1111/j.1365-2929.2005.02368.x>
- Volet, S., Summers, M., & Thurman, J. (2009). High-level co-regulation in collaborative learning: How does it emerge and how is it sustained? *Learning and Instruction*, 19(2), 128–143. <http://dx.doi.org/10.1016/j.learninstruc.2008.03.001>
- World Health Organization. (2010). *A framework for action on interprofessional education and collaborative practice*. Geneva, Switzerland: World Health Organization.

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