

Identifying Interdisciplinary Research Collaboration in Instructional Technology

Yonjoo Cho¹ 

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Abstract Interdisciplinarity is defined as communication and collaboration across academic disciplines. The instructional technology (IT) field has claimed to have an interdisciplinary nature influenced by neighboring fields such as psychology, communication, and management. However, it has been difficult to find outstanding evidence of the field's interdisciplinary research efforts, except with psychology. IT and neighboring fields including human performance technology, instructional design, learning sciences, human resource development, and human resource management share common goals of learning and performance in diverse contexts. These fields are converging in terms of underscoring the importance of people in improving organizational performance through learning, development, and innovations. In this context, the purpose of this study was to identify interdisciplinary research collaboration efforts in the field through a review of literature on the topic. Based on the review of the literature, I provided implications for research and practice.

Keywords Instructional technology · Human performance technology · Interdisciplinary research collaboration

Interdisciplinarity is defined as “communication and collaboration across academic disciplines” (Jacobs and Frickel 2009, p. 44). As social phenomena become more complex and multi-dimensional, conducting interdisciplinary research is getting more attention (Dubinsky et al. 2013; Kurland et al.

2010). For example, Dubinsky et al. (2013) presented a case study of how the core concepts of neuroscience can be brought to bear on in-service teachers' development in the field of education. Kurland et al. (2010) introduced an interdisciplinary approach to developing a university's sustainability course in collaboration with family and consumer sciences, geography, management, political science, psychology, recreation and tourism, and urban studies.

Elinor Ostrom, the first female Nobel Laureate in Economic Sciences in 2009, stated the criticality of interdisciplinary research in the social sciences: “Narrow disciplinary boundaries limit our science's progress” (Ostrom 2009). Her seminal study on deforestation (Ostrom and Nagendra 2006) conducted long-term interdisciplinary research in which they analyzed the institutional factors affecting deforestation using multiple research methods including satellite image data, social-ecological measurements on the ground, and experimental laboratories. Her study is critical in terms of: (a) conducting research on deforestation on a global scale; (b) using a large-scale mixed-methods research design; and (c) delivering complex and nuanced study findings.

Problem Statement

Although the instructional technology (IT) field has claimed to have an interdisciplinary nature influenced by fields such as psychology, communication, and management (Ely 2008), it has been difficult to find outstanding evidence of the field's interdisciplinary efforts, except with psychology (Weinstein and Shuck 2011). To identify evidence of interdisciplinary research collaboration in IT, my research group and I did a quick search for the articles whose titles and abstracts, which have been published between 1989 and 2015 in *Educational Technology Research and Development (ETR&D)* and the

✉ Yonjoo Cho
choyonj@indiana.edu

¹ Indiana University, Bloomington, IN, USA

British Journal of Educational Technology (BJET), the two premier academic journals in the field, indicated an interdisciplinary nature. This search resulted in only a small number of articles: 12 articles in *ETR&D* (e.g., Gall et al. 2010; Kirby et al. 2005; Schwen et al. 1998) and 20 articles in *BJET* (e.g., Cho et al. 2013; Ely 2008; Kalz and Specht 2014). This result indicates that the IT field has had little interest in interdisciplinary research.

IT and neighboring fields including human performance technology (HPT), instructional design (ID), learning sciences (LS), human resource development (HRD), and human resource management (HRM), however, share common goals of learning and performance in diverse contexts and are converging on the importance of people in improving organizational performance through learning, development, and innovations (Cho and Yoon 2010; Ruona and Gibson 2004).

In this context, the purpose of this study was to identify interdisciplinary research collaboration efforts in the field of IT through a review of the literature on the topic. To this end, I will first discuss Stokes' (1997) concept of *Pasteur's Quadrant* which is important to understand why the field needs interdisciplinary research collaboration. The concept of *Pasteur's Quadrant* is defined as an integration of "considerations of use" (practice) and a "quest for foundational understanding" (theory) (Stokes 1997, p. 73) required in applied fields such as IT. I will then review the literature on interdisciplinary research efforts in IT and neighboring fields including HPT (Cho et al. 2011), instructional design (ID) (Cho et al. 2013), LS (Kirby et al. 2005), HRD (Cho and Park 2012b), and HRM (Cho and Yoon 2010). Based on the review of the literature on interdisciplinary research, I provided implications for research and practice.

Conceptual Framework: *Pasteur's Quadrant*

Interdisciplinarity is expected to integrate knowledge and solve problems that individual disciplines cannot solve alone (Jacobs and Frickel 2009). Stokes' (1997) concept of *Pasteur's Quadrant* is a useful conceptual framework for the balancing act of research and practice in applied fields including computer science (Arnold 2008), management (Tushman and O'Reilly 2007), and HPT (Cho and Yoon 2010) (see Table 1).

The goal of basic research is the discovery of knowledge and the production of new knowledge as in physics, whereas applied research purports the discovery of new relationships in the knowledge within the domain to which the research is applied (Torraco 2004). Table 1 shows that an ideal type of research in applied fields is the combination of foundational knowledge and research motivated by potential uses as Louis Pasteur, a French chemist and microbiologist, did in his significant discoveries in vaccination, microbial fermentation, and pasteurization. Instead of concentrating on pure theory

testing and development, use-based research intertwining theory (research) and use (practice) is indispensable to address complex performance problems in organizations (Cho and Yoon 2010; Tushman and O'Reilly 2007).

The importance of use-based research in applied fields incorporating theory and practice also resonates in IT and HPT which are regarded as practice-oriented (Cho et al. 2011; Cho et al. 2013) and in neighboring fields such as HRD and HRM which are considered theory-oriented (Cho and Yoon 2010; Jo et al. 2009) in relative terms, which calls for interdisciplinary research collaboration.

Interdisciplinary Research Collaboration Efforts

The IT field is one of many fields focusing on issues of learning, development, and performance, and shares common goals with neighboring fields including HPT, ID, LS, HRD, and HRM. This has led me to review the literature on the IT field's research collaboration with its neighboring fields to identify its interdisciplinary research collaboration efforts. There are other neighboring fields including workplace learning (Ghosh 2014), adult education (Jacobs 2014), and vocational education (Hill et al. 2013) that are also important to discuss but those fields need more evidence to examine their relationships with IT. In this section, therefore, I focus on four interdisciplinary research collaboration efforts in neighboring fields (ID, LS, HPT, HRD, and HRM) in relation to IT.

ID and LS

Kirby et al. (2005) provided a citation analysis of publications (journals and proceedings articles) in the fields of instructional systems design (ISD)¹ and LS to examine to what degree the two fields are integrated. ISD was defined as "the design of materials for learning" (p. 37) and LS "the scientific understandings of learning" (p. 38). Kirby et al. (2005) revealed that the two fields are generally isolated from each other. Despite the two fields' shared interest in IT, the two fields are "largely distinct" (p. 45); however, the study also implied that "the trend was toward greater cross-field citation" (p. 45).

The fields of ISD and LS might have converged more since this study was first conducted 10 years ago. Design-based research (e.g., McKenney and Reeves 2013), for instance, has become much more present and highly regarded as a new research approach in the two fields. As anecdotal evidence shows increased cross-field publications in the two fields, conducting a replication study is the next step to examine to what degree the two fields have evolved in terms of interdisciplinary research collaboration.

¹ The term ISD was used interchangeably with ID in the current study.

Table 1 Pasteur's quadrant as conceptual framework

		Considerations of use	
		No	Yes
Quest for foundational understanding	Yes	Basic Disciplinary Research	Use-Inspired Research (e.g., Applied Fields)
	No		Pure Applied Research (e.g., Consulting Firms)

Adapted from Stokes 1997, *Pasteur's quadrant: Basic science and technological innovation*, p. 73

ID, IT, and HPT

The relationship between ID, IT, and HPT surfaced from two citation network analyses of IT (Cho et al. 2013) and HPT (Cho et al. 2011). Cho et al. (2011) found from a citation network analysis of articles published between 1988 and 2010 in *Performance Improvement Quarterly*, the representative academic journal in HPT, that the field was firmly grounded in instructional design and technology. Cho et al. (2013) also found from a citation network analysis of articles published between 1989 and 2011 in *ETR&D*, a top academic journal in IT, that ID emerged as an important research theme in the field. Considering that ID was among the key themes both in IT and HPT, it is evident that the two fields are closely related.

When it comes to the relationship between IT and HPT, many HPT practitioners are believed to begin their career as instructional designers but they tend to distinguish themselves from the IT field as being equipped with a broader systems view and emphasize the importance of non-instructional interventions in the process of performance improvement (Cho and Yoon 2010; Rummler 2007). In line with ID research, the IT and HPT fields have different emphases. IT has produced studies on conceptual frameworks, ID models, and designing learning environments, whereas HPT studies emphasized instructional designers' practices from the lens of experts and novices, which is more practice-oriented than IT (Cho and Park 2012a). This is presumably due to each field's relative emphasis, on theory in IT, and practice in HPT.

IT, HPT, and HRD

Recently diverse literature review methods have been used to landscape the state of the IT and HPT fields including: a content analysis of the HPT field (Cho and Park 2012a), citation analysis of the IT field (Gall et al. 2010), and citation network analysis of IT (Cho et al. 2013) and HPT (Cho et al. 2011). Citation network analysis, one of the most recent review methods, borrows a social network analysis approach from sociology to examining relational and network attributes in the citation data that other methods have not paid attention to. As citation network analyses in IT (Cho et al. 2013), HPT (Cho et al. 2011), and HRD (Jo et al. 2009) are available,

it has become possible to compare and contrast key research themes of these neighboring fields (see Table 2).

Table 2 indicates that key themes of IT (e.g., ID, learning environments, the role of technology) identified in Cho et al. (2013) were not totally independent but overlapped in many respects with those of HPT (e.g., performance, ID, performance support) (Cho et al. 2011) and HRD (e.g., learning and performance, training transfer) (Jo et al. 2009). Although ID did not surface as a key research theme of the HRD field in Jo et al. (2009), ID has been recognized as an important intervention for the practice of HRD, and has also played a critical role in the instructional nature of the field (Hardré 2003).

In addition, Cho and Zachmeier (2015) found from their interviews with 40 HRD educators who teach HRD courses in higher education institutions in North America, Europe, and Asia that ID has consistently been a foundation course in HRD education. In the field of HRM, using the ID model, Aguinis and Kraiger (2009) reviewed the literature on training and development. Van Rooij (2012) also examined the current state of research on the use of systematic ID procedures to develop work-related training.

HPT, HRD, and HRM

As the then leader of ASTD's (currently, ATD) Task Force on Competencies and Standards, McLagan (1989) showed a close relationship between HRD and HRM in her seminal HR Wheel. While HRD was defined as the integrated use of training and development, career development, and organization development to improve individual, group, and organizational effectiveness, HRM was defined as handling labor relations, employee assistance, compensation/benefits, and HR information systems (McLagan 1989; Werner 2015).

To McLagan's (1989) classical view of HRD and HRM, Ruona and Gibson (2004) added HPT as a growing, innovative field whose presence has been stronger since the 1990s, as HR fields have progressed from operationally reactive to strategic and proactive roles to eventually create learning organizations (see Table 3).

Table 3 shows the relationship between HPT and HRD. The changing role of HRD is similar to HPT. Similar to the shift of HR functions from reactive operations to proactive

Table 2 Comparison of key research themes of IT, HPT, and HRD

Key research theme	Academic field		
	IT	HPT	HRD
	<ul style="list-style-type: none"> • Instructional Design • Learning Environments • The Role of Technology • IT Research • Psychological Foundations 	<ul style="list-style-type: none"> • Performance • Instructional Design • Performance Support • Organization/Workplace • Transfer of Training 	<ul style="list-style-type: none"> • Learning and Performance • Theory Building • Training Transfer

Adapted from “Using citation network analysis in educational technology,” by Y. Cho and S. Park, 2012b, *Educational Technology*, 52(3), p. 40

strategies over the past 20 years (Ruona and Gibson 2004), the focus of HPT has evolved from individuals’ behavioral improvement to performance improvement at the group and the organizational level (Rummler 2007). HPT has gained recognition for the solid application of behaviorism, especially systematic processes of instructional design (Hardré 2003) and varied HPT models (Wilmoth et al. 2010).

Discussion

In this study, it became clear that IT and neighboring fields (HPT, ID, LS, HRD, and HRM) have close relationships and are converging in terms of: (a) focusing on learning and development at individual, group, and organizational levels, (b) improving organizational performance through people, (c) moving into implementing interdisciplinary perspectives, (d) attempting to bridge the gap between theory and practice in view of *Pasteur’s Quadrant*, and (e) using technology for learning and performance in organizations (Cho and Yoon

2010; Ruona and Gibson 2004). Based on the study findings, I provide implications for research and practice.

Implications for Research

I present three outstanding research topics as possible interdisciplinary research collaboration in the field. First, citation network analysis is an excellent research method for providing qualitative details in the overview of the field, given the fact that citation network analyses of IT (Cho et al. 2013), HPT (Cho et al. 2011), and HRD (Jo et al. 2009) have already expanded the limited landscape of the fields. A distinctive feature of citation network analysis is a theoretical framework borrowed from social network analysis, which is a methodology for examining structures among actors, groups, and organizations, with some patterns of interaction or ties between them (Hatala 2006). Identifying whose scholarly works are the most influential, and what relationships are the most impactful in the fields, rather than focusing on rankings of individual authors and schools (Gall et al. 2010), would be

Table 3 The relationship between HPT and HRD

	Operationally reactive	Operationally proactive	Strategically reactive	Strategically proactive
HRD	<ul style="list-style-type: none"> • Job and task analysis • ISD • Job-focused training • Instructor-driven delivery 	<ul style="list-style-type: none"> • Needs assessment • Individual performance improvement with a focus on factors of training • Alternative methods for training delivery (e.g., computer-based) • Evaluation 	<ul style="list-style-type: none"> • Systemic models and methods for whole system performance improvement and performance consulting • Multiskilling • Cross-training • Constructivist learning approaches • Performance support systems 	<ul style="list-style-type: none"> • Ensuring knowledgeable, agile, reflective workforce and workplace • Organizational learning and learning organization • Self-directed learning and development (coaching, informal learning, etc.) • Knowledge management

Adapted from “The making of twenty-first-century HR: An analysis of the convergence of HRM, HRD, and OD,” by W. E. A. Ruona and S. K. Gibson, 2004, *Human Resource Management*, 43, p. 52

possible through the use of citation network analysis. As convergence in research topics and interests between IT and neighboring fields calls for research collaboration, there is a strong need to investigate a cross-discipline citation study between them in the near future.

Second, online teaching and learning surfaced as a strong candidate for interdisciplinary research collaboration in the field. In a review of IT research in ten major academic journals over the past decade, West and Borup (2014) found that distance education-related topics emerged as the most common key words. In the management field, Arbaugh et al. (2013), in a review of the literature on online management instruction, found that attention to “online instruction and instructors” has been lacking as compared to research on “student characteristics and perceptions” that IT research has generated in the past years. Borrowed from education, Arbaugh and Benbunan-Fich (2006) developed and tested a conceptual framework of teaching approaches based upon epistemological (objectivist versus constructivist) and social (use of individual versus group activities) dimensions in online teaching. The study findings indicated that students learn better where objectivist teaching approaches were supported by the use of collaborative learning techniques. Arbaugh and his colleagues’ research on online management instruction is unique in borrowing education theories and presenting balanced study findings (in terms of not being overly positive as in the IT field) on the effectiveness of online teaching and learning in the management field. As the use of technology in organizations is becoming the norm, how to integrate technology in training and development, as well as in schools, requires us to look at other fields’ efforts at technology integration.

Third, the concept of person-organization (P-O) fit borrowed from industrial and organizational (I-O) psychology has recently been applied to K-12 education (Youngs et al. 2015). P-O fit is defined as “employees’ sense of fit with their organizations” (Youngs et al., p. 37). This study opens a possibility to conduct research on teacher communication and retention in relation to key outcomes of P-O fit research in I-O psychology. Given that too little attention is being paid to the pedagogical, organizational, cultural and other factors that determine what fails, what works, and what transfers successfully into other contexts (Latchem 2014), this study suggests that research on individual teachers’ instruction and technology integration in schools need to examine organizational contexts of their schools compared to the current focus on teachers. With the help of interdisciplinary research collaboration, the IT field can provide more rigorous and relevant approaches to solving challenging issues in schools where the field has been slow in their implementation.

Implications for Practice

In this study, I presented results of citation network analyses of IT (Cho et al. 2013) and HPT (Cho et al. 2011) and research on HRD education (Cho and Zachmeier 2015) pointing out that ID is a common denominator in the IT, HPT, and HRD fields. This indicates that there are possibilities to conduct research collaboration in these fields focusing on ID’s role, state, and impact on IT and its neighboring fields. Mirroring neighboring fields through research collaboration will help the IT field learn how other fields have evolved, converged, and diverged over time, and how and where IT fits or complements those neighboring fields. As the IT field is geared toward integrating as many factors as possible to be effective in improving performance and promoting learning in organizations using technology, borrowing concepts, tools, and ideas from neighboring fields is a necessary next step.

Recently, ID and instructional designers have gained attention from those wanting to transform higher education such as the Bill & Melinda Gates Foundation (Intentional Futures 2016). In a trends report of higher education (Berrett 2016), the rise of ID and instructional designers was listed among the 10 key shifts in higher education where online learning and new classroom technologies spread. Particularly, “research” was one of the most important skills and areas of expertise that instructional designers should have (Intentional Futures 2016), which means future instructional designers are required to be equipped with knowledge about interdisciplinary research including LS and neuroscience to make an impact in organizations. In another report on online education (MIT Online Education Policy Initiative 2016), increasing interdisciplinary collaboration between education and other fields was recommended as the number one strategy to reform higher education. As these reports pay particular attention to the importance of ID and instructional designers, identifying interdisciplinary research will be extremely useful for instructional designers’ new competencies and qualifications.

In addition, the review of the literature on interdisciplinary research collaboration and related studies could be used as a “reading list” for beginning instructional designers and scholars to help them get a grasp of important studies on the topic. Either in the context of master’s and doctoral programs, or in on-the-job training, beginning designers and researchers could read and reflect on the topic through the identified influential studies.

Conclusion

There is a pressing need in higher education for deeper integration of research across the fields that impact learning (MIT Online Education Policy Initiative 2016). The IT field, however, has a long tradition of emphasizing technology-related

topics and research on the role of technology. As a result, “the field as a whole is still very technology-centric” (West and Borup 2014, p. 553) and there is a “perceived lack of impact of educational technology” (Hooper, 2008, p. 235) both in K-12 schools and in organizations. Latchem (2014), in his review of the field, shared the same sentiment:

The last 40 years have seen an ever-repeating cycle of hype and hope, adoption of much-heralded new tools or methods, lack of evidence of positive educational outcomes and subsequent transfer of enthusiasm to the next development (p. 5).

In this context, interdisciplinary research collaboration between IT and neighboring fields is mutually beneficial in generating not only rigorous and relevant research but “imaginative and innovative research” (Alvesson and Sandberg 2013, p. 128) whose major goal is to solve real and complex problems at work, whether it is an organization or a school. Of course, it is arguably not easy to overcome silos coming from incompatible styles of thought, research traditions, techniques, and language across disciplinary domains (Jacobs and Frickel 2009; Kurland et al. 2010; Strober 2011). However, as the unit of analysis in IT research becomes larger, more complex, and globalized, due to contextual differences, there is an urgent call to investigate learning, development, and innovations in diverse organizational settings through theoretical diversity (Haynes and Cho 2013), multiple perspectives, and mixed-methods research designs.

Compliance with Ethical Standards

Ethical Approval This article does not contain any studies with human participants performed by the author.

Conflict of Interest Yonjoo Cho declares that she has no conflict of interest.

References

- Aguinis, H., & Kraiger, K. (2009). Benefits of training and development for individuals and teams, organizations, and society. *Annual Review of Psychology*, 60, 451–474.
- Alvesson, M., & Sandberg, J. (2013). Has management studies lost its way? Ideas for more imaginative and innovative research. *Journal of Management Studies*, 50, 128–152.
- Arbaugh, J. B., & Benbunan-Fich, R. (2006). An investigation of epistemological and social dimensions of teaching in online learning environments. *Academy of Management Learning & Education*, 5(4), 435–447.
- Arbaugh, J. B., Dearmond, S., & Rau, B. L. (2013). New uses for existing tools? A call to study on-line management instruction and instructors. *Academy of Management Learning & Education*, 12(4), 635–655.

- Arnold, D. (2008). Pasteur’s quadrant: cultural heritage as inspiration for basic research in computer science. *ACM Journal on Computing and Cultural Heritage*, 1(1), 1–13.
- Berrett, D. (2016). Instructional design: Demand grows for a new breed of academic. *The Chronicle of Higher Education*. Retrieved from <http://chronicle.com/article/Instructional-Design/235425?cid=cp32>.
- Cho, Y., & Park, S. (2012a). Content analysis of the 20 most influential articles in *Performance Improvement Quarterly*. *Performance Improvement Quarterly*, 25(3), 7–22.
- Cho, Y., & Park, S. (2012b). Using citation network analysis in educational technology. *Educational Technology*, 52(3), 38–42.
- Cho, Y., & Yoon, S. W. (2010). Theory development and convergence of human resource fields: implications for human performance technology. *Performance Improvement Quarterly*, 23(3), 39–56.
- Cho, Y., & Zachmeier, A. (2015). HRD educators’ views on teaching and learning: an international perspective [Special issue]. *Advances in Developing Human Resources*, 17(2), 145–161.
- Cho, Y., Jo, S. J., Park, S., Kang, I., & Chen, Z. (2011). The current state of human performance technology: a citation network analysis of *Performance Improvement Quarterly*, 1988–2010. *Performance Improvement Quarterly*, 24(1), 69–95.
- Cho, Y., Park, S., Jo, S. J., & Suh, S. (2013). The landscape of educational technology viewed from the *ETR&D* journal. *British Journal of Educational Technology*, 44(5), 677–694.
- Dubinsky, J. M., Roehrig, G., & Varma, S. (2013). Infusing neuroscience into teacher professional development. *Educational Researcher*, 42(6), 317–329.
- Ely, D. (2008). Frameworks of educational technology. *British Journal of Educational Technology*, 39(2), 244–250.
- Gall, J. E., Ku, H. Y., Gurney, K., Tseng, H. W., Yeh, H. T., & Chen, Q. (2010). Citations of *ETR&D* and related journals, 1990–2004. *Educational Technology Research and Development*, 58(3), 343–351.
- Ghosh, R. (2014). *Intersections between HRD & workplace learning*. Houston: Presented at the Academy of Human Resource Development Conference.
- Hardré, P. L. (2003). Beyond two decades of motivation: a review of the research and practice in instructional design and human performance technology. *Human Resource Development Review*, 2, 54–81.
- Hatala, J. P. (2006). Social network analysis in human resource development. *Human Resource Development Review*, 5(1), 45–71.
- Haynes, R. K., & Cho, Y. (2013). Improving learning and performance in diverse contexts: The role and importance of theoretical diversity. In M. Orey, S. A. Jones, & R. M. Branch (Eds.), *Educational media and technology yearbook* (Vol. 37, pp. 27–43). New York: Springer.
- Hill, R. B., Kuchinke, K. P., & Zinser, R. (2013). Connecting workforce education and human resource development. *Human Resource Development Review*, 12(1), 3–10.
- Hooper, R. (2008). Educational technology—a long look back. *British Journal of Educational Technology*, 39(2), 234–236.
- Intentional Futures. (2016). *Instructional design in higher education: A report on the role, workflow, and experience of instructional designers* (Report). Retrieved from http://intentionalfutures.com/reports/instructional_design/#.
- Jacobs, R. L. (2014). Perspectives on adult education, human resource development, and the emergence of workforce development. *New Horizons in Adult Education and Human Resource Development*, 26(1), 13–21.
- Jacobs, J., & Frickel, S. (2009). Interdisciplinarity: A critical assessment. *Annual Review of Sociology*, 35, 43–65.
- Jo, S. J., Jeung, C.-W., Yoon, H. J., & Park, S. (2009). Analysis of the citation network among articles in AHRD journals: *HRDQ*, *HRDI*, *ADHR*, and *HRDR*. *Human Resource Development Quarterly*, 20(4), 503–537.
- Kalz, M., & Specht, M. (2014). Assessing the crossdisciplinarity of technology-enhanced learning with science overlay maps and

- diversity measures. *British Journal of Educational Technology*, 45(3), 415–427.
- Kirby, J. A., Hoadley, C. M., & Carr-Chellman, A. A. (2005). Instructional systems design and the learning sciences: a citation analysis. *Educational Technology Research and Development*, 53(1), 37–48.
- Kurland, N. B., Michaud, K. E. H., Best, M., Wohldmann, E., Cox, H., Pontikis, K., et al. (2010). Overcoming silos: the role of an interdisciplinary course in shaping a sustainability network. *Academy of Management Learning & Education*, 9(3), 457–476.
- Latchem, C. (2014). BJET editorial: opening up the educational technology research agenda. *British Journal of Educational Technology*, 45(1), 3–11.
- McKenney, S., & Reeves, T. (2013). Systematic review of design-based research progress: is a little knowledge a dangerous thing? *Educational Researcher*, 42(2), 97–100.
- McLagan, P. A. (1989). Models for HRD practice. *Training and Development Journal*, 43(9), 49–59.
- MIT Online Education Policy Initiative. (2016). *Online education: A catalyst for higher education reforms* (Final Report). Retrieved from https://oeppi.mit.edu/sites/default/files/MIT%20Online%20Education%20Policy%20Initiative%20April%202016_0.pdf.
- Ostrom, E. (2009). *A general framework for analyzing sustainability of social-ecological systems*. Bloomington: Presented at the School of Library Information Science's Networks and Complex Systems Talk, Indiana University.
- Ostrom, E., & Nagendra, H. (2006). Insights on linking forests, trees, and people from the air, on the ground, and in the laboratory. *PNAS*, 103(51), 19224–19231.
- Rummler, G. A. (2007). The past is prologue: an eyewitness account of HPT. *Performance Improvement*, 46(10), 5–9.
- Ruona, W. E. A., & Gibson, S. K. (2004). The making of twenty-first-century HR: an analysis of the convergence of HRM, HRD, and OD. *Human Resource Management*, 43, 49–66.
- Schwen, T. M., Kalman, H. K., Hara, N., & Kisling, E. D. (1998). Potential knowledge management contributions to human performance technology research and practice. *Educational Technology Research and Development*, 46(4), 73–89.
- Stokes, D. E. (1997). *Pasteur's quadrant: Basic science and technological innovation*. Washing, D.C.: Brookings Institution Press.
- Strober, M. H. (2011). *Interdisciplinary conversations: Challenging habits of thought*. Stanford: Stanford University Press.
- Torraco, R. J. (2004). Challenges and choices for theoretical research in human resource development. *Human Resource Development Quarterly*, 15, 171–188.
- Tushman, M., & O'Reilly, C. (2007). Research and relevance: implications of Pasteur's quadrant for doctoral programs and faculty development. *Academy of Management Journal*, 50, 769–774.
- Van Rooij, S. W. (2012). Training older workers: lessons learned, unlearned, and relearned from the field of instructional design. *Human Resource Management*, 51(2), 281–298.
- Weinstein, M. G., & Shuck, B. (2011). Social ecology and worksite training and development: introducing the social in instructional system design. *Human Resource Development Review*, 10(3), 286–303.
- Werner, J. M. (2015). Human resource management and HRD: connecting the dots or ships passing in the night? In R. F. Poell, T. S. Rocco, & G. L. Roth (Eds.), *The Routledge companion to human resource development* (pp. 89–98). London: Routledge.
- West, R. E., & Borup, J. (2014). An analysis of a decade of research in 10 instructional design and technology journals. *British Journal of Educational Technology*, 45(4), 545–556.
- Wilmoth, F. S., Prigmore, C., & Bray, M. (2010). HPT models. In R. Watkins & D. Leigh (Eds.), *Handbook of improving performance in the workplace, vol. 2: selecting and implementing performance interventions* (pp. 5–26). Silver Spring: International Society for Performance Improvement.
- Youngs, P., Pogodzinski, B., Grogan, E., & Perrone, F. (2015). Person-organization fit and research on instruction. *Educational Researcher*, 44(1), 37–45.