SCIENCE MAPPING THE KNOWLEDGE BASE ON SIMULATIONS AND SERIOUS GAMES IN MANAGEMENT EDUCATION, 1960-2018

Philip Hallinger
Mahidol University, University of Johannesburg
hallinger@gmail.com

Ray Wang
Thammasat University, Mahidol University
raywang1@tu.ac.th

Uyen-Phuong Nguyen
Mahidol University
rachel.uyenphuong@gmail.com

ABSTRACT

This review of the research used science mapping to analyze the knowledge base on the use of simulations and serious games in management education from 1960 to 2018. The authors used bibliometric tools to analyze 1,156 Scopus-indexed documents that describe simulation- and game-based learning in management education. This quantitative review of the literature revealed a rapidly growing publication trajectory with 80% of the documents published since 2000 and 55% since 2010. The review empirically affirms the broad, long-term use of simulations and serious games in management education and highlights connections between this literature and related literature in education, psychology and other professions. Citation analyses highlighted the role of the journal, Simulation & Gaming as the single most influential journal in this literature. Empirical analysis of publications led to the identification of Joseph Wolfe, Albert Faria, and Eduardo Salas as 'canonical' authors whose scholarship has shaped discourse in this field of inquiry. While this is a global literature, scholars located in Anglo-American-European societies contributed for 85% of the relevant documents. This finding suggests a need for programmatic research that examines both the design and instructional use of simulations across different cultural contexts. In a global management education context, greater attention needs to be given to the 'portability' of the underlying theories and decision rules that underlie simulations.

INTRODUCTION

The challenge of finding more effective ways of developing the knowledge and skills of prospective and practicing managers is not new. The use of cases, games and simulations in management education has been amply documented over the past 100 years (Cohen & Rhenman, 1961; Faria, 1987, 2001; Gragg, 1951; Walker, Bridges, & Chan, 1996; Wolfe, 1993). Nonetheless, in recent years, there has been there has been a virtual explosion of research on the use of simulations and serious games (SSG-Man Ed) in management education (Asiri, Greasley, & Bocij, 2017; Keys & Wolfe, 1990; Martin, Kolomitro, & Lam, 2014). This has been confirmed in a series of research reviews produced over the past 20 years literature (Crookall, 2010, 2012; Faria, Hutchinson, Wellington, & Gold, 2009; Hallinger & Wang, 2019; Salas, Wildman, & Piccolo, 2009).

The current review of research used science mapping to extend findings from prior reviews of research on the use of SSGs in management education (van Eck & Waltman, 2014; Zupic & Čater, 2015). More specifically, this review sought to document and analyze key trends in knowledge production on SSG-ManEd (Bragge, Thavikulwat, & Töyli, 2010). The following research questions guided this review:

1. What is the size, growth trajectory and geographical distribution of documents published on SSG-ManEd between 1960 and 2018?
2. What journals have been most influential in shaping the development of this literature?
3. What authors and documents have had the greatest influence on discourse in this domain of management education over the past six decades?

In order to address these research questions, the authors identified 1,156 relevant Scopus-indexed documents consisting of journal articles, books, book chapters, and conference papers. Bibliographic data associated with these documents were analyzed quantitatively using descriptive statistics, citation analysis and co-citation analysis (Zupic & Čater, 2015). Following a lineage of earlier research reviews (e.g., Anderson, 2009; Bell, Kanar, & Kozlowski, 2008; Clapper, 2016; Faria, 1987, 2001; Keys & Wolfe, 1990), the authors chart future directions in research on the use of simulations and serious games in management education.

METHOD

The current review of research relied on science mapping, a method review that applies bibliometric analysis to a corpus of related documents. As Bragge and colleagues (2010) observed, "[B]ibliometric approaches can reveal hidden patterns in the data and allow the analysis of large data sets beyond what is feasible with more traditional approaches" to review (p. 870). While scholars have employed science mapping methods to review the inter-disciplinary literature on simulation-based learning (Bragge et al., 2010; Hallinger & Wang, 2019), the current review is distinguished by its more narrow focus on the use of simulations and serious games in management education.

IDENTIFICATION OF SOURCES

We adapted Sitzmann's (2011) definition of simulation-based learning to guide this review. Sitzmann asserted that, "Simulation games refer to instruction delivered via personal computer that immerses trainees in a decision-making exercise in an artificial environment in order to learn the consequences of their decisions" (Sitzmann, 2011, p. 490). We broadened this definition to include mobile apps, board games and role-play games. In sum, the topical scope of this review included the use of simulations and serious games in management education aimed at prospective and practicing managers in the public, private, and education sectors.

The authors selected Scopus as the document repository from which to source relevant documents. Unlike a search engine like Google Scholar, Scopus offers advanced capabilities for export of bibliographic data used in science mapping. Scopus also provides more comprehensive coverage of peer-reviewed research documents in education and management than the most commonly used alternative, the Web of Science (Hallinger & Kovačević, 2019; Mongeon & Paul-Hus, 2016). In order to obtain a broad picture of this literature, the authors sourced conference papers, book chapters, books, and journal articles. Because Scopus coverage offers less comprehensive coverage prior to 1960, we delimited the period from 1960 through 2018 as the timeframe for the review.

FIGURE 1.
PRISMA diagram of source identification procedures
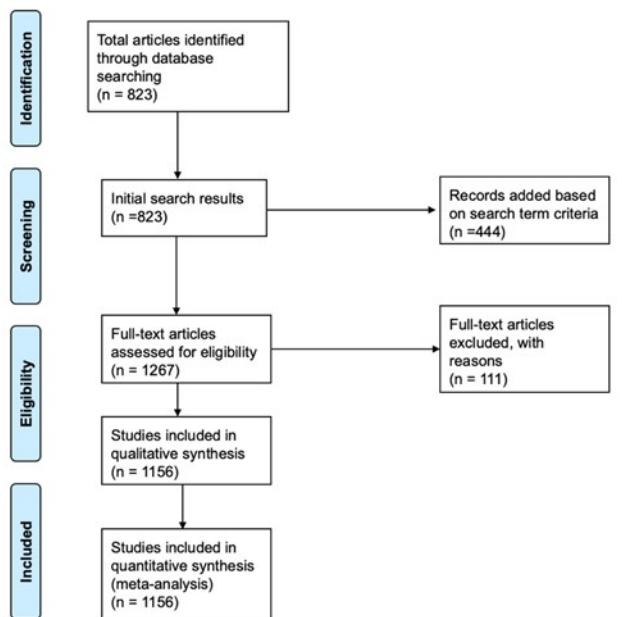
The authors used the PRISMA framework (see Figure 1) to guide our document search (Moher, Liberati, Tetzlaff, & Altman, 2009). The initial search used the following terms: "simulation-based learning" OR "simulation based learning" OR "games" AND "management," AND "education". This search resulted in a list consisting of 823 records (see Figure 1). Due to the limited accuracy of the Scopus search engine, we conducted a supplemental search in Google Scholar which yielded 444 additional documents that were then located and added to the list in Scopus. Document titles and abstracts were independently reviewed in order to ensure relevance to the topic of this study. The document had to focus on the use of a simulation(s) or serious game(s) that:

1. embedded learning in a 'context' designed to resemble an organizational environment,
2. required participants to make decisions modeled on a real-life managerial problem or challenge,
3. incorporated a moderate to high degree of complexity, and
4. related explicitly to management education.

Application of these criteria led to the exclusion of 111 documents, leaving a total of 1,156 Scopus-indexed documents for review.

DATA ANALYSIS

The Scopus document list of 1,156 documents was exported as an Excel file that included article title, author affiliation, keywords, abstract, and citation data. Basic statistical trends were analyzed using Scopus analytical tools and Excel. Citation analysis, conducted in the VOSviewer software package (van Eck & Waltman, 2014), assessed scholarly influence. Although citation analysis is widely used to assess the impact of journals, scholars and research documents, the results are limited to the index from which the documents are sourced (e.g., Scopus, Web of Science, Google Scholar). Consequently, citation analyses based on different document repositories yield different 'total citations' for the same journals, authors and documents. Because this review extracted document information from Scopus, we use the metric of 'Scopus citations' to identify influential authors, documents and journals in the knowledge base on SSG-ManEd. Citation analysis was conducted on the journals, authors, and documents located in our database.

Co-citation analysis, also conducted in VOSviewer (van Eck & Waltman, 2014), was used to gain complementary insights into patterns of influence for both journals and authors in this domain. Small (1973) defined co-citation as the frequency with which two units (e.g., journal, authors, or documents) have been cited together in the reference lists of other documents. For example, if the journals *Simulations & Gaming* and *Computers in Education* appear together in the reference list of a document in our database, they each accrue a single 'co-citation'. If these two journals frequently appear together in the reference lists in our document database, we can assume that the research they publish as a similarity. In this review, we used journal co-citation analysis to identify frequently co-cited journals as well as to visualize via a network map the relationships among journals publishing on SSG-ManEd (van Eck & Waltman, 2014; White & McCain, 1998).

RESULTS

The findings are presented in the order of the research questions outlined at the beginning of the paper.

KNOWLEDGE PRODUCTION TRENDS IN SSG-MAN ED RESEARCH

The 1,156 documents identified in the SSG-ManEd corpus represent a substantial corpus. Scopus-indexed publications on SSG-ManEd emerged slowly during the mid-1960s and grew steadily into the 1990s (see Figure 2). However, consistent with the broader SSG literature (Hallinger & Wang, 2019), 80% of the SSG-ManEd documents were published since 2000, and 55% since 2010. These data affirm that the use of simulations and games in management education is not a fad, and that interest continues to grow rapidly (see Bragge et al., 2010; Hallinger & Wang, 2019).

These documents were authored in 64 countries spanning the world (not tabled). Yet, despite this evidence of global

FIGURE 2.
Growth trajectory of publications on simulations and serious games
in management education, 1960 to 2018 (*n* = 1,156 documents)
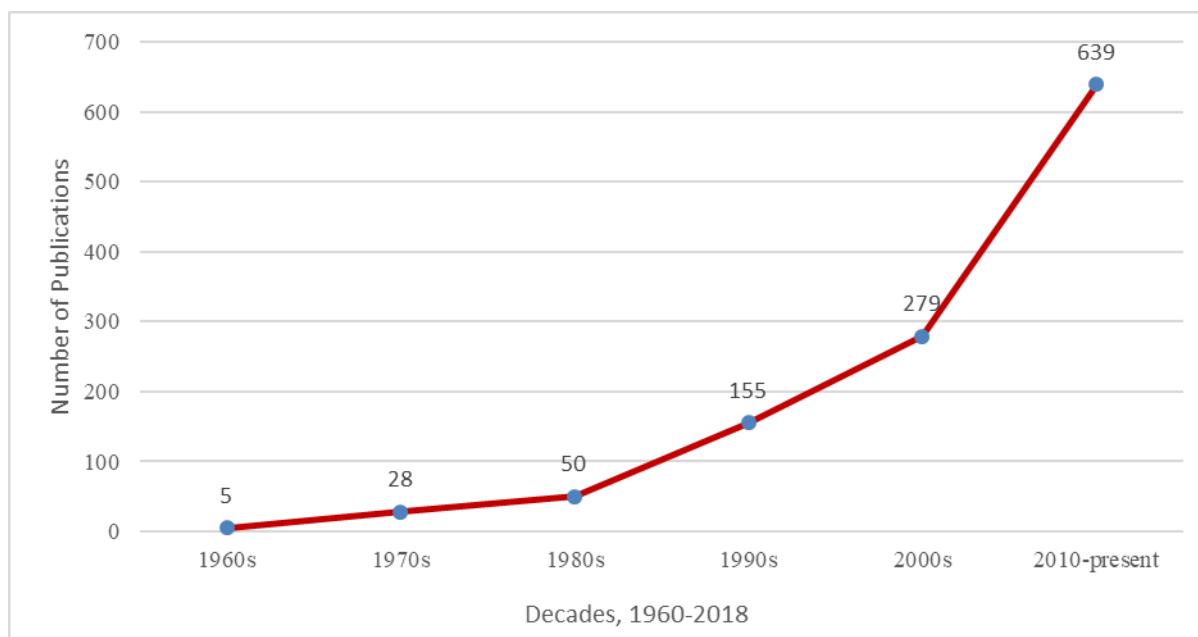
interest, the literature is dominated by publications authored in Anglo-American and European countries. This is indicated in Figure 3 which reveals that research on SSG-ManEd is dominated by contributions from Anglo-American and European scholars. Disaggregation of the document database by affiliation of the first author revealed that 85% of the documents were authored in Anglo-American or European countries.

FIGURE 3.
Leading countries by scholarly contributions to the literature on simulations
and serious games in management education, 1960-2018 (*n* =1,156)
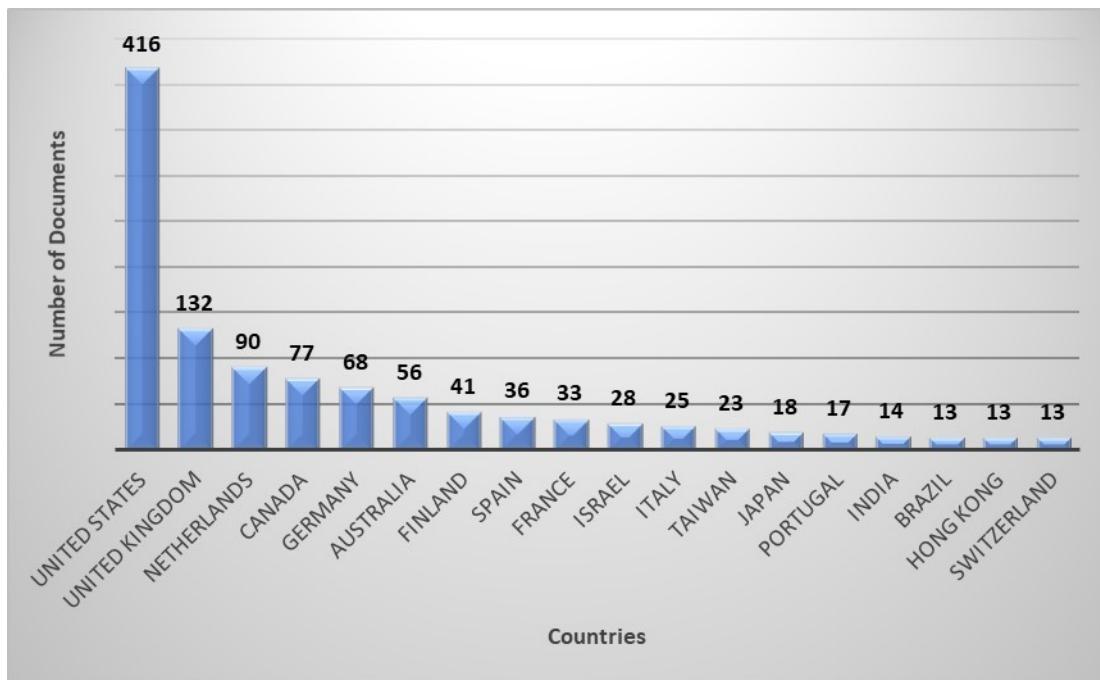
While they only represented 15% of the SSG-ManEd knowledge base, we did observe a trend of increasing contributions from Asia (Hallinger & Kantamara, 2001; Hallinger, Shaobing, & Jiafang, 2017; Lu, Hallinger, & Showanasai, 2014; Su & Lu, 2016; Tao, Cheng, & Sun, 2009), Latin America (Barros, Dantas, Veronese, & Werner, 2006; Ducrot, Van Paassen, Barban, Daré, & Gramaglia*,* 2015; González et al.*,* 2015) and Africa (Grace & Cohen, 2016; Scholtz, Kapeso, & de Villiers, 2017). These data indicate that we continue to lack research on SSG-ManEd in many of the international contexts in which management education is currently being delivered. Indeed, these emerging regions represents the highest growth markets for management education.

INFLUENTIAL SOURCES

Journals, conference papers and books represent the key modes of disseminating knowledge about the use of SSGs in management settings around the world. The 1,156 documents in our database were published in 554 discrete sources, suggesting a broad scope of academic interest. Data shown in Table 1 support our assertion that this is an inter-disciplinary field of study. Although the top-cited journals are concentrated in business, management, and accounting, they also feature journals specializing in computer science, and educational psychology. Deeper inspection of the full list of sources revealed journals in general education, education management, logistics, healthcare, engineering, and information sciences. Moreover, a closer inspection of the journals finds that they represent multiple functional disciplines within management education (e.g., HRM, operations, marketing, project management, ERP). In addition, conferences have played a significant role in the development of this literature (ABSEL, ASEE).

The journal, *Simulations and Gaming*, emerged from this analysis as the single most dominant source publishing research on SSG-ManEd. This finding was supported by both total published documents as well as total citations. Also notable is the fact that all of these top-cited journals feature in the first or second quartile of Scopus-indexed publications. This is an indirect affirmation of the quality of research being produced in this field.

Next we conducted 'source co-citation analysis' in VOSviewer which generates a map that visualizes similarities (VOS) among sources frequently cited in our document database (van Eck & Waltman, 2014). Because source co-citation analysis is based on the 'sources cited in the reference lists of the review documents', it captures sources that are neither in the review database, nor in Scopus. This allows the analysis to develop a much broader picture of influence within the literature, as well as connections to related knowledge bases beyond management (e.g., in education, psychology, medicine).

TABLE 1.
**Analysis of influential journals publishing articles on simulations and serious games
in management education, 1960-2018 (*n* = 1,156 documents)**

Rank	Source	Docu- ments	Scopus Citations	CPD[1]	Subject[2]	Scopus Quartile[3]
1	*Simulation & Gaming*	139	2692	19	Bus, Man & Acc[4]	Q2
2	*International Journal of Man Ed.*	18	131	7	Bus, Man & Acc	Q2
3	*Journal of Management Education*	16	128	8	Bus, Man & Acc	Q2
4	*Computers & Education*	14	486	35	Computer Science	Q1
5	*Journal of Marketing Education*	12	129	11	Bus, Man & Acc	Q1
6	*Journal of Man. Development*	11	275	25	Bus, Man & Acc	Q1
7	*AMLE[5]*	7	289	41	Bus, Man & Acc	Q1
8	*Education and Training*	6	109	18	Bus, Man & Acc	Q2
9	*J. of Operational Research Society*	5	184	37	Bus, Man & Acc	Q1
10	*Journal of Management*	3	325	108	Bus, Man & Acc	Q1
11	*Procedia Computer Science*	3	86	29	Computer Science	-
12	*System Dynamics Review*	3	84	28	Bus, Man & Acc	Q2
13	*Instructional Science*	2	92	46	Ed. Psychology	Q1
14	*International Journal of HRM*	2	89	45	Bus, Man & Acc	Q1

[1]CPD= Citations per document [2] Business, Management and Accounting
[2]Subject= Follows Scimago Journal and & Country Rank (https://www.scimagojr.com/)
[3]Scopus Quartile = Follows Scimago Journal Rank (https://www.scimagojr.com/)
[4]Business Management & Accounting
[5]Academy of Management Learning & Education

FIGURE 4.
**Journal co-citation map of the literature on simulations and serious games
in management education (threshold 35 co-citations, display 87 journals)**
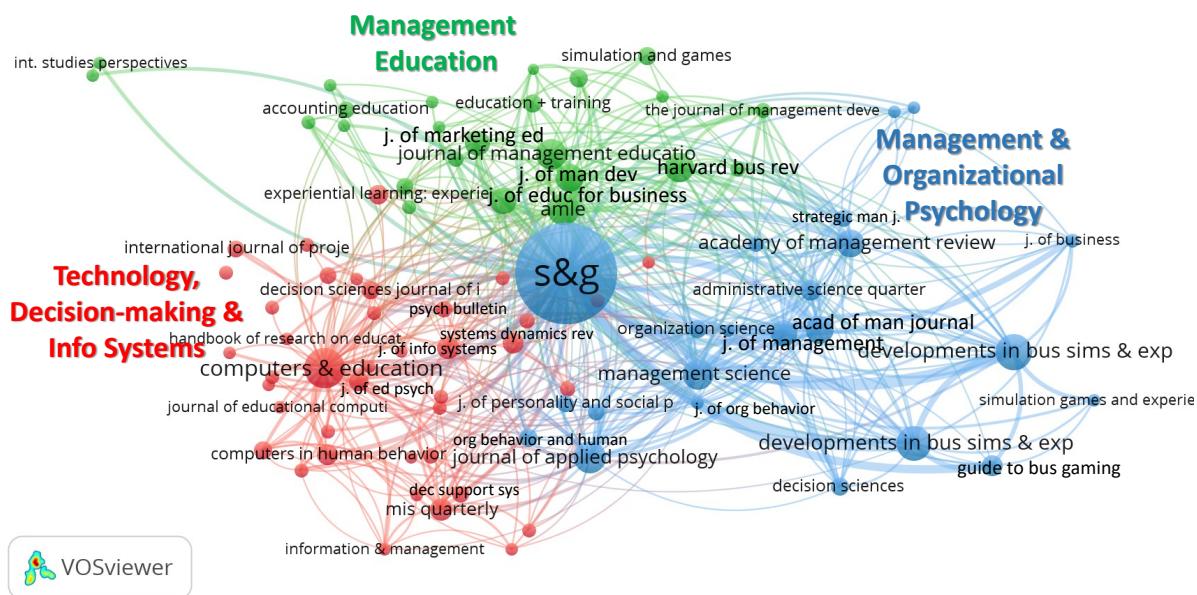
In this analysis we set VOSviewer to a threshold of 35 co-citations, meaning that the map would only include sources that had gained at least 35 co-citations in our review documents. This yielded a co-citation map consisting of 87 sources (i.e., journals, books or conference proceedings). We interpret the co-citation map in Figure 4 from several perspectives. First, the size of the 'nodes' on the map highlights the relative number of co-citations for these top co-cited journals; larger nodes indicate higher levels of co-citation. Second, the 'proximity' of nodes provides an indication of the frequency with which any two journals have been co-cited in the reference lists of documents in our review database. Nodes that are far apart on the map are seldom co-cited and typically reflect different sub-fields within the knowledge base. Nodes that are close to one another bear an closer intellectual relationship in

the research they publish. Links between the nodes represent co-citations of specific sources. Sources that bear strong co-citation relationships may also share a common color.

Inspection of the journal co-citation map immediately highlights *Simulation and Gaming* (S&G) as the most influential source of knowledge in this literature. This conclusion is based on the large size of the node, its central location on the map and the pattern of dense links to numerous sources in all three source clusters. It is accurate to state that almost any research document reporting on SSG-ManEd topics will include citations from S&G. Consistent with the citation analysis, this analysis supports the conclusion that no other source approaches S&G in terms of scholarly impact on this field.

More broadly, the map reveals three clusters of key sources that have influenced the evolution of knowledge on SSG-ManEd. The blue cluster, anchored by S&G, includes 23 sources that focus on 'management and organizational psychology'. Note that not all of these sources actually published papers on the use of simulations and serious games in management education. However, they appear on the map due to the fact that documents in our database frequently included references to papers that had been published in these sources. Thus, for example, scholars writing on the use of SSGs in management education frequently referred to core management concepts (e.g., organizational learning, organizational change, complexity theory, employee motivation, leadership) that were studied and elaborated in these journals (e.g., *Journal of Management, Academy of Management Review, Journal of Applied Psychology*) and conference proceedings (e.g., ABSEL).

The red cluster is comprised of 40 sources, primarily journals, that specialize in 'technology' (e.g., *Computers & Education, Journal of Educational Computing, Computers and Human Behavior*), and 'decision and information systems' (*System Dynamics Review, MIS Quarterly, Journal of Information Systems*). These foci reflect two key pillars of simulation-based learning. The first is the use of computer technology as a platform for delivering simulations (e.g., Grace & Cohen, 2016; Kiili & Lainema, 2010; Liao & Chen, 2007; Pasin & Giroux, 2011; Tao et al., 2009). The second lies in the use of systems dynamics, management information systems, and decision processes to inform the design of simulations e.g., (Barros et al., 1996; Kiili, 2007; Senge & Sterman, 1992; Sterman, 1994). Thus, journals located in this cluster not only publish articles on simulation-based learning, but also contain the 'related theoretical knowledge' on which SSG-ManEd scholars draw to support the design and use of simulations and games. Indeed, the surprisingly large size of this cluster reflects the wide scope of sources related to technology, information, and decision-making that underlie the SSG-ManEd literature.

The last cluster consists of 24 sources, primarily journals, that focus on management education in general (e.g., *AMLE, Journal of Management Education, Journal of Management Development, Journal of Business Education, Management Learning*) or management learning in functional sub-fields (e.g., *Journal of Marketing Education, Accounting Education, Marketing Education Review*). The journals located in this cluster are the most frequent disseminators of documents that focus explicitly on SSG-ManEd. Indeed, if we refer back to the journal citation analysis in Table 1, it is evident that seven of the top eight producers of knowledge on SSG-ManEd are located in the cluster. The one exception is S&G, which nonetheless is closely linked to this cluster. Thus, despite being much smaller than the red cluster, the sources in this cluster demonstrate greater impact on knowledge production.

TABLE 2
Highly-cited authors in the literature on simulations and serious games in management education, 1960-2018 (*n* = 1,156 documents)

Rank	Author	Country	Documents[1]	Scopus Citations	CPD[2]
1	Wolfe J.	USA	35	995	28.4
2	Faria A.	USA	18	713	39.6
3	Salas, E.	USA	9	375	41.7
4	Lainema, T.	Finland	22	367	16.7
5	Keys, B.	USA	9	351	39.0
6	Kiili, K.	Finland	6	315	52.5
7	Wellington W.	Canada	7	307	43.9
8	Latham, G.	Canada	3	244	81.3
9	Gold, S.	USA	6	161	26.8
10	Anderson, P.	USA	6	148	24.7
11	Tao, Y.H.	Taiwan	7	143	20.4
12	Léger, P.	Canada	5	142	28.4
13	Cronan T.	USA	7	141	20.1
14	Thavikulwat, P.	Thailand	14	141	10.1
15	Lawton, L.	USA	3	135	45

[1]Minimum of 3 published documents [2] CPD = citations per document

TABLE 3
**Highly-cited documents in the literature on simulations and serious games
in management education, 1960-2018 (*n* = 1,156 documents)**

Rank	Document	Type[1]	Scopus Citations
1	Keys B. & Wolfe J. (1990). The role of management games and simulations in education and research.	Rev	234
2	Seijts G. et al. (2004). Goal setting and goal orientation: An integration of two different yet related literatures.	Rev	215
3	Kiili K. (2007). Foundation for problem-based gaming.	Con	150
4	Faria A. et al. (2009). Developments in business gaming: A review of the past 40 years.	Rev	143
5	Avolio B. et al. (1988). Transformational leadership in a management game simulation: Impacting the bottom line.	Emp	142
6	Kayes A. et al. (2005). Experiential learning in teams.	Con	141
7	Salas E. et al. (2009). Using simulation-based training to enhance management education.	Rev	138
8	Faria A. (1998). Business simulation games: Current usage levels-an update	Emp	134
9	Faria A. & Wellington W. (2004). A survey of simulation game users, former-users, and never-users.	Emp	119
10	Lane D. (1995). On a resurgence of management simulations and games.	Emp	118
11	Tao Z. et al. (2009). What influences college students to continue using business simulation games? The Taiwan experience.	Emp	107
12	Faria A. (1987). A survey of the use of business games in academia and business.	Emp	99
13	Wolfe J. & Crookall, D. (1998). Developing a scientific knowledge of simulation/gaming.	Con	98
14	Pasin F & Giroux, H. (2011). The impact of a simulation game on operations management education.	Emp	97
15	Wolfe J. (1997). The effectiveness of business games in strategic management course work.	Emp	94
16	Faria A. (2001). The changing nature of business simulation/ gaming research: A brief history.	Rev	93
17	Anderson P. & Lawton, L. (2009). Business simulations and cognitive learning: Developments, desires, and future directions.	Rev	92
18	Zantow K. et al. (2005). More than fun and games: Reconsidering the virtues of strategic management simulations.	Con	81
19	Bell et al. (2008). Current issues and future directions in simulation-based training in North America.	Rev	80
20	Wolfe J. & Chanin M. (1993). The integration of functional and strategic management skills in a business game learning environment.	Emp	80

[1] Emp=empirical; Con=conceptual; Rev=review

ANALYSIS OF INFLUENTIAL AUTHORS AND DOCUMENTS

We used a three-step analytical strategy to address the next research question. First, we identified the most productive authors (i.e., by number of authored documents). Then we applied author citation and co-citation analysis to the documents in our database. Finally, we employed document citation analysis.

The most frequent contributors to this literature have been Wolfe (35 documents), Lainema (22), Faria (18), and Thavikulwat (14). Readers might be surprised by the omission of several well-known scholars associated with simulation-based learning from this list (e.g., Crookall, Gosen, Washbush). However, our database excluded documents on simulations and games that did not focus explicitly on management education (e.g., Crookall, 2010; Gosen & Washbush, 2004). Thus, this analysis is not based on the full corpus of publications of these management scholars. Similarly, there were other SSG scholars outside of management disciplines who occasionally published on management issues (e.g., Shtub, Parush, Mayer). Our study only included a portion of their published works.

Analysis of total Scopus citations identified Wolfe (995), Faria (713), Salas (375), Lainema (367), and Keys (351) as the most influential scholars contributing to the literature (see Table 2). It should be emphasized that this table only includes citations accrued from the Scopus-indexed publications included in our review database. Thus, these 'total citations' do not refer to the citation impact of these scholars based on their full list of publications. Given this caveat, the authors interpret these findings to indicate a moderate level of citation impact for scholars working within this 'niche' field of education and management.

We noted that the table is comprised of a surprisingly diverse set of international scholars from North America, Europe and Asia. We consider this to be a positive result given the broader geographical imbalance noted earlier. Finally, the contributions of these thought leaders has not been limited to management education, but also to the broader literature on the simulation- and game-based learning (Bragge et al., 2010; Hallinger & Wang, 2019).

Author co-citation analysis complemented these findings in several respects. First, we call attention to authors who appear in both the top-cited and top co-cited author tables (indicated by an asterisk in Table 3). These include Wolfe, Faria, Salas, Keys, Anderson, Wellington, Thavikulwat, Gold, Lainema, and Léger. The fact they rise to the top in these complementary analyses affirms their influence in this field.

Table 3 also highlights the contributions of several scholars who are not primarily associated with management education (e.g., Duke, Sterman) or with simulation- and game-based learning (e.g., Senge, Kolb). Their appearance in this table affirms one of the key contributions of co-citation analysis; its ability to identify the intellectual roots from which a field of study grows. For example, SSG-ManEd scholars have long drawn on Kolb's (1984) theoretical work on experiential learning as a rationale and framework for the design and evaluation of simulations and games. Senge (Senge & Fulmer, 1993; Senge & Sterman, 1992), Sterman (1987, 1994), and Duke (Duke & Greenblatt, 1981) have played instrumental roles in highlighting the capacity of simulations and games to address complex problems and develop the capacity for 'systems thinking'.

Finally, we sought to gain an additional perspective on this literature through document citation analysis (see Table 4). The

TABLE 4
Highly co-cited authors in the literature on simulations and serious games in management education

Rank	Author	Country	Research Focus	Co-Citations
1	*Wolfe, J.	USA	Simulations & Games	606
2	*Faria, A.	USA	Business Simulations	440
3	Kolb, D.	USA	Experiential Learning	311
4	*Salas, E.	USA	Business Simulations	254
5	*Keys, J.B.	USA	Business Simulations	251
6	Sterman, J.	USA	Computer Simulations	246
7	*Anderson, P.H.	USA	Simulations & Games	177
8	*Wellington, W.	Canada	Business Games/Simulations	172
9	*Thavikulwat, P.	Thailand	Business Games/Simulations	156
10	*Gold, S.	USA	Business Games	152
11	Duke, R.	USA	Simulation & Games	142
12	Lawton, L.	USA	Business Simulations	140
13	*Lainema, T.	Finland	Business Simulations	120
14	Crookall, D.	France	SBL theory	110
15	Senge, P.	USA	Systems theory	108

* Indicates that this author also appeared in the list of top-cited authors table

most highly cited documents in this field include reviews of research, empirical studies, and conceptual papers (see Table 2). These papers have conceptualized the use of SSGs in management education as a method of learning (e.g., Kayes et al., 2005; Wolfe and Crookall, 1998) and documented their growing use over time (e.g., Faria, 1987, 1998, 2001; Faria et al., 2009; Keys & Wolfe, 1990; Lane, 1995; Wolfe, 1993; Wolfe & Crookall, 1998). Some of the more recent papers analyzed different design features and instructional approaches used in conjunction with SSGs (e.g., Anderson & Lawton, 2009; Bell et al., 2008; Salas et al., 2009; Seijts, Latham, Tasa, & Latham, 2004), as well as their effectiveness in management education (e.g., Anderson & Lawton, 2009; Avolio et al., 1988; Faria & Wellington 2004; Pasin & Giroux, 2011; Tao et al., 2009; Wolfe, 1997).

DISCUSSION

This review of research documented and analyzed publication patterns in the literature on simulations and serious games in management education from 1960 to 2018. In this section, we highlight limitations of the review, and discuss our interpretation of key findings and implications for research and practice.

LIMITATIONS

The first limitation of this review lies in the fact that Scopus does not include all potentially relevant documents. Thus, some relevant documents were not captured in the review. Nonetheless, as noted earlier, the use of co-citation analysis compensated to some extent for this limitation.

In our view, the main limitation of the review arose from ambiguity in determining the eligibility of documents. In some cases, the boundaries of 'management education' lacked the clarity and precision we would have liked. For example, papers on the use of simulations for learning about 'water management' and 'healthcare management' sometimes challenged our decision-making. Thus, we acknowledge that the topical inclusion/exclusion decisions were not always clear cut. Therefore, although the authors double-coded the documents, another scholar might well come to slightly different decisions. Nonetheless, we believe that the impact of this limitation on the findings of the review was not significant.

INTERPRETATION OF FINDINGS

Comparison of our results with a recently published review of research (Hallinger & Wang, 2019) found that our database of 1,156 SSG-ManEd documents represents about 40% of the full Scopus-indexed literature on simulation-based learning. This verifies not only the existence of a significant corpus of SSG-ManEd research, but also the centrality of management education research within the broader field of research on simulations and serious games. Our analyses further documented the scope of SSG's penetration into most functional subjects that comprise management education: leadership, HRM, operations, supply chain, project management, business process management, and management information systems. Moreover, this is a rapidly growing field in which 56% of the literature has been published since 2010. This rapidly accelerating publication trajectory suggests that the use of simulations in management education will continue to grow significantly in coming years.

Geographical analysis of this corpus found that SSGs are being used worldwide in management education. Nonetheless, most SSG-ManEd publications have been authored in Anglo-American-European countries. Indeed, only 15% of the 1,156 SSG-ManEd documents originated outside of economically developed, Western countries. This is an important gap that has yet to be adequately addressed, despite its acknowledgement in past reviews of this literature (e.g., Morgan, 2000; Salas et al., 2009).

While initial studies support the efficacy of simulation-based learning in non-Western societies (e.g., Chung, 2015; Hallinger, Lu, & Showanasai, 2010; Lu et al., 2014; Tao et al., 2009), the field needs research that documents the learning outcomes of simulation- and game-based learning in a more diverse set of cultural contexts (Salas et al., 2009). This research can be conceptualized in related but different lines of inquiry.

The first focuses on the design of simulations and serious games for use in different cultural contexts. The efficacy of simulation-based learning is grounded, to a significant extent, on the proposition that learners are motivated by the contextual validity of the problem setting (Brown et al., 1989; Hallinger & Lu, 2012; Keane et al., 2015; Sterman, 1994; Morgan, 2000). But we cannot simply assume that the 'problem context' presented in a simulation will 'travel well' to different destinations (Chung, 2015; Hallinger & Kantamara, 2001; Hallinger & Lu, 2012; Hofstede & Pedersen, 1999). Cultural adaptation may require the revision of 'context descriptions' in order to make the simulation or game relevant in a different context (Hallinger et al., 2017; Walker et al., 1996).

Furthermore, there is an abundant literature which supports the conclusion that 'best practices' in managing people and organizations vary across cultures (e.g., House, Javidan, Hanges, & Dorfman, 2002). This implies that existing management simulations may also require a 'rethink' of the validity of underlying theoretical frameworks when used internationally. This may yield revision of the underlying decision rules that govern human interaction and define 'successful strategies' (Hallinger & Kantamara, 2001; Hallinger et al., 2017; Salas et al., 2009).

A similar assertion can be made concerning the 'efficacy' of simulation-based learning as a learning process. Research should explore the range of instructional adaptations needed to exploit the potential of SSGs in different cultural environments. We cannot simply assume that the same 'instructional approach' to using SSGs will have comparable results in different contexts

(Hallinger & Kantamara, 2001; Hofstede & Pedersen, 1999; Morgan, 2000). For example, learners in Asian societies are accustomed to structured forms of learning (King et al., 2015; Walker et al., 1996). Thus, different forms of structuring and debriefing may be needed to help learners scaffold their learning with simulations and games in these and similar societies (Brown et al., 1989; Hallinger & Lu, 2012; Hofstede & Pedersen, 1999; Lu et al., 2014; Morgan, 2000).

The broader implication is that research is needed that examines the cross-cultural validity of simulations and games from the perspectives of both design and instructional processes. This conclusion seems especially salient in the current global management education environment. Increasingly, management simulations designed in one society (e.g., USA, UK, Australia Netherlands, Germany) are being used in global partnership programs with learners in 'other societies'. We cannot assume that the problem contexts, underlying theories, and decision rules of simulations are universally applicable (Hallinger & Kantamatra, 2001; Hallinger & Lu, 2012; Hallinger et al. 2017; Salas et al., 2009). Moreover, adaptations in instructional process used with the simulations and games may also be required in different contexts (Hofstede & Pedersen, 1999; Morgan, 2000; Walker et al., 1996).

In saying this, the authors do not mean to suggest that learners can only benefit from a simulation designed for their particular society. However, we do assert suggest that designers and instructors cannot take the 'portability' of simulations and games for granted. We need to be more aware of the cultural assumptions of the theories and decision rules underlying simulations and highlight these assumptions in debriefings.

Another contribution of this review lies in the identification of key journals, authors and documents based on empirically supported contributions to this literature. Journal citation and co-citation analyses highlighted the centrality of *Simulation and Gaming*, to the development of this knowledge base. The founders and caretakers of this journal deserve commendation for their success in developing an intellectual platform capable of sustaining a creative, theory-informed, growing program of research across a period of 50 years. The results of this review reaffirm earlier assessments of the broader contributions of this journal to the literature on simulations and games (e.g., Bragge et al., 2010; Clapper, 2016; Crookall, 2012; Wolfe & Crookall, 1998).

Our citation analyses identified a rich inter-disciplinary mix of journals that have supported the research published in this field. Analysis of the top-cited journals found that this research is being published in high quality, Scopus Q1 and Q2 journals. This reinforces our perception of a maturing literature that has attracted a strong community of authors. These scholars have leveraged theories from education, psychology and management towards development of a research-based literature on SSG-ManEd. In our judgment, this places SSG's in a favorable position compared with other forms of active learning being used in higher education such as problem-based learning, flipped classrooms, team-based learning, and case-based learning (Betihavas, Bridgman, Kornhaber, & Cross, 2016; McLean, 2016; Sisk, 2011; Zahid, Varghese, Mohammed, & Ayed, 2016).

Journal co-citation analysis identified a conceptual map comprised of three main domains of knowledge underlying this knowledge base: 1) management education, 2) management and organizational psychology, and 3) technology, decision-making and information systems. This again attests to the inter-disciplinary nature of this field. The strength of the journals presented in the co-citation map in Figure 5 offers additional support for the conclusion that this is a theory informed field.

As Bragge and colleagues (2010) observed, a key contribution of science mapping lies in the empirical identification of key authors and documents. Earlier, White and McCain (1998) coined the term, "canonical scholars" to highlight authors who have made highly significant, empirically supported contributions to the knowledge base sustained over a period of several decades. The author and document citation analyses conducted for this review highlight Joseph Wolfe, and Albert Faria, and Eduardo Salas as 'canonical scholars' in the domain of SSG-ManEd.

Joseph Wolfe, who ranked first on all four of our metrics (see Tables 2-4), stands out as the preeminent scholar in this field. Wolfe authored a series of commentaries and reviews of research that charted progress and delineated research challenges at several points in the evolution of this literature (e.g., Keys & Wolfe, 1990; Wolfe, 1993, 1997; Wolfe & Crookall, 1998). His publications also include research on the design and use of simulations in business education (e.g. Wolfe, 1993, 1997, 2014; Wolfe & Chanin, 1993). Albert Faria, another long-term contributor to this literature, has been a key figure in monitoring, highlighting, and critiquing the use of simulation-based learning in management education (Faria, 1987, 1998, 2001; Faria et al., 2009; Faria & Wellington, 2004). Salas co-authored one of the key reviews of research on the use of simulation-based learning in management education (Salas et al., 2009). Notably, his contributions have been less centrally located in 'business management' than Wolfe and Faria. Instead his research on SSG-ManEd crosses over into other domains of management education and training (e.g., Marlow, Lacerenza, Reyes, & Salas, 2017; Salas, Bowers & Rhodenizer, 1998; Salas, Wilson, Burke, & Priest, 2005).

Finally, we believe that the authors and documents identified in this review represent a useful resource for all scholars in this field. Rather than blindly groping their way through the literature, the findings presented in this review can guide young scholars towards 'key sources' identified by empirical analysis. Indeed, the lead author was not familiar with all of the key authors and documents highlighted in this review despite having published papers on simulation-based learning for 30 years. The significance of these lists is further suggested by the identification of scholars and documents associated with learning theories that underlie simulation-based learning (e.g., Brown et al., 1989; Kolb, 1984; Senge & Fulmer, 1993). This connection is significant in that it points us towards the theoretical underpinnings of the knowledge base on simulations and serious games in management education.

REFERENCES

Anderson, P. H., & Lawton, L. (2009). Business simulations and cognitive learning: Developments, desires, and future directions *Simulation & Gaming, (40)*2, 193-216.

Asiri, A., Greasley, A., & Bocij, P. (2017, July), A review of the use of business simulation to enhance students' employability (WIP). In *Proceedings of the Summer Simulation Multi-Conference*, Society for Computer Simulation International, 39-54.

Avolio, B. J., Waldman, D. A., & Einstein, W. O. (1988), Transformational leadership in a management game simulation: Impacting the bottom line, *Group & Organization Studies 13*(1), 59-80.

Barros, M. D. O., Dantas, A. R., Veronese, G. O., & Werner, C. M. (2006). Model-driven game development: Experience and model enhancements in software project management education. *Software Process: Improvement and Practice 11*(4), 411-421.

Bell, B. S., Kanar, A. M., & Kozlowski, S. W. (2008). Current issues and future directions in simulation-based training in North America, *International Journal of Human Resource Management, 19*, 1416–1434.

Betihavas, V., Bridgman, H., Kornhaber, R., & Cross, M. (2016). The evidence for 'flipping out': A systematic review of the flipped classroom in nursing education. *Nurse Education Today, 38*, 15-21.

Bragge, J., Thavikulwat, P., & Töyli, J. (2010). Profiling 40 years of research in simulation & gaming, *Simulation & Gaming 41*(6), 869-897.

Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*, *18*(1), 32-42.

Chung, C. (2015). Comparison of cross culture engineering ethics training using the simulator for engineering ethics education. *Science and Engineering Ethics, 21* (2), 471-478.

Clapper, T. C. (2016). The way forward for Simulation & Gaming (S&G). *Simulation & Gaming*, *43*(1), 5-14.

Cohen, K. J., & Rhenman, E. (1961). The role of management games in education and research. *Management Science, 7*(2), 131–166.

Crookall, D. (2010). Serious games, debriefing, and simulation/ gaming as a discipline. *Simulation & Gaming, 41*(6), 898-920.

Crookall, D. (2012). The founding of modern simulation/ gaming: S&G and ISAGA four decades on", *Simulation & Gaming, 43*(1), 5-14.

Ducrot, R., Van Paassen, A., Barban, V., Daré, W. S., & Gramaglia, C. (2015). Learning integrative negotiation to manage complex environmental issues: Example of a gaming approach in the peri-urban catchment of São Paulo, Brazil. *Regional Environmental Change, 15*(1), 67-78.

Duke, R., & Greenblat, C. (1981). *Principles and practices of gaming simulation.* Beverly Hills, CA: Sage.

Faria, A. J. (1987). A survey of the use of business games in academia and business. *Simulation & Games, 18*(2), 207-224.

Faria, A. J. (1998). Business simulation games: Current usage levels—An update. *Simulation & Gaming*, *29*(3), 295-308.

Faria, A. J. (2001). The changing nature of business simulation/ gaming research: A brief history, *Simulation & Gaming, 32*(1), 97–110.

Faria, A. J., & Wellington, W. J. (2004). A survey of simulation game users, former-users, and never-users. *Simulation & Gaming*, 35(2), 178-207.

Faria, A. J., Hutchinson, D., Wellington, W. J., & Gold, S. (2009). Developments in business gaming: A review of the past 40 years. *Simulation & Gaming, 40*(4), 464-487.

González, V. A., Orozco, F., Senior, B., Ingle, J., Forcael, E., & Alarcón, L. F. (2015). LEBSCO: Lean-based simulation game for construction management classrooms. *Journal of Professional Issues in Engineering Education and Practice, 141*(4), 1-11.

Gosen, J., & Washbush, J. (2004). A review of scholarship on assessing experiential learning effectiveness. *Simulation & Gaming, 35*(2), 270-293.

Grace, T., & Cohen, J. (2016). *Business process management and digital game based learning*, Paper presented Twenty-second Americas Conference on Information Systems, San Diego, CA.

Gragg, C. I. (1951). *Because wisdom can't be told.* Boston: Intercollegiate Case Clearing House.

Hallinger, P., & Kantamara, P. (2001). Learning to lead global changes in local cultures-Designing a computer-based simulation for Thai school leaders. *Journal of Educational Administration, 39*(3), 197-220.

Hallinger, P., & Kovačević, J. (2019). A bibliometric review of research on educational administration:

Science mapping the literature, 1960 to 2018. *Review of Educational Research*, *89*(3), 335–369.

Hallinger, P., & Lu, J. (2012). Overcoming the Walmart syndrome: Adapting problem-based management education in East Asia. *Interdisciplinary Journal of Problem-based Learning, 6*(1), 16-42.

Hallinger, P., Lu, J. F., & Showanasai, P. (2010). Learning to lead organizational change in Thailand: Assessment of a problem-based learning approach. *Educational Review, 62*(4), 467-486.

Hallinger, P., Shaobing, T., & Jiafang, L. (2017). Learning to make change happen in Chinese schools: Adapting a problem-based computer simulation for developing school leaders. *School Leadership & Management, 37* (1-2), 162-187.

Hallinger, P., & Wang, R. (2019). The evolution of simulation-based learning across the disciplines, 1965–2018: A science map of the literature. *Simulation & Gaming*.

Hofstede, G. J., & Pedersen, P. (1999). Synthetic cultures: Intercultural learning through simulation games. *Simulation & Gaming, 30*(4), 415-440.

House, R., Javidan, M., Hanges, P., & Dorfman, P. (2002). Understanding cultures and implicit leadership theories across the globe: an introduction to project GLOBE. *Journal of World Business, 37*(1), 3-10.

Kayes, A. B., Kayes, D. C., & Kolb, D. A. (2005). Experiential learning in teams. *Simulation & Gaming*, *36*(3), 330-354.

Keane, M. G., Allain, T. J., Mwandumba, H. C., O'Toole, P. A., Gill, D., & Gordon, M. A. (2015). PWE-434 Evaluation of the impact of the learning context on the acquisition of complex professional skills through simulation based training courses. *Gut, 64*, A400-A401.

Keys, B. (1986). Improving management development through simulation gaming. *Journal of Management Development, 5*(2), 41-56.

Keys, B., & Wolfe, J. (1990). The role of management games and simulations in education and research. *Journal of Management, 16*(2), 307-336.

Kiili, K. (2007). Foundation for problem-based gaming. *British Journal of Educational Technology*, *38*(3), 394-404.

Kiili, K., & Lainema, T. (2010). Power and flow experience in time-intensive business simulation game. *Journal of Educational Multimedia and Hypermedia, 19*(1), 39-57.

King, R. B., Bernardo, A. B., & King, R. B. (2015). *Psychology of Asian learners*, Singpore: Springer.

Kolb, D.A. (1984). Experiential learning: Experience as the source of learning and development, Prentice Hall, Englewood Cliffs NJ.

Lane, D. C. (1995). On a resurgence of management simulations and games. *Journal of the operational Research Society*, *46*(5), 604-625.

Liao, Y. K., & Chen, Y. W. (2007). The effect of computer simulation instruction on student learning: A meta-analysis of studies in Taiwan. *Journal of information Technology and Applications, 2*(2), 69-79.

Lu, J., Hallinger, P., & Showanasai, P. (2014). Simulation-based learning in management education: A longitudinal quasi-experimental evaluation of instructional effectiveness. *Journal of Management Development, 33*(3), 218-244.

Marlow, S. L., Lacerenza, C. N., Reyes, D., & Salas, E. (2017). 11 The science and practice of simulation-based training in organizations. In K. Brown (Ed.), *The Cambridge handbook of workplace training and employee development* (pp. 256-277). Cambridge: Cambridge University Press.

Martin, B. O., Kolomitro, K., & Lam, T. C. (2014). Training methods: A review and analysis. *Human Resource Development Review, 13*(1), 11-35.

McLean, S. F. (2016). Case-based learning and its application in medical and health-care fields: A review of worldwide literature. *Journal of Medical Education and Curricular Development, 3*, JMECD-S20377.

Moher, D., Liberati, A., Tetzlaff, J., & Altman, D. G. (2009). Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *Annals of Internal Medicine*, *151*(4), 264-269.

Mongeon, P., and Paul-Hus, A. (2016). The journal coverage of Web of Science and Scopus: A comparative analysis. *Scientometrics, 106*(1), 213-228.

Morgan, K. (2000). Cross-cultural considerations for simulation-based learning environments. *Simulation & Gaming, 31*(4), 491-508.

Pasin, F., & Giroux, H. (2011). The impact of a simulation game on operations management education. *Computers & Education, 57*(1), 1240-1254.

Salas, E., Bowers, C. A., & Rhodenizer, L. (1998). It is not how much you have but how you use it: Toward a rational use of simulation to support aviation training. *The International Journal of Aviation Psychology, 8*(3), 197-208.

Salas, E., Wildman, J., & Piccolo, R. (2009). Using simulation-based training to enhance management education. *Academy of Management Learning & Education, 8*(4), 559–573.

Salas, E., Wilson, K. A., Burke, C. S., & Priest, H. A. (2005). Using simulation-based training to improve patient safety: what does it take? *The Joint Commission Journal on Quality and Patient Safety*, *31*(7), 363-371.

Scholtz, B. M., Kapeso, M., & de Villiers, M. R. (2017). The usefulness and ease of use of a mobile simulation application for learning of ERP systems, *South African Computer Journal, 29*(2), 87-105.

Seijts, G. H., Latham, G. P., Tasa, K., & Latham, B. W. (2004). Goal setting and goal orientation: An integration of two different yet related literatures, *Academy of Management Journal, 47*(2), 227-239.

Senge, P. M., & Fulmer, R. M. (1993). Simulations, systems thinking and anticipatory learning, *Journal of Management Development, 12*(6), 21-33.

Senge, P. M., & Sterman, J. D. (1992). Systems thinking and organizational learning: Acting locally and thinking globally in the organization of the future. *European Journal of Operational Research*, *59*(1), 137-150.

Sisk, R. J. (2011). Team-based learning: Systematic research review. *Journal of Nursing Education, 50*(12), 665-669.

Sitzmann, T. (2011). A meta-analytic examination of the instructional effectiveness of computer-based simulation games, *Personnel Psychology, 64*(2), 489-528.

Small, H. (1973). Co-citation in the scientific literature: A new measure of the relationship between two documents. *Journal of the American Society for information Science, 4*, 265-269.

Sterman, J. D. (1987). Testing behavioral simulation models by direct experiment. *Management Science, 33*(12), 1572-1592.

Sterman, J. D. (1994). Learning in and about complex systems. *System Dynamics Review, 10*(2-3), 291-330.

Su, Y. L., & Lu, N. (2016). Credit risk game simulation for supply chain finance based on multi-agent, *International Journal of u-and e-Service, Science and Technology, 9*(4), 77-90.

Tao, Y. H., Cheng, C. J., & Sun, S. Y. (2009). What influences college students to continue using business simulation games? The Taiwan experience. *Computers & Education, 53*(3), 929-939.

van Eck N.J., & Waltman, L. (2014). Visualizing bibliometric networks. In Y. Ding, R. Rousseau, & D. Wolfram (Eds.), *Measuring scholarly impact: Methods and practice* (pp. 285–320). Springer: Dordrecht.

Walker, A., Bridges, E., & Chan, B. (1996). Wisdom gained, wisdom given: Instituting PBL in a Chinese culture. *Journal of Educational Administration, 34*(5), 12-31.

White, H. D., & McCain, K. W. (1998). Visualizing a discipline: An author co-citation analysis of information science, 1972–1995. *Journal of the American Society for Information Science, 49*(4), 327-355.

Wolfe, J. (1993). A history of business teaching games in English-speaking and post-socialist countries: The origination and diffusion of a management education and development technology. *Simulation & Gaming, 24*(4), 446-463.

Wolfe, J. (1997). The effectiveness of business games in strategic management course work. *Simulation & Gaming, 28*(4), 360-376.

Wolfe, J. (2014, March). The global business game: A strategic management and international business simulation. In *Developments in Business Simulation and Experiential Learning: Proceedings of the Annual ABSEL conference (Vol. 27).*

Wolfe, J., & Chanin, M. (1993). The integration of functional and strategic management skills in a business game learning environment. *Simulation & Gaming*, *24*(1), 34 -46.

Wolfe, J., & Crookall, D. (1998). Developing a scientific knowledge of simulation/gaming. *Simulation & Gaming, 29*(1), 7-19.

Zahid, M. A., Varghese, R., Mohammed, A. M., & Ayed, A. K. (2016). Comparison of the problem based learning-driven with the traditional didactic-lecture-based curricula. *International Journal of Medical Education, 7*, 181.

Zantow, K., Knowlton, D. S., & Sharp, D. C. (2005). More than fun and games: Reconsidering the virtues of strategic management simulations. *Academy of Management Learning & Education, 4*(4), 451-458.

Zupic, I., & Cater, T. (2015). Bibliometric methods in management and organization. *Organizational Research Methods*, *18*(3), 429-472.