

# Complex Systems Science and Community-Based Research: A Scoping Review Protocol

Travis R. Moore<sup>1\*</sup>, Helena VonVille<sup>2</sup>, Winnie Poel<sup>3</sup>, Glory Dee A. Romo<sup>4</sup>, Ian Lim<sup>5</sup>, Robert W. S. Coulter<sup>6</sup>

<sup>1</sup>School of Human Ecology, University of Wisconsin-Madison, Madison, Wisconsin, United States

<sup>2</sup>Health Sciences Library System, University of Pittsburgh, Pittsburgh, Pennsylvania, United States

<sup>3</sup>Institute for Theoretical Biology, Humboldt Universität zu Berlin, Berlin, Germany

<sup>4</sup>School of Management, University of the Philippines Mindanao, Philippines

<sup>5</sup>Housing & Development Board, Singapore, Singapore

<sup>6</sup>Graduate School of Public Health, University of Pittsburgh, Pittsburgh, Pennsylvania, United States

## ABSTRACT

There is an abundance of community-based research literature that incorporates complex system science concepts and techniques. However, currently there is a gap in how these concepts and techniques are being used, and, more broadly, how these two fields complement one another. The debate on how complex systems science meaningfully bolsters the deployment of community-based research has not yet reached consensus, therefore, we present a protocol for a new scoping review that will identify characteristics at the intersection of community-based research and complex systems science. This knowledge will enhance the understanding of how complex systems science, a quickly evolving field, is being utilized in community-based research and practice.

*Keywords:* Complex systems science, systems science, community systems dynamics, community-based research, scoping review protocol

## 1. Background

Complex systems science (CSS) is a field focused on describing how elements with heterogeneous properties dynamically interact with each other and their environments to produce patterns of phenomenon over time. CSS is a diverse phenomenology comprised of concepts and analytical techniques that, relative to the field or fields it is deployed in, attempts to explore the rich variation of structure and behavior of actors at multiple scales with differing individual motivations and priorities (Hammond, 2009; Williams & Hummelbrunner, 2010). The structure and behavior of actor systems have many moving parts and operative pathways, which interact to produce rich variation in outcomes that cannot be reduced to a single mechanism. Complex systems (CS) are composed of many heterogeneous pieces, interacting with each other in subtle or nonlinear ways that strongly influence the overall behavior of the system. CS share a few general properties found in Table 1. Given these general properties' utility in exploring the nature of complex systems, many fields have deployed this phenomenology in effort to explain intractable issues. One such field is community-based research (CBR).

**Table 1.** Complex systems (CS) properties and explanations.

Complex System Properties	Property Explanation
Individuality*	CS are often multi-level and driven by decentralized, local interaction of constituent parts. Each level is composed of autonomous actors who adapt their behavior individually.
Heterogeneity*	Substantial diversity (goals, rules, constraints, etc.) among actors at each level.
Interdependence*	CS usually contain many interdependent interacting pieces, connected across different levels with feedback and nonlinear dynamics.
Emergence*	CS are often characterized by emergent, unexpected phenomena—patterns of collective behavior that form in the system are difficult to predict from separate understanding of each individual element.
Tipping*	CS are also often characterized by tipping or the impacts caused by small changes that can seem out of proportion.
Nonlinearity**	Sensitivity to initial conditions; small actions can have large consequences (see tipping).
Dynamical**	Interaction within, between, and among systems and subsystems are rapidly changing.
Adaptive**	Interacting elements and agents respond and adapt to each other so that what emerges and evolves is a function of ongoing adaptation among both interaction elements and the responsive relationships interacting agents have with their environment.
Uncertainty**	Process and outcomes are unpredictable, sometimes uncontrollable, and many times unknowable in advance.

*Note.* \*Denotes concepts from Hammond (2009) \*\*Denotes concepts from Patton (2010)

### *Community-Based Research*

Community-based research (CBR) has emerged as a transformative research paradigm that bridges the gap between science and practice through community engagement and social action with the goals of social justice and equity (Galea, Ettman, & Vlahov, 2019; Strand, Marullo, Cutforth, Stoecker, & Donohue, 2003). Because CBR is a paradigm of research practice, and less of a methodology, it functions from a grounding in principles: (1) community is a unit of identity; (2) CBR builds on strengths and resources within the community; (3) CBR facilitates a collaborative, equitable partnership in all phases of research, involving and empowering and power-sharing process that attends to social inequities; (4) CBR promotes co-learning and capacity building among all partners; (5) CBR promotes research as a long-term process with a commitment to sustainability to address issues of race, ethnicity, racism, and social class (Collins et al., 2018; Galea et al., 2019; Wallerstein, Duran, Oetzel, & Minkler, 2017). These principles guide researchers to conduct research processes that employ a community-engaged approach in which residents have equal power in determining the research agenda and resource allocation (Thomas Wolff, 2001; Tom Wolff et al., 2016). Importantly, the broad use of “community” in CBR often masks a multiple reality in which there are diverse types of communities, as well as differences within communities. For this reason, we define “community” based off of MacQueen and colleagues’ (2001) review that identified five core elements that define community: (1) locus, a sense of place, (2) sharing, common interests and perspectives, (3) joint action, a sense of

coherence and identity, (4) social ties, and (5) diversity (Brown, 2005). Our review will utilize a broader sentiment of CBR principles: inclusion of community members and stakeholders in any aspect of the research process.

### *Complex Systems Science and Community-based Research*

In the last decade, researchers have started to combine CSS and CBR into novel and fruitful approaches to explore and address what West Churchman (1967) coined as wicked problems, intractable puzzles that plague the human condition due to their eternally changing, complex nature (Skaburskis, 2008). For example, researchers in North Carolina coalesced network analysis and participatory research methods to evaluate systems science workshops for childhood obesity prevention (Frerichs et al., 2018). These researchers combined complex systems science concepts and analytical techniques with community-based participatory research methods to more effectively evaluate a program geared toward addressing a complex social issue like obesity. While this example is in the field of public health, many examples can be found in other fields such as environmental science (Gaydos, Petrasova, Cobb, & Meentemeyer, 2019; Pagano, Pluchinotta, Pengal, Cokan, & Giordano, 2019), healthcare (Laycock, Bailie, Matthews, & Bailie, 2019), medicine (Cholewicki et al., 2019), and food systems (Ebhuoma, Simatele, Tantoh, & Donkor, 2019) among others.

How researchers deploy these approaches together is relatively unknown, and no other scoping review of these two bodies of literature has been completed. That is, as of September 1<sup>st</sup>, 2019, a search through JBI Database of Systematic Reviews and Implementation Reports, Cochrane Database of Systematic Reviews, CINAHL, PubMed, EPPI, and Epistemonikos did not reveal a scoping protocol or scoping review of CSS and CBR. The closest related systematic review to our planned scoping review concerned community participation in health systems research (George, Mehra V, & Sriram, 2015). Although related, Mehra and Sriram's review does not consider CBR and CSS as two distinct bodies of literature and, instead, focuses on health systems rather than complex systems.

We believe that a scoping review of CSS and CBR is warranted, especially given researchers' proliferating use of CSS and CBR in their studies. In this scoping review we ask, "how are researchers using CSS and CBR to construct and inform their research?"

## **2. Methods/Design**

This scoping review follows the reporting guidelines as set forth by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA; Moher, 2009) and JBI's Reviewer's Manual (Aromataris & Munn, 2017), and assessed for quality using the AMSTAR 2.0 checklist (Faggion, 2015).

### **2.1 Inclusion criteria**

Table 2 summarizes our inclusion criteria. Eligibility criteria and methods of analysis have been determined a priori. Our scoping review aims to understand the nature of two discrete but increasingly overlapping fields. We ask, "How are complex system science concepts and/or strategies used in this article," and "Are stakeholders included in any part of the study?" Thus, inclusion criterion of this scoping review parameterizes study attributes for our primary objective of understanding how CSS and CBR are being used in research studies.

## 2.2 Types of participants

The protocol for this scoping review will explore conceptual and logistical overlap between two fields of research and practice. Thus, there are no inclusion or exclusion criteria for the types of participants to be involved in this review beyond that they are human subjects. And because the scoping review covers a breadth of literature, we will only be inspecting articles for researchers or practitioners who included stakeholders, broadly defined as study participants who have an interest or concern with the topic of study or the implications of research or evaluation.

## 2.3 Concept

The core concepts central to our scoping review fall under the CSS and CBR disciplines. Complex Systems Science is a diverse phenomenology of concepts and analytical techniques that, relative to the field or fields it is deployed in, attempts to explore the rich variation of structure and behavior of actors at multiple scales with differing individual motivations and priorities (Hammond, 2009; Williams & Hummelbrunner, 2010). The concepts related to this field describe the structure and behavior of complex phenomena. These concepts (Table 1) are used in tandem to our understanding of complex systems techniques, which attempt to model the structure and behavior of complex phenomena. These techniques range from computational methods such as natural language processing (Manning, Manning, & Schütze, 1999) and machine learning to simulation techniques such as agent-based modeling (Bonabeau, 2002) to more practice-based techniques for measuring system dynamics such as causal-loop diagramming (Williams & Hummelbrunner, 2010) and, more recently, participatory group model building (Hovmand, 2014). See Appendix A for a full list of concepts as search terms used to define an initial search of literature.

CBR is a transformative research paradigm that bridges the gap between science and practice through community, stakeholder engagement and social action with the goals of social justice and equity (Galea et al., 2019; Strand et al., 2003). Thus, a central tenet of CBR is inclusion. Inclusion of stakeholders in our abstract review will be conceptualized broadly: were stakeholders included at any point in the research process, from research design to dissemination? In our review of articles, we will be looking more closely at: the extent to which stakeholders were involved; for how long stakeholders were engaged; and how stakeholders were engaged. Though not an inclusion criterion, we will be interested in stakeholder empowerment and capacity building as outcomes of a CBR project. Stakeholder empowerment is defined by the extent to which stakeholders are involved in and control the research process and can be used as a proxy to evaluate a project's level of stakeholder engagement (Späth & Scolobig, 2017). Capacity building refers to the process by which individuals and organizations obtain, improve, and retain the skills, knowledge, tools, equipment and other resources needed to do their jobs competently or to a greater capacity (Simpson, Wood, & Daws, 2003).

While these two fields are central to our scoping review, the phenomenon of interest is the intersection of these two fields. We want to know how and to what extent each field builds from the other. How are CSS researchers deploying the concept of stakeholder inclusion in their work? How are CBR researchers using concepts of emergence or nonlinearity and techniques of simulation or agent-based modeling in their work? And if there are researchers who seem to be coalescing the two approaches in their research, what does this overlap look like?

## 2.4 Context

There will be no contextual parameters defined for our scoping review. Studies from around the world, published in English, regardless of socio-cultural context will be reviewed. Due to the nature of CBR work, research will likely be placed in diverse community settings. However, our scoping review will not limit our search based on context.

## 2.5 Types of studies

Reviewers will review only scholarly sources that contain existing, published literature (e.g., primary research studies, systematic reviews, meta-analyses, letters, guidelines, and websites). However, because one of our criteria of inclusion is stakeholder inclusion, we anticipate that that primary research studies will, in effect, make up a majority of our types of studies reviewed. For example, while our scoping review may initially include systematic reviews, if the systematic review did not incorporate stakeholders in the design or execution of their project, that article would not be included in our scoping review.

**Table 2.** Inclusion and exclusion criteria.

Category	Criteria
Types of participants	Human subjects with a focus on those who have a stake in the research process.
Fields	Any field
Concepts	Complex Systems Science concepts (Table 1)
Outcomes	Community-Based Research concepts: stakeholder inclusion Any, but interested in stakeholder empowerment and capacity building
Language	English
Context	Any
Types of Studies	Scholarly sources

## 2.6 Search strategy

First, Medline (Ovid) and Embase (Elsevier) have been searched using a combination of MeSH terms and title, abstract, and keywords in English. This initial search was followed by an analysis of the text words contained in the title and abstract of retrieved papers, and of the index terms used to describe the articles. Syntax and terminology were adapted as appropriate to search several other databases: PsycINFO (Ovid), AGRICOLA (Ovid), ERIC (EBSCO), Academic Search Premier (EBSCO), and Web of Science (Clarivate). A health sciences librarian with systematic review expertise developed all searches. An updated search was performed to find new citations as well as to incorporate a term not applied during the first round of searching. Strategies and search dates for each database are available in Appendix A. EndNote (Clarivate) was used initially to store all citations found in the search process and to check for duplicates. They were then uploaded into DistillerSR (Evidence Partners, Ottawa, Canada). Search strategies and results were tracked using an Excel workbook designed specifically for this purpose (VonVille, 2018).

## 2.7 Study selection

All screening and full text reviews will be completed using DistillerSR. Prior to screening all titles and abstracts, participants will be trained on the use of DistillerSR and on the aims,

eligibility criteria, and exclusion criteria of the project. The titles and abstracts of articles considered for inclusion will be independently screened by four of six authors and two student scholars, blinded to journal titles. From these data, we will calculate an interrater reliability score (i.e., the Kappa statistic) to determine the level of rater agreement. Disagreements will be resolved by the first author, who, on a weekly basis, will solicit or provide feedback on unique or common disagreements. A similar process (e.g., screening by two independent rates) will occur for screening full text articles. Prior to screening full text articles, each study will be searched in Retraction Watch (<http://www.retractionwatch.com>). An additional search will be completed for each study in PubMed using a retraction/correction database search filter (<http://bit.ly/pubmed-filters>) to ensure the study should be included and the correct data was used for analysis. A list of excluded citations from each step may be requested from the first author.

## **2.8 Data extraction**

To satisfy our objective of exploring how CSS and CBR fields have overlapped one another in terms of concepts, techniques, and strategies, we will chart the results of our scoping review by extracting and documenting the author(s), year of publication, where the study was published (if not empirical) or conducted (if empirical), the aims and/or purpose, the study population, the strategies/methods/techniques used in data collection and analyses, the outcomes of the study, and the key findings of the study that relate to our primary objective. These key findings or study outcomes relate to several categories of interest (see Table 2). In particular, we will be interested in documenting the ways in which each study uses concepts and techniques from CSS and the extent to which the study included stakeholders in the research process. A template data extraction instrument will be used to document extraction results. This process will proceed iteratively whereby the charting table is continually updated (Valaitis et al., 2012).

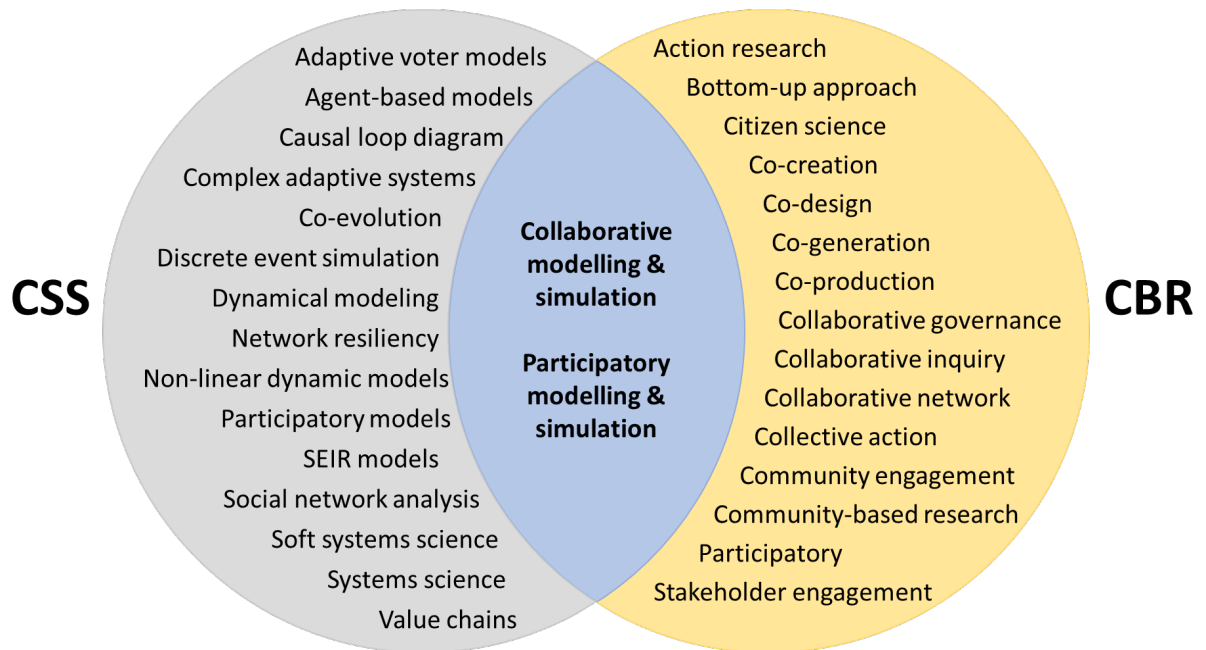
## **3. Presentation of Results**

The presentation of results of our scoping review will include a map of the data extracted from the included papers in diagrammatic form accompanied with a description that aligns with our objectives and scope of the review. This map will include overlapping concepts from across papers that span both the CSS and CBR fields. The map may take the form of a two circle Venn diagram to describe discrete and overlapping concepts and techniques (Figure 1).

Our presentation of results will include a map of a dynamic topic modeling analysis of included studies. Dynamic topic modeling is a family of probabilistic time series models to explore the evolution of topics in document collections (Blei & Lafferty, 2006). The results of this analysis will be displayed in a chronological map to document the change over time in a range of topics related to the two fields of interest to our scoping review objective: how CSS and CBR literature overlap. This approach will also take the place of normally showing results as a distribution of studies by year or period of publication. This will be a novel approach in scoping and systematic reviews that will bolster our exploration of these two bodies of literature.

Our presentation of results will also include a table that summarizes our extracted data (see data extraction section) as well as a narrative around the salient elements (refer to Table 2) of the studies that seem to coalesce the CSS and CBR disciplines.

**Figure 1.** Discrete and overlapping topics.



## Declarations

**Funding:** The authors declare they have received no funding to support this protocol.

**Competing interests:** The authors declare that they have no competing interests.

**Acknowledgments:** The authors of this report would like to extend a warm thank you to the members of the 2019 Complex Systems Summer School at the Santa Fe Institute who shared their valuable time, knowledge, opinions, experiences, and insights for this project.

## References

- Advani, S. M., Advani, P. G., VonVille, H. M., & Jafri, S. H. (2018). Pharmacological management of cachexia in adult cancer patients: A systematic review of clinical trials. *BMC Cancer*, *18*(1), 1174. <https://doi.org/10.1186/s12885-018-5080-4>
- Blei, D. M., & Lafferty, J. D. (2006). Dynamic topic models. *Proceedings of the 23rd International Conference on Machine Learning - ICML '06*, 113–120. <https://doi.org/10.1145/1143844.1143859>
- Bonabeau, E. (2002). Agent-based modeling: Methods and techniques for simulating human systems. *Proceedings of the National Academy of Sciences*, *99*(suppl 3), 7280–7287. <https://doi.org/10.1073/pnas.082080899>
- Cholewicki, J., Popovich, J. M., Aminpour, P., Gray, S. A., Lee, A. S., & Hodges, P. W. (2019). Development of a collaborative model of low back pain: Report from the 2017 NASS consensus meeting. *The Spine Journal*, *19*(6), 1029–1040. <https://doi.org/10.1016/j.spinee.2018.11.014>

- Collins, S. E., Clifasefi, S. L., Stanton, J., The LEAP Advisory Board, Straits, K. J. E., Gil-Kashiwabara, E., ... Wallerstein, N. (2018). Community-based participatory research (CBPR): Towards equitable involvement of community in psychology research. *American Psychologist*, *73*(7), 884–898. <https://doi.org/10.1037/amp0000167>
- Ebhuoma, E. E., Simatele, M. D., Tantoh, H. B., & Donkor, F. K. (2019). Asset vulnerability analytical framework and systems thinking as a twin methodology for highlighting factors that undermine efficient food production. *Jàmbá: Journal of Disaster Risk Studies*, *11*(1), 1–12. <https://doi.org/10.4102/jamba.v11i1.597>
- Faggion, C. M. (2015). Critical appraisal of AMSTAR: Challenges, limitations, and potential solutions from the perspective of an assessor. *BMC Medical Research Methodology*, *15*(1), 63. <https://doi.org/10.1186/s12874-015-0062-6>
- Frerichs, L., Young, T. L., Dave, G., Stith, D., Corbie-Smith, G., & Hassmiller Lich, K. (2018). Mind maps and network analysis to evaluate conceptualization of complex issues: A case example evaluating systems science workshops for childhood obesity prevention. *Evaluation and Program Planning*, *68*, 135–147. <https://doi.org/10.1016/j.evalprogplan.2018.03.003>
- Galea, S., Ettman, C. K., & Vlahov, D. (2019). *Urban Health*. Oxford University Press.
- Gaydos, D. A., Petrasova, A., Cobb, R. C., & Meentemeyer, R. K. (2019). Forecasting and control of emerging infectious forest disease through participatory modelling. *Philosophical Transactions of the Royal Society B*. Retrieved from <https://royalsocietypublishing.org/doi/abs/10.1098/rstb.2018.0283>
- George, A. S., Mehra, V., Scott, K., & Sriram, V. (2015). Community Participation in Health Systems Research: A Systematic Review Assessing the State of Research, the Nature of Interventions Involved and the Features of Engagement with Communities. *PLOS ONE*, *10*(10), e0141091. <https://doi.org/10.1371/journal.pone.0141091>
- Hammond, R. A. (2009). Complex systems modeling for obesity research. *Preventing Chronic Disease*, *6*(3), A97.
- Hovmand, P. S. (2014). Group Model Building and Community-Based System Dynamics Process. In P. S. Hovmand (Ed.), *Community Based System Dynamics* (pp. 17–30). [https://doi.org/10.1007/978-1-4614-8763-0\\_2](https://doi.org/10.1007/978-1-4614-8763-0_2)
- Laycock, A., Bailie, J., Matthews, V., & Bailie, R. (2019). Using developmental evaluation to support knowledge translation: Reflections from a large-scale quality improvement project in Indigenous primary healthcare. *Health Research Policy and Systems*, *17*(1), 70. <https://doi.org/10.1186/s12961-019-0474-6>
- Manning, C. D., Manning, C. D., & Schütze, H. (1999). *Foundations of Statistical Natural Language Processing*. MIT Press.
- Moher, D. (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. *Annals of Internal Medicine*, *151*(4), 264. <https://doi.org/10.7326/0003-4819-151-4-200908180-00135>
- Pagano, A., Pluchinotta, I., Pengal, P., Cokan, B., & Giordano, R. (2019). Engaging stakeholders in the assessment of NBS effectiveness in flood risk reduction: A participatory System Dynamics Model for benefits and co-benefits evaluation. *Science of The Total Environment*, *690*, 543–555. <https://doi.org/10.1016/j.scitotenv.2019.07.059>
- Patton, M. Q. (2010). *Developmental Evaluation: Applying Complexity Concepts to Enhance Innovation and Use*. Guilford Press.
- Simpson, L., Wood, L., & Daws, L. (2003). Community capacity building: Starting with people not projects. *Community Development Journal*, *38*(4), 277–286. <https://doi.org/10.1093/cdj/38.4.277>



- Skaburskis, A. (2008). The Origin of “Wicked Problems.” *Planning Theory & Practice*, 9(2), 277–280. <https://doi.org/10.1080/14649350802041654>
- Späth, L., & Scolobig, A. (2017). Stakeholder empowerment through participatory planning practices: The case of electricity transmission lines in France and Norway. *Energy Research & Social Science*, 23, 189–198. <https://doi.org/10.1016/j.erss.2016.10.002>
- Strand, K., Marullo, S., Cutforth, N. J., Stoecker, R., & Donohue, P. (2003). Principles of best practice for community-based research.
- Valaitis, R., Martin-Misener, R., Wong, S. T., MacDonald, M., Meagher-Stewart, D., Austin, P., ... Team, the S. P. H. C. through P. H. and P. C. C. (2012). Methods, strategies and technologies used to conduct a scoping literature review of collaboration between primary care and public health. *Primary Health Care Research & Development*, 13(3), 219–236. <https://doi.org/10.1017/S1463423611000594>
- Wallerstein, N., Duran, B., Oetzel, J. G., & Minkler, M. (2017). *Community-Based Participatory Research for Health: Advancing Social and Health Equity*. John Wiley & Sons.
- Williams, B., & Hummelbrunner, R. (2010). *Systems Concepts in Action: A Practitioner’s Toolkit*. Stanford University Press.
- Wolff, T. (2001). Community coalition building—contemporary practice and research: introduction. *American journal of community psychology*, 29(2), 165-172.
- Wolff, T., Minkler, M., Wolfe, S. M., Berkowitz, B., Bowen, L., Butterfoss, F. D., & Lee, K. S. (2017). Collaborating for equity and justice: Moving beyond collective impact. *Nonprofit Quarterly*, 9, 42-53.

## Appendix A

### Search strategies and number of articles found

**Table 1.** Summary of databases searched.

<b>TTable</b>	<b>Vendor/Interface</b>	<b>Database</b>	<b>Date searched</b>	<b>Database update</b>	<b>Searcher</b>
1a	Ovid	Medline®	July 25, 2019	Ovid MEDLINE(R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations and Daily 1946 to July 23, 2019	Helena M. VonVille
1b	Ovid	PsycINFO®	July 25, 2019	1806 to July, 2019	Helena M. VonVille
1c	Elsevier Engineering Village	Compendex & Knovel	August 2, 2019	August 2, 2019	Helena M. VonVille
1d	Elsevier	Embase®	August 2, 2019	August 2, 2019	Helena M. VonVille
1e	ProQuest	ASFA: American Science and Fisheries Abstracts	August 2, 2019	August 2, 2019	Helena M. VonVille
1f	EBSCO	Academic Search Premier	August 5, 2019	August 5, 2019	Helena M. VonVille
1g	Ovid	AGRICOLA	August 5, 2019	1970 to July 2019	Helena M. VonVille
1h	EBSCO	ERIC (Educational Resource Information	August 5, 2019	August 5, 2019	Helena M. VonVille

		Clearinghouse)			
lj	Clarivate Analytics	Web of Science (Indexes=SCI-EXPANDED, SSCI, A&HCI, ESCI Timespan=All years)	August 7, 2019	August 7, 2019	Helena M. VonVille

**Table 1a.** Medline® search strategy.

<b>Provider/Interface</b>	Ovid
<b>Database</b>	Medline®
<b>Date searched</b>	July 25, 2019; Updated January 30, 2020
<b>Database update</b>	Ovid MEDLINE(R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations and Daily 1946 to July 23, 2019; 1946 to January 29, 2020
<b>Search developer(s)</b>	Helena M. VonVille
<b>Limit to English</b>	Yes
<b>Date Range</b>	No date limit
<b>Publication Types</b>	No publication types excluded
<b>Search filter source</b>	No filter used

1	("collaborative modeling" or "collaborative modelling" or "collaborative simulation" or "participatory modeling" or "participatory modelling" or "participatory simulation").ti,ab,kw.
2	Community-Based Participatory Research/
3	Community Participation/
4	("Action research" or "Bottom-up approach" or "Citizen science" or "co-construct" or "co-create" or "co-created" or "co-creates" or "co-design" or "co-generate" or "co-generated" or "co-generates" or "co-produce" or "Collaborative governance" or "Collaborative inquiry" or "Collaborative network" or "Collective action" or "Community engagement" or "Community-based evaluation" or "Community-based" or "Community-based participatory research" or "Community-based research" or "Community-engaged" or "Community-engaged research" or "Community-placed research" or "Participatory" or "Stakeholder engaged" or "stakeholder engagement").ti,ab,kw.
5	2 or 3 or 4
6	systems theory/
7	("Adaptive voter model" or "Agent-based models" or "Causal loop diagram" or "Complex adaptive system" or "Complex adaptive systems" or "Complex system" or "Complex systems" or "Co-evolve" or "Co-evolved" or "Co-evolves" or "Co-evolving" or "co-evolution" or "Discrete event simulation" or "Dynamical modeling" or "Dynamical modelling" or "network resiliency" or "Non-linear dynamic model" or "Non-linear dynamic models" or "Participatory model" or "Participatory models" or "SEIR" or "Social network analysis" or "Soft systems methodology" or "soft systems science" or "State-space model" or "Susceptible-Exposed" or "Susceptible-Infection-Recovered model" or "Systems dynamics" or "Systems science" or "Systems thinking" or "Value chains").ti,ab,kw.
8	6 or 7
9	5 and 8
10	1 or 9
11	10 and english.la.
	<b>Updated 1/30/2020: reran search and added "group model building"</b>
1	("collaborative modeling" or "collaborative modelling" or "collaborative simulation" or "group model building" or "participatory modeling" or "participatory modelling" or

	"participatory simulation").ti,ab,kw.
2	Community-Based Participatory Research/
3	Community Participation/
4	("Action research" or "Bottom-up approach" or "Citizen science" or "co-construct" or "co-create" or "co-created" or "co-creates" or "co-design" or "co-generate" or "co-generated" or "co-generates" or "co-produce" or "Collaborative governance" or "Collaborative inquiry" or "Collaborative network" or "Collective action" or "Community engagement " or "Community-based evaluation" or "Community-based" or "Community-based participatory research" or "Community-based research" or "Community-engaged" or "Community-engaged research" or "Community-placed research" or "Participatory" or "Stakeholder engaged" or "stakeholder engagement").ti,ab,kw.
5	2 or 3 or 4
6	systems theory/
7	("Adaptive voter model" or "Agent-based models" or "Causal loop diagram" or "Complex adaptive system" or "Complex adaptive systems" or "Complex system" or "Complex systems" or "Co-evolve" or "Co-evolved" or "Co-evolves" or "Co-evolving" or "co-evolution" or "Discrete event simulation" or "Dynamical modeling" or "Dynamical modelling" or "network resiliency" or "Non-linear dynamic model" or "Non-linear dynamic models" or "Participatory model" or "Participatory models" or "SEIR" or "Social network analysis" or "Soft systems methodology" or "soft systems science" or "State-space model" or "Susceptible-Exposed" or "Susceptible-Infection-Recovered model" or "Systems dynamics" or "Systems science" or "Systems thinking" or "Value chains").ti,ab,kw.
8	6 or 7
9	5 and 8
10	1 or 9
11	10 and english.la.

**Table 1b.** PsycINFO search strategy.

<b>Provider/Interface</b>	Ovid
<b>Database</b>	PsycINFO®
<b>Date searched</b>	July 25, 2019; update January 30, 2020
<b>Database update</b>	1806 to July Week 3 2019; 1806 to January Week 3 2020
<b>Search developer(s)</b>	Helena M. VonVille
<b>Limit to English</b>	Yes
<b>Date Range</b>	No date limit
<b>Publication Types</b>	Journals only (excludes books, book chapters, dissertations)
<b>Search filter source</b>	No filter used

1	("collaborative modeling" or "collaborative modelling" or "collaborative simulation" or "participatory modeling" or "participatory modelling" or "participatory simulation").ti,ab,id.
2	community involvement/ or collective efficacy theory/
3	action research/
4	("Action research" or "Bottom-up approach" or "Citizen science" or "co-construct" or "co-create" or "co-created" or "co-creates" or "co-design" or "co-generate" or "co-generated" or "co-generates" or "co-produce" or "Collaborative governance" or "Collaborative inquiry" or "Collaborative network" or "Collective action" or "Community engagement " or "Community-based evaluation" or "Community-based" or "Community-based participatory research" or "Community-based research" or "Community-engaged" or "Community-engaged research" or "Community-placed research" or "Participatory" or "Stakeholder engaged" or "stakeholder engagement").ti,ab,id.
5	2 or 3 or 4
6	systems theory/
7	("Adaptive voter model" or "Agent-based models" or "Causal loop diagram" or "Complex adaptive system" or "Complex adaptive systems" or "Complex system" or "Complex systems" or "Co-evolve" or "Co-evolved" or "Co-evolves" or "Co-evolving" or "co-evolution" or "Discrete event simulation" or "Dynamical modeling" or "Dynamical modelling" or "network resiliency" or "Non-linear dynamic model" or "Non-linear dynamic models" or "Participatory model" or "Participatory models" or "SEIR" or "Social network analysis" or "Soft systems methodology" or "soft systems science" or "State-space model" or "Susceptible-Exposed" or "Susceptible-Infection-Recovered model" or "Systems dynamics" or "Systems science" or "Systems thinking" or "Value chains").ti,ab,id.
8	6 or 7
9	5 and 8
10	1 or 9
11	10 and english.la.
12	limit 11 to all journals
	<b>Updated 1/30/2020: reran search and added "group model building"</b>
1	("collaborative modeling" or "collaborative modelling" or "collaborative simulation" or "group model building" or "participatory modeling" or "participatory modelling" or "participatory simulation").ti,ab,id.

2	community involvement/ or collective efficacy theory/
3	action research/
4	("Action research" or "Bottom-up approach" or "Citizen science" or "co-construct" or "co-create" or "co-created" or "co-creates" or "co-design" or "co-generate" or "co-generated" or "co-generates" or "co-produce" or "Collaborative governance" or "Collaborative inquiry" or "Collaborative network" or "Collective action" or "Community engagement " or "Community-based evaluation" or "Community-based" or "Community-based participatory research" or "Community-based research" or "Community-engaged" or "Community-engaged research" or "Community-placed research" or "Participatory" or "Stakeholder engaged" or "stakeholder engagement").ti,ab,id.
5	2 or 3 or 4
6	systems theory/
7	("Adaptive voter model" or "Agent-based models" or "Causal loop diagram" or "Complex adaptive system" or "Complex adaptive systems" or "Complex system" or "Complex systems" or "Co-evolve" or "Co-evolved" or "Co-evolves" or "Co-evolving" or "co-evolution" or "Discrete event simulation" or "Dynamical modeling" or "Dynamical modelling" or "network resiliency" or "Non-linear dynamic model" or "Non-linear dynamic models" or "Participatory model" or "Participatory models" or "SEIR" or "Social network analysis" or "Soft systems methodology" or "soft systems science" or "State-space model" or "Susceptible-Exposed" or "Susceptible-Infection-Recovered model" or "Systems dynamics" or "Systems science" or "Systems thinking" or "Value chains").ti,ab,id.
8	6 or 7
9	5 and 8
10	1 or 9
11	10 and english.la.
12	limit 11 to all journals

**Table 1c.** Compendex & Knovel search strategy.

<b>Provider/Interface</b>	Elsevier Engineering Village
<b>Database</b>	Compendex & Knovel
<b>Date searched</b>	August 2, 2019
<b>Database update</b>	August 2, 2019
<b>Search developer(s)</b>	Helena M. VonVille
<b>Limit to English</b>	Yes
<b>Date Range</b>	No date limit
<b>Publication Types</b>	Journals only
<b>Search filter source</b>	No filter used

((((( {Action research} OR {Bottom-up approach} OR {Citizen science} OR {co-construct} OR {co-create} OR {co-created} OR {co-creates} OR {co-design} OR {co-generate} OR {co-generated} OR {co-generates} OR {co-produce} OR {Collaborative governance} OR {Collaborative inquiry} OR {Collaborative network} OR {Collective action} OR {Community engagement} OR {Community-based evaluation} OR {Community-based} OR {Community-based participatory research} OR {Community-based research} OR {Community-engaged} OR {Community-engaged research} OR {Community-placed research} OR {Participatory} OR {Stakeholder engaged} OR {stakeholder engagement}))) WN ALL) AND (JA WN DT) AND (English WN LA) AND (1884-2020 WN YR)) AND ( ((( {Adaptive voter model} OR {Agent-based models} OR {Causal loop diagram} OR {Complex adaptive system} OR {Complex adaptive systems} OR {Complex system} OR {Complex systems} OR {Co-evolve} OR {Co-evolved} OR {Co-evolves} OR {Co-evolving} OR {co-evolution} OR {Discrete event simulation} OR {Dynamical modeling} OR {Dynamical modelling} OR {network resiliency} OR {Non-linear dynamic model} OR {Non-linear dynamic models} OR {Participatory model} OR {Participatory models} OR {SEIR} OR {Social network analysis} OR {Soft systems methodology} OR {soft systems science} OR {State-space model} OR {Susceptible-Exposed} OR {Susceptible-Infection-Recovered model} OR {Systems dynamics} OR {Systems science} OR {Systems thinking} OR {Value chains}))) WN ALL) AND (JA WN DT) AND (English WN LA) AND (1884-2020 WN YR))) OR ( ((( {collaborative modeling} OR {collaborative modelling} OR {collaborative simulation} OR {participatory modeling} OR {participatory modelling} OR {participatory simulation}))) WN ALL) AND (JA WN DT) AND (English WN LA) AND (1884-2020 WN YR)))

**Will be updated to incorporate “group model building”**



**Table 1d.** EMBASE search strategy.

<b>Provider/Interface</b>	Elsevier
<b>Database</b>	Embase®
<b>Date searched</b>	August 2, 2019
<b>Database update</b>	August 2, 2019
<b>Search developer(s)</b>	Helena M. VonVille
<b>Limit to English</b>	Yes
<b>Date Range</b>	No date limit
<b>Publication Types</b>	Conference proceedings excluded
<b>Search filter source</b>	No filter used

1	'collaborative modeling':ti,ab,kw OR 'collaborative modelling':ti,ab,kw OR 'collaborative simulation':ti,ab,kw OR 'participatory modeling':ti,ab,kw OR 'participatory modelling':ti,ab,kw OR 'participatory simulation':ti,ab,kw
2	'participatory research'/de
3	'community participation'/de
4	Action research:ti,ab,kw OR "Bottom-up approach":ti,ab,kw OR "Citizen science":ti,ab,kw OR "co-construct":ti,ab,kw OR "co-create":ti,ab,kw OR "co-created":ti,ab,kw OR "co-creates":ti,ab,kw OR "co-design":ti,ab,kw OR "co-generate":ti,ab,kw OR "co-generated":ti,ab,kw OR "co-generates":ti,ab,kw OR "co-produce":ti,ab,kw OR "Collaborative governance":ti,ab,kw OR "Collaborative inquiry":ti,ab,kw OR "Collaborative network":ti,ab,kw OR "Collective action":ti,ab,kw OR "Community engagement ":ti,ab,kw OR "Community-based evaluation":ti,ab,kw OR "Community-based":ti,ab,kw OR "Community-based participatory research":ti,ab,kw OR "Community-based research":ti,ab,kw OR "Community-engaged":ti,ab,kw OR "Community-engaged research":ti,ab,kw OR "Community-placed research":ti,ab,kw OR "Participatory":ti,ab,kw OR "Stakeholder engaged":ti,ab,kw OR "stakeholder engagement":ti,ab,kw
5	#2 OR #3 OR #4
6	'systems theory'/de
7	Adaptive voter model:ti,ab,kw OR "Agent-based models":ti,ab,kw OR "Causal loop diagram":ti,ab,kw OR "Complex adaptive system":ti,ab,kw OR "Complex adaptive systems":ti,ab,kw OR "Complex system":ti,ab,kw OR "Complex systems":ti,ab,kw OR "Co-evolve":ti,ab,kw OR "Co-evolved":ti,ab,kw OR "Co-evolves":ti,ab,kw OR "Co-evolving":ti,ab,kw OR "co-evolution":ti,ab,kw OR "Discrete event simulation":ti,ab,kw OR "Dynamical modeling":ti,ab,kw OR "Dynamical modelling":ti,ab,kw OR "network resiliency":ti,ab,kw OR "Non-linear dynamic model":ti,ab,kw OR "Non-linear dynamic models":ti,ab,kw OR "Participatory model":ti,ab,kw OR "Participatory models":ti,ab,kw OR "SEIR":ti,ab,kw OR "Social network analysis":ti,ab,kw OR "Soft systems methodology":ti,ab,kw OR "soft systems science":ti,ab,kw OR "State-space model":ti,ab,kw OR "Susceptible-Exposed":ti,ab,kw OR "Susceptible-Infection-Recovered model":ti,ab,kw OR "Systems dynamics":ti,ab,kw OR "Systems science":ti,ab,kw OR "Systems thinking":ti,ab,kw OR "Value chains":ti,ab,kw
8	#6 OR #7
9	#5 AND #8
10	#1 OR #9
11	#10 NOT ([medline]/lim OR 'conference abstract'/it OR 'conference paper'/it OR

	'conference review'/it) AND [english]/lim
	<b>Updated 1/30/2020: reran search and added "group model building"</b>
1	'collaborative modeling':ti,ab,kw OR 'collaborative modelling':ti,ab,kw OR 'collaborative simulation':ti,ab,kw OR 'group model building':ti,ab,kw OR 'participatory modeling':ti,ab,kw OR 'participatory modelling':ti,ab,kw OR 'participatory simulation':ti,ab,kw
2	'participatory research'/de
3	'community participation'/de
4	'Action research':ti,ab,kw OR 'Bottom-up approach':ti,ab,kw OR 'Citizen science':ti,ab,kw OR 'co-construct':ti,ab,kw OR 'co-create':ti,ab,kw OR 'co-created':ti,ab,kw OR 'co-creates':ti,ab,kw OR 'co-design':ti,ab,kw OR 'co-generate':ti,ab,kw OR 'co-generated':ti,ab,kw OR 'co-generates':ti,ab,kw OR 'co-produce':ti,ab,kw OR 'Collaborative governance':ti,ab,kw OR 'Collaborative inquiry':ti,ab,kw OR 'Collaborative network':ti,ab,kw OR 'Collective action':ti,ab,kw OR 'Community engagement ':ti,ab,kw OR 'Community-based evaluation':ti,ab,kw OR 'Community-based':ti,ab,kw OR 'Community-based participatory research':ti,ab,kw OR 'Community-based research':ti,ab,kw OR 'Community-engaged':ti,ab,kw OR 'Community-engaged research':ti,ab,kw OR 'Community-placed research':ti,ab,kw OR 'Participatory':ti,ab,kw OR 'Stakeholder engaged':ti,ab,kw OR 'stakeholder engagement':ti,ab,kw
5	#2 OR #3 OR #4
6	'systems theory'/de
7	'Adaptive voter model':ti,ab,kw OR 'Agent-based models':ti,ab,kw OR 'Causal loop diagram':ti,ab,kw OR 'Complex adaptive system':ti,ab,kw OR 'Complex adaptive systems':ti,ab,kw OR 'Complex system':ti,ab,kw OR 'Complex systems':ti,ab,kw OR 'Co-evolve':ti,ab,kw OR 'Co-evolved':ti,ab,kw OR 'Co-evolves':ti,ab,kw OR 'Co-evolving':ti,ab,kw OR 'co-evolution':ti,ab,kw OR 'Discrete event simulation':ti,ab,kw OR 'Dynamical modeling':ti,ab,kw OR 'Dynamical modelling':ti,ab,kw OR 'network resiliency':ti,ab,kw OR 'Non-linear dynamic model':ti,ab,kw OR 'Non-linear dynamic models':ti,ab,kw OR 'Participatory model':ti,ab,kw OR 'Participatory models':ti,ab,kw OR 'SEIR':ti,ab,kw OR 'Social network analysis':ti,ab,kw OR 'Soft systems methodology':ti,ab,kw OR 'soft systems science':ti,ab,kw OR 'State-space model':ti,ab,kw OR 'Susceptible-Exposed':ti,ab,kw OR 'Susceptible-Infection-Recovered model':ti,ab,kw OR 'Systems dynamics':ti,ab,kw OR 'Systems science':ti,ab,kw OR 'Systems thinking':ti,ab,kw OR 'Value chains':ti,ab,kw
8	#6 OR #7
9	#5 AND #8
10	#1 OR #9
11	#10 NOT ([medline]/lim OR 'conference abstract'/it OR 'conference paper'/it OR 'conference review'/it) AND [english]/lim

**Table 1e.** ASFA search strategy.

<b>Provider/Interface</b>	ProQuest
<b>Database</b>	ASFA: American Science and Fisheries Abstracts
<b>Date searched</b>	August 2, 2019
<b>Database update</b>	August 2, 2019
<b>Search developer(s)</b>	Helena M. VonVille
<b>Limit to English</b>	Yes
<b>Date Range</b>	No date limit
<b>Publication Types</b>	Limit to scholarly articles
<b>Search filter source</b>	No filter used

S1	ab("collaborative modeling" OR "collaborative modelling" OR "collaborative simulation" OR "participatory modeling" OR "participatory modelling" OR "participatory simulation") OR ti("collaborative modeling" OR "collaborative modelling" OR "collaborative simulation" OR "participatory modeling" OR "participatory modelling" OR "participatory simulation") OR if("collaborative modeling" OR "collaborative modelling" OR "collaborative simulation" OR "participatory modeling" OR "participatory modelling" OR "participatory simulation")
S2	MAINSUBJECT.EXACT("User participation") OR MAINSUBJECT.EXACT("Participatory approach")
S3	ab("Action research" or "Bottom-up approach" or "Citizen science" or "co-construct" or "co-create" or "co-created" or "co-creates" or "co-design" or "co-generate" or "co-generated" or "co-generates" or "co-produce" or "Collaborative governance" or "Collaborative inquiry" or "Collaborative network" or "Collective action" or "Community engagement " or "Community-based evaluation" or "Community-based" or "Community-based participatory research" or "Community-based research" or "Community-engaged" or "Community-engaged research" or "Community-placed research" or "Participatory" or "Stakeholder engaged" or "stakeholder engagement") OR ti("Action research" or "Bottom-up approach" or "Citizen science" or "co-construct" or "co-create" or "co-created" or "co-creates" or "co-design" or "co-generate" or "co-generated" or "co-generates" or "co-produce" or "Collaborative governance" or "Collaborative inquiry" or "Collaborative network" or "Collective action" or "Community engagement " or "Community-based evaluation" or "Community-based" or "Community-based participatory research" or "Community-based research" or "Community-engaged" or "Community-engaged research" or "Community-placed research" or "Participatory" or "Stakeholder engaged" or "stakeholder engagement") OR if("Action research" or "Bottom-up approach" or "Citizen science" or "co-construct" or "co-create" or "co-created" or "co-creates" or "co-design" or "co-generate" or "co-generated" or "co-generates" or "co-produce" or "Collaborative governance" or "Collaborative inquiry" or "Collaborative network" or "Collective action" or "Community engagement " or "Community-based evaluation" or "Community-based" or "Community-based participatory research" or "Community-based research" or "Community-engaged" or "Community-engaged research" or "Community-placed research" or "Participatory" or "Stakeholder engaged" or "stakeholder engagement")
S4	S2 OR S3

S5	ab("Adaptive voter model" or "Agent-based models" or "Causal loop diagram" or "Complex adaptive system" or "Complex adaptive systems" or "Complex system" or "Complex systems" or "Co-evolve" or "Co-evolved" or "Co-evolves" or "Co-evolving" or "co-evolution" or "Discrete event simulation" or "Dynamical modeling" or "Dynamical modelling" or "network resiliency" or "Non-linear dynamic model" or "Non-linear dynamic models" or "Participatory model" or "Participatory models" or "SEIR" or "Social network analysis" or "Soft systems methodology" or "soft systems science" or "State-space model" or "Susceptible-Exposed" or "Susceptible-Infection-Recovered model" or "Systems dynamics" or "Systems science" or "Systems thinking" or "Value chains") OR ti("Adaptive voter model" or "Agent-based models" or "Causal loop diagram" or "Complex adaptive system" or "Complex adaptive systems" or "Complex system" or "Complex systems" or "Co-evolve" or "Co-evolved" or "Co-evolves" or "Co-evolving" or "co-evolution" or "Discrete event simulation" or "Dynamical modeling" or "Dynamical modelling" or "network resiliency" or "Non-linear dynamic model" or "Non-linear dynamic models" or "Participatory model" or "Participatory models" or "SEIR" or "Social network analysis" or "Soft systems methodology" or "soft systems science" or "State-space model" or "Susceptible-Exposed" or "Susceptible-Infection-Recovered model" or "Systems dynamics" or "Systems science" or "Systems thinking" or "Value chains") OR if("Adaptive voter model" or "Agent-based models" or "Causal loop diagram" or "Complex adaptive system" or "Complex adaptive systems" or "Complex system" or "Complex systems" or "Co-evolve" or "Co-evolved" or "Co-evolves" or "Co-evolving" or "co-evolution" or "Discrete event simulation" or "Dynamical modeling" or "Dynamical modelling" or "network resiliency" or "Non-linear dynamic model" or "Non-linear dynamic models" or "Participatory model" or "Participatory models" or "SEIR" or "Social network analysis" or "Soft systems methodology" or "soft systems science" or "State-space model" or "Susceptible-Exposed" or "Susceptible-Infection-Recovered model" or "Systems dynamics" or "Systems science" or "Systems thinking" or "Value chains")
S6	S4 AND S5
S7	S1 OR S6
S8	S1 or S6 Limit to scholarly articles & English
	<b>Will be updated to incorporate “group model building”</b>

**Table 1f.** Academic Search Premier search strategy.

<b>Provider/Interface</b>	Ebsco
<b>Database</b>	Academic Search Premier
<b>Date searched</b>	August 5, 2019
<b>Database update</b>	August 5, 2019
<b>Search developer(s)</b>	Helena M. VonVille
<b>Limit to English</b>	Yes
<b>Date Range</b>	No date limit
<b>Publication Types</b>	Limit to academic journals
<b>Search filter source</b>	No filter used

S1	TI ( ("collaborative modeling" OR "collaborative modelling" OR "collaborative simulation" OR "participatory modeling" OR "participatory modelling" OR "participatory simulation" ) OR KW ( ("collaborative modeling" OR "collaborative modelling" OR "collaborative simulation" OR "participatory modeling" OR "participatory modelling" OR "participatory simulation" ) OR AB ( ("collaborative modeling" OR "collaborative modelling" OR "collaborative simulation" OR "participatory modeling" OR "participatory modelling" OR "participatory simulation" ) )
S2	((DE "SHARED leadership") OR (DE "COMMUNITY-based participatory research")) OR (DE "COOPERATIVE research")) AND (DE "ACTION research" OR DE "ACTION research in education")
S3	TI ( "Action research" OR "Bottom-up approach" OR "Citizen science" OR "co-construct" OR "co-create" OR "co-created" OR "co-creates" OR "co-design" OR "co-generate" OR "co-generated" OR "co-generates" OR "co-produce" OR "Collaborative governance" OR "Collaborative inquiry" OR "Collaborative network" OR "Collective action" OR "Community engagement " OR "Community-based evaluation" OR "Community-based" OR "Community-based participatory research" OR "Community-based research" OR "Community-engaged" OR "Community-engaged research" OR "Community-placed research" OR "Participatory" OR "Stakeholder engaged" OR "stakeholder engagement" ) OR KW ( "Action research" OR "Bottom-up approach" OR "Citizen science" OR "co-construct" OR "co-create" OR "co-created" OR "co-creates" OR "co-design" OR "co-generate" OR "co-generated" OR "co-generates" OR "co-produce" OR "Collaborative governance" OR "Collaborative inquiry" OR "Collaborative network" OR "Collective action" OR "Community engagement " OR "Community-based evaluation" OR "Community-based" OR "Community-based participatory research" OR "Community-based research" OR "Community-engaged" OR "Community-engaged research" OR "Community-placed research" OR "Participatory" OR "Stakeholder engaged" OR "stakeholder engagement" ) OR AB ( "Action research" OR "Bottom-up approach" OR "Citizen science" OR "co-construct" OR "co-create" OR "co-created" OR "co-creates" OR "co-design" OR "co-generate" OR "co-generated" OR "co-generates" OR "co-produce" OR "Collaborative governance" OR "Collaborative inquiry" OR "Collaborative network" OR "Collective action" OR "Community engagement " OR "Community-based evaluation" OR "Community-based" OR "Community-based participatory research" OR "Community-based research" OR "Community-engaged" OR "Community-engaged research" OR "Community-placed research" OR "Participatory" OR "Stakeholder engaged" OR "stakeholder engagement" )

S4	S2 OR S3
S5	DE "SYSTEMS theory" OR DE "SOCIAL systems"
S6	TI ( "Adaptive voter model" OR "Agent-based models" OR "Causal loop diagram" OR "Complex adaptive system" OR "Complex adaptive systems" OR "Complex system" OR "Complex systems" OR "Co-evolve" OR "Co-evolved" OR "Co-evolves" OR "Co-evolving" OR "co-evolution" OR "Discrete event simulation" OR "Dynamical modeling" OR "Dynamical modelling" OR "network resiliency" OR "Non-linear dynamic model" OR "Non-linear dynamic models" OR "Participatory model" OR "Participatory models" OR "SEIR" OR "Social network analysis" OR "Soft systems methodology" OR "soft systems science" OR "State-space model" OR "Susceptible-Exposed" OR "Susceptible-Infection-Recovered model" OR "Systems dynamics" OR "Systems science" OR "Systems thinking" OR "Value chains" ) OR KW ( "Adaptive voter model" OR "Agent-based models" OR "Causal loop diagram" OR "Complex adaptive system" OR "Complex adaptive systems" OR "Complex system" OR "Complex systems" OR "Co-evolve" OR "Co-evolved" OR "Co-evolves" OR "Co-evolving" OR "co-evolution" OR "Discrete event simulation" OR "Dynamical modeling" OR "Dynamical modelling" OR "network resiliency" OR "Non-linear dynamic model" OR "Non-linear dynamic models" OR "Participatory model" OR "Participatory models" OR "SEIR" OR "Social network analysis" OR "Soft systems methodology" OR "soft systems science" OR "State-space model" OR "Susceptible-Exposed" OR "Susceptible-Infection-Recovered model" OR "Systems dynamics" OR "Systems science" OR "Systems thinking" OR "Value chains" ) OR AB ( "Adaptive voter model" OR "Agent-based models" OR "Causal loop diagram" OR "Complex adaptive system" OR "Complex adaptive systems" OR "Complex system" OR "Complex systems" OR "Co-evolve" OR "Co-evolved" OR "Co-evolves" OR "Co-evolving" OR "co-evolution" OR "Discrete event simulation" OR "Dynamical modeling" OR "Dynamical modelling" OR "network resiliency" OR "Non-linear dynamic model" OR "Non-linear dynamic models" OR "Participatory model" OR "Participatory models" OR "SEIR" OR "Social network analysis" OR "Soft systems methodology" OR "soft systems science" OR "State-space model" OR "Susceptible-Exposed" OR "Susceptible-Infection-Recovered model" OR "Systems dynamics" OR "Systems science" OR "Systems thinking" OR "Value chains" )
S7	S5 OR S6
S8	S4 AND S7
S9	(S1 OR S8) AND LA english Limit: Academic Journals
	<b>Will be updated to incorporate “group model building”</b>

**Table 1g.** AGRICOLA search strategy.

<b>Provider/Interface</b>	Ovid
<b>Database</b>	AGRICOLA
<b>Date searched</b>	August 5, 2019
<b>Database update</b>	1970 to July 2019
<b>Search developer(s)</b>	Helena M. VonVille
<b>Limit to English</b>	Yes
<b>Date Range</b>	No date limit
<b>Publication Types</b>	No publication types excluded
<b>Search filter source</b>	No filter used

1	("collaborative modeling" or "collaborative modelling" or "collaborative simulation" or "participatory modeling" or "participatory modelling" or "participatory simulation").ti,ab,id.
2	Community Participation/
3	("Action research" or "Bottom-up approach" or "Citizen science" or "co-construct" or "co-create" or "co-created" or "co-creates" or "co-design" or "co-generate" or "co-generated" or "co-generates" or "co-produce" or "Collaborative governance" or "Collaborative inquiry" or "Collaborative network" or "Collective action" or "Community engagement " or "Community-based evaluation" or "Community-based" or "Community-based participatory research" or "Community-based research" or "Community-engaged" or "Community-engaged research" or "Community-placed research" or "Participatory" or "Stakeholder engaged" or "stakeholder engagement").ti,ab,id.
4	2 or 3
5	("Adaptive voter model" or "Agent-based models" or "Causal loop diagram" or "Complex adaptive system" or "Complex adaptive systems" or "Complex system" or "Complex systems" or "Co-evolve" or "Co-evolved" or "Co-evolves" or "Co-evolving" or "co-evolution" or "Discrete event simulation" or "Dynamical modeling" or "Dynamical modelling" or "network resiliency" or "Non-linear dynamic model" or "Non-linear dynamic models" or "Participatory model" or "Participatory models" or "SEIR" or "Social network analysis" or "Soft systems methodology" or "soft systems science" or "State-space model" or "Susceptible-Exposed" or "Susceptible-Infection-Recovered model" or "Systems dynamics" or "Systems science" or "Systems thinking" or "Value chains").ti,ab,id.
6	4 and 5
7	1 and 6
8	7 and english.la.
	<b>Will be updated to incorporate “group model building”</b>

**Table 1h.** ERIC search strategy.

<b>Provider/Interface</b>	Ebsco
<b>Database</b>	ERIC (Educational Resource Information Clearinghouse)
<b>Date searched</b>	8/5/2019
<b>Database update</b>	43682
<b>Search developer(s)</b>	Helena M. VonVille
<b>Limit to English</b>	Yes
<b>Date Range</b>	No date limit
<b>Publication Types</b>	Dissertations excluded
<b>Search filter source</b>	No filter used

S1	TI ( ("collaborative modeling" OR "collaborative modelling" OR "collaborative simulation" OR "participatory modeling" OR "participatory modelling" OR "participatory simulation" ) OR KW ( ("collaborative modeling" OR "collaborative modelling" OR "collaborative simulation" OR "participatory modeling" OR "participatory modelling" OR "participatory simulation" ) OR AB ( ("collaborative modeling" OR "collaborative modelling" OR "collaborative simulation" OR "participatory modeling" OR "participatory modelling" OR "participatory simulation" ) )
S2	((DE "Participative Decision Making") OR (DE "Citizen Participation")) OR (DE "Community Involvement")) OR (DE "Community Cooperation") OR (DE "Participatory Research") OR (DE "Action Research")
S3	TI ( "Action research" OR "Bottom-up approach" OR "Citizen science" OR "co-construct" OR "co-create" OR "co-created" OR "co-creates" OR "co-design" OR "co-generate" OR "co-generated" OR "co-generates" OR "co-produce" OR "Collaborative governance" OR "Collaborative inquiry" OR "Collaborative network" OR "Collective action" OR "Community engagement " OR "Community-based evaluation" OR "Community-based" OR "Community-based participatory research" OR "Community-based research" OR "Community-engaged" OR "Community-engaged research" OR "Community-placed research" OR "Participatory" OR "Stakeholder engaged" OR "stakeholder engagement" ) OR KW ( "Action research" OR "Bottom-up approach" OR "Citizen science" OR "co-construct" OR "co-create" OR "co-created" OR "co-creates" OR "co-design" OR "co-generate" OR "co-generated" OR "co-generates" OR "co-produce" OR "Collaborative governance" OR "Collaborative inquiry" OR "Collaborative network" OR "Collective action" OR "Community engagement " OR "Community-based evaluation" OR "Community-based" OR "Community-based participatory research" OR "Community-based research" OR "Community-engaged" OR "Community-engaged research" OR "Community-placed research" OR "Participatory" OR "Stakeholder engaged" OR "stakeholder engagement" ) OR AB ( "Action research" OR "Bottom-up approach" OR "Citizen science" OR "co-construct" OR "co-create" OR "co-created" OR "co-creates" OR "co-design" OR "co-generate" OR "co-generated" OR "co-generates" OR "co-produce" OR "Collaborative governance" OR "Collaborative inquiry" OR "Collaborative network" OR "Collective action" OR "Community engagement " OR "Community-based evaluation" OR "Community-based" OR "Community-based participatory research" OR "Community-based research" OR "Community-engaged" OR "Community-engaged research" OR "Community-placed research" OR "Participatory" OR "Stakeholder engaged" OR "stakeholder engagement" )



S4	S2 OR S3
S5	(DE "Systems Approach") OR (DE "Systems Development")
S6	TI ( "Adaptive voter model" OR "Agent-based models" OR "Causal loop diagram" OR "Complex adaptive system" OR "Complex adaptive systems" OR "Complex system" OR "Complex systems" OR "Co-evolve" OR "Co-evolved" OR "Co-evolves" OR "Co-evolving" OR "co-evolution" OR "Discrete event simulation" OR "Dynamical modeling" OR "Dynamical modelling" OR "network resiliency" OR "Non-linear dynamic model" OR "Non-linear dynamic models" OR "Participatory model" OR "Participatory models" OR "SEIR" OR "Social network analysis" OR "Soft systems methodology" OR "soft systems science" OR "State-space model" OR "Susceptible-Exposed" OR "Susceptible-Infection-Recovered model" OR "Systems dynamics" OR "Systems science" OR "Systems thinking" OR "Value chains" ) OR KW ( "Adaptive voter model" OR "Agent-based models" OR "Causal loop diagram" OR "Complex adaptive system" OR "Complex adaptive systems" OR "Complex system" OR "Complex systems" OR "Co-evolve" OR "Co-evolved" OR "Co-evolves" OR "Co-evolving" OR "co-evolution" OR "Discrete event simulation" OR "Dynamical modeling" OR "Dynamical modelling" OR "network resiliency" OR "Non-linear dynamic model" OR "Non-linear dynamic models" OR "Participatory model" OR "Participatory models" OR "SEIR" OR "Social network analysis" OR "Soft systems methodology" OR "soft systems science" OR "State-space model" OR "Susceptible-Exposed" OR "Susceptible-Infection-Recovered model" OR "Systems dynamics" OR "Systems science" OR "Systems thinking" OR "Value chains" ) OR AB ( "Adaptive voter model" OR "Agent-based models" OR "Causal loop diagram" OR "Complex adaptive system" OR "Complex adaptive systems" OR "Complex system" OR "Complex systems" OR "Co-evolve" OR "Co-evolved" OR "Co-evolves" OR "Co-evolving" OR "co-evolution" OR "Discrete event simulation" OR "Dynamical modeling" OR "Dynamical modelling" OR "network resiliency" OR "Non-linear dynamic model" OR "Non-linear dynamic models" OR "Participatory model" OR "Participatory models" OR "SEIR" OR "Social network analysis" OR "Soft systems methodology" OR "soft systems science" OR "State-space model" OR "Susceptible-Exposed" OR "Susceptible-Infection-Recovered model" OR "Systems dynamics" OR "Systems science" OR "Systems thinking" OR "Value chains" )
S7	S5 OR S6
S8	S4 AND S7
S9	S1 OR S8
S10	(( S1 OR S8 ) NOT PU Dissertations/Theses ) AND LA english Limits: Reports, Academic journals, ERIC documents
	<b>Will be updated to incorporate “group model building”</b>

**Table 1i.** Web of Science search strategy.

<b>Provider/Interface</b>	Clarivate Analytics
<b>Database</b>	Web of Science (Indexes=SCI-EXPANDED, SSCI, A&HCI, ESCI Timespan=All years)
<b>Date searched</b>	August 7, 2019
<b>Database update</b>	August 7, 2019
<b>Search developer(s)</b>	Helena M. VonVille
<b>Limit to English</b>	Yes
<b>Date Range</b>	No date limit
<b>Publication Types</b>	Limit to articles
<b>Search filter source</b>	No filter used

#1	TOPIC: (("collaborative modeling" or "collaborative modelling" or "collaborative simulation" or "participatory modeling" or "participatory modelling" or "participatory simulation"))
#2	TOPIC: (("Action research" or "Bottom-up approach" or "Citizen science" or "co-construct" or "co-create" or "co-created" or "co-creates" or "co-design" or "co-generate" or "co-generated" or "co-generates" or "co-produce" or "Collaborative governance" or "Collaborative inquiry" or "Collaborative network" or "Collective action" or "Community engagement " or "Community-based evaluation" or "Community-based" or "Community-based participatory research" or "Community-based research" or "Community-engaged" or "Community-engaged research" or "Community-placed research" or "Participatory" or "Stakeholder engaged" or "stakeholder engagement"))
#3	TOPIC: (("Adaptive voter model" or "Agent-based models" or "Causal loop diagram" or "Complex adaptive system" or "Complex adaptive systems" or "Complex system" or "Complex systems" or "Co-evolve" or "Co-evolved" or "Co-evolves" or "Co-evolving" or "co-evolution" or "Discrete event simulation" or "Dynamical modeling" or "Dynamical modelling" or "network resiliency" or "Non-linear dynamic model" or "Non-linear dynamic models" or "Participatory model" or "Participatory models" or "SEIR" or "Social network analysis" or "Soft systems methodology" or "soft systems science" or "State-space model" or "Susceptible-Exposed" or "Susceptible-Infection-Recovered model" or "Systems dynamics" or "Systems science" or "Systems thinking" or "Value chains"))
#4	#3 AND #2
#5	#4 OR #1
#6	(#5) AND LANGUAGE: (English)
#7	(#6) AND LANGUAGE: (English) AND DOCUMENT TYPES: (Article)
	<b>Will be updated to incorporate “group model building”</b>

**Table 2.** Non-database searches yielding new studies.

**Scopus or Web of Science results**

Not completed.

**Bibliographies searched**

Not completed.

**Author names searched**

Not completed.