Preregistration for Quantitative Research in Psychology (PRP-QUANT) Template

Title

T1 Title
The title should be focused and descriptive, using relevant key terms to reflect what will be done in the study. Use title case (https://apastyle.apa.org/style-grammar-guidelines/capitalization/title-case).
Prior Knowledge and Learning: A Bibliometric Analysis of a Fragmented Field of Research

T2 Contributors, Affiliations, and Persistent IDs (recommend ORCID iD)
Provide in separate entries the full name of each contributor, each contributor's professional affiliation, and each contributor's persistent ID. See ORCID iD for an example of persistent ID (https://orcid.org/). Optional: include the intended contribution of each person listed (e.g. statistical analysis, data collection; see CRediT, https://casrai.org/credit/).
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T3 Date of Preregistration
This is assigned by the system upon preregistration submission.

T4 Versioning information

This is assigned by the system upon submission of original and subsequent revisions. Should be a persistent identifier, if not a DOI.

T5 Identifier

This unique identifier is assigned by the system upon submission.

T6 Estimated duration of project

Include best estimate for how long the project will take from preregistration submission to project completion.

5 months

T7 IRB Status (Institutional Review Board/Independent Ethics Committee/Ethical Review Board/Research Ethics Board)

If the study will include human or animal subjects, provide a brief overview of plans for the treatment of those subjects in accordance with established ethical guidelines. If appropriate institutional approval has been obtained for the study, provide the relevant identifier here. If the study will be exempt from ethical board review, provide reasoning here.

Not applicable

T8 Conflict of Interest Statement

Identify any real or perceived conflicts of interest with this study execution. For example, any interests or activities that might be seen as influencing the research (e.g., financial interests in a test or procedure, funding by pharmaceutical companies for research).

None declared.

T9 Keywords

Include terms specific to your topic, methodology, and population. Use natural language and avoid words used in the title or overly general terms. If you need help with keywords, try a keyword search using your proposed keywords in a search engine to check results.

prestorage, permanent stored knowledge, prestored knowledge, knowledge store, implicit knowledge, archival memory, experiential knowledge, background knowledge, world knowledge, pre-existing knowledge, preexisting knowledge, personal knowledge, learning, instruction, education, training, teaching, school, lessons, achievement, memory, acquisition, practice, artificial intelligence, cognitive model, categories trends, bibliometrics

T10 Data accessibility statement and planned repository

"We plan to make the data available (yes / no)
If "yes", please specify the planned data availability level by selecting one of the options:

- Data access via download; usage of data for all purposes (public use file)
- Data access via download; usage of data restricted to scientific purposes (scientific use file)
- Data access via download; usage of data has to be agreed and defined on an individual case basis
- Data access via secure data center (no download, usage/analysis only in a secure data center)
- Data available upon email request by member of scientific community
- Other (please specify)

Other
Due to copyright reasons, we will provide identifiers and basic metadata of documents included in the analysis corpus.

T11 Optional: Code availability

We plan to make the code available (yes / no).
If "yes", please specify the planned code availability level (use same descriptors of data in T10).

Yes
Code access via download; usage of data for all purposes (public use file)

T12 Optional: Standard lab practices

Standard lab practices refer to a (timestamped) document, software package, or similar, which specifies standard pipelines, analytical decisions, etc. which always apply to certain types of research in a lab. Specify here and refer to at the appropriate positions in the remainder of the template:
We plan to make the standard lab practices available (yes / no).
If "yes", please specify the planned standard lab practices availability level (use same descriptors of data in T10).

No

Abstract

(150 words)

A1 Background

(See introduction I1)

Prior knowledge is a prime predictor of learning outcomes. Thus far, the effects of prior knowledge has been studied regarding various content areas and in many different scientific fields. This fragmentation of the field may hinder scientific progress. Thus, an integrating overview of research on this topic is needed.

A2 Objectives and Research questions

(See introduction I2)

The overall aim of this exploratory study is to provide an overview of the field of prior knowledge in learning contexts by bibliometrically analyzing publications in psychology, educational sciences, and medical sciences. A total of 13 research questions will be addressed, referring to five areas: (1) topics, theories, and research methods of prior knowledge research, (2) methods and samples in educational settings, (3) prevalence of theoretically relevant terms, (4) publication outlets, and (5) subfields of psychology.

A3 Participants

(See methods M4)

Publication records and metadata will be collected from PsycINFO, PSYNDEX, ERIC, MEDLINE, and Web of Science. English-language research published between 1980 and 2020 will be included.

A4 Study method

(See methods M10-14)

Besides basic text statistics and frequency analyses, Structural Topic Modeling will be applied for topic identification.

Introduction

(no word limit)

I1 Theoretical background

Provide a brief overview that justifies the research hypotheses.

The prior knowledge of learners is one of the central determinants of successful learning. We define knowledge as information stored in memory. We define prior knowledge as knowledge that learners have stored in long-term memory at the onset of learning (Brod, Werkle-Bergner, & Shing, 2013; Dochy, Segers, & Buehl, 1999). It has been suggested that prior knowledge is the best predictor of learning success (Ausubel, 1968). A variety of scholars have empirically investigated this proposition over the past several decades. Previous research showed that prior knowledge explains between 30% to 60% of the variance in learning outcomes (Dochy, 1992).
To date, prior knowledge ist studied in various contexts and by a wide range of disciplines, including psychology, educational sciences, and medicine. A comprehensive overview of the research strains and foci in prior knowledge research is, thus far, missing. Such an overview would provide helpful insights for integrating and developing the research field.

I2 Objectives and Research question(s)

Outline objectives and research questions that inform the methodology and analyses (below).

In prior knowledge research, the writing of integrative literature reviews and meta-analyses is hampered by the lack of a comprehensive overview across disciplines. Thus, the overall aim of this exploratory study is to provide such an overview by bibliometrically analyzing publications of the learning sciences (i.e., Psychology, Cognitive Science, Educational Research). In order to shed light on the field of prior knowledge in learning contexts, a total of 13 research questions (RQs) will be addressed.

The first two RQs characterize an interdisciplinary overview of topics in prior knowledge research. Importantly, instead of searching for contents specified à priori (and finding only those), we use a fully data-driven approach for mapping the field comprehensively:

1. What are the main topics and subtopics of prior knowledge research?
2. How do topics relate to each other in terms of semantic similarity?

Whereas RQ 1 identifies publication contents in a fully exploratory manner, we accompany this bottom-up approach with frequency analyses of known and theoretically relevant terms. For the investigation of the following RQs we will specify lists of terms and

determine the frequencies of these terms in the included search hits. The terms will be compiled from published review articles (de Jong & Fergusson-Hessler, 1996; Dochy & Alexander, 1995). This will help us to investigate research questions 3 to 8:

3. What is the content domain of the investigated knowledge (e.g., mathematics, medicine, history, art)?
4. Which age groups and/or educational stages (e.g., primary, secondary, tertiary, or vocational education) are investigated?
5. What common theories of knowledge acquisition are mentioned (e.g., Mayer's Theory of Multimedia Learning, Vosniadou's theory of Conceptual Change, the Three P model of learning etc.)?
6. Which measures (e.g., reaction times, fMRI, problem solving) are employed?
7. What research designs (e.g., experiments, longitudinal studies) are used?
8. How frequently are different types, characteristics, and representations of knowledge investigated (e.g. declarative or procedural knowledge, fragmented or integrated knowledge, semantic networks or production rules, domain-specific or domain-general knowledge)?

For researchers, lecturers, and students alike, identifying the academic outlets for their topics of interest is highly relevant (where to publish, where to look for latest research and discussions, etc.). We address this issue by identifying main journals that publish prior knowledge research (RQ 9) and investigate their topical similarity (RQ 10):

9. Which journals are the most common outlets of prior knowledge research?
10. How do journals relate to each other in terms of topical similarity?

As prior knowledge is a construct of interest in different disciplines (e.g., Educational Psychology, Cognitive Neuroscience) and sub-fields (e.g., Multimedia Learning, Conceptual Change, Instructional Effectiveness), the last three RQs aim at determining their respective contributions (in terms of publication output) and their interrelation:

11. Which disciplines and subfields of disciplines address prior knowledge?
12. How do disciplines and subfields differ regarding publication output?
13. How do disciplines and subfields relate to each other in terms of topical similarity?

I3 Hypothesis (H1, H2, …)

Provide hypothesis for predicted results. If multiple hypotheses, uniquely number them (e.g., H1, H2a, H2b,) and refer to them the same way at other points in the registration document and in the manuscript.

not available / exploratory study

I4 Exploratory research questions (if applicable; E1, E2, ...)
If planning exploratory analyses, provide rationale for them here. If multiple exploratory analyses, uniquely number them (E1, E2, ...) and refer to them in the same way in the registration document and in future publications.
Additional exploratory analyses are considered in terms of comparing results from RQs 1–13 from two decades (i.e., 2001–2010 vs. 2011–2020). This allows us to examine how research on prior knowledge has evolved over time.

Method

M1 Time point of registration
Select one of the options: ● Registration prior to creation of data ● Registration prior to any human observation of the data ● Registration prior to accessing the data ● Registration prior to analysis of the data ● Other (please specify; might include if T1 longitudinal data has been analyzed, but T2 has not yet been analyzed)
Registration prior to creation of data

M2 Proposal: Use of pre-existing data (re-analysis or secondary data analysis)
Will pre-existing data be used in the planned study? If yes, indicate if the data were previously published and specify the source of the data (e.g., DOI or APA style reference of original publication). Specify your level of knowledge of the data (e.g., descriptive statistics from previous publications), whether or not this is relevant for the hypotheses of the present study, and how it is assured that you are unaware of results or statistical patterns in the data of relevance to the present hypotheses.
No

Sampling Procedure and Data Collection

M3 Sample size, power and precision
(1) Relevant sample sizes: e.g., single groups, multiple groups, and sample sizes (or sample ranges) found at each level of multilevel data. (2) Provide power analysis (e.g. power curves) for fixed-N designs. For sequential designs, indicate your 'stopping rule' such as the points at which you intend to be viewing your data and in any way analyzing them (e.g., t-tests and correlations, but even descriptively such as with histograms).
Not applicable

M4 Participant recruitment, selection, and compensation

Indicate (a) methods of recruitment (e.g., subject pool advertisement, community events, crowdsourcing platforms, snowball sampling); (b) selection and inclusion/exclusion criteria (e.g., age, visual acuity, language facility); (c) details of any stratification sampling used; (d) planned participant characteristics (gender, race/ethnicity, sexual orientation and gender identity, SES, education level, age, disability or health status, geographic location); (e) compensation amount and method (e.g., same payment to all, pay based on performance, lottery).

(a) Recruitment
Databases:
As prior knowledge is a research topic in psychology as well as in the educational and medical sciences, we will gather publication records from the discipline-specific databases PsycINFO, PSYNDEX, ERIC, and MEDLINE. In addition, we will search the Web of Science using discipline filters. To build the analysis corpus, the following fields will be exported: Title, year of publication, author names, author affiliation, abstract, keywords (author keywords and controlled terms), classification / research categories, methodology, journal information (incl. ISSN), and sample information (age group, educational level). Year of publication and author names are included for duplicate detection across databases. Author affiliation will be used as a proxy for psychological subfields if the database does not provide a respective field.

(b) Selection criteria
Search string:
The search strategy will include synonyms of prior knowledge according to Dochy & Alexander (1995, p. 227) together with terms indicating learning contexts. Specifically, we will search titles, abstracts, and keywords using the following query:

> ("prior knowledge" OR
> prestorage OR "permanent stored knowledge" OR "prestored knowledge" OR "knowledge store" OR "implicit knowledge" OR "archival memory" OR "experiential knowledge" OR "background knowledge" OR "world knowledge" OR "pre-existing knowledge" OR "preexisting knowledge" OR "personal knowledge")
> AND
> (learn* OR instruct* OR educat* OR development* OR train* OR teach* OR school* OR lesson* OR achiev* OR memor* OR acquisition OR practicing OR practice* OR artificial intelligence OR cognitive model* OR categor*)

Exclusion criteria:
The exclusion criteria for the publications are as follows:

- not in English language or without English translation
- published prior to 1980 or after 2020
- database duplicate

(c) – (e): not applicable

M5 How will participant drop-out be handled?

Indicate any special treatment for participants who drop out (e.g., there is follow-up in a manner different from the main sample, last value carried forward) or whether participants are replaced.

Not applicable

M6 Masking of participants and researchers

Indicate all forms of masking and/or allocation concealment (e.g., administrators, data collectors, raters, confederates are unaware of the condition to which participants were assigned).

Not applicable

M7 Data cleaning and screening

Indicate all steps related to data quality control, e.g., outlier treatment, identification of missing data, checks for normality, etc.

We will check for duplicates, unify metadata (e.g., journal titles), and perform standard text preprocessing (e.g., stopword removal).

M8 How will missing data be handled?

Indicate any procedures that will be applied during the analysis to deal with missing data, such as (a) case deletions; (b) averaging across scale items (to handle missing items for some); (c) test of missingness (MAR, MCAR, MNAR assumptions; (d) imputation procedures (FIML vs. MI); (e) Intention to treat analysis and per protocol analysis (as appropriate).

Missing data (i.e., empty metadata fields) will be deleted case-wise for descriptive analysis of respective variables.

M9 Other information (optional)

For example, training of raters/participants or anything else not yet specified.

None

Conditions and design

M10 Type of study and study design

Indicate the type of study (e.g., experimental, observational, crosssectional vs. longitudinal, single case, clinical trial) and planned study design (e.g., between vs. within subjects, factorial, repeated measures, etc.), number of factors and factor levels, etc..

Empirical study of bibliometric data

M11 Randomization of participants and/or experimental materials

If applicable, describe how participants are assigned to conditions or treatments, how stimuli are assigned to conditions, and how presentation of tests, trials, etc. is randomized. Indicate the randomization technique and whether constraints were applied (pseudo-randomization). Indicate any type of balancing across participants (e.g., assignments of responses to hands, etc.).

Not applicable

M12 Measured variables, manipulated variables, covariates

This section shall be used to unambiguously clarify which variables are used to operationalize the hypotheses specified above (item I3). Please (a) list all measured variables, and (b) explicitly state the functional role of each variable (i.e., independent variable, dependent variable, covariate, mediator, moderator). It is important to (c) specify for each hypothesis how it is operationalized, i.e., which variables will be used to test the respective hypothesis and how the hypothesis will be operationally defined in terms of these variables. The description here shall be consistent with the statistical analysis plans specified under AP6 (below).

Exploratory study, not applicable

M13 Study Materials

Please describe any relevant study materials. This could include, for example, stimulus materials used for experiments, questionnaires used for rating studies, training protocols for intervention studies, etc.

Not applicable

M14 Study Procedures

Please describe here any relevant information about how the study will be conducted, e.g., the number and timing of measurement time points for longitudinal research, the number of blocks or runs per session of an experiment, laboratory setting, the group size in group testing, the number of training sessions in interventional studies, questionnaire administration for online assessments, etc.

Not applicable

M15 Other information (optional)

Analysis plan

(NOTE: If this varies by hypothesis, repeat analysis plan for each)

AP1 Criteria for post-data collection exclusion of participants, if any
Describe all criteria that will lead to the exclusion of a participant's data (e.g. performance criteria, non-responding in physiological measures, incomplete data). Be as specific as possible.
Not applicable

AP2 Criteria for post-data collection exclusions on trial level (if applicable)
Describe all criteria that will lead to the exclusion of a trial or item (e.g. statistical outliers, response time criteria). Be as specific as possible.
Not applicable

AP3 Data preprocessing
Describe all data manipulations that are performed in preparation of the main analyses, e.g. calculation of variables or scales, recoding, any data transformations, preprocessing steps for imaging or physiological data (or refer to publicly accessible standard lab procedure, cf. T12).
We will preprocess the corpus by tokenizing, transforming to lower case, and removing both standard stopwords (e.g., “the”, “and”) and stopwords for scientific abstracts (“study”, “investigated”, “results”). The latter list of stopwords will be synthesized using the stopwords provided by Christ, Penthin, & Kröner (2019) and an English translation of the stopwords made available by Bittermann & Klos (2019). Moreover, punctuation, numbers, symbols, and separators will be removed and finally, tokens will be lemmatized.

AP4 Reliability analysis (if applicable)

Specify the type of scale reliability that will be estimated, whether it is internal consistency (e.g. Cronbach's alpha, omega), test-retest reliability, or some other form (e.g., a confirmatory factor analysis incorporating multiple factors as sources of variance). In a study involving measure development, researchers should specify criteria for removing items from measures a priori (e.g., largest factor loading magnitude, smallest drop in alpha-if-item removed).

As we employ Structural Topic Models (see AP6) using deterministic spectral initialization, topic reliability is no concern (in contrast to, e.g., Latent Dirichlet Allocation using Gibbs Sampling).

AP5 Descriptive statistics

Specify which descriptive statistics will be calculated for which variables. If appropriate, specify which indices of effect size will be used. If descriptive statistics are linked to specific hypotheses, explicitly link the information given here to the respective hypothesis.

Descriptive statistics will be calculated for the following database fields: publication year, classification codes, study methodology, sample characteristics, affiliation (as a proxy for psychological subfields). In addition, term frequencies will be calculated.

AP6 Statistical models (provide for each hypothesis if varies)

Specify the statistical model (e.g. t test, ANOVA, LMM) that will be used to test each of your hypotheses. Give all necessary information about model specification (e.g., variables, interactions, planned contrasts) and follow-up analyses. Include model selection criteria (e.g., fit indices), corrections for multiple testing, and tests for statistical violations, if applicable. Wherever unclear, describe how effect sizes will be calculated (e.g., for d-values, use the control SD or the pooled SD).

Explorative study, no hypothesis testing (see AP8)

AP7 Inference criteria

Specify the criteria used for inferences (e.g., p values, Bayes factors, effect size measures) and the thresholds for accepting or rejecting your hypotheses. If possible, define a smallest effect size of interest. If inference criteria differ between hypotheses, specify separately for each hypothesis and respective statistical model by explicitly referring to the numbers of the hypotheses. Describe which effect size measures will be reported and how they are calculated.

We will use standard $p < 0.05$, if applicable.

AP8 Exploratory analysis (optional)

Describe any exploratory analyses to be conducted with your data. Include here any planned analyses that are not confirmatory in the sense of being a direct test of one of the specified hypotheses.

Topic Modeling:
For identifying topics of prior knowledge research (RQ 1), we will first join titles, abstracts, and keywords to a text corpus. We will preprocess the corpus by tokenizing, transforming to lower case, and removing both standard stopwords (e.g., “the”, “and”) and stopwords for scientific abstracts (“study”, “investigated”, “results”). The latter list of stopwords will be synthesized using the stopwords provided by Christ et al. (2019) and an English translation of the stopwords made available by Bittermann & Klos (2019). Moreover, terms defining the corpus (e.g., “prior knowledge”, see M4b) will be excluded.
Punctuation, numbers, symbols, and separators will be removed and finally, tokens will be lemmatized. Next, we will employ structural topic modeling (STM; Roberts et al., 2014) for topic identification. STM considers topic correlations and thus yielding well-separated topics – which is of particular advantage given the topical specificity of our corpus (i.e., prior knowledge). For finding the optimal number of topics, we will examine several candidate models regarding both statistical metrics (i.e., semantic coherence, Mimno et al., 2011; exclusivity, Roberts et al., 2014) and a qualitative investigation of topic interpretability, granularity level (semantic broadness vs. specificity), and validity. Based on our experience with comparable corpora, we will set the initial range to 5–50 topics. After determining the optimal number of topics, potentially remaining uninterpretable and invalid topics will be excluded. The semantic hierarchy of topics (main topics, subtopics) will be examined using hierarchical clustering of topic correlations (based on the document-topic-probability distributions). These topic correlations will be used for a network representation of topic similarity (RQ 2).

Frequency analyses:
In order to determine the frequency of content domains (RQ 3), theories (RQ 5), measures (RQ 6), and research designs (RQ 7), we will first compile a list of known examples (e.g., Vosniadou’s theory of conceptual change). Using these examples as seeds, we will mine the corpus of publication records for co-occurring and associated terms and n-grams. For instance, if Theory X was not on our list, but is often mentioned along with Theory Y, then we add Theory Y to our list. Additionally, we will use generic terms like “theory”, “model”, “analysis”, or “teaching” for keywords-in-context (KWIC) analysis. After completion of the respective lists, we will determine the overall frequency for each list entry. As the psychological databases PsycINFO and PSYNDEX offer a specific field for study methodology (e.g., longitudinal study, qualitative study, theoretical discussion), this field will be additionally considered for RQ 7.

PsycINFO, PSYNDEX, and ERIC provide separate fields for age classes of study participants or the educational level that is addressed in the publication. Hence, we will amalgamate these fields for RQ 4. As MEDLINE and Web of Science do not provide

sample information, we will identify potential abstracts using a keyword-based search ("sample", "subjects", "participants", "grade", "elementary", etc.) and extract sample information manually.

Regarding terms referring to knowledge types, characteristics, and representations (RQ 8), we will count how often the following terms co-occur with "knowledge":

- Types of knowledge: "declarative, procedural, conditional, episodic, semantic, strategic, experiential, category, conceptual"
- Characteristics of knowledge: "domain-specific, domain-transcending, domain-general, metacognitive, meta-cognitive, situation*, situated, surface, deep, isolat*, structur*, automatiz*, compil*, verbal, pictorial, explicit, implicit, tacit, fragment*, integrat*, context-specific, automatiz*, abstract*, concrete*"
- Representations of knowledge: "representation*, mental model*, semantic network*, proposition*, production rule*, schema*, script*, neural network*, imagery, mental image*, brain*"

Using both journal titles and ISSN fields, we will calculate how often a journal appears in our corpus (RQ 9).

Subdiscipline classification:
Psychological subfields will be determined using the classification field of PsycINFO and PSYNDEX (e.g., educational psychology, clinical psychology). For publications from the remaining databases, psychological subfields are derived from journal names (e.g., "Journal of Clinical Psychology") and author affiliations (e.g., "Department for Educational Psychology). In any of these cases, multiple classifications are possible and will be considered. With publications assigned to subfields, an overview of included subfields (RQ 11) will be generated using frequency tables of publications by subfield (RQ 12).

Topical similarity networks:
For subfields and journals, we will analyze networks of topical similarity (RQs 10 and 13). Specifically, subfields (resp. journals) are nodes, with topical similarity as edges. Topical similarity is operationalized as correlations between the aggregated mean distributions of document-topic-probability. This approach enables us to examine which subfields (and journals) address similar (sub-)topics within prior knowledge research.

AP9 Other information (optional)

Other information optional

(NOTE: If needed, multiple lines with other information can be included)

O1 Other information (optional)
If there is any additional information that you feel needs to be included in your preregistration, please enter it here. Literature cited, disclosures of any related work such as replications or work that uses the same data, or other context that will be helpful for future readers would be appropriate here.

References

R1 References

Enter your references below. Use a consistent format (e.g., https://apastyle.apa.org/style-grammar-guidelines/references/examples)

Ausubel, D. P. (1968). *Educational psychology: A cognitive view*. Holt, Rinehart and Winston: New York.

Bittermann, A., & Klos, E. M. (2019, June 19). Code zu: "Ist die psychologische Forschung durchlässig für aktuelle gesellschaftliche Themen? Eine szientometrische Analyse am Beispiel Flucht und Migration mithilfe von Topic Modeling". *PsychArchives*. https://doi.org/10.23668/psycharchives.2499

Brod, G., Werkle-Bergner, M., & Shing, Y. L. (2013). The influence of prior knowledge on memory: a developmental cognitive neuroscience perspective. *Frontiers in Behavioral Neuroscience, 7*, 139. https://doi.org/10.3389/fnbeh.2013.00139

Christ, A., Penthin, M, & Kröner, S. (2019). Research General Stop Words for: Big Data and Digital Aesthetic, Arts and Cultural Education: Hot Spots of Current Quantitative Research. *PsychArchives*. http://dx.doi.org/10.23668/psycharchives.2613

de Jong, T., & Ferguson-Hessler, M. G. (1996). Types and qualities of knowledge. *Educational psychologist, 31*(2), 105–113. https://doi.org/10.1207/s15326985ep3102_2

Dochy, F. (1992). *Assessment of prior knowledge as a determinant for future learning: The use of prior knowledge state tests and knowledge profiles*. Utrecht/London: Lemma.

Dochy, F. J., & Alexander, P. A. (1995). Mapping prior knowledge: A framework for discussion among researchers. *European Journal of Psychology of Education, 10*(3), 225–242. https://doi.org/10.1007/BF03172918

Dochy, F., Segers, M., & Buehl, M. M. (1999). The relation between assessment practices and outcomes of studies: The case of research on prior knowledge. *Review of educational research, 69*(2), 145-186. https://doi.org/10.3102%2F00346543069002145

Mimno, D., Wallach, H. M., Talley, E., Leenders, M., & McCallum, A. (2011, July). Optimizing semantic coherence in topic models. *Proceedings of the Conference on Empirical Methods in Natural Language Processing* (262–272). Association for Computational Linguistics. Chicago. https://www.aclweb.org/anthology/D11-1024.pdf

Roberts, M. E., Stewart, B. M., Tingley, D., Lucas, C., Leder-Luis, J., Gadarian, S. K. et al. (2014). Structural Topic Models for Open-Ended Survey Responses. *American Journal of Political Science,58*(4), 1064–1082. https://doi.org/10.1111/ajps.12103