International Platform of Registered Systematic Review and Meta-analysis Protocols

INPLASY

The application of exponential random graph models to online learning networks: a scoping review protocol

INPLASY202470039
doi: 10.37766/inplasy2024.7.0039
Received: 10 July 2024
Published: 10 July 2024

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ADMINISTRATIVE INFORMATION

Support - Not available.

Review Stage at time of this submission - Formal screening of search results against eligibility criteria.

Conflicts of interest - None declared.

INPLASY registration number: INPLASY202470039

Amendments - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 10 July 2024 and was last updated on 10 July 2024.

INTRODUCTION

Review question / Objective The objective of this scoping review was to provide a comprehensive examination of pertinent research on the analysis of online learning environments using ERGMs, with a focus on identifying methods for analyzing collaboration in the extant literature. This study reviewed published articles that used ERGMs to analyze the connectedness of learners in online discussions. The following four research questions were posed: 1) How many articles investigating scholarly online communication using ERGMs exist among the total number of articles using ERGMs?, 2) What are the characteristics and challenges associated with analyzing online discussion forums using ERGMs?, 3) What types of "terms" tend to be used in the analysis of articles?, and 4) Which specific competencies or educational areas are examined through the use of ERGMs?

Background As online education continues to gain traction, it is imperative to investigate how interactions within the learning community contribute to individual competencies. There is a growing challenge to analyze networks to delve into students' development. As a suite of computational and statistical methods, exponential random graph models (ERGMs) examine intricate network structures based on the relational data within the network. However, research on network ties in the field of education is still in its early stages, and no comprehensive reviews have been conducted on network structure for collaborative learning in online discussion. Consequently, it is pertinent to undertake a scoping review for mapping the existing literature, identify any gaps in current research, and explore the evolving nature of this field.

Rationale Online discussion forums provide a record of the relationship-building processes among students, allowing for an understanding of how they interact with each other (Poquet et al., 2022). The analysis of collaborative data has significantly enhanced the methods available for determining the connectedness of members using

social network analysis (SNA) techniques (Robins et al., 2007). With regard to online communication, discussion forums are directed towards investigation (Gašević et al., 2019; Song et al., 2020). The formation of knowledge networks occurs when members of an organization utilize flexible and dynamic communication relationships to gain access to and transfer knowledge (Su et al., 2010). The establishment of knowledge ties represents academic behavior within the community context. In this analysis, exponential random graph models (ERGMs), a novel technique grounded in SNA, have demonstrated potential in elucidating network dynamics in online learning and estimating learners' interactions (Poquet et al., 2020; Zhang et al., 2016).

METHODS

Strategy of data synthesis Strategy encompassed the process of identifying relevant sources of information. The search query was formulated to identify variations in the name of ERGM ("exponential family random graph models" OR "ERGMs" OR "exponential family random graph model" OR "ERGM") for screening the titles, keywords, and abstracts. The search was restricted to articles written in English. Articles were selected from Scopus and ScienceDirect on May 21, 2024. Scopus is the largest citation database globally (Schotten et al., 2017). ScienceDirect is an online database of published scientific research provided by Elsevier (Tenopir et al., 2008).

Searching on dataset from Scopus and ScienceDirect using the following keywords and command operations: TITLE ("educat" OR "university" OR "learn" OR "school" OR "lesson" OR "student" OR "decision" OR "practice" OR "knowledge" OR "teach" OR "facilitat" OR "online" OR "discuss" OR "forum" OR "engage" OR "motivat" OR "participat" OR "autonom" OR "responsib" OR "involv" OR "interact" OR "collaborat" OR "cooperat" OR "community" OR "social network" OR "MOOC" OR "e-learning" OR "academic" OR "disciplinary" OR "team" OR "group" OR "organization" OR "organisation" OR "context" "course" OR "communicat").

Eligibility criteria Since this study aims to collect articles that utilize inherent relational data to explore, articles that rely on indirect datasets of learning behavior were excluded. Furthermore, the selection of articles focused on studies that analyze learning behavior to shed light on pedagogical issues. The inclusion and exclusion criteria for articles are presented below.

Inclusion criteria: Focused on the actors of learners in online academic discussion networks, Examining the message exchanges of learners.

Exclusion criteria: Studies: commentary, editorial, erratum, extended abstract, letter, note, review, presentation, No calculation results of ERGMs, Dataset based on face-to-face communication, interviews, or questionnaires, Friendship network without learning activities, Patient network, Studies in terms of algorithm calculation, connectedness, or topology, Studies using sample or secondary datasets, discussions on political activities, mental characteristics, health, games, or social issues.

Source of evidence screening and selection This study employed a scoping review approach to systematically and transparently produce a contemporary research synthesis. While scoping reviews frequently employ methods analogous to those used in systematic literature reviews (Armstrong et al., 2011), this study applied Preferred Reporting Items for Systematic Reviews and Meta-Analysis extension for scoping reviews (PRISMA-ScR) (Tricco et al., 2018). Additionally, the protocol of the search, appraisal, synthesis, and analysis (SALSA) framework protocol was utilized to standardize the review process.

Data management In the SALSA process, three reviewers independently conducted the screening process. The retrieved results were subjected to a preliminary screening and subsequent removal process using Endnote 21. Any discrepancies were resolved through discussion, reference to other materials (e.g., R-library manuals), and clarification within the team. Subsequently, the reviewers engaged in a process of collaborative discussion to resolve any remaining conflicts until a consensus was reached on the final inclusion.

Reporting results / Analysis of the evidence A data extraction scheme was modified with reference to a previous study (Yu et al., 2024). Four developed data categories can facilitate an enhanced comprehension of the distinctive characteristics of individual learners and the underlying network structure. The following shows the fields of data extraction scheme of this study.

Bibliometrics: Author, Publication year, Source title, Indexed in education, Quartile, Study site, Funding source, FWCI

Study design: ERGM application, ERGM type, Node type, Data source, and Analysis software

Network profile: Number of networks, Average number of nodes, Direction, Density, Centrality, and Goodness of fit (GOF).

Network structure: Course content, Effects on learning, Node-based covariate, Dyadic-covariate, and Structural covariate.

Presentation of the results The results were presented in the form of four tables for each data extraction schema. Additionally, a table was provided which summarized the frequency of the screening strings regarding educational and learning perspectives in the title and abstract search results for all collected articles.

Language restriction The analysis was restricted only to articles written in English.

Country(ies) involved The scoping review was conducted by three members of a Thai organization. The corresponding author is of Japanese nationality, while the other two authors are of Thai nationality.

Other relevant information NA.

Keywords ERGMs, learning, online discussion, SALSA, SIENA, review.

Dissemination plans Results will be disseminated through publication in a peer-review journal.

Contributions of each author

Author 1 - Masami Yoshida - The author designed study conceptualization, performed the article search and data extraction, and prepared the original draft of the manuscript.
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Author 2 - Nammon Ruangrit - All authors contributed to the manuscript review and revision. All authors independently screened the retrieved publications and extracted data and participated in joint discussions to resolve remaining conflicts until a consensus was reached on the final inclusion.
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