REVIEW ARTICLE

ResearchGate and Academia.edu as networked socio-technical systems for scholarly communication: a literature review

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ResearchGate and Academia.edu have been increasingly acknowledged as the most popular academic social network sites (ASNS) for scholarly communication. Along with their benefits for supporting communication and knowledge sharing within academic communities, concerns over quality and credibility remain a pertinent issue. In terms of research investigation, ASNS have attracted strong attention for new scholarly practice and their potential for building, maintaining and enhancing reputation. However, a thorough understanding is still lacking of how these sites operate as networked socio-technical systems reshaping scholarly practices and academic identity. This article analyses 39 empirical studies published in peer-reviewed journals with a specific focus on ResearchGate and Academia.edu. The aim is to describe the status of the research and to identify gaps and priorities in the areas of scholarly networked learning and shared knowledge. Results show that the number of studies focusing on ResearchGate was more than double those dedicated to Academia.edu. While both sites have attracted attention in the library and information sciences as deployments for reputation building and alternative ranking systems, such as ResearchGate metrics, there is a dearth of research investigating practices and new modes of communication in the light of a networked participatory approach to scholarship. Most of the studies analysed focused on the general uptake or impact assessment of alternative metrics, while very few investigated individual and collective scholarly practices. This study points to the need for specific research on open and distributed learning achieved in ASNS according to a networked learning perspective.

Keywords: academic social network sites; networked scholarship; scholarly communication; socio-technical systems; ResearchGate; Academia.edu

Introduction

Academic social network sites (ASNS) like ResearchGate and Academia.edu have progressively become the most popular social networking services developed specifically to support academic and research practices (Nicholas, Herman, and Jamali 2015a). In May 2017 the website ranking service Alexa.com listed ResearchGate and Academia.edu as being respectively at 321st and 577th place among the world's websites. These sites have attracted considerable attention as platforms for scholarly endeavour and reputation building, as well as for their enhancement of open dissemination practices, provision of alternative indicators of scientific impact and

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strengthening of relationships among large cohorts of scholars (Jordan 2014; Nández and Borrego 2013; Nicholas, Herman, and Jamali 2015a).

The study of digital infrastructures for supporting scholars' information and communication processes from an information science perspective is well established (Borgman 2007). Digital scholarship has also been a theme of investigation in the educational technology sector, where the term is regarded as shorthand for the transformative intersection of digital content, networked distribution and open practices (Weller 2011). In this line of research, several authors have conceptualised theoretical frameworks and epistemological approaches to analyse the relationship between scholarly practice and technology and have explored new forms of scholarship fostered by social networks. From this perspective, Networked Participatory Scholarship (NPS) has been advanced as 'the emergent practice of scholars' use of participatory technologies and online social networks to share, reflect upon, critique, improve, validate and further their scholarship' (Veletsianos and Kimmons 2012, p. 768). In this approach the emergent use of tools like Facebook, Twitter, Academia.edu and Mendeley reveals how scholarly knowledge has come to be acquired, tested, validated and shared, as well as how university subcultures of 'invisible college' (Wagner 2008) are constructed. From this perspective, NPS seems to be an emergent and separate techno-cultural scholarly system that intersects mainstream academia (Stewart 2015).

Examining increasing social media use in scholarly practice, Greenhow and Gleason (2014) formulated the concept of social scholarship, which encompasses social media affordances and their influence on the ways in which academia accomplishes scholarship through values like promotion of users and decentralised accessible knowledge. Significant changes to scholarly practice being introduced by the participatory web as a space of active involvement, presence and socialisation of knowledge have also been pointed out by Costa (2013), who reported how scholars' 'approaches to digital scholarship practices are highly influenced by their online social capital' (p. 1).

Empirical studies carried out in the light of these networked and social participatory frameworks have mostly focused on the microblogging site Twitter in scholarly practice (Li and Greenhow 2015; Stewart 2015). Very few studies have thoroughly investigated ASNS use in the light of theoretical frameworks developed in the educational technology sector aimed at analysing social digital scholarship practice.

At the same time, there is a general scarcity of literature reviews dedicated to ASNS, how they are used as part of scholarly life, their current limitations and the potential avenues for future research. Two examples conducted in the library and information science field stand out, one by Kjellberg, Haider and Sundin (2016) and another by Williams and Woodacre (2016). The first study (Kjellberg, Haider, and Sundin 2016) reviewed only research articles in library and information science and related fields. The scarce and fragmentary nature of the evidence describing scholars' experiences in these environments and the lack of understanding about the ways these environments are actually used and experienced (Veletsianos 2016) indicates there is an urgent need to systematically investigate the use being made of academic digital networked platforms. The understanding gained could prove valuable for guiding research practices and for implementing effective professional development for researchers (Raffaghelli *et al*. 2016).

This article provides a critical review of empirical studies focusing on the use of ResearchGate and Academia.edu as scholarly social network sites. The study adopts

a socio-technical research approach that employs a three-level analysis of ASNS (Manca 2017; Manca and Raffaghelli 2017). The framework comprises a macro level, which constitutes the socio-economic layer of ASNS; a meso-level, which comprises the techno-cultural layer of ASNS; and a micro level, which constitutes the networked-scholar layer of ASNS. The purpose is to outline a map of the empirical approaches used in the analysis of current uses of ResearchGate and Academia.edu among scholarly communities based on the framework and to identify gaps and priority areas in scholarly networked learning and shared knowledge. The ultimate aim is to highlight what kinds of studies ResearchGate and Academia.edu have attracted until now among different discipline-related research inquiries.

In the following section, the methods and materials of the survey are presented, along with the results obtained and their analysis. Considerations about the implications of the study are provided with indications for further research.

Theoretical framework

A multilevel framework for analysing ASNS

Some authors have attempted to reconceptualise digital scholarship in terms of complex techno-cultural systems that exploit technological innovations and deploy dominant and alternative academic cultural values (Stewart 2015). Recent socio-technical approaches have been proposed to analyse social media sites like Twitter, Facebook, YouTube, Flickr and Wikipedia as platforms that encompass coevolving networks of people and technologies with economic infrastructure and legal–political governance (van Dijck 2013). According to these approaches, social media are the result of techno-cultural and political economy views that ultimately shape the way that social communication forms and develops on the platforms.

Elaborating on these conceptual premises, a framework that also accommodates individual use of academic platforms and the ways scholars exploit these sites for scholarly purposes has been formulated (Manca 2017; Manca and Raffaghelli 2017). The framework analyses both the systemic/infrastructural dimension of ASNS and their personal/practical dimension at three different levels: (1) the *socio-economic level*, which includes components related to ownership (commercial and non-profit), governance (protocols and rules for managing user activities) and business model (the engineering of connectivity through subscription models); (2) the *techno-cultural level*, which includes components associated with technology (services that help encode activities into a computational architecture that steers user behaviour), user/usage (user agency and participation) and content (standards of content and delivery of products); and (3) the *networked-scholar level*, which includes components related to networking (connectivity of communication and collaboration), knowledge sharing (collective and distributed learning) and identity (reputation and trust as elements that shape academic personae). In this framework ASNS and scholarly sociality are seen as interrelated dimensions and the individual and systemic exploitation of such sites is treated as being intertwined.

ResearchGate and Academia.edu as networked socio-technical systems

ResearchGate is a social network service founded in 2008 by the physicists Ijad Madisch and Sören Hofmayer along with computer scientist Horst Fickenscher.

Today the site has more than 12 million members from 193 different countries, mostly in hard scientific disciplines. As to the socio-economic layer, ResearchGate is a for-profit company with headquarters in Berlin. The governance component is mostly managed through the Terms and Conditions, which stipulate that the company does not store any personal data from former users, nor sell or otherwise share personal data with third parties. The business model is largely based on a wide range of free-of-charge services supplemented with subscription-based services like the Job Openings section for posting job ads.

As far as the techno-cultural level is concerned, ResearchGate implements features to spur users' connectivity and to channel social interaction, for instance by automatically signalling other users who may be of interest. The site's homepage provides a news feed that allow users to monitor recent activity, together with other features like endorsing researchers for their skills and expertise and suggestions on new researchers to follow. Recommend and Follow buttons are available to foster further interaction with peers and to highlight projects and publications. Users can also become actively engaged by participating in the Questions discussion threads, both by posing research questions and by sharing expertise.

At the networked-scholar level, the possibility to build an individual network of contacts is mostly based on the Follow feature, which gives users access to new and updated information, together with opportunities to locate relevant expertise. Knowledge sharing chiefly regards the adding or uploading of research products, commenting on publications and projects, and asking and replying to questions via the Questions feature. The personal profile includes a tab for displaying expertise and skills, which users can browse when seeking to locate users with competencies useful for their research. User identity is mostly conveyed through the profile. Moreover, ResearchGate proposes its own set of proprietary reputation metrics: RG Score, RG Reach and h-index. RG Score has been criticised for having questionable reliability and an opaque calculation methodology that makes it hard to compare with other popular standard scores (Kraker and Lex 2015).

Academia.edu is a social networking service founded in 2008 by Richard Price. The service counts over 52 million accounts and attracts 36 million unique visitors a month. In contrast with ResearchGate, the platform is more popular in the arts and humanities and to a lesser extent in the social sciences and economics (Kramer and Bosman 2016). As to the socio-economic layer, Academia.edu is a for-profit company with headquarters in San Francisco. When posting, uploading, publishing, submitting or transmitting member content, users grant Academia.edu a worldwide, revocable, non-exclusive, transferable license to exercise any and all rights under copyright. The platform's business model is largely based on provision of a wide range of free-of-charge services that are supplemented by premium accounts, like enhanced analytics and a job board for advertising academic vacancies.

At the techno-cultural level, the homepage provides a constant news feed that updates users on new uploads, bookmarked publications and different user actions. The home page also features functions like Suggested Sessions and Suggested Academics for increasing one's connectivity on the basis of similar research interests. Moreover, Academia.edu offers a feature called Sessions, which allows users to create a special page where peers and colleagues can leave general comments on papers or line-specific annotations. The site encourages the sharing of diverse types of scientific output, including papers, books, book chapters and drafts, as well as conference presentations and teaching material.

As far as the networked-scholar level is concerned, users mostly build their individual network of contacts using the Follow feature. This allows them to subscribe to their contacts' updates without automatic reciprocation. The knowledge sharing component chiefly regards the adding or uploading of research output such as publications, drafts and teaching materials. It also covers contribution to Sessions pages, where users can leave general comments on papers or line-specific annotations. The Profile feature includes a Total Views tally, a top percentile designation and an Author Rank, which is a function of the PaperRanks of the papers on the user's profile. Adacemia.edu also provides an analytics dashboard, which gives users an overview of how others have interacted with their publications. By insisting on the relevance of dashboard analytics, Academia.edu has been criticised for reinforcing a culture of incessant self-monitoring and for amplifying and accelerating the logic of self-branding among scholars (Duffy and Pooley 2017).

Aims of the study

The aim of the study is twofold: to outline a map of empirical studies related to the scholarly use of ResearchGate and Academia.edu in light of the framework presented above and to identify gaps and priority areas in scholarly networked learning and shared knowledge. The studies have been classified according to the three levels of the framework and their main components: (1) the socio-economic level (ownership, governance, business model); (2) the techno-cultural layer (technology, user/usage, content); and (3) the networked-scholar layer (networking, knowledge sharing, identity). The ultimate aim is to identify what kind of studies ResearchGate and Academia.edu have mostly attracted among different discipline-related research inquiries and what research areas deserve further investigation.

Methodology

Materials and methods

The focus of the review is to provide a critical and theoretically founded analysis of peer-reviewed papers that (1) appear in English language academic journals; (2) specifically investigate the use of ResearchGate and Academia.edu for scholarly purposes; (3) report empirical findings; and (4) present research questions and documentation of all procedures (Freeman *et al*. 2007). Although conference proceedings, unpublished manuscripts, research abstracts and dissertations may offer well-documented research with supported findings, the decision to exclude these sources was made because peer-reviewed academic journals are supposed to ensure higher quality publications. Moreover, theoretical studies and position papers were excluded because the review was primarily concerned with the state of empirical research. Finally, since many studies investigated other social media or social network sites, only studies that included separate results for ResearchGate or Academia.edu were considered.

The corpus of the study was collected through an extensive search using the keywords 'ResearchGate' and 'Academia.edu' (applied separately) and distinct search criteria for each source, as follows: (1) Web of Science (TOPIC, English articles, review); (2) Scopus (TITLE-ABS-KEY, English articles, review, articles in press); (3) EBSCO Academic journals, Journals, Reviews (TX All Text, English). No specific time span was defined.

The searches were run on 30 April 2017 and yielded a number of articles distributed as follows: (1) Web of Science: 52 papers (ResearchGate) and 16 papers

(Academia.edu); (2) Scopus: 86 papers (ResearchGate) and 23 papers (Academia. edu); (3) EBSCO Academic journals, Journals, Reviews: 42 papers (ResearchGate) and 15 papers (Academia.edu). The records were examined and filtered for inclusion according to the workflow reported in Table 1. In the end, the total number of papers selected for review was 39.

Procedure and data analysis

The 39 selected papers were analysed and coded according to the following criteria:

- Author(s) and year of publication
- Academic social network site investigated (ResearchGate and/or Academia.edu)
- Geographical area of authors' affiliation
- Research area
- Research design and methods (quantitative method; qualitative method; mixed approach)
- Aim and theme of the study (general uptake; outreach; assessing impact; practices and new modes of communication)
- Framework level (socio-economic: ownership, governance, business model; techno-cultural: technology, usage, content; networked-scholar: networking, sharing knowledge, identity)
- Main findings

These guidelines were partially derived from a simplified list of guidelines taken from Newman and Elbourne (2004). Theme topics were adopted from a recent review (Kjellberg, Haider, and Sundin 2016), with the exclusion of the 'Specific tools and cases' category. Application of the three-level framework was made possible through an iterative process of qualitative content analysis (Hsieh and Shannon 2005).

Results

Demographics of the studies

As reported in Table 2, the majority of the studies (23, 59%) specifically investigated ResearchGate, 13 (33.3%) were devoted to both ResearchGate and Academia.edu,

Table 1. Workflow for inclusion of relevant studies in the review.

1. Relevant records retrieved according to search criteria
Web of Science: $n = 52$ (ResearchGate), 16 (Academia.edu)
SCOPUS: $n = 86$ (ResearchGate), 23 (Academia.edu)
EBSCO (Academic journals, Journals, Reviews): $n = 42$ (ResearchGate), 15 (Academia.edu)
2. Relevant records after exclusion based on title and abstract reading
Web of Science: $n = 26$ (ResearchGate), 14 (Academia.edu)
SCOPUS: $n = 43$ (ResearchGate), 18 (Academia.edu)
EBSCO (Academic journals, Journals, Reviews): $n = 25$ (ResearchGate), 10 (Academia.edu)
3. References after deduplication
$n = 51$
4. Relevant studies for review based on full text reading
$n = 39$

Table 2. Demographics of the studies.

Site analysed	ResearchGate	23
	Academia.edu	3
	ResearchGate and Academia.edu	13
Year of publication	2012	1
	2013	0
	2014	5
	2015	9
	2016	13
	2017	11
Geographical provenance of the authors' affiliations[a]	North America	17
	South America	2
	Europe	40
	Middle East	9
	Africa	1
	Asia	16
	Australia	1

[a]The total is more than the number of authors (83), as some are affiliated with more than one institution.

while only 3 (7.7%) focused exclusively on Academia.edu. The temporal distribution showed that there was an exponential growth in the number of published articles in 2016 and 2017, accounting for 24 articles (61.5%), although the search was performed in April, so 2017 figures are necessarily incomplete. When considering the geographical provenance of the authors' affiliations, distribution showed a prominence of European affiliated authors, accounting for almost half of the total (40 out of 83).

Out of the 39 articles, nine were written by a core cluster of prolific author groups: six papers (Jamali, Nicholas, and Herman 2016; Nicholas, Clark, and Herman 2016a; Nicholas, Herman, and Clark 2016b; Nicholas, Herman, and Jamali 2015a; Nicholas *et al.* 2017a, 2017b) were authored at CIBER Research Ltd., a private limited company based in the United Kingdom, and three (Thelwall and Kousha 2014, 2015, 2017) were written by scholars affiliated with the Statistical Cybermetrics Research Group at the University of Wolverhampton, UK.

Research areas and methods

One of the aims of the review was to map the research areas most interested in ResearchGate and Academia.edu as topics for investigation. This was mainly pursued by scrutinising the research area categorisations attributed to the papers in the Web of Science (WoS) and Scopus databases. Since the two databases adopt different indicators for research domain and subject area, a unified list of disciplines cannot be obtained. For instance, WoS uses an Essential Science Indicators scheme that comprises 22 subject areas in science and social sciences and a GIPP Mapping Table with six broad disciplines (Arts & Humanities; Clinical, Pre-Clinical & Health; Engineering & Technology; Life Sciences; Physical Sciences; Social Sciences) covering all fields of scholarly research and containing significant overlap between disciplines. In Scopus there are 26 subject areas, plus a general subject area containing multidisciplinary journals, which are organised into five top level subject areas (Life Sciences; Social Sciences; Physical Sciences; Health Sciences; General). Since direct mapping was not possible, a mediation between WoS and Scopus's categorisation was identified

at the top and the medium level for social sciences and physical sciences. Where a journal was not indexed in either of the two databases (e.g., *International Journal of Knowledge Content Development & Technology*), relevant information was sought on the journal website. Table 3 reports the number of articles retrieved from different journals and the main research area/s of those journals.

The distribution in Table 3 shows that 24 (61.5%) out of the 39 studies were published in journals belonging to the social sciences (library and information sciences) or to the social sciences (library and information sciences) and physical sciences (computer science). Nine (23.1%) were published in different social science subareas, some in association with physical sciences (computer science), while another three (7.7%) appeared in journals of the physical sciences (computer science) and the remaining three (7.7%) pertained to the health and life sciences areas. Only three (7.7%) articles appeared in education-related journals (*Computers & Education* and *International Review of Research in Open and Distributed Learning*).

As far as research methods are concerned, quantitative measures were the most widely employed investigation method (27, 69.2%), with 12 studies using survey tools. Other quantitative methods concerned statistical measurements (correlational analysis, etc.), bibliometric analysis, clustering techniques (Abdulhayoglu and Thijs 2017), methods of social network analysis (Alheyasat 2015; Borrego 2017; Hoffmann, Lutz, and Meckel 2016) and neural network models (Alheyasat 2016). Qualitative (4, 10.3%) and mixed method (8, 20.5%) studies employed interviews and focus groups, as well as qualitative and content analysis of posts retrieved from the two sites.

Very few studies made explicit mention of a theoretical framework or conceptual background. Some studies were strongly rooted in bibliometric and scientometric approaches but elsewhere reference to theory was limited to the following: social cognitive theory (Corvello and Felicetti 2014), uses and gratifications theory (Meishar-Tal and Pieterse 2017), Whitley's theory of degrees of mutual dependence and task uncertainty (Megwalu 2015), the Technology Acceptance Model (Tamjidyamcholo *et al.* 2016), networked learning (Manca and Ranieri 2017) and conceptual frameworks based on Boyer's model of scholarship (Nicholas, Herman, and Clark 2016b).

Themes of the studies and three-level framework analysis

The majority of the studies (26, 66.7%) dealing with the adoption of ResearchGate and Academia.edu among scholars investigated the degree of use and penetration of these tools for enabling scholarly communication (Table 4). Studies of this kind focused on analysing diffusion among selected or broad scholar populations in specific countries like Spain (Borrego 2017; Ortega 2015a), Italy (Manca and Ranieri 2016, 2017; Marra 2016), Finland (Laakso *et al.* 2017), Norway (Mikki *et al.* 2015), United Kingdom (Mabvuure *et al.* 2014), Andean countries (Campos Freire, Rivera Rogel, and Rodríguez 2014), Israel (Meishar-Tal and Pieterse 2017), Arab countries (Elsayed 2016), India (Madhusudhan 2016), South Africa (Onyancha 2015), the United States (Tran and Lyon 2017), or in cross-regions (Haustein *et al.* 2014; Jamali, Nicholas, and Herman 2016; Nicholas, Herman, and Jamali 2015a; Nicholas *et al.* 2015b) with a focus on early-career researchers (Nicholas *et al.* 2017a, 2017b).

Papers with impact assessment (20 studies, 51.3%) mostly investigated ResearchGate metrics (Abdulhayoglu and Thijs 2017; Hoffmann, Lutz, and Meckel 2016; Kuo *et al.* 2017; Nicholas, Clark, and Herman 2016a; Nicholas, Herman, and

Table 3. Number of papers retrieved from different journals and related research domain/ subject areas.

Journal name	Number of articles	Main research topics/areas
Journal of the Association for Information Science and Technology	5	Social sciences (library and information sciences), physical sciences (computer science)
Learned Publishing	5	Social sciences (library and information sciences)
Scientometrics	3	Social sciences (library and information sciences), physical sciences (computer science)
Computers in Human Behavior	2	Social sciences (psychology), physical sciences (computer science)
International Review of Research in Open and Distributed Learning	2	Social sciences (education)
PLoS One	2	Life sciences, health sciences
College & Research Libraries	1	Social sciences (library and information sciences)
Computers & Education	1	Social sciences (education), physical sciences (computer science)
Contemporary Engineering Sciences	1	Physical sciences (computer science)
Current Issues in Libraries, Information Science and Related Fields	1	Social sciences (library and information sciences)
Electronic Markets	1	Social sciences (economics and business), physical sciences (computer science)
Information Services & Use	1	Social sciences (library and information sciences), physical sciences (computer science)
International Arab Journal of Information Technology	1	Physical sciences (computer science)
International Journal of Knowledge Content Development & Technology	1	Physical sciences (computer science)
Journal of Informetrics	1	Social sciences (library and information sciences), physical sciences (computer science)
Journal of Plastic, Reconstructive & Aesthetic Surgery	1	Health sciences
Knowledge Management	1	Social sciences (economics and business)
New Library World	1	Social sciences (library and information sciences)
Online Information Review	1	Social sciences (library and information sciences), physical sciences (computer science)
Performance Measurement and Metrics	1	Social sciences (library and information sciences)
Quality & Quantity	1	Social sciences (social sciences), physical sciences (mathematics)
Research Evaluation	1	Social sciences (library and information sciences), physical sciences (computer science)
Revista Latina de Comunicación Social	1	Social sciences (communication)
Social Science Computer Review	1	Social sciences (library and information sciences), physical sciences (computer science)
South African Journal of Libraries and Information Science	1	Social sciences (library and information sciences)
The International Information & Library Review	1	Social sciences (library and information sciences)

Table 4. Themes of the studies and the three-level framework.

	Socio-economic level			Techno-cultural level			Networked-scholar level		
	Ownership	Governance	Business model	Technology	Usage	Content	Networking	Knowledge sharing	Identity
General uptake	–	–	–	–	21	1	–	2	2
Impact assessment	–	–	–	2	7	1	–	–	10
Practices and new modes of communication	–	–	–	–	1	–	–	1	–
Outreach	–	–	–	–	–	–	–	–	–

The total number is more than 39 because some studies investigated more than one theme.

Clark 2016b; Onyancha 2015; Ortega 2015b; Shrivastava and Mahajan 2015, 2017; Thelwall and Kousha 2015; Yu *et al.* 2016), in some cases compared with other ASNS or scholarly social media services (Campos Freire, Rivera Rogel, and Rodríguez 2014; Mikki *et al.* 2015; Nicholas, Herman, and Jamali 2015a; Thelwall and Kousha 2017). Only a couple of studies analysed the reputation mechanisms of Academia.edu (Niyazov *et al.* 2016; Thelwall and Kousha 2014).

Lastly, only two studies investigated scholarly practices and new modes of communication: one looked at whether authors comply with the publisher's copyright policies when they self-archive full-text versions of their articles on ResearchGate (Jamali 2017), while the other examined scholars' information exchange in the form of question answering and small group discussions on ResearchGate (Jeng *et al.* 2017).

Analysis of records according to the three level-framework shows particular concentration on investigating ASNS features and affordances related to the techno-cultural and the networked-scholar level. Specifically, most of the studies that analyse the usage component are concerned with general uptake. These latter adopt a variety of research approaches for investigating user agency and implicit and explicit participation of cohorts of researchers. Two studies investigated ASNS according to the technology component and analysed impact assessment through features of ResearchGate for supporting scholars' reputation building endeavours (Nicholas, Clark, and Herman 2016a; Nicholas, Herman, and Clark 2016b). As to the content component, one study analysed disciplinary coverage of ResearchGate to characterise typical articles uploaded (Thelwall and Kousha 2017).

At the networked-scholar level, identity was the main aspect investigated, mostly considered in terms of impact assessment of ASNS metrics and reputation mechanisms. Knowledge sharing practices were analysed in terms of propensity and willingness to share expertise with others (Alheyasat 2015), what factors influence the knowledge utilisation behaviour of researchers (Corvello and Felicetti 2014) and scholars' information exchange in the form of question answering and small group discussions (Jeng *et al.* 2017).

No study was concerned with the components of the socio-economic level.

Discussion

This review was aimed at identifying the kind of research studies that have investigated ResearchGate and Academia.edu, with particular regard for the disciplinary areas from which those studies emerged. It also sought to identify gaps and priority areas in scholarly networked learning and shared knowledge in these scholarly platforms. Although it came as little surprise, given that the two sites were launched in 2008, there was a noticeable increase in the number of articles from 2012 through 2017 and this trend is expected to grow further. Results showed that ResearchGate attracted greater attention from academic research communities, mainly due to its proprietary reputation metrics. Indeed, impact assessment was a specific topic of interest for this ASNS especially among bibliometrics and scientometrics oriented scholars in light of the current popularity of alternative metrics and altmetrics (Priem and Hemminger 2010; Thelwall *et al.* 2013).

In the effort to gauge interest from a wide variety of disciplinary areas, this review relied on interdisciplinary databases like WoS, Scopus and EBSCO. Nevertheless, the majority of the studies retrieved and analysed appeared in journals of the library and

information sciences (for instance, Kjellberg, Haider, and Sundin 2016), computer science and the digital humanities research areas. This tendency may be attributed to the long-standing interest within these disciplines in scholarly communication and to the changing role of librarian services in the emergence of new types of digital services (Borgman 2007). In this light, the dominance of European-affiliated authors may well reflect the increasing interest of the European Commission towards emerging reputation and funding mechanisms in the context of open science and Science 2.0 (Nicholas, Herman, and Jamali 2015a; Vuorikari and Punie 2015). In particular, the private UK company CIBER Research has been conducting extensive theoretical and empirical research, partially commissioned by the European Commission, on digital scholarship and was responsible for the highest number of articles from a single group of authors (6 out of the total 39).

On the other hand, very few studies on the scholarly use of ResearchGate and Academia.edu were published in education-related journals. This suggests that although theoretical research is quite advanced in the area (Costa 2013; Greenhow and Gleason 2014; Stewart 2015; Veletsianos and Kimmons 2012), empirical studies are still rare. Moreover, these studies mostly focus on general uptake of ASNS by scholars, revealing a dearth of research that investigates individual and collective practices related to how scholarly communication is changing. As stressed by Veletsianos (2016), the fragmentary nature of the evidence about scholars' experiences in online social networks and social media and the lack of understanding of the ways scholars are using and experiencing social media demand further research. In light of the results from this review, more specific studies are required on open and distributed learning generated in ASNS according to a networked learning perspective, including both individual and collective scholarly practices.

The absence of studies focused on outreach and on how social media and ASNS can be used to make science more openly available denotes that research on open science–based scholarly practices are still rare or poorly documented. This might also be confirmed by the results of a previous review (Kjellberg, Haider, and Sundin 2016), which, despite being based on a larger sample of studies, reported a small group of papers dealing explicitly with the aspects of outreach and open dissemination of research results involving a public audience and science on a large scale.

Another consideration regards the absence of studies that deal with the socio-economic components. While critical considerations in popular and specialised press have been made about the for-profit nature and business models of ResearchGate and Academia.edu (Bond 2017; Matthews 2017), no empirical study investigated how these issues impact on scholars' decision to adopt or reject these sites in open science and for scholarly research dissemination. Further research could analyse how researchers come to terms with copyright or infringements of terms of use and how the availability of data on these proprietary sites may constitute a limitation to extensive research on users' activity.

Finally, the majority of the studies considered in the review employed quantitative methods with surveys and various statistical methodologies, similar to those used in bibliometrics. Moreover, except for those based on bibliometric and scientometric approaches and some other studies conceptually grounded in theory, most of the studies did not explicitly relate to theoretical understandings of science or scholarly communication. In this light, along with more empirical research framed by social and NPS approaches, an effort to combine methodological approaches for data collection, analysis and management at the different levels of scholarship might

provide a more thorough understanding of the complexity of ASNS as three-level scholarly platforms. From this perspective, for instance, qualitative methods such as ethnographic observations, narrative approaches and participatory and design-based research models could contribute to shed light on new practices among scholars for building reputation and professional identity as complementary approaches to bibliometric studies.

Conclusions

This study provides a thorough analysis of current research into how ResearchGate and Academia.edu are used for scholarly communication. It also applies a theoretical framework through which to disassemble the multidimensionality of ASNS according to different levels of analysis. Further investigation into ASNS as networked socio-technical microsystems that combine emergent user practices and content with the platform's organisational and structural level could contribute to the advancement of knowledge about the potential and challenges of these sites in the open science landscape.

Knowledge in the field could also benefit greatly from analysing how scholarly communication in the age of open science and social media sites is changing across different geographical areas. While there is a steady growth in the overall body of research on ASNS especially in the English language literature, the use of these sites as a research topic itself is relatively under-explored in the non-English language scientific literature. The significance of this gap is underlined by the consideration that non-English languages are widely used in research and academic publishing, especially in the applied disciplines of sciences and social sciences (Liu 2016). From this perspective, local and cross-geographical studies might benefit from the consultation of language-specific databases, such as SCIELO for Spanish-language studies.

Finally, further studies could address limitations regarding current methodological approaches and complementing descriptive methods. Use of cross-citation bibliometric maps might, for instance, provide evidence of interdisciplinary cohesion or lack of cohesion of research, as was proved in similar studies (Raffaghelli *et al*. 2016). Further research might benefit from a mixed method approach to highlight research contributions from separate academic fields.

References

References marked with an asterisk indicate records included in the dataset retrieved for and analysed in this review.

*Abdulhayoglu, M. A. & Thijs, B. (2017) 'Use of ResearchGate and Google CSE for author name disambiguation', *Scientometrics*, vol. 111, no. 3, pp. 1965–1985.

*Alheyasat, O. (2015) 'Examination expertise sharing in academic social networks using graphs: the case of ResearchGate', *Contemporary Engineering Sciences*, vol. 8, no. 3, pp. 137–151.

*Alheyasat, O. (2016) 'Investigation and analysis of ResearchGate user's activities using neural networks', *International Arab Journal of Information Technology*, vol. 13, no. 2, pp. 320–325.

Bond, S. (2017) 'Dear scholars, delete your account at Academia.Edu', *Forbes,* 23 Jan., [online] Available at: https://www.forbes.com/sites/drsarahbond/2017/01/23/dear-scholars-delete-your-account-at-academia-edu/#6fed4a4d2d62

Borgman, C. L. (2007) *Scholarship in the Digital Age: Information, Infrastructure, and the Internet*, The MIT Press, Cambridge, MA.

*Borrego, A. (2017) 'Institutional repositories versus ResearchGate: the depositing habits of Spanish researchers', *Learned Publishing*, vol. 30, no. 3, pp. 185–192.

*Campos Freire, F., Rivera Rogel, D. & Rodríguez, C. (2014) 'Presence and impact of Andean universities in online social networks', *Revista Latina de Comunicación Social*, vol. 69, pp. 571–592.

*Corvello, V. & Felicetti, A. M. (2014) 'Factors affecting the utilization of knowledge acquired by researchers from scientific social networks: an empirical analysis', *Knowledge Management: An International Journal*, vol. 13, no. 3, pp. 15–26.

Costa, C. (2013) 'The habitus of digital scholars', *Research in Learning Technology*, vol. 21, no. 1, pp. 1–17.

Duffy, B. E. & Pooley, J. D. (2017) '"Facebook for Academics": The convergence of self-branding and social media logic on Academia.edu', *Social Media + Society*, vol. 3, no. 1, pp. 1–11.

*Elsayed, A. M. (2016) 'The use of academic social networks among Arab researchers: a survey', *Social Science Computer Review*, vol. 34, no. 3, pp. 378–391.

Freeman, M., *et al.*, (2007) 'Standards of evidence in qualitative research: an incitement to discourse', *Educational Researcher*, vol. 36, no. 1, pp. 25–32.

Greenhow, C. & Gleason, B. (2014) 'Social scholarship: reconsidering scholarly practices in the age of social media', *British Journal of Educational Technology*, vol. 45, no. 3, pp. 392–402.

*Haustein, S., *et al.*, (2014) 'Coverage and adoption of altmetrics sources in the bibliometric community', *Scientometrics*, vol. 101, no. 2, pp. 1145–1163.

*Hoffmann, C. P., Lutz, C. & Meckel, M. (2016) 'A relational altmetric? Network centrality on ResearchGate as an indicator of scientific impact', *Journal of the Association for Information Science and Technology*, vol. 67, no. 4, pp. 765–775.

Hsieh, H.-F. & Shannon, S. E. (2005) 'Three approaches to qualitative content analysis', *Qualitative Health Research*, vol. 15, no. 9, pp. 1277–1288.

*Jamali, H. R. (2017) 'Copyright compliance and infringement in ResearchGate full-text journal articles', *Scientometrics*, vol. 112, no. 1, pp. 241–254.

*Jamali, H. R., Nicholas, D. & Herman, E. (2016) 'Scholarly reputation in the digital age and the role of emerging platforms and mechanisms', *Research Evaluation*, vol. 25, no. 1, pp. 37–49.

*Jeng, W., *et al.*, (2017) 'Information exchange on an academic social networking site: a multi-discipline comparison on ResearchGate Q&A', *Journal of the Association for Information Science and Technology*, vol. 68, no. 3, pp. 638–652.

Jordan, K. (2014) 'Academics and their online networks: exploring the role of academic social networking sites', *First Monday*, vol. 19, no. 11.

Kjellberg, S., Haider, J. & Sundin, O. (2016) 'Researchers' use of social network sites: a scoping review', *Library & Information Science Research*, vol. 38, no. 3, pp. 224–234.

Kraker, P. & Lex, E. (2015) 'A critical look at the ResearchGate score as a measure of scientific reputation', *Quantifying and Analysing Scholarly Communication on the Web Workshop (ASCW'15)*, Web Science Conference 2015, Oxford, UK.

Kramer, B. & Bosman, J. (2016) 'Swiss army knives of scholarly communication – ResearchGate, Academia, Mendeley and others', *STM Innovation seminar* 2016, [online] Available at: http://www.stm-assoc.org/events/innovations-seminar-2016/

*Kuo, T., *et al.*, (2017) 'From sociability to creditability for academics', *Computers in Human Behavior*, vol. 75, pp. 975–984.

*Laakso, M., *et al.*, (2017) 'Research output availability on academic social networks: implications for stakeholders in academic publishing', *Electronic Markets*, vol. 27, no. 2, pp. 125–133.

Li, J. & Greenhow, C. (2015) 'Scholars and social media: tweeting in the conference backchannel for professional learning', *Educational Media International*, vol. 52, no. 1, pp. 1–14.

Liu, W. (2016) 'The changing role of non-English papers in scholarly communication: evidence from Web of Science's three journal citation indexes', *Learned Publishing*, vol. 30, no. 2, pp. 115–123.

*Mabvuure, N. T., *et al*., (2014) 'A cross-sectional study of the presence of United Kingdom (UK) plastic surgeons on social media', *Journal of Plastic, Reconstructive & Aesthetic Surgery*, vol. 7, no. 3, 362–367.

*Madhusudhan, M. (2012) 'Use of social networking sites by research scholars of the University of Delhi: a study', *The International Information & Library Review*, vol. 44, no. 2, pp. 100–113.

Manca, S. (2017) 'An analysis of ResearchGate and Academia.edu as socio-technical systems for scholars' networked learning: a multilevel framework proposal', *Italian Journal of Educational Technology*, vol. 25, no. 3, pp. 20–34.

Manca, S. & Raffaghelli, J. E. (2017) 'Towards a multilevel framework for analysing academic social network sites: a networked socio-technical perspective', *Proceedings of the 4th European Conference on Social Media – ECSM 2017*, Vilnius, Lithuania, 3–4 July 2017, pp. 193–201.

*Manca, S. & Ranieri, M. (2016) '"Yes for sharing, no for teaching!": social Media in academic practices', *The Internet and Higher Education*, vol. 29, pp. 63–74.

*Manca, S. & Ranieri, M. (2017) 'Networked scholarship and motivations for social media use in scholarly communication', *International Review of Research in Open and Distributed Learning*, vol. 18, no. 2, pp. 123–138.

*Marra, M. (2016) 'Professional social networks among Italian astrophysicists. Prospective changes in validation and dissemination practices?', *Information Services and Use, vol.* 35, no. 4, pp. 243–249.

Matthews, D. (2017) 'Scholars launch non-profit rival to ResearchGate and Academia.edu', *Times Higher Education,* 8 Nov., [online] Available at: https://www.timeshighereducation.com/news/scholars-form-non-profit-rival-to-researchgate

*Megwalu, A. (2015) 'Academic social networking: a case study on users' information behavior', *Current Issues in Libraries, Information Science and Related Fields*, vol. 39, 185–214.

*Meishar-Tal, H. & Pieterse, E. (2017) 'Why do academics use academic social networking sites?', *International Review of Research in Open and Distributed Learning,* vol. 18, no. 1, 1–22.

*Mikki, S., *et al*., (2015) 'Digital presence of Norwegian scholars on academic network sites- where and who are they?', *PLoS One*, vol. 10, no. 11, pp. 1–17.

Nández, G. & Borrego, A. (2013) 'Use of social networks for academic purposes: a case study', *The Electronic Library*, vol. 31, no. 6, pp. 781–791.

Newman, M. & Elbourne, D. (2004) 'Improving the usability of educational research: guidelines for the reporting of primary empirical research studies in education (the REPOSE guidelines)', *Evaluation & Research in Education*, vol. 18, no. 4, pp. 201–212.

*Nicholas, D., *et al*., (2017a) 'Where and how early career researchers find scholarly information', *Learned Publishing*, vol. 30, no. 1, pp. 19–29.

*Nicholas, D., Clark, D. & Herman, E. (2016a) 'ResearchGate: reputation uncovered', *Learned Publishing*, vol. 29, no. 1, pp. 173–182.

*Nicholas, D., Herman, E. & Clark, D. (2016b) 'Scholarly reputation building: how does ResearchGate Fare?', *International Journal of Knowledge Content Development & Technology*, vol. 6, no. 2, pp. 67–92.

Nicholas, D., Herman, E. & Jamali, H. R. (2015a) *Emerging Reputation Mechanisms for Scholars*, European Commission, Joint Research Centre, Institute for Prospective Technological Studies, Brussels.

*Nicholas, D., *et al*., (2015b) 'New ways of building, showcasing, and measuring scholarly reputation', *Learned Publishing*, vol. 28, no. 3, pp. 169–183.

*Nicholas, D., *et al*., (2017b) 'Early career researchers: scholarly behaviour and the prospect of change', *Learned Publishing*, vol. 30, no. 2, pp. 157–166.

*Niyazov, Y., *et al*., (2016) 'Open access meets discoverability: citations to articles posted to Academia.edu', *PLoS One*, vol. 11, no. 2, pp. 1–41.

*Onyancha, O. B. (2015) 'Social media and research: an assessment of the coverage of South African universities in ResearchGate, Web of Science and the Webometrics Ranking of

World Universities', *South African Journal of Libraries and Information Science*, vol. 81, no. 1, pp. 8–20.

*Ortega, J. L. (2015a) 'Disciplinary differences in the use of academic social networking sites', *Online Information Review*, vol. 39, no. 4, pp. 520–536.

*Ortega, J. L. (2015b) 'Relationship between altmetric and bibliometric indicators across academic social sites: the case of CSIC's members', *Journal of Informetrics*, vol. 9, no. 1, pp. 39–49.

Priem, J. & Hemminger, B. M. (2010) 'Scientometrics 2.0: toward new metrics of scholarly impact on the social Web', *First Monday*, vol. 15, no. 7.

Raffaghelli, J. E., Cucchiara, S., Manganello, F. & Persico, D. (2016) 'Different views on digital scholarship: separate worlds or cohesive research field?', *Research in Learning Technology*, vol. 24, no. 1, pp. 1–17.

*Shrivastava, R. & Mahajan, P. (2015) 'Relationship amongst ResearchGate altmetric indicators and Scopus bibliometric indicators', *New Library World*, vol. 116, no. 9/11, pp. 564–577.

*Shrivastava, R. & Mahajan, P. (2017) 'An altmetric analysis of ResearchGate profiles of physics researchers: a study of University of Delhi (India)', *Performance Measurement and Metrics*, vol. 18, no. 1, pp. 52–66.

Stewart, B. E. (2015) 'In abundance: networked participatory practices as scholarship', *International Review of Research in Open and Distributed Learning*, vol. 16, no. 3, pp. 318–340.

*Tamjidyamcholo, A., *et al.*, (2016) 'Willingness of members to participate in professional virtual communities', *Quality & Quantity*, vol. 50, no. 6, pp. 2515–2534.

Thelwall, M., *et al.*, (2013) 'Do altmetrics work? Twitter and ten other social web services', *PLOS One*, vol. 8, no. 5, e64841, pp. 1–7.

*Thelwall, M. & Kousha, K. (2014) 'Academia.edu: social network or academic network?', *Journal of the Association for Information Science and Technology*, vol. 65, no. 4, pp. 721–731.

*Thelwall, M. & Kousha, K. (2015) 'ResearchGate: disseminating, communicating, and measuring Scholarship?', *Journal of the Association for Information Science and Technology*, vol. 66, no. 5, pp. 876–889.

*Thelwall, M. & Kousha, K. (2017) 'ResearchGate articles: age, discipline, audience size, and impact', *Journal of the Association for Information Science and Technology*, vol. 68, no. 2, pp. 468–479.

*Tran, C. Y. & Lyon, J. A. (2017) 'Faculty use of author identifiers and researcher networking tools', *College and Research Libraries*, vol. 78, no. 2, pp. 171–182.

van Dijck, J. (2013) *The Culture of Connectivity. A Critical History of Social Media*, Oxford University Press, Oxford.

Veletsianos, G. (2016) *Social Media in Academia: Networked Scholars*, Routledge, New York.

Veletsianos, G. & Kimmons, R. (2012) 'Networked participatory scholarship: Emergent technocultural pressures toward open and digital scholarship in online networks', *Computers & Education*, vol. 58, no. 2, pp. 766–774.

Vuorikari, R. & Punie, Y. (2015) *Analysis of Emerging Reputation and Funding Mechanisms in the Context of Open Science 2.0*, European Commission, Joint Research Centre, Brussels.

Wagner, C. (2008) *The New Invisible College: Science for Development*, Brookings Institution Press, Washington, DC.

Weller, M. (2011) *The Digital Scholar. How Technology is Transforming Scholarly Practice*, Bloomsbury, London.

Williams, A. E. & Woodacre, M. A. (2016) 'The possibilities and perils of academic social networking sites', *Online Information Review*, vol. 40, no. 2, pp. 282–294.

*Yu, M.-C., *et al.*, (2016) 'ResearchGate: an effective altmetric indicator for active researchers?', *Computers in Human Behavior*, vol. 55, pp. 1001–1006.