An analysis of ResearchGate and Academia. edu as socio-technical systems for scholars' networked learning: a multilevel framework proposal

Un'analisi di ResearchGate e Academia.edu come sistemi socio-tecnici per l'apprendimento in rete degli accademici: una proposta di framework multilivello

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ABSTRACT Academic social network sites (ASNS) like ResearchGate and Academia.edu are digital platforms for information sharing and systems for open dissemination of scholarly practices that are gaining momentum among researchers of multiple disciplines. Although ASNS are increasingly transforming scholarly practices and academic identity, a unifying theoretical approach that analyses these platforms at both a systemic/infrastructural and at a personal/individual level is missing. Moreover, despite there is an increasing amount of studies on social media benefits for scholarly networking and knowledge sharing, very few studies have investigated specific benefits of ResearchGate and Academia.edu for scholars' professional development according to a networked learning perspective. This study focuses on academic social network sites as networked socio-technical systems and adopts a three-level analysis related to ASNS as platforms for digital scholarship and scholarly communication. The approach comprises: 1) a macro-level, which constitutes the socio-economic layer; 2) a meso-level, which comprises the techno-cultural layer; and 3) a micro-level, which constitutes the networked-scholar layer. The study reports on investigations into the technological features provided by ResearchGate and Academia.edu for networked learning that are based on the multilevel approach. The final aim is to exemplify how these digital services are socio-technical systems that support scholars' knowledge sharing and professional learning.

KEYWORDS Academic social network sites, ResearchGate, Academia.edu, Socio-technical systems, Networked learning, Professional development.

SOMMARIO Social network accademici (ASNS) come ResearchGate e Academia.edu sono piattaforme

digitali per la condivisione di informazioni e sistemi per la disseminazione aperta di pratiche accademiche che stanno acquisendo sempre maggiore interesse tra i ricercatori di diverse discipline. Sebbene i ASNS stiano progressivamente trasformando le pratiche dei ricercatori e l'identità accademica, manca ancora un approccio teorico unificante che analizzi queste piattaforme sia a livello sistemico-infrastrutturale che personale/individuale. Inoltre, nonostante esistano un crescente numero di studi sui benefici dei social media per il networking accademico e la condivisione di conoscenza, pochissimi hanno analizzato i benefici specifici di ResearchGate e Academia.edu per lo sviluppo professionale degli accademici secondo la prospettiva dell'apprendimento in rete. Questo studio è incentrato sui social network accademici come sistemi socio-tecnici di natura reticolare e adotta un approccio a tre livelli che li analizza come piattaforme per la digital scholarship e la comunicazione accademica. L'approccio comprende: 1) un macro-livello, che costituisce lo strato socio-economico; 2) un livello meso, che include lo strato tecno-culturale; e 3) un micro-livello, che costituisce lo strato del ricercatore in rete. Lo studio riporta i risultati dell'analisi delle caratteristiche tecnologiche di ResearchGate e Academia.edu per l'apprendimento in rete basata sull'approccio multilivello. Obiettivo finale è quello di fornire degli esempi di come questi servizi digitali siano sistemi socio-tecnici che forniscono supporto ai ricercatori per la condivisione di conoscenza e l'apprendimento professionale.

PAROLE CHIAVE Social network accademici**,** ResearchGate, Academia.edu, Sistemi socio-tecnici, Apprendimento reticolare, Sviluppo professionale.

1. INTRODUCTION

Digital technologies and social media are progressively reshaping professional development and work-based learning in a variety of knowledge intensive professions, such as teachers, academics and health professionals (Manca & Ranieri, 2017a). Several studies have shown that professionals employ social media platforms to build learning networks, share professional ideas and engage collaboratively with their peers. For instance, Fox and Bird (2017), that have recently investigated the landscape of academic studies on how teachers and doctors learn through social media, find there is a growing professional interest in social media in these professions, although there is also a further need for a broader evidence base to evaluate benefits in these two professions. With specific reference to social network sites, studies on Facebook groups use for teachers' professional development have shown that teachers participate in social media for sharing and professional support (Kelly & Antonio, 2016; Ranieri, Manca, & Fini, 2012) and for identity positioning (Lundin, Lantz-Andersson, & Hillman, 2017). In addition, studies on Twitter use have found that teachers emphasize sharing novel ideas and collaboration with other teachers to create education-related content as central practices (Carpenter & Krutka, 2015; Macià & García, 2017).

Today in the scholarly field ASNS and ICT in general are redefining academic networking and scholars' identities and increasingly affecting strands of open science and public engagement (Weller, 2011). Digital scholarship is commonly understood as the use of digital evidence, methods of inquiry, research, publication and preservation to achieve scholarly and research goals. In this light, social media are progressively affecting academic scholarship and its four dimensions - discovery, integration, application and teaching (Boyer, 1990) - according to several strands of analysis. One of the approaches, Networked Participatory Scholarship, 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 & Kimmons 2012, p. 768). The emergent uses 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. Another strand of research named Social Scholarship (Greenhow & Gleason, 2014) investigates how social media affordances influence the ways in which academia accomplish scholarship through values like promotion of users and decentralised accessible knowledge. Researchers are studying social media as means through which to promote the enhancement of open dissemination practices, the formulation of alternative indicators of scientific impact, and the strengthening of relationships among cohorts of scholars (Borrego, 2017; Donelan, 2016; Manca & Ranieri, 2017b; Nández & Borrego, 2013).

However, while 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 (Kimmons & Veletsianos, 2016; Li & Greenhow 2015; Stewart, 2015), very few studies have thoroughly investigated academic social network sites (ASNS) like ResearchGate and Academia.edu use in the light of theoretical frameworks developed in the educational technology sector and aimed at analysing social digital scholarship practice. Most of the research focused on these two services has been produced in the library and information sciences as deployments for reputation building and alternative ranking systems (Hoffman, Lutz, & Meckel, 2016; Kuo, Tsai, Wu, & Alhalabi, 2017; Niyazov et al., 2016; Thelwall & Kousha, 2015). Today there is a dearth of research investigating practices and new modes of communication in the light of a networked participatory approach to scholarship that employ ResearchGate and Academia.edu.

Moreover, although ASNS are held to benefit scholars by enhancing their visibility and reputation, and by increasing opportunities for collaboration and exchange (Nicholas, Herman, & Jamali, 2015), descriptions of scholars' experiences of these platforms are fragmentary, and comprehensive views of how digital scholarship should be investigated are lacking (Raffaghelli, Cucchiara, Manganello, & Persico, 2016). The debate is stagnating in separate research strands that do not accommodate infrastructural issues and phenomenological experiences of use. Present limitations demand a theoretically founded approach capable of providing a framework for analysing ASNS both at a systemic/infrastructural level and at a personal/individual one that provides evidence of support for scholars' networked learning and professional development.

This study elaborates a conceptual analysis of ASNS in accordance with a multi-level framework that was investigated in a previous publication (Manca & Raffaghelli, 2017). The proposal is aimed at analysing how sociality and digital platforms like ResearchGate and Academia.edu are interrelated and how systemic and individual employments of these sites might best be investigated in the light of scholars' professional learning. Although the idea of analysing scholarly communication forums as socio-technical interaction networks is not new (Kling, McKim, & King, 2003), research on ASNS through a socio-technical perspective both at the platform's organizational and individual level is scarce. This study provides an analysis of the technological features employed by the two most prominent ASNS, ResearchGate and Academia.edu, for networked learning and scholars' knowledge sharing.

In the following sections, the theoretical background of the study is presented along with a detailed description of the technological features of ResearchGate and Academia.edu.

2. THEORETICAL BACKGROUND

Focus on patterns in the design and use of technologies as highly context dependent can be dated back at least to the '70s (Williams & Edge, 1996), while early ideas of the social construction of technology can be traced back to the early '80s (Bijker, Hughes, & Pinch, 1987). According to socio-technical approaches, technological systems are determined by social forces and by technological features at the same time. Design, implementation and use of information technologies are the result of interactions and negotiations

between technology, users and organizational contexts (Huysman & Wulf, 2006).

Digital scholarship has recently been reconceptualised as a complex techno-cultural system that includes technological innovations and dominant cultural values, along with differential identity markers and norms of practice and prestige (Stewart, 2015). On one hand, ASNS, being digital platforms and infrastructures that support digital scholarly practices, can be considered socio-material phenomena. On another hand, scholars have investigated scholarly communities as knowledge-sharing entities that are formed by trust, a sense of mutuality and recognition by peers (Costa, 2016; Fulk & Yuan, 2013; Huysman & Wulf, 2006). A socio-technical approach that combines emergent user practices and content with the platform's organizational level has been proposed in the study of social media and social network sites as microsystems (van Dijck, 2013). The approach positions social media like Twitter, Facebook, YouTube, Flickr and Wikipedia as systems that encompass coevolving networks of people and technologies with economic infrastructure and legal-political governance and blends techno-cultural and political economy views. It also provides a two-layered approach that addresses social media platforms as socio-economic structures and techno-cultural constructs. Both of these two layers comprise different components. The socio-economic layer includes: 1) an ownership component, which governs commercial and non-profit platforms according to different policies; 2) a governance component, which is constituted by technical and social protocols and sets of rules for managing user activities; and 3) a business model component, which mediates the engineering of connectivity through subscription models. The techno-cultural layer includes: 1) a technology component, namely a number of services that help encode activities into a computational architecture that steers user behaviour; 2) a user/usage component, which orients user agency and implicit and explicit participation; and 3) a content component, which determines the standardization of content and the uniform delivery of products.

However, it should be noted that van Dijck's two-level framework does not explicitly encompass the individual use of social platforms and ways single users exploit these sites for specific purposes. To this end, we consider the concept of Networked Participatory Scholarship (NPS) proposed by Veletsianos and Kimmons (2012). According to NPS, scholars' learning and knowledge in networked spaces are facilitated, negotiated, and constructed both individually and socially. The incorporation of the ideas of NPS provides a third new layer, the networked-scholar layer, which concerns the actual uses of ASNS by individuals and communities of scholars. In this light, the networked-scholar layer comprises three major components: 1) a networking component, which refers to the structural dimension of scholarship and how the connectivity of communication and collaboration is engineered; 2) a knowledge-sharing component, which concerns the collective and distributed learning dimension; and 3) an identity component, which relates to reputation and trust as elements that shape academic personae.

In this perspective, ASNS might be conceived as three-layered structures that comprise a socio-economic, a techno-cultural and a networked-scholar layer, as illustrated in Figure 1.
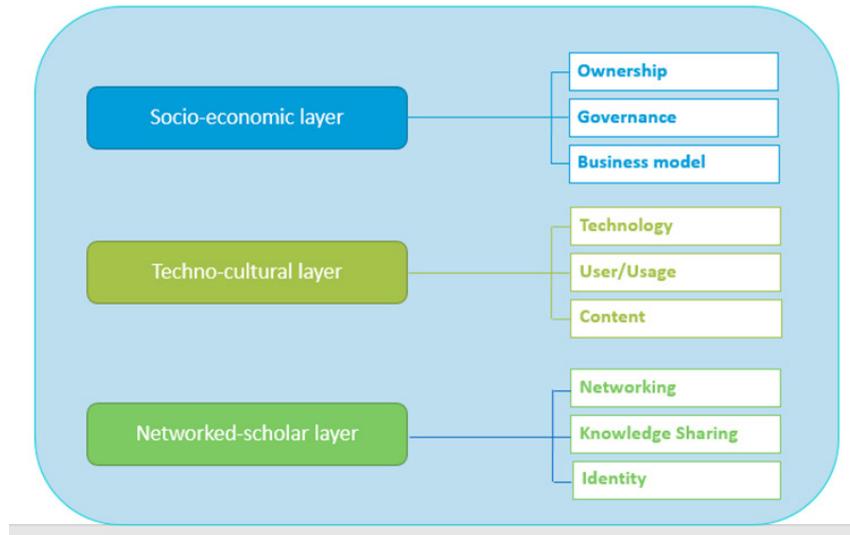
Figure 1. The multilayer approach for analysing ASNS according to a networked socio-technical perspective.

In the following, an attempt to investigate ASNS according to a multi-level analysis that emphasises the several dimensions involved in these sites according to a socio-technical perspective is presented. A macro–meso–micro framing approach (Dopfer, Foster, & Potts, 2004) with the aim of investigating the meanings across the systemic, organizational and individual layers is employed.

3. THE MULTI-LAYERED FRAMEWORK

3.1. *The socio-economic layer*

The macro-level identifies the ASNS components that are at stake in framing the socio-economic model. From the perspective of the ownership component, ASNS are generally for-profit enterprises. They have attracted a range of external investors over the years and established agreements with other platforms and API-based services (e.g. Twitter, Facebook, LinkedIn, Google) to implement each other's buttons and get reciprocal access to data streams. The governance component regards the mechanisms by which communication and data traffic are managed and includes the Terms and Conditions agreement governing, and legally framing, the provider-user relationship. Finally, most of these platforms have supplemented their basic free-of-charge services with paid subscriptions as part of their overall business plan. In this respect, the socio-economic layer of ASNS is positioned in terms of ownership, governance and business model, and ascertains the opportunities and limitations for members to connect. It ultimately shapes the way that social relationships form and develop on the platform.

3.2. *The techno-cultural layer*

The meso-level identifies the ASNS components that are at stake in building the techno-cultural layer. The first, technology, comprises the computational architecture through programmed directives that steer user behaviour; it provides a mediator layer that shapes the performance of social acts by means of services. The platform interface reflects the owner's strategic choices about the final presentation of information

and default/optional settings, as in the case of the individual's biographical data (e.g. real name, academic qualification, affiliation and gender). The typical default setting is displayed to all users for identification purposes, while sensitive information like contact details are disclosed only to mutual followers.

The complex of algorithms, protocols and default settings shapes the networking experiences of users active on academic platforms and engineers sociality in diverse manners. Sociality is, for instance, encoded by aggregating and processing (meta)data to calculate network connections within a given subnetwork or community, which is defined according to specific parameters like affiliation, country and research topics. Features like News Feed and Network Updates, partly adopted in the attempt to emulate high-profile social network sites, allow users to monitor members' activities like new uploads, bookmarked publications and shared updates, and can also generate suggestions for new contacts or new activities to take part in. In this light, ASNS prioritise the events and actions considered most meaningful to foster connectivity among users like prompting endorsements to recommend other researchers for their skills and expertise, and to spur new connections like suggesting academics to follow.

The second component, user/usage, concerns activation of platform features according to implicit and explicit user participation. While the former regards the usage inscribed in platform design by means of the encoding mechanisms mentioned above, the latter concerns how actual users interact with the platform. Usage can be limited to reading and acquiring information about what other users post, or can regard active participation, such as posting new content or activating new connections. Both types of usage can generate professional benefits for academics; stumbling upon relevant information not only enriches their personal knowledge base, it can also help them build a transactive memory or a cognitive representation of who is who in their networks (see Utz, 2016). Transactive memory is further fostered, for instance, through the possibility to ask and respond to user questions in a dedicated Question & Answer section of the platform. Moreover, by checking the profiles of other users, reading news feeds or approaching peers for advice and knowledge sharing, socio-emotional effects can be achieved as social lubricant (Utz, 2016).

Lastly, the content component concerns the types of information resources that can be shared on ASNS. Being academically oriented, ASNS mostly prompt the uploading and sharing of academic output, which mainly comprises research papers but also grey literature like open datasets, drafts, results from failed experiments, and open reviews of papers. However, researchers can also ask research-related questions and share their expertise through Question & Answer sections, showcase the projects they are currently working on, and share updates with collaborators and peers. Each platform sets and applies its own particular standards for content, formatting and delivery in line with the way it engineers connectivity and sociality.

3.3. *The networked-scholar layer*

The micro-level identifies the ASNS components that are at stake in building relations at the networked-scholar layer. The first component, networking, concerns the possibility to build an individual network of contacts using the features provided by the platform. In this view, ASNS offer a range of possibilities for users to build their personal network in order to access fresh information or locate relevant expertise. Unlike other social networking services that are based on reciprocal ties (e.g. "friends" or "connections"), ASNS usually rely on the "follow" function, exploiting one-way relations that do not imply automatic reciprocation. The concept of "following" concerns a loose kind of connection that serves to exploit latent ties, namely ties that are still potential and can be activated socially (Haythornthwaite, 2005), which may eventually become weak ties (Genoni, Merrick, & Willson, 2005). 'Bookmarking' publications and 'following' other users' projects or research items are additional features for trailing users.

The second component, knowledge sharing, concerns sharing knowledge with peers. Knowledge sharing has been investigated in information public goods theory (Fulk & Yuan, 2013), as well as in studies on

content sharing in social network sites like Facebook (Fu, Wu, & Cho, 2017). Academic social network sites provide a range of features that support content distribution and sharing, mostly based on adding or uploading new articles. However, while some ASNS prompt the sharing of references, others openly encourage full text upload or support private one-to-one exchange when sharing involves copyrighted material available with peers that do not have access to commercial channels of distribution. Other features to exploit knowledge sharing and expertise are the Search function, which allows users to search for fellow researchers, publications, questions, job announcements, research interests and affiliations, Discussion Sessions, and Asking Questions. By browsing the existing list of Q&As or setting up a new discussion session, users can gain valuable access to the expertise of peers in a much more effective way than conventional expert directories. As discussed below, motivations for sharing and perceptions of personal and collective gains have direct consequences on the reputational mechanism and overall identity.

Lastly, the third component, identity, refers to reputation and trust as elements shaping academic personae. As acknowledged by Veletsianos and Stewart (2016), scholars disclose specific personal and professional information to promote their evolving professional identity and to boost their reputation in terms of visibility. In ASNS, identity is mostly conveyed through features like the profile and a number of strictly associated components. The profile, the main place where visibility and reputation are constructed, usually displays a user's network size (i.e. the number of Followers and Following), tie strength (weak ties are constituted by Followers and Following, while strong ties regard co-authors, who are usually listed separately), skills and expertise, number of peer endorsements, and awards and achievements. Further features allow the visualization of new followers, research products, projects, teaching resources, engagement in discussion sessions and number of citations. Reputation is further exploited in overall scores, which some ASNS offer as community measures to value users' willingness to share knowledge and expertise (see Nicholas, Herman & Jamali, 2015).

4. AN ANALYSIS OF RESEARCHGATE AND ACADEMIA.EDU

ResearchGate and Academia.edu are undoubtedly the most popular of the social networking services developed specifically to support academic and research practices (Nicholas, Herman & Jamali, 2015). These sites allow academics to build a professional profile, connect with colleagues, share publications, and state their mission in terms of research sharing, openness and transparency.

In the following, the two platforms are analysed according to the multilevel framework presented above, providing examples of features that correspond to the socio-economic, techno-cultural and networked-scholar layers[1]. Analysing ASNS in this way has the advantage of disassembling these sites according to explicit and implicit dimensions that steer users' behaviour. This facilitates reflection on how connectivity among users is engineered in these specific academic microsystems.

4.1. *ResearchGate and the imperative of openness*

ResearchGate is a social network service founded in 2008 and has attracted more than 12 million members distributed worldwide in 193 countries. The majority of the members, sixty per cent, belong to a wide range of hard scientific disciplines such as medicine, biology, engineering, chemistry, computer science and physics. The stated mission of ResearchGate is «*to connect the world of science and make research open to all*».

4.1.1. *ResearchGate socio-economic layer*

Defined as «*a free Facebook-style social network aimed solely at scientists worldwide*», ResearchGate is a

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[1] For a complete updated list of features, see http://tinyurl.com/ACMERGfunctions

for-profit company headquartered in Berlin that counts more than 260 employees. The company has completed four rounds of financing and over the years has attracted a wide range of external investors, including Bill Gates and venture capitalists. It has also established agreements with other social platforms and now users can connect with API-based services like Facebook, LinkedIn and Google.

The governance component is mostly managed through the Terms and Conditions that regulate the provider-user relationship. One of the most important terms concerns the Statement on Privacy and Data Protection, which operates in full compliance with German laws. The statement also claims that email addresses are processed solely to send information or notifications about the Service, although they reserve the right to attach a minor part of advertisements for products and services of third parties. As for intellectual property rights of third parties, ResearchGate can, at its discretion, disable and/or terminate the accounts of users who infringe or repeatedly infringe the copyrights of others in accordance with the Digital Millenium Copyright Act (DMCA). On the other side, users are required to indemnify ResearchGate in case of copyright infringements.

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. In addition, in the near future, the company is likely to adopt highly targeted advertising so that scientific conferences can market their events on the platform and companies can advertise products, devices, books and services to scientists, leading the way to an academic-oriented marketplace along the lines of Amazon.

4.1.2. *ResearchGate techno-cultural layer*

The capability to connect users with each other and to foster communication between them is enabled by the technology component. Through a number of invisible algorithms and protocols that execute the programmed social tasks of interaction among members, ResearchGate implements features to spur users' connectivity and to channel social interaction, for instance, automatically signalling which other people one may be interested in contacting and adding to his/her network. Like Facebook and other popular social network sites, ResearchGate Home provides News Feeds that allow users to monitor members' activities like new uploads, new projects, bookmarked publications, comments and shared updates. Other features of this kind include prompting endorsements of researchers for their skills and expertise and suggesting new researchers to follow. Connectivity and interaction are also fostered through the Recommend button, which is quite similar to the Like button in Facebook, and the Follow button for projects and publications. ResearchGate gives users the option to share bibliographic references to their own work but nonetheless solicits them to add full-texts by indicating the number of references that the user has added without full texts and stressing the advantages that sharing full-texts brings for increasing the visibility of one's work and boosting personal ratings.

As reported in the previous sections, platform usage can be passive, i.e. limited to reading and acquiring information about what others post, or can regard active participation, such as posting new content or activating new connections. One way of engaging actively in the network is to participate in the Questions discussion threads by posing research questions and/or sharing expertise.

Finally, at the content level, ResearchGate affords the publication of diverse types of scientific output. These include not just publications, but also grey literature such as open datasets, drafts, results from failed experiments, and open reviews of papers that users have read or worked with. Indeed, a significant feature distinguishing ResearchGate from other academic networks is the possibility to publish raw data and media files in order to stimulate discussion among interested members. A recently added feature allows users to organise research outputs into Projects so that publications and other research outputs are grouped according to research topics. However, the Project is also seen by some as something in itself to share and promote,

not just as a thematic label for outputs. Finally, the Timeline has been adopted to showcase research output from start to finish and provides an overview of a researcher's publishing history, questions, open reviews, and publication comments over time.

4.1.3. *ResearchGate networked-scholar layer*

The possibility to build an individual network of contacts is mostly based on the Follow feature, through which users can subscribe to others' updates without this being automatically reciprocated. The Follow function gives users access to new and updated information and opportunities to locate relevant expertise. Each user's personal network of Following and Followers is displayed in her/his profile. The list of co-authors is also displayed in a specific tab, highlighting strong ties in one's network of contacts. To strengthen ties in their personal network, researchers can also use the Recommend resources function to spotlight publications, projects, etc.

The knowledge sharing component chiefly regards the adding or uploading of research products but also includes Commenting on publications and projects and asking and replying to questions via the Questions feature, which is of value for boosting knowledge and expertise sharing. Another key feature for retrieving useful information and maintaining distributed memory is the Search function, which allows users to search for fellow researchers, publications, question/answer topics, job announcements, research interests and affiliations; the possibility to browse the existing list of Q&As is also useful to these ends. In addition, the personal profile includes a tab for displaying Expertise and skills; users can browse this when seeking to locate competences useful for their research. As stressed in previous sections, motivations to share and perceptions of personal and collective gains have direct consequences on the reputational mechanism and researchers' identity.

User identity is mostly conveyed through the Profile, the main feature for constructing visibility and reputation. Information displayed in a researcher's profile includes: a short bio; visualization of research products and projects; list of Followers and Following; engagement in Q&A sessions; and awards and achievements. Researchers can also raise their visibility by listing their best publications in a Featured Research tab.

However, what distinguishes ResearchGate from other social network sites for academics is its set of proprietary reputation metrics. These can be also seen as community measures of value that encourage user interaction by rewarding the willingness to share knowledge and expertise. In this perspective, Research-Gate provides three types of scores: RG Score, RG Reach and h-index. RG Score is a metric that measures scientific reputation calculated by combining two factors. One is the community's response to all the research outputs one shares, response being expressed through number of views. The other is the user's level of overall activity across the platform: Q&A participation, number of followers attracted, etc. RG Reach gauges the visibility of ones' work on the platform in terms of how many individual researchers are notified when one adds new research. The total reach is calculated by adding the number of direct connections one has to the number of people connected to one's work as co-authors and project collaborators. Lastly, h-index measures the impact of one's work by considering the number of publications a researcher has published and displayed in his/her profile, and the number of citations these have attracted, regardless of which journal the study was published in. The service provides two separate h-indices for each author: while the first includes self-citations, the second does not. Users are encouraged to increase their impact and boost their scores by adding as many publications as possible to their profile; they are also constantly reminded to add full-texts that are missing.

4.2. *Academia.edu and the paradigm of sharing*

Academia.edu is a social networking service founded in 2008 that counts almost 50 million accounts and at-

tracts over 36 million unique visitors a month. In contrast with ResearchGate, the platform is more popular in Arts and Humanities and to a lesser extent in Social Sciences and Economics (Kramer & Bosman, 2016).

4.2.1. *Academia.edu socio-economic layer*

Academia.edu is a for-profit company headquartered in San Francisco with a small team of 18 people. The platform has recently brought its total equity funding to almost 20 million dollars from a number of capital ventures that have fuelled the growth of the platform and the team. Connection with other social media services regards account sharing (users can log in with third party accounts like Google and Facebook) and the possibility to tweet the uploading of a new publication.

As for the governance component, the site's Terms of Use grant users the right to download, view and print any Academia.edu content solely for personal and non-commercial purposes. When posting, uploading, publishing, submitting or transmitting member content, members grant Academia.edu a worldwide, revocable, non-exclusive, transferable license to exercise any and all rights under copyright, in any medium. Since an account may be linked to other online accounts, relationships with third party service providers are regulated accordingly. As for intellectual property rights of third parties, Academia.edu can terminate the accounts of users who may infringe or repeatedly infringe the rights of copyright holders.

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, mostly organised around enhanced analytics. These provide additional features like Mentions, Readers, Advanced Search and Extra Analytics, as well as full text search of PDFs and a Job Board for advertising academic vacancies. Academia.edu is also aiming to commercially engage R&D institutions by providing them with trending research data gleaned from algorithms that aggregate the latest high-impact papers in a given research area.

4.2.2. *Academia.edu techno-cultural layer*

The technology component to spur users' interactions and building of new contacts is engineered in a similar way to ResearchGate. Academia.edu's Home provides a constant news feed that updates users on new uploads, bookmarked publications, user actions like joining or commenting on a discussion session and publications Recommended by one's contacts. 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 members can invite others to join Academia.edu using the platform's automated invitation system. In this light, the agreement with social media third parties like Facebook and Twitter engineers automatically following social media contacts when they sign up to Academia.edu.

As far as the usage component is concerned, Academia.edu offers a unique feature called Sessions that allows users to create a special page where peers and colleagues can leave general comments on papers or line-specific annotations. Permission levels depend on whether the contributor is a mutual follower or is outside the author's network of contacts. Restrictions are also applied to language, in so far as the only language allowed is English.

Finally, at the content level, Academia.edu affords the publication of diverse types of scientific products, including papers, books, book chapters, drafts, but also conference presentations and teaching material.

4.2.3. *Academia.edu networked-scholar layer*

Users build an individual network of contacts mostly using the Follow feature, through which they subscribe to contacts' updates without being automatically reciprocated. The list of each user's Followers, Following and Co-authors can be accessed via their profile by clicking on separate links; they are not automatically displayed there.

The knowledge sharing component chiefly regards the adding or uploading of research products such as publications, drafts and teaching materials. However, it also includes contributing to Sessions pages, where users can leave general comments on papers or line-specific annotations. A key feature for retrieving useful information and maintaining distributed memory is the Search function, which allows users to search for papers, people, research interests and affiliations (full text search of PDFs is also available, but only for premium accounts).

The Profile feature, where user identity is mostly conveyed, displays various information: a short bio; research interests; contact details; number of Followers, Following and Co-authors; and lists of research products. In terms of reputation, the profile also 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. In order to enhance visibility, users can also benefit from adding social media profiles, such as Twitter, Facebook, Google Scholar, LinkedIn and Skype to their profile.

The service also provides an analytics dashboard, which gives the user an overview of how others have interacted with their own publications (number of visitors, views and downloads, as well as the related countries and cities of provenance, etc.). However, detailed analysis is accessible only with a premium account. All the data about visits to one's profile and papers can be exported in a CSV file, which can then be opened in a spreadsheet program for further analysis. The service also prompts sending of emails to users that are periodically alerted to the paper views with subject lines like «*Someone just searched for you on Google and found your page on Academia.edu. To see what city they came from and what paper they viewed, follow the link below*».

5. DISCUSSION AND CONCLUSION

Although academic social network sites present features similar to general social network sites' (Ellison & boyd, 2013), they are also specific socio-technical systems that offer unique technological affordances to researchers and scholarly communities. The aim of this study was to explore ASNS as social infrastructures for digital scholarship that allow knowledge sharing and scholarly networking at different levels. From this perspective, a multi-layer analysis has been proposed to investigate academic social media platforms like ResearchGate and Acadmia.edu as microsystems that combine emergent user practices and content with the platform's organizational level according to three distinct levels, each involving a number of components.

As socio-technical systems, ASNS foster some forms of social interaction and constrain others, like the 'Questions' tool in ResearchGate that does not allow the posting of questions in languages other than English. This means that affordances may come at a price especially when they are implemented in for-profit services. An aggressive policy of marketing concerned with the for-profit nature of these services has spurred several criticisms among users. In the past, ResearchGate was criticised for sending co-authors unsolicited invitations to join the service, unless the author-member explicitly opted out of this. Such marketing tactics caused many researchers to boycott ResearchGate or even to unsubscribe. The company has since changed this policy and now invitations are only sent if a member chooses to invite co-authors to join. More recently, ResearchGate has attracted strong criticism for harvesting data available on the web, such as affiliations, publication records and full texts, and using these to automatically generate nominal profiles that are not actually owned by the people concerned (Van Noorden, 2014).

Moreover, powerful as they may sound, ASNS technological architectures are also influencing the factors academia consider relevant in the evaluation of scientific productivity and academic rankings. For instance, on insisting on the relevance of dashboard analytics, Academia.edu is criticised for reinforcing a culture of incessant self-monitoring and for amplifying and accelerating the logic of self-branding among scholars that is increasingly encouraged by university quantifiable policies (Duffy & Pooley, 2017). Other scholars

question whether RG Scores are creating ghost academic reputations while progressively advocating the role of assessing scholars' reputation (Orduna-Malea, Martín-Martín, Thelwall, & López-Cózar, 2017). Indeed, RG Score has been criticized for having questionable reliability and an opaque calculation methodology that makes it hard to compare it with other popular standard scores (Nicholas, Herman, & Clark, 2016; Thelwall & Kousha, 2015).

Moreover, while these systems are open and are increasingly encouraging open sharing, how ASNS reconcile open access and sharing policies with their business models and corporate governance needs to be carefully considered. More generally we are observing a clash between the rhetoric of open science and «*the profit motive [that] is fundamentally misaligned with core values of academic life, potentially corroding ideals like unfettered inquiry, knowledge-sharing, and cooperative progress*» (Pooley, 2017, n.p.). In this light, how ASNS reconcile open access and sharing policies with their business models and corporate governance needs to be carefully considered in researchers' practices and future research in the field.

Despite these criticisms, forms of researchers' technological appropriation and transformation should be considered in future research. An in-depth analysis of the socio-technical affordances these platforms offer for supporting digital scholarship should be carried out, considering that at present empirical research on the use of ASNS in scholarly communities seems to have mostly attracted attention in the library and information sciences. While the majority of these studies focus on the general uptake or impact assessment of alternative metrics, very few have investigated the individual and collective scholarly practices that ASNS support from a networked learning perspective (Manca, submitted). If this tendency may be attributed to the longstanding interest within library and information sciences for scholarly communication (Borgman, 2007), the educational technology field could contribute by helping recompose the fragmented picture of studies concerned with digital scholarship into a cohesive research field (Raffaghelli, Cucchiara, Manganello, & Persico, 2016).

6. REFERENCES

Bijker, W. E., Hughes, T. P., & Pinch, T. J. (Eds.) (1987). *The social construction of technological systems*. Cambridge, MA: The MIT Press.

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

Borrego, A. (2017). Institutional repositories versus ResearchGate: The depositing habits of Spanish researchers. *Learned Publishing*, *30*(3), 185-192.

Boyer, E. L. (1990). *Scholarship reconsidered: priorities of the professoriate*. San Francisco, CA: Carnegie Foundation.

Carpenter, J. P., & Krutka, D. G. (2015). Engagement through microblogging: Educator professional development via Twitter. *Professional Development in Education*, *41*(4), 707-728.

Costa, C. (2016). Double gamers: academics between fields. *British Journal of Sociology of Education*, *37*(7), 993-1013.

Donelan, H. (2016). Social media for professional development and networking opportunities in academia. *Journal of Further and Higher Education*, *40*(5), 706-729.

Dopfer, K., Foster, J., & Potts, J. (2004). Micro-meso-macro. *Journal of Evolutionary Economics*, *14*(3), 263-279.

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*, *3*(1), 1-11.

Ellison, N. B., & boyd, d. (2013). Sociality through Social Network Sites. In W. H. Dutton (Ed.), *The Oxford Handbook of Internet Studies* (pp. 151-172). Oxford, UK: Oxford University Press.

Fox, A., & Bird, T. (2017). #any use? What do we know about how teachers and doctors learn through social media use? *Qwerty. Open and Interdisciplinary Journal of Technology, Culture and Education*, *12*(2), 64-87.

Fu, P.-W., Wu, C.-C., & Cho, Y.-J. (2017). What makes users share content on facebook? Compatibility among psychological incentive, social capital focus, and content type. *Computers in Human Behavior*, *67*, 23-32.

Fulk, J., & Yuan, Y. C. (2013). Location, Motivation, and Social Capitalization via Enterprise Social Networking. *Journal of Computer-Mediated Communication*, *19*(1), 20-37.

Genoni, P., Merrick, H., & Willson, M. (2005). The use of the Internet to activate latent ties in scholarly communities. *First Monday*, *10*(12).

Greenhow, C., & Gleason, B. (2014). Social scholarship: Reconsidering scholarly practices in the age of social media. *British Journal of Educational Technology*, *45*(3), 392-402.

Haythornthwaite, C. (2005). Social networks and Internet connectivity effects. *Information, Communication & Society*, *8*(2), 125-147.

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*, *67*(4), 765-775.

Huysman, M., & Wulf, V. (2006). IT to support knowledge sharing in communities, towards a social capital analysis. *Journal of Information Technology*, *21*(1), 40-51.

Kelly, N., & Antonio, A. (2016). Teacher peer support in social network sites. *Teaching and Teacher Education*, *56*, 138-149.

Kimmons, R., & Veletsianos, G. (2016). Education scholars' evolving uses of twitter as a conference backchannel and social commentary platform. *British Journal of Educational Technology*, *47*(3), 445–464.

Kling, R., McKim, R., & King, A. (2003). A Bit More to It: Scholarly Communication Forums as Socio-Technical Interaction Networks. *Journal of the American Society for Information Science and Technology*, *54*(1), 47-67.

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

Kuo, T., Tsai, G. Y., Wu, Y-C. J., & Alhalabi. W. (2017). From sociability to creditability for academics. *Computers in Human Behavior*, *75*, 975-984.

Li, J., & Greenhow, C. (2015). Scholars and social media: tweeting in the conference backchannel for

professional learning. *Educational Media International*, *52*(1), 1-14.

Lundin, M., Lantz-Andersson, A., & Hillman, T. (2017). Teachers' reshaping of professional identity in a thematic FB-group. *Qwerty. Open and Interdisciplinary Journal of Technology, Culture and Education*, *12*(2), 12-29.

Macià, M., & García, I. (2017). Properties of Teacher Networks in Twitter: Are They Related to Community-Based Peer Production? *The International Review of Research in Open and Distributed Learning*, *18*(1), 110-140.

Manca, S. (submitted). ResearchGate and Academia.edu as networked socio-technical systems for scholarly communication: a literature review. *Research in Learning Technology*.

Manca, S., & Raffaghelli, J. E. (2017). Towards a Multilevel Framework for Analysing Academic Social Network Sites: A Networked Socio-Technical Perspective. In A. Skaržauskienė & N. Gudelienė (Eds.), *Proceedings of the 4th European Conference on Social Media – ECSM 2017*, Vilnius, Lithuania 3-4 July 2017, pp. 193-201.

Manca, S., & Ranieri, M. (2017a). Editorial. Reshaping professional learning in the social media landscape: theories, practices and challenges. *Qwerty. Open and Interdisciplinary Journal of Technology, Culture and Education*, *12*(2), 5-11.

Manca, S., & Ranieri, M. (2017b). Networked Scholarship and Motivations for Social Media use in Scholarly Communication. *The International Review of Research in Open and Distributed Learning*, *18*(2), 123-138.

Nández, G., & Borrego, A. (2013). Use of social networks for academic purposes: a case study. *The Electronic Library*, *31*(6), 781-791.

Nicholas, D., Herman, E., & Clark, D. (2016). Scholarly Reputation Building: How does ResearchGate Fare? *International Journal of Knowledge Content Development & Technology*, *6*(2), 67-92.

Nicholas, D., Herman, E., & Jamali, H. R. (2015). *Emerging reputation mechanisms for scholars*. Brussels: European Commission, Joint Research Centre, Institute for Prospective Technological Studies.

Niyazov, Y., Vogel, C., Price, R., Lund, B., Judd, D., Akil, A., Mortonson, M., Schwartzman, J., & Shron, M. (2016). Open Access Meets Discoverability: Citations to Articles Posted to Academia.edu. *PLoS ONE*, *11*(2): e0148257, 1-41.

Pooley, J. (2017). Scholarly communications shouldn't just be open, but non-profit too. *LSE Impact Blog*, August 15, 2017. Retrieved from http://blogs.lse.ac.uk/impactofsocialsciences/2017/08/15/scholarly-communications-shouldnt-just-be-open-but-non-profit-too/

Orduna-Malea, E., Martín-Martín, A., Thelwall, M., & López-Cózar, E. D. (2017). Do ResearchGate Scores create ghost academic reputations? *Scientometrics*, *112*(1), 443-460.

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*, *24*(1), 1-17.

Ranieri, M., Manca, S., & Fini, A. (2012). Why (and how) do teachers engage in social networks? An exploratory study of professional use of Facebook and its implications for lifelong learning. *British*

Journal of Educational Technology, *43*(5), 754-769.

Stewart, B. E. (2015). In Abundance: Networked Participatory Practices as Scholarship. *International Review of Research in Open and Distributed Learning*, *16*(3), 318-340.

Thelwall, M., & Kousha, K. (2015). ResearchGate: Disseminating, communicating, and measuring scholarship? *Journal of the Association for Information Science and Technology*, *66*(5), 876-889.

Utz, S. (2016). Is LinkedIn making you more successful? The informational benefits derived from public social media. *New Media & Society*, *18*(11), 2685-2702.

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

Van Noorden, R. (2014). Online collaboration: Scientists and the social network. *Nature*, *512*, 126-129.

Veletsianos, G., & Kimmons, R. (2012). Networked Participatory Scholarship: Emergent techno-cultural pressures toward open and digital scholarship in online networks. *Computers & Education*, *58*(2), 766-774.

Veletsianos, G., & Stewart, B. (2016). Discreet Openness: Scholars' Selective and Intentional Self-Disclosures Online. *Social Media + Society*, *2*(3), 1-11.

Weller, M. (2011). *The Digital Scholar. How technology is transforming scholarly practice*. London/New Delhi/New York/Sydney: Bloomsbury.

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

Williams, R. & Edge, D. (1996). The social shaping of technology. *Research Policy*, *25*(6), 865-899.