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Coverage and adoption of altmetrics sources in the bibliometric community

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Abstract Altmetrics, indices based on social media platforms and tools, have recently emerged as alternative means of measuring scholarly impact. Such indices assume that scholars in fact populate online social environments, and interact with scholarly products in the social web. We tested this assumption by examining the use and coverage of social media environments amongst a sample of bibliometricians examining both their own use of online platforms and the use of their papers on social reference managers. As expected,

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coverage varied: 82 % of articles published by sampled bibliometricians were included in Mendeley libraries, while only 28 % were included in CiteULike. Mendeley bookmarking was moderately correlated (.45) with Scopus citation counts. We conducted a survey among the participants of the STI2012 participants. Over half of respondents asserted that social media tools were affecting their professional lives, although uptake of online tools varied widely. 68 % of those surveyed had LinkedIn accounts, while Academia.edu, Mendeley, and ResearchGate each claimed a fifth of respondents. Nearly half of those responding had Twitter accounts, which they used both personally and professionally. Surveyed bibliometricians had mixed opinions on altmetrics' potential; 72 % valued download counts, while a third saw potential in tracking articles' influence in blogs, Wikipedia, reference managers, and social media. Altogether, these findings suggest that some online tools are seeing substantial use by bibliometricians, and that they present a potentially valuable source of impact data.

Keywords Altmetrics · Social media presence · Reference managers · Download counts · Citation counts

Introduction

Altmetrics, indices based on activity in social media environments, have recently emerged as alternative means of measuring scholarly impact (Priem 2010; Priem et al. 2010). The idea of impact measuring which moves beyond citation analysis, however, emerged long before the advent of social media (Martin and Irvine 1983; Cronin and Overfelt 1994). One of the underlying problems with citation analysis as basis for evaluating scientific impact is that citations paint a limited picture of impact (Haustein 2014). On the one hand, researchers often fail to cite all influences (MacRoberts and MacRoberts 1989). On the other hand, the total readership population includes not only authors but also "pure," i.e. non-publishing, readers, who are estimated to constitute one-third of the scientific community (Price and Gürsey 1976; Tenopir and King 2000). Publications are used in the development of new technologies, applied in daily work of professionals, support teaching, and have other societal effects (Schlögl and Stock 2004; Rowlands and Nicholas 2007; Research Councils UK 2011; Thelwall 2012).

Thus, a better way of approaching scholarly impact is to consider citations as just one in a broader spectrum of possible uses. Webometrics and electronic readership studies gathered impact and usage data in a broader sense, but have been restricted by scalability problems and access to data (Thelwall et al. 2005; Thelwall 2010). As altmetrics are based on clearly defined social media platforms, that often provide free access to usage data through Web APIs, data collection is less problematic, although accuracy is still a problem (Priem 2014). With these new sources comes the possibility of analyzing online usage of scholarly resources independently of publishers. Tracking the use of scholarly content in social media means that researchers are able to analyze impact more broadly (Li et al. 2012; Piwowar 2013). Moreover, many online tools and environments surface evidence of impact relatively early in the research cycle, exposing essential but traditionally invisible precursors like reading, bookmarking, saving, annotating, discussing, and recommending articles.

In order to explore the potential of altmetrics, this work studies the applicability and use of altmetrics sources and indicators in the bibliometric community. Since it is still unclear how broadly these platforms are used, by whom and for what purposes, this study aims to evaluate the representativeness and validity of altmetrics indicators using the bibliometric community and literature as an initial reference set. We focus on measuring the impact of conventional peer-reviewed publications, such as journal articles and proceedings papers, on the social web as well as how bibliometricians perceive and use social media tools in their daily work routine. In addition, we studied whether uptake of social media activities as well as interconnections between researchers on social networks (i.e. LinkedIn) change over time. New forms of output, such as research results published in blogs, comments and tweets, are not addressed in this paper.

We apply a two-sided approach, aiming to answer the following sets of research questions

- RQ1: To what extent are bibliometrics papers present on bibliographic databases and social reference managers? How comprehensive is the coverage of the literature on platforms like Mendeley and CiteULike? How many users do they have and how many times are they used?
- RQ2: (a) To what extent are bibliometricians present on social media platforms? Does uptake of social media activities change over time? (b) For what purposes are social media platforms used (e.g. for contact management)? Do bibliometricians see potential in the new metrics to reflect a broader impact than citations?

We answered the first set of questions by evaluating the coverage and intensity of use of bibliometrics literature in social reference managers. Publications by presenters of the 2010 STI conference served as a reference set, as they represent a group of both established and new bibliometricians. The second set of research questions was approached by searching for web presences of 2010 STI presenters (RQ2a) and by surveying the attendees of the 2012 STI conference in Montréal regarding their use of social media (RQ2b).

Altmetrics literature review

Altmetrics research to date has focused on exploring potential data sources, correlating alternative impact data with citations and analyzing it from a content perspective; for overviews of this research see Bar-Ilan et al. (2014), Haustein (2014), and Priem (2014). When it comes to monitoring the impact of scholarly publications, Mendeley (mendeley.com) and CiteULike (citeulike.org) have proven particularly useful. They combine social bookmarking and reference management functionalities and allow users to save literature, share them with other users, and add keywords and comments (Henning and Reichelt 2008; Reher and Haustein 2010). Both social bookmarking systems use a bag model for resources, meaning that a particular resource can be simultaneously saved or bookmarked by several users. This functionality allows for counting resource-specific bookmarking actions like the number of users who saved a particular resource. According to self-reported numbers, Mendeley is considerably larger than CiteULike (CuL). During data collection in March 2012, CuL claimed to have 5.9 million unique papers versus more than 34 million in Mendeley (Bar-Ilan et al. 2012). As of August 2012, Mendeley claims to be the largest research catalog with 280 million bookmarks to 68 million unique documents uploaded by 1.8 million users (Ganegan 2012). In November 2012 Mendeley reached 2

million users (Mendeley 2012) and by November 2013 almost 2.7 million users had signed up and created more than 491 million bookmarks to scientific references.[1]

Case studies focusing on the coverage of social reference managers support Mendeley's position as a leader in the field. Li et al. (2012) investigated how bookmarks in Mendeley and CuL reflect papers' scholarly impact and found that 92 % of sampled Nature and Science articles had been bookmarked by at least one Mendeley user, and 60 % by one or more CuL users. Bar-Ilan (2012a, b) found 97 % coverage of recent JASIST articles in Mendeley. Priem et al. (2012) showed that the coverage of articles published in the PLoS journals was 80 % in Mendeley and 31 % in CuL. Li and Thelwall (2012) sampled 1,397 F1000 Genomics and Genetics papers and found that 1,389 of those had been bookmarked in Mendeley. Recently, two large scale studies of Mendeley's coverage and bookmark counts were conducted: Mohammadi and Thelwall (in press) considered all published English research articles in 2008 in the social sciences and the humanities indexed by Web of Science. By 2011, the coverage of Mendeley for the social sciences was 58 % and the coverage for humanities was 28 %. Zahedi et al. (2013) collected metrics for 20,000 random publications indexed by WoS, and found that Mendeley's coverage (37 %) was the highest among all altmetric sources. Haustein et al. (submitted) report a coverage of 66 % for 1.4 million PubMed papers published between 2010 and 2012.

Studies have found moderate correlation between bookmarks and Web of Science (WoS) citations. Li et al. (2012) reported $r = .55$ of Mendeley and $r = .34$ of CuL readers with WoS citations, respectively. Weller and Peters (2012) arrived at slightly higher correlation values for a different article set between Mendeley, CuL, BibSonomy, and Scopus. Bar-Ilan (2012a, b) found a correlation of .46 between Mendeley readership counts and WoS citations for the JASIST articles. Li and Thelwall (2012) found high correlation (.69) between Mendeley and WoS for the articles recommended on F1000. User-citation correlations for the Nature and Science publications were .56 (Li et al. 2012) and Priem et al. (2012) found a correlation of .5 between WoS citations and Mendeley users for the PLoS publications. Schlögl et al. (2013) studied the relations between downloads, citations and readership counts (bookmarking) for the Journal of Strategic Information Systems, and they found a correlation of .51 between citations and bookmarking, and .73 between downloads and bookmarking. Mohammadi and Thelwall (in press) reported a correlation of .52 for the social sciences and .43 in the humanities for articles covered both by WoS and by Mendeley. Zahedi et al. (2013) found a lower correlation of .31. Haustein et al. (submitted) found a Spearman correlation of 0.39 and 0.46 for PubMed papers published in 2011 including and excluding papers without Mendeley readers, respectively.

While bookmarks in reference managers reflect readership of scholarly articles, Twitter activity reflects discussion around these articles. Several studies have analyzed tweets "citing" scholarly publications. Priem and Costello (2010) and Priem et al. (2011) found that scholars use Twitter as a professional medium for sharing and discussing articles, while Eysenbach (2011) showed that highly-tweeted articles were 11 times more likely to become highly-cited later. Weller and Puschmann (2011), and Letierce et al. (2010) analyzed the use of Twitter during scientific conferences and revealed that there was discipline-specific tweeting behavior regarding topic and number of tweets as well as references to different document types (i.e., blogs, journal articles, presentation slides). Thelwall et al. (2013) found statistically significant associations between citations and tweets for a large set of articles indexed by PubMed but correlations were very low on average, i.e. 0.07 and 0.16 including and excluding papers without any tweets (Haustein

[1] As reported on mendeley.com on November 15, 2013.

et al. submitted). Along with Twitter, other studies have examined citations from Wikipedia articles (Nielsen 2007) and blogs (Groth and Gurney 2010; Shema et al. 2012, in press) as potential sources reflecting alternative impact of scholarly documents.

Apart from aforementioned studies, which focused on quantitative analysis of social media impact, there is a more content-oriented research approach which particularly examines tags attached to products of scholarly practice. Bar-Ilan (2011) studied the items tagged with "bibliometrics" on Mendeley and CuL, whereas Haustein and Peters (2012) and Haustein et al. (2010) showed that tags represent a reader-specific view on articles' content which could be used to analyze journal content from a readers perspective (as opposed to the author and indexer perspectives).

Although altmetric indicators and data sources are increasingly applied in evaluation studies, little is yet known about the users of such social media platforms or how researchers integrate them into their research environment (Mahrt et al. 2013). Understanding who is using social media tools for which purpose is, however, crucial to the application of altmetrics for evaluation purposes. Given that a representative share of documents are covered by social media tools and the user community can be identified, social media platforms can be valuable sources for measuring research impact from the readers' point of view, functioning as supplements to citation analysis. In contrast to citations, altmetrics potentially cover the whole readership and are available in real time.

RQ1: Coverage of bibliometrics papers in bibliographic databases and social reference managers

Before analyzing the alternative impact of bibliometrics literature and authors from the bibliometric community, it is necessary to explore which sources are suitable and provide the best coverage. Comparing them to traditional sources of impact evaluation provides information about the differences between use in citation and use in other contexts.

Method

In order to create a list of bibliometrics publications, all documents authored by presenters of the 2010 STI conference in Leiden were collected on WoS and Scopus. We chose this author-based, bottom-up approach to facilitate linking altmetrics data to authors as well as just documents. The group of presenters at the STI conference was considered to represent a core group of both established and new members of the current bibliometric community. The presenters' names were retrieved from the conference program. The final list contained 57 researchers, who together had authored 1,136 papers[2] covered in Scopus. Mendeley publication and readership information was retrieved manually via the Mendeley Web search interface from mendeley.com. At the time of data collection in March 2012 the manual approach proved more comprehensive, as the API, searched via the ImpactStory tool,[3] only returned one of multiple entries matching the search criteria. More recent

[2] Some presenters were omitted either because they had not published in sources covered by Scopus or WoS or due to ambiguous names, for which relevant papers could not be identified. Documents without a doi were not considered as it was needed to identify papers on some of the altmetrics platforms. For a more detailed description of data collection, see Bar-Ilan et al. (2012).

[3] http://impactstory.org.

searches seem to indicate this problem has since been resolved. In CuL, publications can be searched by DOI. However, it should be noted that bibliographic data in CuL or Mendeley are often incomplete (Haustein and Siebenlist 2011). The number of articles bookmarked in CuL might thus be higher than the number retrieved via doi. The manual search in Mendeley showed that 33 % of the documents retrieved did not contain a doi.

Results

As shown in Table 1, the coverage of the 1,136 bibliometrics documents in Mendeley was good: 928 (82 %) of the documents had at least one Mendeley bookmark, while only 319 (28 %) of articles were in CuL. Although coverage in CuL may be underestimated because bookmarks without a correct doi were not retrieved, this confirmed the results found by other studies (e.g. Li et al. 2012; Priem et al. 2012). Unsurprisingly given Mendeley's very recent founding, older articles were less bookmarked. Of the 85 sample articles published before 1990, only 44 % had readers in Mendeley, while 88 % of those published since 2000 had Mendeley bookmarks (see Fig. 1). Mendeley's popularity was not only reflected in the coverage of documents but also by the average activity on bookmarked documents: in Mendeley each document was bookmarked by a mean of 9.5 users, compared to a usage rate of 2.4 in CuL. Correlations between Scopus citations and users counts were .45 for Mendeley and .23 for CuL. These moderate correlations confirmed previous findings for other samples and suggest that altmetrics may indeed reflect impact not reflected in citation counts.

RQ2: Use and perception of (social) web platforms by the bibliometric community

For the above mentioned sample of bibliometricians, we also studied their presence on social media platforms, specifically on LinkedIn and Twitter, and we checked for the existence of Google Scholar Citation profiles at two different points in time (RQ2a). The pre-check of (social) web activity helped choosing appropriate questions to be included in the questionnaire for the study of RQ2b whereas the data collection at different points in time allowed for investigating changes in (social) web usage behavior.

Method used for RQ2a

Data for the STI2010 presenters were originally collected in February 2012. Data collection was repeated in November 2013. This time we also collected data on the presence on two major scholarly social media platforms, Academia.edu and ResearchGate, and also from ORCID. Even though Google Scholar Citations and ORCID accounts are not defined as social media platforms, they both enhance Web visibility, and thus they were included as well. Google Scholar Citation profiles were introduced for a limited number of users in July 2011 and rolled out for general use in November 2011. ORCID is the latest newcomer for author profiles, launched in October 2012.

Results for RQ2a

Since we collected data from Google Scholar Citation profiles at two different points in time, we could prove the increased establishment of Google Scholar Citation profiles from

Table 1 Coverage and citation or usage rates of a sample of 1,136 bibliometrics documents

	Scopus	Web of science	Mendeley	CiteULike
Number of indexed documents	1,136	957	928	319
Total event counts	18,755	17,858	8,847	777
Percent sampled with nonzero event counts (total)	85 % (961)	74 % (845)	82 % (928)	28 % (319)
Mean events per article with nonzero count	19.5	21.1	13.4	2.4

"Events" are either bookmarks or citations, depending on the database

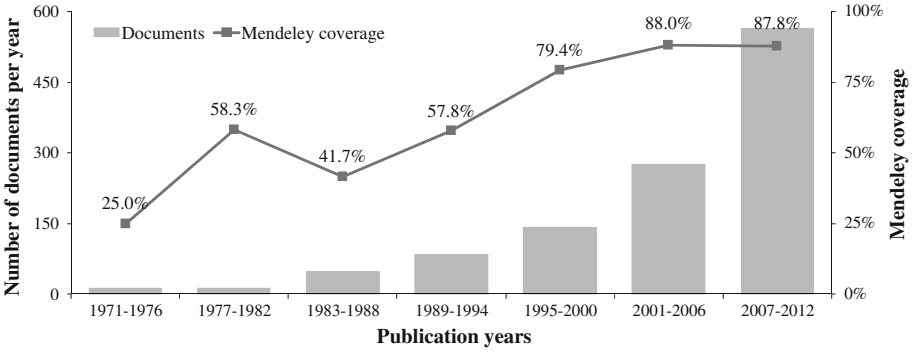

Fig. 1 Coverage of sampled documents in Mendeley per publication year. Overall coverage is 82 % ($n = 1{,}136$)

STI2010 presenters (see Table 2 where new profiles are highlighted in bold). An increase in usage could also be shown for LinkedIn and Twitter. In February 2012 13 (23 %) researchers in our sample had Google Scholar Citation profiles, by November 2013 this number increased to 30 (53 %), indicating the popularity of this platform. We also observed a slight increase in the number of LinkedIn accounts from 40 (70 % of the researchers in the sample) to 45 (79 %). LinkedIn was the most popular social media platform among the bibliometricians in our sample. Twitter usage remained low, although the number of researchers with Twitter accounts increased from 8 (14 %) to 11 (19 %). Among the scholarly social media platforms ResearchGate (33 researchers, 58 %) was more popular than Academia.edu (17 researchers, 30 %). Although ORCID is a rather new service already 20 researchers in our sample (35 %) set up an ORCID ID. It seems that bibliometricians are aware of the potential of ORCID for author disambiguation as well as the use of (social) web platforms to increase visibility on the web. Mas-Bleda et al. (2013) manually searched for web presences of 1,517 European highly cited scientists between November 2012 and March 2013 (identified through ISI's highlycited.com) from engineering, physical sciences, health sciences, life sciences and social sciences disciplines. LinkedIn was the most popular social network across disciplines in their research as well, although usage shares were lower compared to bibliometricians and range between 18% and 29%. They found Google Scholar Citation profiles for 24% of social scientists, compared with only 6% of health scientists. These results allow us to suggest that

Table 2 Scholarly and professional social media presence of the sampled researchers

Name	GoogleCitations profile 2012	LinkedIn account 2012	Twitter account 2012	Google Citations Profile 2013	LinkedIn account 2013	Twitter account 2013	Academia.edu 2013	ResearchGate 2013	Orcid 2013
Aguillo, Isidro	Y	Y	N	Y	Y	**Y**	Y	Y	Y
Aksnes, Dag W	N	Y	N	N	Y	N	N	Y	N
Andersen, Jens Peter	N	Y	Y	**Y**	Y	Y	Y	Y	Y
Archambault, Éric	Y	Y	N	Y	Y	N	N	N	Y
Bar-Ilan, Judit	Y	Y	Y	Y	Y	Y	Y	Y	Y
Bonaccorsi, Andrea	N	Y	N	N	Y	N	N	Y	N
Bornmann, Lutz	N	Y	N	**Y**	Y	N	N	Y	Y
Boyack, Kevin	N	Y	N	**Y**	Y	N	N	Y	Y
Bubela, Tania	N	Y	N	N	Y	N	N	Y	N
Buter, Renald	N	Y	N	N	Y	N	N	N	N
Butler, Linda	N	N	N	N	N	N	Y	Y	N
Daniel, Hans-Dieter	N	N	N	**Y**	N	N	N	N	Y
De Filippo, Daniela	N	N	N	**Y**	N	N	N	Y	N
Engels, Tim	Y	N	N	Y	**Y**	N	N	N	N
Foray, Dominique	N	Y	N	N	Y	N	N	Y	N
Gerritsma, Wouter	Y	Y	Y	Y	Y	Y	Y	Y	Y
Gingras, Yves	N	N	N	N	N	N	Y	N	N
Glänzel, Wolfgang	N	Y	N	N	**Y**	N	N	Y	N
Gorraiz, Juan	N	Y	N	**Y**	Y	N	Y	Y	Y
Gumpenberger, Christian	N	Y	N	**Y**	Y	N	N	Y	Y
Hardeman, Sjoerd	N	Y	N	N	Y	N	N	N	N
Harnad, Stevan	Y	Y	Y	Y	Y	Y	Y	Y	N
Haustein, Stefanie	N	Y	Y	**Y**	Y	Y	Y	Y	Y
Hoekman, Jarno	N	Y	N	**Y**	Y	N	N	Y	N

Table 2 continued

Name	GoogleCitations profile 2012	LinkedIn account 2012	Twitter account 2012	Google Citations Profile 2013	LinkedIn account 2013	Twitter account 2013	Academia.edu 2013	ResearchGate 2013	Orcid 2013
Klavans, Richard	N	Y	N	N	Y	N	N	N	N
Kousha, Kayvan	Y	Y	N	Y	Y	N	Y	Y	Y
Kuan, Chung-Huei	N	N	N	N	N	N	N	N	N
Larivière, Vincent	Y	N	N	Y	N	**Y**	N	N	N
Leten, Bart	N	N	N	N	**Y**	N	N	Y	N
Levitt, Jonathan M	N	Y	N	N	Y	N	N	N	N
Leydesdorff, Loet	Y	Y	N	Y	Y	**Y**	Y	Y	Y
Luwel, Marc	N	Y	N	N	Y	N	N	Y	N
Marchant, Thierry	N	N	N	N	N	N	N	Y	Y
Mauleón, Elva (Elba)	N	N	N	N	N	N	N	Y	N
Neufeld, Jörg	N	N	N	N	**Y**	N	N	N	N
Noyons, Ed	N	Y	Y	N	Y	Y	N	N	Y
Paier, Manfred	N	Y	Y	N	Y	Y	Y	Y	N
Picard-Aitken, Michelle	N	Y	N	N	Y	N	N	N	N
Porter, Alan L.	N	N	N	**Y**	**Y**	N	N	Y	Y
Rafols, Ismael	Y	Y	N	Y	Y	N	Y	Y	Y
Sandstrom, Ulf	Y	Y	N	Y	Y	N	Y	N	N
Schloegl, Christian	N	N	N	**Y**	N	N	Y	Y	N
Schmoch, Ulrich	N	Y	N	N	Y	N	N	Y	N
Schneider, Jesper W	N	Y	N	**Y**	Y	N	Y	Y	Y
Schubert, Torben	N	N	N	N	N	N	N	N	N
Shelton, Robert D.	N	N	N	**Y**	N	N	N	N	N
Small, Henry	N	Y	N	N	Y	N	N	N	N
Tunger, Dirk	N	N	N	N	**Y**	N	N	N	N

Table 2 continued

Name	GoogleCitations profile 2012	LinkedIn account 2012	Twitter account 2012	Google Citations Profile 2013	LinkedIn account 2013	Twitter account 2013	Academia.edu 2013	ResearchGate 2013	Orcid 2013
Van Eck, Nees Jan	Y	Y	Y	Y	Y	Y	N	N	Y
Van Leeuwen, Thed	N	Y	N	**Y**	Y	N	N	Y	N
Van Looy, Bart	N	Y	N	**Y**	Y	N	N	Y	N
Van Raan, Anthony	N	Y	N	**Y**	Y	N	N	Y	N
Van Vught, Frans A	N	Y	N	N	Y	N	N	N	N
Waltman, Ludo	Y	Y	N	Y	Y	N	Y	N	Y
Yegros–Yegros, Alfredo	N	Y	N	N	Y	N	N	N	N
Zitt, Michel	N	N	N	N	N	N	N	N	N
Zuccala, Alesia	N	Y	N	**Y**	Y	N	N	N	N

bibliometricians are rather heavy users of metrics-related services and are not representative for the majority of scientists.

Since we were able to find (social) web activity among bibliometricians and the results of RQ1 confirmed that reference managers (Mendeley in particular) were a rich source for usage data and impact measurements of bibliometrics publications, we wanted to study who generated this usage data. For answering RQ2b, we surveyed a sample of the bibliometrics community to learn how, for what purposes, and why they use various online environments and if bibliometricians interconnect with each other on social networks (i.e. LinkedIn). Our goal was to better understand the significance of altmetrics indicators drawn from these environments.

Method used for RQ2b

The paper and pencil survey was conducted among participants of the 17th International Conference on science and technology indicators (STI) in Montréal. Participants filled out the survey during the conference from September 5th to 8th 2012. The survey contained open and closed questions; these mainly asked if and how members of the bibliometric community used social media with regards to organizing their literature and promoting their work, as well as how such tools influenced their professional lives. SPSS and Open Code were used for the analysis of the survey. All openly designed questions were coded using the Grounded Theory approach (Glaser and Strauss 1967): codes were assigned to participants' statements, and these were then used to generate broader categories reflecting patterns of answering behavior.

Since LinkedIn proved to be the most popular social network among the sample presenters from STI2010, the survey respondents were also asked to provide their name and email on the last page of the survey, in order to be able to study the interconnections between them. To protect the anonymity of the respondents of the survey, the page with the personal details was immediately detached from the questionnaire. LinkedIn allows to see another person's connections only if the interested person is connected to him or her. The 50 survey participants who provided their personal details were invited to connect to Judit Bar-Ilan, and 45 of them accepted the invitation. The interconnections on LinkedIn between these 45 researchers were studied in January 2013 and again in November 2013. Judit Bar-Ilan was removed from the list, as she was connected to all the other researchers in the set.

Results for RQ2b

Of the 166 participants of the STI 2012 as indicated on the attendee list, 71 returned the questionnaire, resulting in a response rate of about 42.8 %. Of the survey participants 63.4 % were male and 33.8 % were female, while 2.8 % did not indicate their gender. Compared to the conference, females were somewhat overrepresented in our sample. While the youngest participant was 26 and the oldest 64, most respondents were between 31 and 40 years old. The mean age was 41.5 years. The respondents came from a mixed professional background, as 14.1 % were research scientists and 14.1 % worked in the R&D industry. 15.5 % indicated that they had another background, 12.7 % were doctoral candidates, 11.3 % research managers, 8.5 % government employees and 7.0 % librarians. 4.2 % were associate professors/readers, 2.8 % students, 2.8 % postdocs, 2.8 % assistant

Table 3 Knowledge and usage of social bookmarking services and reference managers

	BibSonomy	Connotea	CiteULike	Delicious	Mendeley
Heard about the service ($n = 70$)	35.7 %	35.7 %	72.9 %	64.3 %	77.1 %
Used the service ($n = 70$)	1.4 %	2.9 %	12.9 %	11.4 %	25.7 %
Perceived usefulness	4.0 %	8.0 %	17.6 %	17.8 %	33.3 %
	($n = 25$)	($n = 25$)	($n = 51$)	($n = 45$)	($n = 54$)

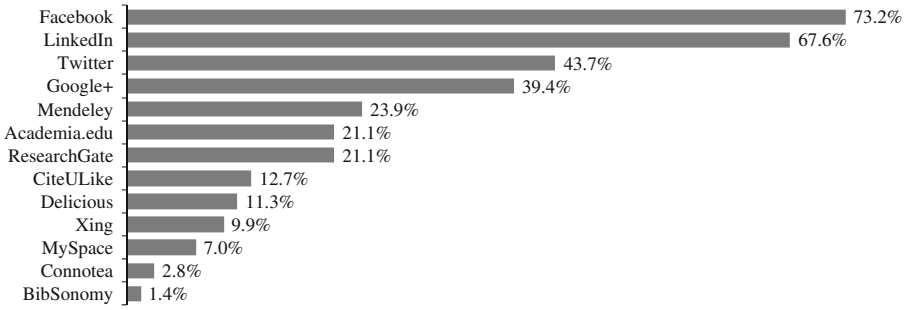

Fig. 2 Percentage of participants having a profile on or using social media tools mentioned in the survey ($n = 71$)

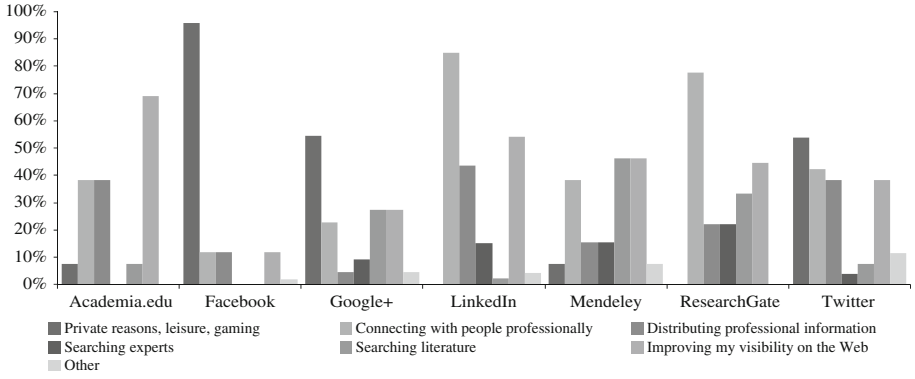

Fig. 3 What are participants using particular social networks for? Question allowed for multiple answers (Academia.edu: $n = 13$; Facebook: $n = 50$; Google+: $n = 22$; LinkedIn: $n = 46$; Mendeley: $n = 13$; ResearchGate: $n = 9$; Twitter: $n = 26$. MySpace ($n = 4$) and Xing ($n = 5$) are not shown)

professors/lecturers and 2.8 % full professors. One participant (1.4 %) did not indicate his professional background.

Sixty people answered the question about reference management, 35 (58.3 %) of whom use reference management software to organize scientific literature. The category "reference management software" includes desktop based software and web reference management services. A "personal solution" of literature management was described by 38.3 % of respondents, which summarizes storing documents on local computers or on the Web as well as organizing literature on book shelves or in Word documents. Alerts from

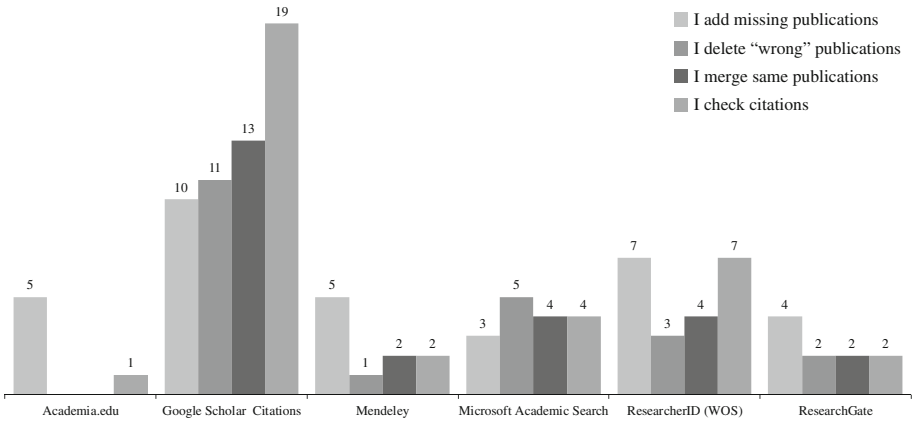

Fig. 4 What are participants doing with their publications profile? Question allowed for multiple answers (Academia.edu: $n = 5$; Google Scholar Citations: $n = 22$; Mendeley: $n = 8$; Microsoft Academic Search: $n = 7$; Researcher ID (WoS): $n = 14$; ResearchGate: $n = 9$)

journals, bibliographic databases, or libraries fall in the category "information suppliers", which was described by 12 people (20.0 %) as their way to find literature. Four people stated explicitly that they do not manage literature, because there is no need since they are not researchers.

When asked in a multiple choice question about whether they had heard of and used any of the social bookmarking services BibSonomy, CuL, Connotea, Delicious, or Mendeley, the latter was the most popular among respondents. Table 3 shows the percentage of the 70 respondents who knew and used the different bookmarking services and reference managers. Note that 77.1 % of the respondents had heard about Mendeley, but only 25.7 % actually used it. A similar percentage of the respondents had heard about CuL (72.9 %), but only 12.9 % of the respondents were actual users. The category "perceived usefulness" represents the percentage of a given platform's actual users compared to the number who have heard about it. By this measure, BibSonomy and CuL, were perceived to be relatively less useful; only 4.0 and 8.0 % of those who knew the tools, respectively, actually used them. Mendeley was not only the most known tool, but also the one with the highest number of users. A third of all who had heard of the tool, used it, even though usage was rather occasional.

While there were more male than female users, the age structure of the Mendeley users corresponded to that of all participants. Both the youngest and the oldest respondent were Mendeley users. Although the numbers were too low to be representative, there was a tendency towards a professional background in research of Mendeley users: the share of full professors, postdocs, doctoral candidates, and research scientists was higher among Mendeley users compared to the overall percentage of participants, while the percentage of research managers and members of R&D industry was lower. Thirteen of the 18 people who used Mendeley indicated that their purposes for using it were reference managing and connecting with people. Both purposes were equally important reasons to use Mendeley. This emphasizes that Mendeley connects literature management with the social aspect of connecting people who are interested in the same contents whereas CuL is mostly used for literature search.

The survey showed that Facebook, LinkedIn, Twitter, and Google+ were the most popular social networks. Figure 2 summarizes how many survey participants used the different social media tools. 52 people (73.2 %) had a profile on Facebook, 48 (67.6 %) on

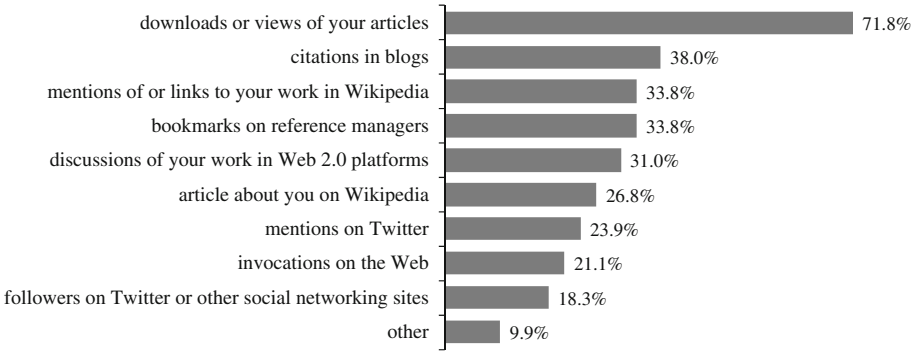

Fig. 5 Which alternative metrics are believed to have potential for article or author evaluation? Question allowed for multiple answers ($n = 71$)

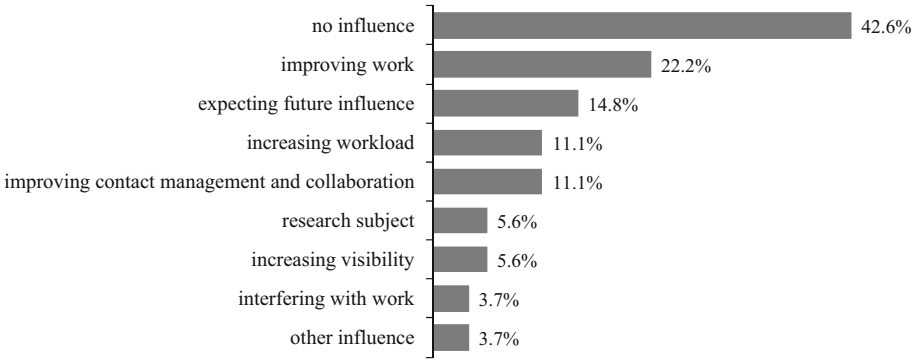

Fig. 6 In what ways do social network and bookmarking systems affect your professional life and/or work flow? Openly designed question ($n = 54$)

LinkedIn, 31 (43.7 %) on Twitter, and 28 (39.4 %) on Google+. Xing was used from 9.9 % of users and 7.0 % used MySpace. Among the tools focusing on the research community, Mendeley (23.9 %), Academia.edu (21.1 %), and ResearchGate (21.1 %) had almost the same number of users in our sample, i.e. about one-fifth of the participants had a profile on each of these platforms (Fig. 3).

Asked for personal publications profiles on Academia.edu, Google Scholar Citations, Mendeley, Microsoft Academic Search, ResearcherID (WoS), or ResearchGate, 32 participants listed their publications at least at one of these platforms. The most popular tool was Google Scholar Citations (22 respondents with profile; 68.8 % of those with at least one of the above mentioned publication profiles), followed by ResearcherID (14: 43.8 %), which can probably be attributed of the popularity and significance of Google and WoS. Google Scholar Citations (see Fig. 4) was mostly used to check citations, WoS was used to check citations and add publications to the ResearcherID, while Academia.edu, Mendeley, and ResearchGate profiles were mostly used to add missing publications. In Microsoft Academic Search, people deleted "wrong" publications from their profiles.

Three percent of the participants used some kind of repository to deposit their work. To seven respondents the question did not apply, as they do not or no longer actively publish. Among those who used a repository, the most common was the institutional repository

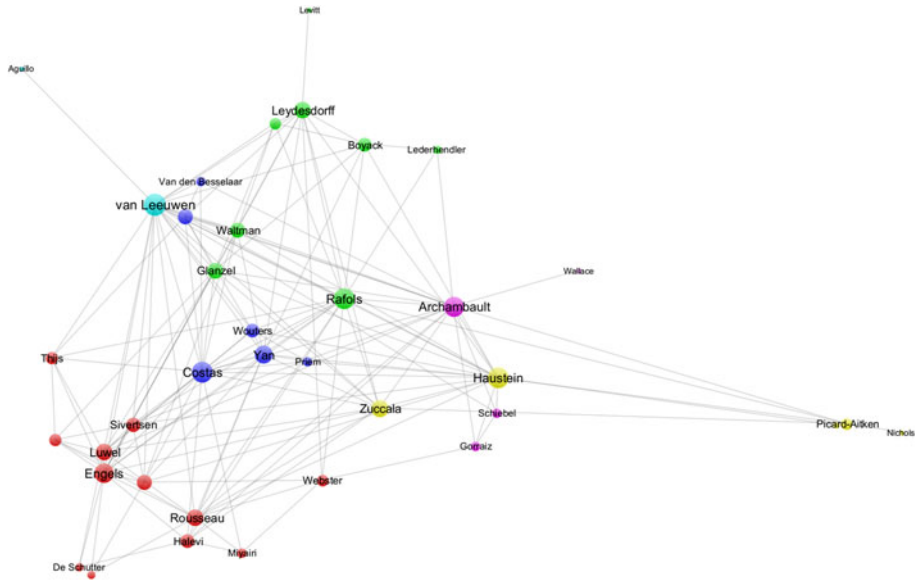

Fig. 7 LinkedIn connections in January 2013

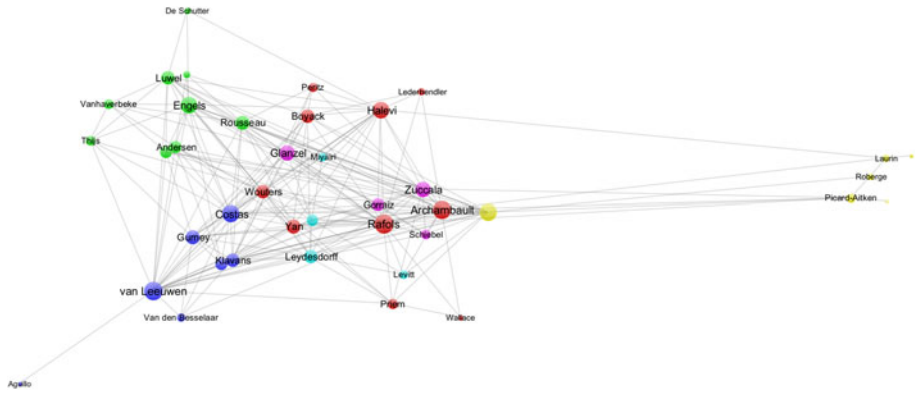

Fig. 8 LinkedIn connections in November 2013

(57.1 %), the second most popular was arXiv (21.4 %). 47.9 % of the respondents provided access to full texts on their homepages.

Although use of altmetrics platforms was quite low among survey participants, 85.9 % thought that altmetrics had some potential in author or article evaluation. The majority, (71.8 %) believed that the number of article downloads or views could be of use in author or article evaluation (see Fig. 5; Kurtz and Bollen 2010 for a review of usage bibliometrics). Other sources such as citations in blogs (38.0 %), Wikipedia links or mentions (33.8 %), bookmarks on reference managers (33.8 %), and discussions on Web 2.0 platforms (31.0 %) were believed to have potential as altmetrics indicators as well.

An openly designed question asked about in what ways social network and bookmarking systems affected professional life and work flow (see Fig. 6). Twenty-three (42.6 %) of the 54

respondents said they were not at all influenced by these tools and 8 (14.8 %) were not yet influenced but expected some impact in the future. 22.2 % of respondents answered that the tools improved their work in terms of finding new information, fast distribution of information, and organization of research material. Two of these stated that social networks and social bookmarking systems "made my life much easier". For 11.1 % the tools improved contact management and collaboration and 5.6 % felt that they improved their visibility. On the other hand, 11.1 % stated that social media tools increased their workload and 3.7 % said that it interfered with their daily work, i.e. causing procrastination and getting lost in discussions on social media sites while delaying work.

Given the high percentage of LinkedIn users and the fact that bibliometricians have seen contact management as a strong advantage of social networks, we investigated the connections among STI2012 participants on LinkedIn and their change over time. Recall that these are the 45 survey participants who provided their details and accepted our invitations on LinkedIn. In January 2013, there were seven isolated researchers, while in November 2013 the number of isolated researchers decreased to five. Figures 7 and 8 depict the interconnections at the two points in time. The visualizations were prepared using VOSviewer. It can be clearly seen that the bibliometricians in the second graph were more interconnected than in the first one which shows the situation in January 2013. At the later point there were eight researchers with 20 or more connections to the other researchers in the dataset. This may indicate that either in general the popularity of LinkedIn increased and more people became members or that LinkedIn was the favorite work-related social network among bibliometricians and that they knew they can find their colleagues there.

Conclusions and outlook

This study has followed a two-sided approach to explore the representativeness and validity of social media platforms to be used as data sources for altmetrics indicators evaluating impact of scholarly documents. By answering RQ1 it has shown that bibliometrics literature was well represented on Mendeley, making it a potential source for evaluating use of scholarly documents in a broader way than citation analysis and independent from publishers. The coverage of the sampled documents was as high as 82 % overall with an even higher coverage of recent documents. Although this age bias was expected, as Mendeley was only launched in 2009, this bias needs to be considered when evaluating older documents. Mendeley did not only dominate in terms of coverage, but had also a much greater number of readers per document than CuL.

Having analyzed how bibliometrics documents were used on social reference managers, the second part of the study aimed at finding out who was generating this use by utilizing (social) web platforms. In order to answer RQ2a we searched for web accounts (e.g., Google Scholar Citation profiles, LinkedIn and Twitter accounts) of STI2010 presenters first to learn which services are actually used by the bibliometricians. This preliminary check revealed that LinkedIn was the most popular service in use. But a search for user profiles carried out one and half year later showed that although LinkedIn is still popular Google Scholar Citations profiles have been able to double its usage numbers since 2012 reflecting exponential growth. However, LinkedIn is increasingly used for establishing interconnections between bibliometricians. The survey for RQ2b was distributed among the core of the bibliometric community present at the 2012 STI conference in Montréal, inquiring social media use and its influence on the working environment of participants. Over half of those surveyed asserted that social media tools were affecting their

professional lives, or that they were expecting future influence. Actual uptake of the platforms varied. Two-thirds of survey participants had LinkedIn accounts, which they used to connect professionally, while social networks with a scholarly focus such as Academia.edu, Mendeley, and ResearchGate were each used by only a fifth of respondents. Nearly half of those responding had Twitter accounts, which is extremely high compared to findings by Priem et al. (2011) and Ponte and Simon (2011), who found a Twitter usage rate of 2.5 and 18 % among scholars, respectively; this may be due to growth in Twitter use, disproportionate use by bibliometricians, or the different methodologies employed. It should be noted that when we searched for Twitter accounts of the 57 STI2010 presenters, we found that 58 % of them had profiles on ResearchGate, while only 19 % of them had Twitter accounts which contrasts with the self-reported data.

Although Mendeley was the most popular social reference manager among the 71 participants, only one-third surveyed use the tool, and their use was rather sporadic. This is surprising given the high coverage of bibliometrics articles in Mendeley; it is unclear who is generating the high reader counts observed. An analysis of Mendeley readership data could clarify whether groups not at the conference (for example, researchers from other disciplines, or students, or practitioners) are using Mendeley heavily. A survey targeted directly at Mendeley users could show their motivations behind saving a document to the reference manager and provide insight in how far a Mendeley reader count actually reflects readership. The surveyed conference participants may also not properly represent the typical social media users and therefore reflect a biased picture of actual usage, although this assumption has to be proven in detailed studies. When altmetrics is broadly defined to include download data, 85 % of bibliometricians surveyed expect at least one altmetrics indicator to become influential in future research evaluation. Around a third of respondents expected such influence from altmetrics based on blogs, Wikipedia, reference managers, and social media. Thus, although their use of social media tools remains modest as yet, survey participants are increasingly aware of the potential of altmetric indicators to supplement traditional evaluation indicators.

This study is limited by the specificity of its sample, and by potential non-response bias (enthusiastic users of social media may have been more likely to complete the survey) and conference attendees being a convenience sample. Results are thus not generalizable. Hence, further research should include the systematic analysis of all scholarly disciplines using this two-sided approach combining quantitative and qualitative analyses. Thus it would be possible to define the extent to which social media platforms cover a discipline's publication output as well as determine who is generating the use and for what purpose. This will help to validate altmetrics indicators as complements to traditional metrics in research evaluation.

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