Why do some research articles receive more online attention and higher altmetrics? Reasons for online success according to the authors

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Abstract

Recent altmetrics research has started to investigate the meaning of altmetrics and whether altmetrics could reveal something about the attention or impact connected to research. This research continues this line of investigations and studies reasons for why some research has received significant online attention in one or both of two social media services; Twitter or Mendeley. This research investigated Finnish researchers' opinions about the reasons for why their research had received significant online attention and if the attention received could reflect scientific or societal impact of their research. Furthermore it was studied whether the authors of the papers with significant online attention actively followed how their papers were shared or discussed online and if the authors thought that the online attention increased either the scientific or societal impact of their work. Based on the findings it can be stated that the level of online attention received is a sum of many factors and that there are also specific differences between the platforms where the attention has been received. For the articles that had received significant attention on Mendeley the reasons for that attention were more often seen as due to an academic audience, while the situation was reverse on Twitter, with the majority of reasons for the attention being linked to a wider audience. Similar trend could be seen when asked about whether the online attention could reflect scientific or societal impact, although a clear consensus about whether online attention could reflect any type of impact at all could not be reached.

Introduction

Altmetrics has been defined as "the study and use of scholarly impact measures based on activity in online tools and environments" (Priem, 2014). The research area thus focuses on investigating what mentions of research products (e.g., scientific articles, datasets, code) on the web and particularly in social media can tell about the impact or influence of the research. While the debate about what is meant with impact and whether altmetrics can reflect impact or should we instead be talking about attention or engagement continues, altmetrics research has focused on investigating what the data can reflect and what it can tell us about the research that have received the online attention. Early altmetrics research focused on investigating possible connections between citations and different altmetrics and discovered certain connections between for instance usage statistics on Mendeley (Mohammadi & Thelwall, 2013), Wikipedia references (Evans & Krauthammer, 2011), and tweets mentioning scientific articles (e.g., Shuai et al., 2012; Thelwall et al., 2013), and the numbers of citations those articles later receive. More recent altmetrics research has moved on to investigate the meaning of altmetrics and whether altmetrics could reveal something about the reach, influence, or engagement connected to research. The present research continues this later line of investigations and studies possible reasons for why some research has received significant online attention in one or both of two social media services, namely Twitter or Mendeley. With the help of a questionnaire we will investigate Finnish researchers' own opinions about the possible reasons for why their research have received significant online attention and whether the researchers feel that the attention received could reflect either scientific or societal impact of their research.

Background

While early altmetrics research focused on investigating relations between citation counts and different altmetrics (e.g., Mohammadi & Thelwall, 2013; Evans & Krauthammer, 2011; Shuai et al., 2012; Thelwall et al., 2013), more recent research have focused increasingly on identifying characteristics of the research articles that may influence the level of online attention the articles receive. Haustein, Costas and Lariviére (2015) investigated possible connections between specific document characteristics (discipline, document type, title length, number of pages and references) and five different altmetrics (number of tweets on Twitter, number of posts on Facebook and Google+, and number of mentions in blogs and mainstream media). Although the coverage of scientific articles was very low on the selected social media platforms (with the possible exception of Twitter), the authors discovered that "both citations and social media metrics increase with the extent of collaboration and the length of the reference list." The results also showed how editorials and news items were the most popular scientific document types shared on Twitter. Didegah, Bowman and Holmberg (2016) conducted a similar study investigating a range of factors associating with citation and altmetric counts of Finnish research articles. The factors investigated were individual collaboration (number of authors), international collaboration (number of different countries that the authors came from), institutional impact (Maximum Mean Normalized Citation Score of the different institutions that the authors were affiliated with), Journal Impact Factor (retrieved from the JCR), journal open accessibility, and field type (OECD field of the article). These were then tested for association between citation counts, number of readers on Mendeley, number of tweets on Twitter, and number of posts on Facebook. The main conclusion was the same as in Haustein, Costas and Lariviére (2015), that the factors driving citations are very much different from those that drive altmetrics, emphasizing that altmetrics cannot be considered as a replacement for citations, but instead possibly as a complement. In Didegah, Bowman and Holmberg (2016) most of the tested factors were significantly determining the altmetrics, either associating with an increase or a decrease of the altmetrics. The differences between some of the results in Haustein, Costas and Lariviére (2015) and Didegah, Bowman and Holmberg (2016) also demonstrate the uncertainty present in altmetrics, as factors such as timing of the study and data quality may influence research results.

Reasons that are not connected to the scientific merits or specific characteristics of the research articles may also influence the online attention some research receives. Haustein et al. (2014) suggested that the highly tweeted articles in their study may have been highly tweeted "because of their curious or humorous content". It would also appear that the promotional activities and social media presence of scientific journals increases the number of altmetric events the articles published in those journals attract (Wang et al., 2017), thus raising some concerns about the usefulness of altmetrics as impact measures. Another concern for the applicability of altmetrics and specifically of tweets as impact measures or indicators of attention has been raised as most of the tweets mentioning research articles (in one specific study) may in fact be "almost entirely mechanical and devoid of original thought" (Robinson-Garcia, et al., 2017). More research and new types of approaches are needed in order to fully understand what different altmetrics may reflect and why some research receive more online attention compared to others.

While most of previous altmetrics research has utilized mainly quantitative research methods, qualitative approaches have been almost non-existent. Qualitative content analysis, for instance, could bring new viewpoints into altmetrics research. Qualitative content analysis can be used as a separate research method as well as a theoretical context provider that can be subjected to several different forms of analysis (Tuomi & Sarajärvi, 2009, 91). Qualitative content analysis can be described as a subjective method of research that enables the interpretation of data through a series of classifications and through the underlying themes of content (Hsieh & Shannon, 2005; Zhang & Wildemuth, 2009). The purpose of qualitative research is not to

produce quantifiable information or to provide statistical significance for the data. Instead, it can be used to help us understand the surrounding reality and to enable us to classify it into different codes of conduct, appearing themes and emerging categories (Zhang & Wildemuth, 2009). The present research will take a more qualitative approach to investigate the possible reasons why some research receives significant online attention on Twitter and on Mendeley.

Data and methods

The goal of this research was to investigate what authors of scientific articles that had received significant attention on either Twitter or Mendeley thought had contributed to the received attention and what they felt that attention could tell, if anything, about the impact of that research. Whereas Mendeley is a social reference manager owned by Elsevier, Twitter is a microblog service with over 300 million active monthly users. Mendeley is mostly used by academics in their work (Mohammadi, Thelwall, Haustein, & Larivère, 2015), while Twitter is used for much wider variety of reasons and purposes (e.g., Ke, Ahn, & Sugimoto, 2016; Mislove, Lehmann, Ahn, Onnela, & Rosenquist, 2011; Semertzidis, Pitoura, & Tsaparas, 2013; Uddin, Imran, & Sajjad, 2014). Both of the selected altmetrics data sources, Twitter and Mendeley, are clearly different in both their purpose and user base, which will give this research an interesting starting point to examine differences in the possible reasons for the accumulated attention and with that an indication of what the metrics accrued from the two altmetrics data sources may reflect.

The overall research design was to create a questionnaire that would demonstrate how the participants view the success of their research articles in two data sources of altmetrics; Twitter and Mendeley. Researchers who during 2012 to 2014 had an affiliation to a Finnish research institute or a university and whose article or articles scored in the top one percent of the most shared articles on Twitter or most saved articles on Mendeley were chosen to participate in the survey. All scientific articles with at least one author with a Finnish affiliation were retrieved from the national VIRTA research publication database. Using DOIs the articles were matched with altmetrics data aggregated and provided for this research by Altmetric LLP (https://www.altmetric.com/). The articles were then sorted in descending order based on how many times they were tweeted or how often they had been saved on Mendeley. Of these only the articles that made the top 1% percent on either platform were chosen for this study. This resulted in a total of 109 articles that were frequently tweeted and 102 articles that were often saved on Mendeley. These articles had a total of 465 authors with a Finnish affiliation, which made the set of participants that were contacted by email. Based on the fields of science of the articles that had received significant online attention, about a third of the authors came from Natural Sciences (33.8%), a third from Medical and Health Sciences (32%), a third from Engineering and Technology (31.4%) and the remaining authors came from Social Sciences and Humanities (2.8%). Of these 170 researchers (36.6 percent of all researchers included in the data) answered the questionnaire (NS=32.4%; MHS=33.5%; ET=28.8%; SSH=5.3%). Due to missing or closed email addresses, 69 researchers (14.8 percent) could not be reached at all. In some cases, the researcher had published an article that faired in more than one online service. If this happened, their answer was registered to the data multiple times: the same answer for both individual online services. However, in the study, each participant was only observed once, i.e. each participant was counted as a single observation.

The questionnaire was conducted as an email survey and the content of it was both in English and in Finnish. Of all the participants, 10 percent (20 people) replied in English. The participants were introduced to four questions regarding the online attention their article received and their own thoughts on what this attention could reflect, questions that also function as the overall research questions of this research:

1. Which factors do you think have influenced the attention this paper has received on the above-mentioned platforms?
2. What do you think this online attention tells about your paper and its societal or scientific impact?
3. Do you actively follow what kind of online attention your work receives?
4. Do you think that the online attention your work receives increases the scientific or societal impact of your work?

Unlike in altmetrics research in general, the aim of this study was to utilize mainly qualitative methods in assessing the research questions. The data analysis based on the answers to the questionnaire first started with a thorough read-through of the answers. After forming a cohesive view on the data, the responses were then submitted to a further, more specific inspection. The data were scanned for words, expressions or sentences that seemed to appear regularly from one answer to another. As instructed by Hsieh and Shannon (2005), the impressions the data left for the researcher were also committed to paper and used in the coding of the answers. Finally, the whole data were coded to different word or phrase categories. The process of coding was performed by using inductive analysis, where the coding takes place by creating new categories when necessary whilst reading through the data instead of submitting the data to a set of fixed categories. By using the means of inductive content analysis, we were able to perceive the forming of different categories based on the material (Zhang & Wildemuth, 2009; Tuomi & Sarajärvi, 2009, 96).

Defining the unit of coding is one of the most important things to take into consideration (Weber, 1990). In qualitative research, the definition of the coded unit is often times more abstract than just an individual word, a sentence or a paragraph (Zhang & Wildemuth, 2009). Therefore in our material, the categories were formed mainly based on individual words, but with the context of the word taken into consideration as well. Depending on the context and the way the respondents answered the proposed question, some of the answers could have been coded into several different categories (Tesch, 1990), as was done with our data. There were some overlapping categories, as the inductive content analysis and the possibility of coding answers into several different categories allowed for this to happen. However, some of these overlapping categories were later merged together wherever possible and their possible negative effects on analysis have been identified during the stages of analysis and discussed by the authors. Towards the end of the process of analysis we strove towards discovering a larger context for the categories identified – main themes that might serve best in describing the opinions of researchers about the success of their research in the analysed online services (Hsieh & Shannon, 2005).

Of the answers from the 170 respondents, 109 answers concerned an article or articles that were among the top one percent of most tweeted research articles on Twitter and 95 concerned an article or articles that were among the top one percent of the most saved references on Mendeley. As some articles appeared in the top one percent on both Twitter and on Mendeley and these answers were inserted to both platforms, the total number of answers ended up being higher than 170. Based on the fields of science of the articles that were among the top one percent of articles that were most frequently saved on Mendeley about half of the respondents (50.5%, 48 persons) came from Natural Sciences (Figure 1). Researchers from Engineering and technology answered the questionnaire with an 34.7 percent share (33 persons), while the share of Medical and Health Science researchers that responded to the questionnaire regarding success in Mendeley, was only 10.5 percent (10 persons) and with Social Sciences researchers amounting to about 4.2 percent (4 persons). Similarly about half of the responses regarding articles that had received significant online attention on Twitter came from one field of science, namely Medical and Health Sciences (49.5%, 54 persons). Researchers from Engineering and

Technology answered the questionnaire with a share of 28.4 percent (31 persons), while the share of answers from Natural Sciences researchers was only 20 respondents (18.3 percent) of the possible 109 people that responded to the questionnaire regarding success on Twitter. Respondents from Social Sciences amounted to about 3.7 percent (4 persons).
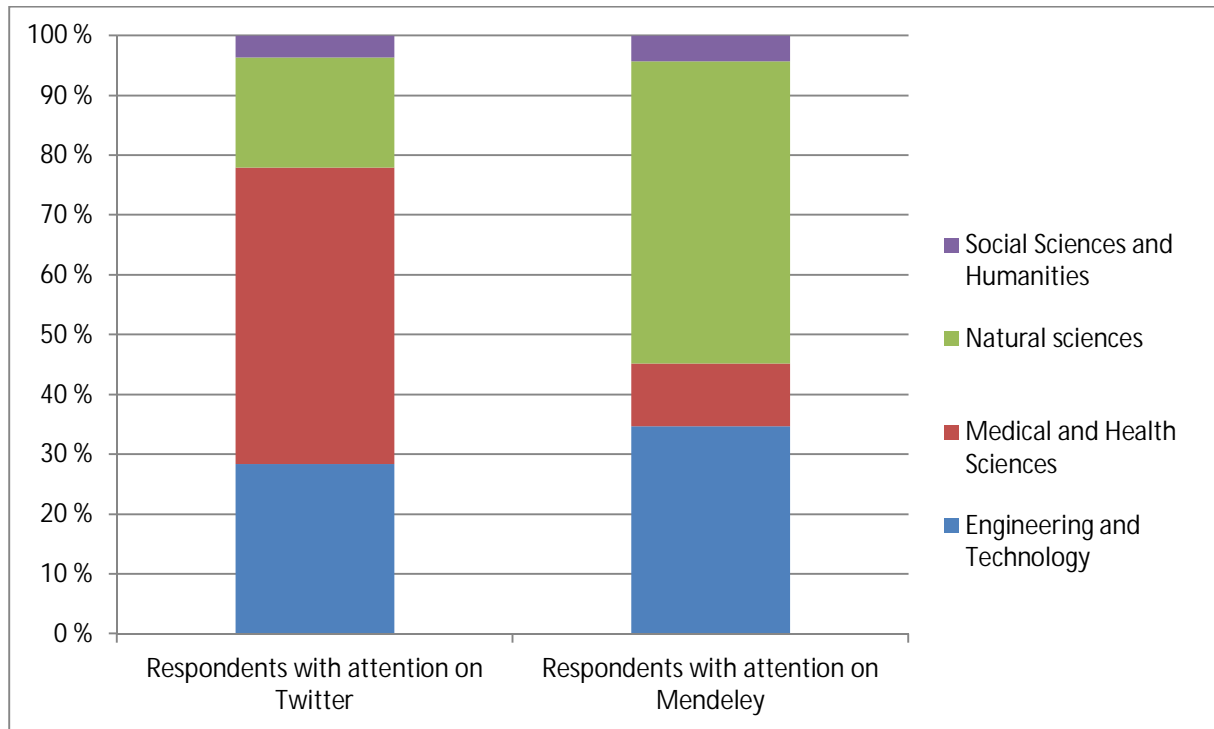

Figure 1. Share of respondents by fields of science and by platform for online attention

Results

As there was no prevailing theoretical frame of reference that would have provided us with hypotheses over the answers, we settled on utilizing the previously introduced method of inductive content analysis by Hsieh and Shannon (2005) to analyse the answers to the questionnaire. With inductive content analysis we were able to identify several reoccurring factors that were mentioned to be behind the online success (question 1) or that were thought to reflect social and scientific impact (question 2) of the paper in question.

The overarching themes that were built by further grouping the categories in question 1 were constructed based on what sort of audience the researchers might have envisioned when they described the reasons for the success of their article. After the first stage of analysis we were able to interpret the data and identify two dominant overarching themes – attention from an academic audience and attention from a wider audience beyond academia. The chosen themes, academic and wider audience, were created based on what type of audience the response could be thought to intend or what type of audience would most likely be appealed to the suggested characteristics that had contributed to the significant online attention of the paper. In other words, in the creation of themes the audience was taken into account. For instance, when considering the reasons stated for the popularity or gained attention the category for "respected publication channel" was coded to be more important for an academic audience, rather than for a wider audience beyond academia. The category "timeliness" on the other hand was coded to be mainly appealing for a wider audience. There were some overlapping between the categories (e.g., timeliness – novelty), but these were not merged together because of the subtle nuances in the meaning and intention of the responses. Behind this decision were the perceived motivations to share the article on Twitter or to save it on Mendeley. It was presumed that an

academic audience has differing motivations to share or save the article than a wider, mainly non-academic audience would have.

Table 1 shows the identified themes from the responses to the first question grouped according to the overarching themes (academic audience – wider audience). The table is sorted descending according to Mendeley categories. As can be seen in Table 1, responses connected to articles that had received significant attention on Twitter emphasized more personal attributes and the role of communication, while responses connected to articles saved on Mendeley reflected a more academic and analytical approach to the factors leading to the received online attention. Where almost 68 percent of the responses for Mendeley were classified as reasons related to an academic audience, for Twitter about 60 percent of the responses were classified as attributes appreciated by a wider audience. For responses connected to Twitter five topics were clearly emphasized as reasons for the received attention; emotionally engaging topic (30 mentions on Twitter, 0 mentions on Mendeley), respected publication channel (T 20, M 23), timeliness of the topic (T 20, M 19), novelty of the topic (T 17, M 6), and popularizable topic (T 16, M 12). For Mendeley the responses were more evenly spread over more topics. There were a total of eight categories that received over ten mentions in the responses; significant research results (40 mentions on Mendeley, 8 mentions on Twitter), respected publication forum (M 23, T 20), timeliness (M 19, T 20), new research method (M 18, T 2), review/meta-analysis article (M 13, T 7), popularizable topic (M 12, T 16), top researchers as authors (M 12, T 2), and interesting topic (M 12, T 0).

Certain categories were clearly more popular for articles that had received significant attention in both Twitter and Mendeley, such as timeliness (Twitter 20 mentions, Mendeley 19 mentions), respected publication channel (T 20, M 23), and popularizable topic (T 16, M 12). The characteristics or aspects of the paper or of its authors that were most frequently mentioned for both successful papers on Twitter and on Mendeley appear to be more general in nature and not necessarily connected specifically to scientific merits of the paper nor to aspects that a more general audience could be thought to find more appealing.

Table1. Factors influencing the attention that top research articles had received on Twitter and Mendeley (A = Academic audience, W = Wider audience).

Theme	Category	Twitter (n)	Mendeley (n)
A	significant research result	8	40
A	respected publication channel	20	23
A	new research method	2	18
A	review article / meta analysis	7	13
A	top researchers among the authors	2	12
A	activity of the authors (in disseminating the results)	8	8
A	surprising result	7	8
A	well known research area	2	7
A	conflicting results	0	7
A	highly cited	0	7
A	international collaboration	6	6
A	connection to the Nobel prize	2	4
A	multidisciplinarity	0	3
A	access to data	2	1
A	basic research	0	1
A	networks of the authors	4	0
A	consortium research	4	0
A	wrong interpretations	2	0
	Total	**76**	**158**
	%	**40.2%**	**67.8%**
W	timeliness	20	19
W	popularizable or personal topic	16	12
W	interesting topic	0	12
W	engaging to wider audience	0	8
W	novelty	17	6
W	visibility in media	7	5
W	open access	0	5
W	press release by the institution / university	9	3
W	title	4	2
W	figures	3	2
W	easily understood	0	1
W	emotionally engaging topic	30	0
W	applicability in practice	5	0
W	societal relevance	2	0
	Total	**113**	**75**
	%	**59.8%**	**32.2%**
	Total	**189**	**233**
	%	**100 %**	**100 %**

In the responses to the second question there were again some identified topics common to both platforms. The responses were again grouped into overarching themes based on what the online attention was thought to reflect or indicate and some clear differences between the platforms in

regard to the second question emerged. Figure 2 shows that online attention was in many cases thought to reflect scientific impact of the article, especially on Mendeley (Twitter 12 mentions, Mendeley 45 mentions). Authors of the articles that had received significant attention on Twitter emphasized their opinion that the online attention was a reflection of some type of impact other than scientific impact (33 respondents), but almost as many respondents (24) stated that they did not believe that attention on Twitter reflected any type of impact. Thus, no clear consensus about the impact could be reached among the authors of the articles that had received significant attention on Twitter. Same, although to a lesser degree could be seen for Mendeley, with 45 responses stating that the online attention is a reflection of scientific impact, 14 responses claiming it to be a reflection of societal impact, and 12 respondents claiming that online attention does not reflect any type of impact. On the other hand, some authors of articles that had received significant attention on Mendeley stated that the online attention correlated with the number of citations their research had received and that it reflected how the scientific community was interested in the research. In addition, other aspects of the research or of its authors (Twitter 22 mentions, Mendeley 39 mentions) and quality of the research (T 18, M 28) were also quite often mentioned as being reflected in the online attention received.
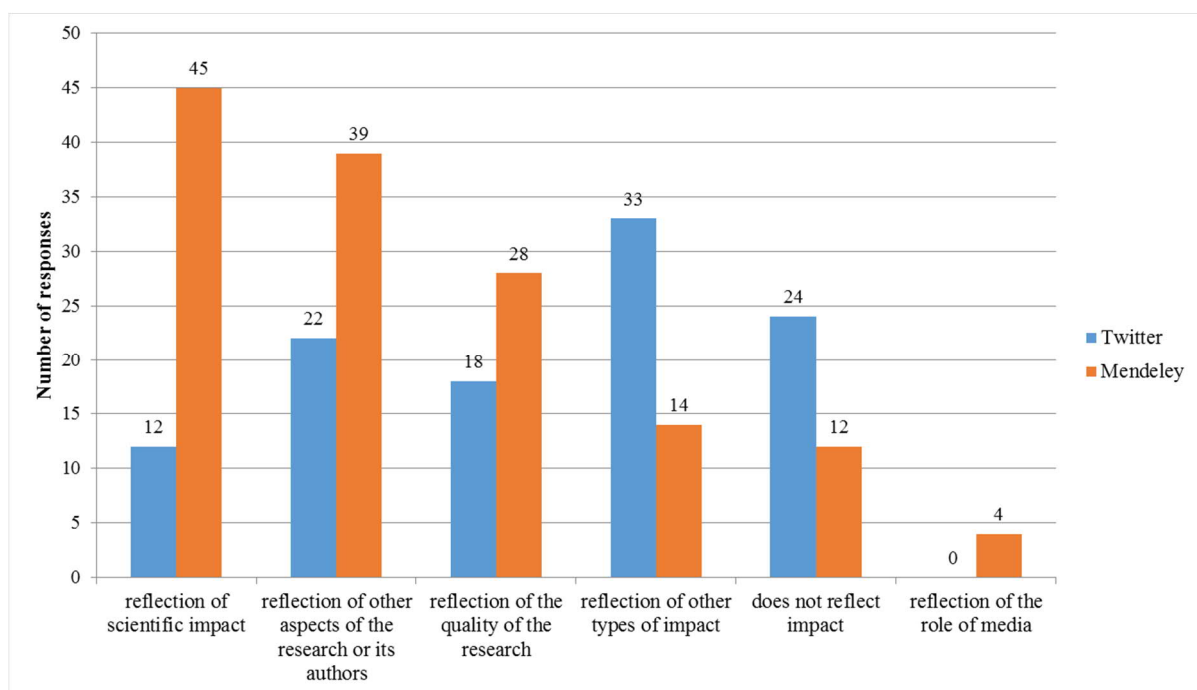

Figure 2. Respondents' opinions about what online attention on Twitter and Mendeley tells about the article's impact, about the research or of other attributes of the article or its authors

The researchers were asked to describe their own activity in following the online attention their articles received (research question 3). The aim of this question was to gain further information on the practical experiences and customs that the respondents have towards monitoring and measuring online attention and with that, of their competence to assess reasons for the online attention their work had received. The responses were divided with about 36% (n=61) of the responses stating that they were actively following the online attention of their work, while about 21% (n=35) answered that they sometimes check it and 41% (n=69) stated that they do not follow the online attention at all. Among others, the lack of know-how and time were mentioned as reasons not to keep track of online attention. On the other hand, a few respondents went as far as to declare that they are not even interested in the online attention their research receives; one respondent stated that such activities are "vanity driven" and another found the whole hype around research impact stressful. Five responses (2%) did not answer the question.

However, about 23% (14 responses) of those that answered YES and about 46% (32 responses) of those that answered NO clarified that they specifically follow the number of citations their work receive. It is thus clear that the question should have been more specific as some respondents have included citations as a way to "*follow what kind of online attention*" their work receive. This is also clear when looking at the services the researchers use to monitor the attention their work receive; citations specifically were mentioned 60 times in the responses and citations in Google Scholar were mentioned 33 times, quite often with an additional comment that citation counts are needed when reporting on research funding or when applying for it. Other frequently mentioned means of tracking the online success or to monitor the level of attention research articles receive were ResearchGate (27 times), searching for the mentions of the article on Google (14 times), Twitter (11 times) and Facebook (11 times). The Altmetric Attention Score of an article was mentioned 10 times. Other sources that were mentioned less frequently included LinkedIn, download counts, news sites, blogs and Wikipedia.

When asked whether the respondents believe that visibility online increases the scientific and/or societal impact of their work the responses were overwhelmingly positive; 63% (102) of the responses believed that online visibility can have positive influence on either scientific or societal impact of research or both and about 15% (25) answered that it may have some limited impact. Many of the respondents commented that they believed that increased visibility will naturally lead to increased awareness among both other scientists and the wider public, which in turn can lead to increased impact. Some of the responses mentioned that increased visibility can at least lead to increased debate, which in turn can have influence on policymaking. A few responses mentioned the importance of visibility and increased awareness to secure research funding. One of the respondents noted that another way through which the online attention could lead to specifically increased scientific impact is by increasing the number of entry points or links to the research and thus making it easier to find (e.g. through higher ranking in search results or simply through serendipity). While about 17% (28) of the responses stated that the respondents were uncertain and perhaps did not know what to answer, only about 4% (7) of the responses clearly stated that they did not believe online attention could lead to any kind of impact.

Interestingly, while a significant majority of the respondents believed that the online attention can lead to increased scientific and/or societal impact, not many researchers were following what kind of attention their work had received online.

Discussion

The overall aim of this study was to investigate Finnish researchers' opinions about the reasons why their research had received significant attention online on either Twitter or Mendeley or on both. Some shared attributes of the research or the publication appeared repeatedly for both Twitter and Mendeley. Especially high quality of the publication channel, timeliness of the publication, and personal connection to the research topic were seen as attributes that influenced the online attention on both platforms. In addition, depending on the platform, top researchers as authors, emotionally appealing subject, and the novelty of the research topic were also often mentioned as reasons for the received attention. Based on the findings it can be stated that the level of online attention received is a sum of many factors and that there are specific differences between the platforms where the attention has been received. The categories were grouped according to whether the researchers thought that the online attention was due to attention received from an academic audience or from a wider more general audience. From this grouping it was apparent that for the articles that had received significant attention on Mendeley the reasons for the attention were more often due to an academic audience and thus more connected to scientific merits of the publication or its authors, while the situation was reverse on Twitter, with the majority of reasons for the attention being linked to a wider audience beyond academia

and with that to a more general interest towards the research publication. These platform specific differences in the reasons for the attention can at least partially be explained with both differing purposes and user types between the platforms; while Mendeley is profiled clearly as a tool to conduct research, the user base of Twitter is much more varied.

The divide between an academic audience and a wider audience was also apparent in the answers to the second question about the researchers own thoughts whether this attention could reflect or tell something about scientific or societal impact of their research. The impact of the articles frequently saved on Mendeley was described to be more connected to a scientific impact, while the articles that were frequently tweeted were thought to reflect the attention from a wider audience. But some disagreement could be seen when the researchers assessed the scientific and the societal impact of their article. The abstract nature of the term impact and the subjective opinions attached to the term made some respondents specify that the online attention gives the research and the research topic visibility, but not impact. On the other hand, in some answers the articles were seen to have some general impact and influence on societal debate. But several respondents stated clearly that they do not believe that the amount of attention on Twitter would tell anything about any possible type of impact of that research.

Although there were clear differences in the answers according to the platform, it is unclear how much the answers were influenced by researchers' own perception of the type of people that are using the platforms. As it would appear that all the respondents recognized both of the platforms, it is possible that their answers have to some degree been influenced by their personal perception of the platforms and of their users. This could be counted for in future studies by repeating the study without revealing on which specific online platforms the articles have received significant attention.

There was a lack of clear consensus about whether the online attention received could reflect scientific or societal impact. Opinions that the online attention contributed positively to impact in general prevailed, although some described the online attention as mere buzz. Some respondents clarified that the traditional approaches to measure impact, such as citation counts, were still considered as the most important means to measure impact and many respondents stated that this is also the way they follow the attention their work receives. In fact, there appeared to be a specific causality in the researchers' thinking about the factors influencing the online attention; the attention measured with altmetrics was often seen as a result of attention that had been reached with bibliometric measures or that was assumed to later be possible to measure with citations. Nevertheless opposite views existed too, as many respondents suggested that online visibility is important for increasing awareness of the research among both other researchers and the wider public.

Citation counts were seen as the primary means to measure the success of an article while online attention, for instance on Mendeley, was merely seen as an event that could be related to citation counts. For instance when asking the researchers whether they follow the online attention their research articles receive (research question 3), many of the researchers that answered "no" drew parallels between the online attention and citation counts. This suggests that even the online attention is given some value, but that that value cannot compete with the productivity goals that are used for instance for funding decisions.

The results did, however, show a consensus among the researchers about the importance of breaking out of the ivory towers and communicating research to a wider audience. The answers often repeated the researchers' view that the online attention received demonstrated how the researchers had fulfilled their societal duty and also how they could bring scientific viewpoints into policy making. It was clear in many responses that the researchers consider that it is important that their research is visible in media and other online platforms, thus contributing to increased awareness and possibly influencing policy making. More research is, nevertheless,

needed to fully understand what the online attention some research receive could tell about societal impact of research or how science has had an impact on policy making.

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