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# Measuring the societal impact of open science – Presentation of a research project

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## Introduction

Research assessment has become increasingly important—especially in these economically challenging times—as funders of research try to identify researchers, research groups, and universities that are most deserving of the limited funds. The goal of any research assessment is to discover research that is of the highest quality and therefore more deserving of funding. As quality is very difficult and time-consuming to assess and can be highly subjective, other approaches have been preferred for assessment purposes (especially when assessing big data). Research assessments usually focus on evaluating the level of impact a research product has made; impact is therefore used as a proxy for quality. Impact can, however, be difficult to identify, track, and quantify, and as the current methods to assess research impact are being increasingly criticized, new methods and data sources need to be investigated. For this purpose, the altmetrics movement is investigating what the online mentions of research products can disclose about the impact research has had and who has been influenced by research. The focus of the research project presented here will be to examine online mentions of research products and to develop methods and tools to evaluate the potential of these mentions for measuring societal impact of Finnish research in Finland and beyond. This research will 1) map the current state of research in Finland using altmetric research methods and data, and 2) investigate novel quantitative indicators of research impact to incentivize researchers in adopting the open science movement.

## Assessing impact of research

Two approaches have traditionally been used to assess research impact: (1) assessments based on citations and (2) assessments based on publication venues. Both approaches have issues that are well-documented (e.g., Vanclay, 2012). Citations have been found to not always reflect quality or intellectual debt as they can be created for many different reasons, some of which do not reflect the scientific value of the cited article (Borgman & Furner, 2002). In addition citations can take a long time to accumulate, which suggests that one is evaluating past impact and past success when assessing research based only on citations. Using the publication venues as the unit of analysis assumes that an article published in a high impact journal (or a journal that has in some other way been judged as more important or "better") has gone through a more rigourous review process and that it therefore has to be of higher quality. While this approach may sound logical in theory, in practice it may not be the case that an article published in an important journal will have higher impact. In addition, neither of the two approaches investigates the actual, current scientific contributions of a specific article, as both approaches use indirect methods to examine proxies of impact.

Another problem with both of these approaches is that they only assess scientific impact—the impact on research publications or on other scientists. Science can, however, have a much wider impact on many different audiences, evidence of which is increasingly demanded by research funders. While science can inspire artists, change what is being taught at schools, increase people's environmental consciousness, lead to technological breakthroughs, have economic impact, benefit culture, public policy or services (Research Excellence Framework 2014) and possibly lead to behavioral changes, none of these impacts outside of scientific impact can be mapped or assessed through citations, nor through investigating the publication venues. Various types of impact have been discussed and some have previously examined approaches to measure the broader societal impact of science (e.g., Wolf, Lindenthal, Szerencsits, Holbrook, & Heß, 2013; Bornmann & Marx, 2014; Walter, Helgenberger, Wiek, & Scholz, 2007), yet there are currently no widely accepted methods of measuring this wider societal impact of research that would be demonstrable (Impact toolkit 2015). Therefore there is a great need for new data sources and methods to aggregate and analyze different sources of data related to wider scientific output beyond academia. The data should be able to demonstrate economic or societal, instrumental, conceptual impact or impact on capacity building. Instrumental impact may mean influencing the development policy, practice or service provision or sharing legislation. Conceptual impact contributes to the understanding of policy issues or reframing debates. Capacity building means impact through technical and personal skill development (ESRC). As scholarly communication is increasingly moving online and becoming more transparent, many researchers have turned to monitor various online sources in order to examine the digital traces left behind from acts including the discussion, comments, and sharing of research products.

It is the 350th birthday of the scientific journal in 2015 and it seems that it has not changed much during this time, while scholarly communication has undergone significant changes over the last couple of decades, primarily because of the use of online tools such as social media. Although publications and citations are still fundamental for scholarly communication, it can now be said that they are no longer irreplaceable. Researchers can share and disseminate their ideas, thoughts, and results openly through various online tools including their online social networks, which allow their network connections to comment, discuss, and share them further. Just as Google ranks websites based on the amount of links they receive, the attention various research products receive in various contexts and by various audiences could be used for ranking (Priem et al., 2010). For instance, events tracked in online contexts—so-called "altmetrics"—could potentially point to research that has had higher impact, more influence, and has received greater attention from a wider audience beyond the closed silos of academia.

Although altmetrics does not yet have a widely accepted definition, the idea and potential with altmetrics is that the mentions and other indicators of visibility and awareness (e.g., number of tweets, comments, blog entries, and social bookmarks) a research article and other research products receive on the web and in social media could tell something about the impact or influence of that research. Shema, Bar-Ilan & Thelwall (2014) try to capture this as they define altmetrics as "*web-based metrics for the impact of scholarly material, with an emphasis on social media outlets as sources of data.*" The term "altmetrics" is being used in two ways: (1) to describe the metrics resulting from the traces of the use and production of research products made in online environments, and (2) as an umbrella term used to identify the research field investigating the meaning and application of these metrics and events. These altmetric events are useful in that they trace the use and production of research outside of academia. Scholars examining altmetric data collect and investigate events surrounding research products from various online sources including social media sites, news outlets, Wikipedia, and blogs, with the assumption that these events can identify something about the wider impact of research or what types of impact (Priem, 2014) research is having. A vast, wide-ranging audience (i.e., not only scholars) is responsible for altmetric events, hence, altmetrics may be able to provide a more nuanced view of the impact research has made on society (Liu & Adie, 2013; Piwowar, 2013). These new metrics should not, however, be considered as alternatives to citations for demonstrating scientific impact, but rather they should be investigated for their potential to demonstrate other forms of societal impact including educational, technological, environmental, economical, and cultural. But as the validity and meaning of some of the altmetrics

acts are still unclear, more research is required to fully understand both what altmetrics actually reflect and which metrics are stable and reliable enough to be used as real indicators of impact outside the academia.

We know that research has impact far beyond citations as less than 1% of the article views in the open access journal PLoS result in later citations (Lin & Fenner, 2014). Thus the impact of research articles is never fully captured. In addition, citations can only reflect the scientific impact of research, as acknowledged by other researchers, while funders and policymakers are increasingly demanding evidence of a wider, societal impact of research (e.g., REF2014 in the UK, http://www.ref.ac.uk/). There are vast audiences and online sources from which research impact and attention received can be collected and measured. For instance earlier research suggests that Mendeley, the online reference manager used by many researchers, can reflect scientific impact (Li, Thelwall & Giustini, 2012), while attention on Facebook and Twitter may come from a wider audience than researchers alone (Bornmann, 2014). In a similar way, research mentioned in policy documents may reflect the societal impact of how research is being used in policymaking. In addition to this social impact can be considered as something that is ”experienced or felt, either a cognitive or a coporal sense at any level of an individual, an economic unit” or more generally by society (Vanclay, Esteves, Aucamp & Franks 2015, p. 2.) By investigating novel data sources for mentions of research products, like those described above, we are able to give a more nuanced understanding of where and how research has had an impact.

## Altmetrics and open science

Altmetrics and the Open Science movement are similar in that altmetrics are mostly derived from open access research products. The most cited definition of open science comes from Nielsen (2011), who defined it as “*the idea that scientific knowledge of all kinds should be openly shared as early as is practical in the discovery process*.” Friesike and Schildhauer (2015) list the different forms, or aspects, of open science by interpreting the meaning of “open”. They argue that the open science movement includes increased transparency of the research process (i.e. making data and tools openly available), increased collaboration by making the research process public and open for anyone to join, and efforts to make science more available to the public through 1) writing in a manner that is understandable even outside of academia, 2) including the public in the research process through “citizen science”, and 3) ensuring open access to scientific literature. In addition, the authors believe that a wider range of quantitative indicators of a broader range of impact can be incentivizing for researchers to make their research more accessible and to adopt the open science ideology (Friesike & Schildhauer, 2015).

One of the shared ideas of altmetrics and open science is that open review could replace the current standard of double blind peer-review. In an open review process reviewers can receive credit for this otherwise hidden part of their work, while the openness of the process could lead to increased transparency. In perhaps its most sophisticated and futuristic view, open review could eventually lead to filtering and impact assessments similar to that of current web search engines where the system simply utilizes the wisdom of crowds in a network to point to more valuable scientific work (Priem, 2011). Yet it may take some time before the current system is replaced because current trends in academic publishing and citation counts still forms the backbone of the academic reward system. Altmetrics, however, may be the best chance at changing the current system for at least two reasons. First, it is of increasing importance to develop new filtering mechanisms to help researchers find the most valuable publications for their work because of the continuous growth of scientific literature (e.g., Jensen, Saric & Bork, 2006; Larsen & von Ins, 2010; Bornmann & Mutz, in press), as there is an estimated doubling of scientific literature every nine years (Bornmann & Mutz, in press). Altmetrics could point researchers to interesting and more valuable research that has received the most attention from other researchers and from the general public. In addition to this social impact can be considered as something that is ”experienced or felt, either a cognitive or a corporal sense at any level of an individual, an economic unit” or more generally by society (Vanclay, Esteves, Aucamp & Franks 2015, p. 2). Second, altmetrics can afford novel indicators for attention, visibility, and impact and provide incentive to researchers to adopt the ideology of the open science movement. Both novel indicators and filtering mechanisms can function as an academic reward mechanism, help researchers find the most valuable publications, and inform

funders, policymakers, and others of the impact research has made.

By developing methods and tools to investigate altmetrics in the context of Finnish research, this project will result in a refined understanding of the impact of Finnish research and create incentives for researchers to adopt the open science movement.

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