# Are Altmetrics Effective in Transdisciplinary Research Fields?

## Altmetric Coverage of Outputs in Educational Research

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**Abstract**

This paper analyzes the coverage of altmetrics for heterogeneous scientific and extra-scientific outputs in a transdisciplinary research field. The transdisciplinary field of educational research is used as a case study to get first insight how current altmetric tools cover the field on the levels of its general publication output, and on the level of research relevant journals. Additionally, an experimental approach analyzes the Twitter mentions of a transdisciplinary research report.

**Keywords:** altmetrics; transdisciplinarity; tweet analytics; educational research; publications practices

## 1    Introduction

In this paper, the coverage of altmetrics is analyzed in a transdisciplinary research field characterized by heterogeneous scientific and extra-scientific outputs. Recently a fundamental transformation of the scientific landscape has been discussed as transdisciplinary research and has become a major topic in science policy agendas. Transdisciplinary research can be described

as a reflexive research approach which integrates societal problems into scientific issues, involves heterogeneous scientific and extra-scientific insights and contributes to both societal and scientific progress (cf. Jahn, Bergmann & Keil, 2012; Gibbons, 1994). Classical scientometrical approaches are mostly limited to an intra-scientific measurement. Altmetrics offer potentials to include extra-scientific communication and have been discussed in the broader context of scientific impact as societal impact (Barnes, 2015; Bornmann, 2014a, 2015; Holmberg et al., 2015). Furthermore, with respect to the heterogeneity of transdisciplinary research outputs, altmetrics are able to integrate a broader range of research products into the scientific evaluation apparatus like datasets, software, algorithms, grey literature, and slides (Bornmann, 2014a; Priem, 2014; Zahedi, Fenner & Costas, 2014). On the other hand, the measurement of non-scientific output is difficult (Koier & Horlings, 2015) and so far no systematic analysis of the accuracy of altmetrics in transdisciplinary research has been presented.

This paper uses the transdisciplinary field of educational research as a case study. Educational research is characterized as problem-oriented, disciplinarily heterogeneous (e.g. psychology, social and political sciences, economics) with a strong alignment to educational practice (Baumann, 2005; Dees, 2015; Deutscher Bildungsrat, 1974). The transdisciplinary character of educational research and its heterogeneous disciplinary publication cultures and practices are used in this study to identify challenges and boundaries of altmetrics, describe transnationality and discuss societal impact.

In this study different methodological ways are tested to get first insight how current altmetric tools cover the field on the levels of its general publication output, and on the level of research relevant journals. An additional experimental approach analyzes the Twitter mentions of a continuous research report on the situation of education in Germany (Autorengruppe Bildungsberichterstattung, 2016). The education report was chosen as a relevant transdisciplinary output in educational research (cf. Dees, 2015: 178), which addresses the extra-scientific world of educational politics, administration, and the general public.

## 2      State of the art

Transdisciplinary research is widely discussed and a variety of conceptualizations exists (Gibbons, 1994; Jahn, Bergmann & Keil, 2012; Nowotny, Scott & Gibbons, 2001). A common setting can be described for this study as: Integrating societal problems into scientific issues, involving heterogeneous scientific and extra-scientific insights and contributing to both societal and scientific progress (Jahn, Bergmann & Keil, 2012; Klein, 2008). Respectively, difficulties emerge concerning operationalization and measurement. The integration of heterogeneous disciplinary knowledge into research (interdisciplinarity) is regarded as difficult to measure in practice (Huutoniemi et al., 2010), for which accounts scientific output (mainly publications) (Wagner et al., 2011). The situation is aggravated by integrating the extra-scientific world (i.e. problems, knowledge, stakeholders, and progress). So, for example, stakeholders and scientists differ in their agendas of interests, which limits the usage of bibliometric methods based on scientific publication data bases (Koier & Horlings, 2015). Furthermore, some authors have argued that the intra-scientific alignment of the publication data bases (i.e. WOS) allows no statements about societal impact (cf. Holmberg et al., 2015). Others emphasize the relational aspects of transnationality, like societal progress, which are difficult to grasp with metrics (Klein, 2008; Koier & Horlings, 2015).

For some time altmetrics have been discussed as so called alternative metrics promising the extension of current citation-based impact factors (Priem et al., 2010). Various potentials are articulated concerning transdisciplinary research (Koier & Horlings, 2015), especially for addressing societal progress (Bornmann, 2014b, 2014a). Altmetrics involves the extra-scientific world (knowledge, stakeholders) and extends the range of research products for scientific evaluation (Bornmann, 2014a, 2015; Priem, 2014; Zahedi, Fenner & Costas, 2014). A further advantage is seen in the more timely response of Twitter citations in comparison to citations in publications (Bornmann, 2016). On the other hand, a series of related limitations have been articulated in altmetrics ranging from coverage, consistency and traceability of data sources and aggregators (Chamberlain, 2013; Zahedi, Fenner & Costas, 2014, 2015) to the dependency on communication and publication practices of different scientific communities (Costas, Zahedi & Wouters, 2014; Peters et al., 2014; Zahedi, Costas & Wouters, 2014) .

Current research in altmetrics still preferably deals with questions, if altmetrics reach already a representative level of coverage and significance in comparison to traditional bibliometrics. Most of the altmetric studies are focused on science and medicine disciplines (e.g. Andersen & Haustein 2015, Bar-Ilan 2014, Adams & Loach 2015). Recently there were some multidisciplinary studies covering also social sciences and arts and humanities. Mohammadi and Thelwall (2014) analyzed Mendeley readers' data of WoS articles from 2008 from different disciplines. With 39% readership statistics articles in the transdisciplinary field of the educational and educational research represented a quite high readership quotation, whereas the humanities articles showed only 13% of Mendeley readers.

Including the whole range of social media sources Costas et al. (2014) found altmetrics data for 22.5% of the arts and humanities articles. In 2015 they published a multi-disciplinary study which analyzed the "thematic orientation of publications mentioned on social media" (Costas, Zahedi & Wouters, 2015). Summing-up the authors stated: "The humanities, natural sciences, and engineering disciplines have a much lower presence of social media metrics. Twitter has a stronger focus on general medicine and social sciences. Other sources (blog, Facebook, Google+, and news media mentions) are more prominent in regards to multidisciplinary journals" (ibid.: 260). Peters et al. (2014) explored the altmetric mentions for publications (journal articles and book chapters) by twelve Leibniz-Institutes (2011–2012). An institute from the Humanities and one from the educational sciences were selected (section A). Both institutes from section A had with 32% and 30% in comparison to the other sections the least mentions in social media.

The heterogeneity of publication practices has been addressed in social science and humanities in general (Fry & Talja, 2004; Nederhof, 2006) and in particular in educational research (Singleton et al., 2015; Dees, 2008), where authors publish aside from journals mainly in monographs and compilations. In transdisciplinary research fields this heterogeneity needs to be considered because various research communities and others are involved. In educational research the heterogeneity of publication practices affects the significance of the publication format 'article'. Articles, the favored publication format of citation data bases, are significantly more used in psychological (36.2%) oriented educational research than in sociological (27.4%) and genuine educational (28.9%) research (Singleton et al., 2015: 83). Thus, research communities with a low article orientation are misrepresented in arti-

cle based citation and reference databases like Web of Science (WOS) and Scopus, which are used as a reference for altmetrics.

# 3     Data and methodology

The survey on the coverage of publication practices in educational research was carried out in subject-specific databases that as far as possible portray the disciplinary heterogeneity. For the field coverage level of publications (as of June 2016) in educational research, the German Education Index (GEI) was used (2010–2015), which offers a broad spectrum of different publication types (e.g. monographs) including grey literature and practice-oriented publications outside of citation-based scientific ranking systems. For all GEI articles with the identifier DOI the altmetrics for the publications were retrieved via the Altmetric.com-API using R and the package rAltmetric on 10 May 2016.

For the analysis of educational journals, the index of editing characteristics of educational research journals DEPOT was used, a proved collection of periodicals relevant for educational research in Germany. All ISSNs of the journals indexed as of 26 February 2016 were inserted in Altmetric.com via the Altmetric.com explorer to retrieve all journal articles indexed in the Altmetric.com database. A further collection of Twitter-mentions addresses a continuous research report on the situation of education in Germany (Autorengruppe Bildungsberichterstattung, 2016). The mentions were recorded via the Twitter-Search API with NodeXL. The tweets were collected for seven days from the day of publication (June 16, 2016).

# 4     Coverage of outputs in educational research

## 4.1     Coverage of educational research publications

The coverage of educational research publications based on the German Education Index (2010–2015) reveals that 21.2% of the publications with DOI have altmetric data. 17.5% of these publications with DOI were mentioned at

Twitter, followed by Blogs (2.3%), Google+ (1.0%), and News (0.2%). The high share of Twitter mentions is in line with the results of previous studies (e.g. Costas, 2015). But only 12% of the collected publication output disposed of a DOI (16,076 out of 134,301) and could be mapped with altmetrics. Concerning the full range of collected publications (2010–2015) and the circumstances of aggregation just 2.5% ($n = 3,404$) could be identified and connected to altmetric data (table 1). A missing DOI is apparently a profound coverage limitation of altmetric studies.

*Table 1: Altmetrics for the publications in the German Education Index (2010–2015)*

| Year | All Pub. | Pub. with DOI | Pub. with Altmetrics (PubA/DOI) (PubA/GEI) | Twitter | Face-book | Blogs | News | Google+ | Wiki-pedia |
|---|---|---|---|---|---|---|---|---|---|
| 2010 to 2015 | 134,301 | 16,076 | 3,404 (21.2%) (2.53%) | 2,816 (17.5%) (2.1%) | 541 (3.4%) (0.4%) | 368 (2.3%) (0.27%) | 29 (0.2%) (0.02%) | 162 (1.0%) (0.12%) | 69 (0.43%) (0.05%) |

A more precise picture emerges when considering the different types of publication used in a transdisciplinary research field with its heterogeneous publication practices. Figure 1 shows the distribution of publication types in the educational database GEI (2010–2015).
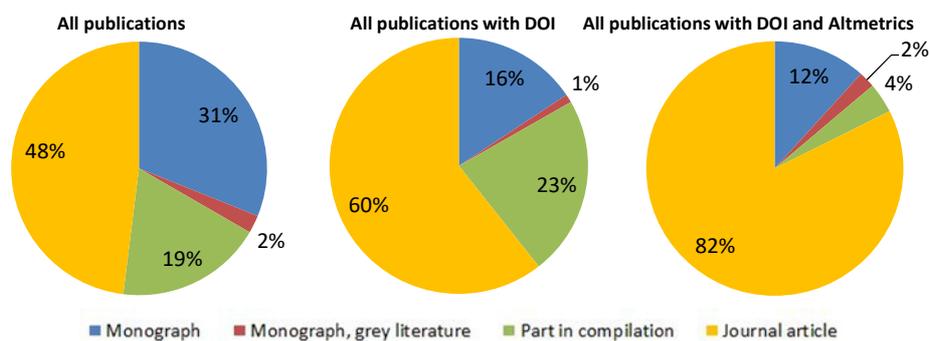


*Fig. 1* Proportion of publication types in the GEI (2010–2015)

Looking at the relation between publication type and availability of DOIs we find: The share of journal articles in the database increases from 48% of all publications to 60% of the publications with DOI and to 82% of the publications with altmetric data. Other major publication types in the field like

monographs and parts of compilations decrease from 52% (all) to 40% (with DOI) to 18% (altmetrics). Taking into account that different research communities in transdisciplinary fields follow different publication practices in terms of preferred publication types, it seems probable that non-journal based fields of educational research face disadvantages when altmetric measurement is applied.

While the detection of impact of research on society is seen as a great potential for altmetrics, the coverage of its output and the capturing of feedback from multiple groups of audience also play a central role in a transdisciplinary field. The study also analyzed the role of language on impact in social media. While publications in German are at 72% in the GEI corpus and thus predominant, German publication output with DOI is 43% and only 5% are covered with altmetric data (fig. 2).
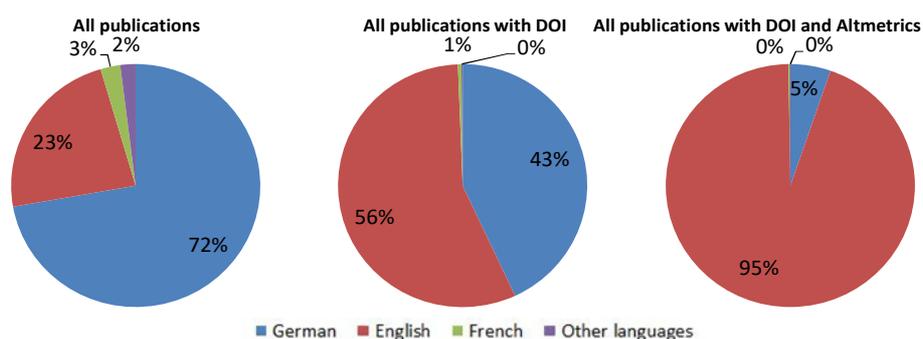


*Fig. 2*
Proportion of publication language in the German Education Index (2010–2015)

Given these conditions, it seems more difficult to address non-English target groups. Against the background of previous studies which focus nearly completely on the predominantly English publications of the WoS more research seems to be needed to reveal the influence of language on the coverage of altmetrics.

## 4.2    Coverage of educational research journals

The index of editing characteristics of educational research journals DEPOT (as of February 2016) describes and qualifies 310 journals building a solid base for analyzing the coverage of altmetrics on a journal level in educational research, but with a focus on German journals (94%). A query of ISSNs on

25 February 2016 revealed that 1,952 articles have altmetric data, sourced from 27 journals, i.e. 8.7% of all DEPOT journals. Reduced to the years 2010–2015 and after revision 1,427 articles from 23 journals have altmetric data, as described in table 2. 12 (52%) of these journals are English language journals, 11 (48%) are German. Due to the data collection method, direct via ISSN from Altmetric.com, it is not possible to have an overview of all publications in DEPOT journals or the publications with DOI. The output was a list of all articles with altmetric mentions.

*Table 2: Altmetrics of Educational Research Journals (DEPOT 2010–2015)*

| Years | All articles with alt-metric data | Twitter | Face-book | Blogs | News | Google+ | Wiki-pedia |
|---|---|---|---|---|---|---|---|
| 2010 to 2015 | 1,427 (100%) | 1,323 (92.7%) | 259 (18.2%) | 74 (5.2%) | 53 (3.7%) | 160 (11.2%) | 21 (1.5%) |

18 of these journals have less than 50 articles with mentions covered by Altmetric.com and 9 journals have less than 10 mentioned articles. Considering the previously described language variety and its constraints for addressing societal progress, only three of the first 10 journals are German journals.

## 4.3    Coverage of Twitter-mentions for a transdisciplinary report

On 16 June 2016 the report 'Bildung in Deutschland 2016' (Autorengruppe Bildungsberichterstattung, 2016) was published. The report is an indicator-based study of the German educational system as a whole. This report is a scientific output, compiled by a transdisciplinary team of educational researchers; its targets are educational policy, educational administration and the broader public. Therefore, the report is an exemplary publication output in the transdisciplinary area of educational research.

The established way to search for altmetric mentions by querying an identifier returned no results. Based on the Twitter-Search-API and a query for 'bildungsbericht' there were 405 unique tweets for the time period from June 16 to June 22, 2016. In addition to the tweets there were 447 retweets from 134 unique tweets. 386 tweets contain URLs to 85 different domains. The most referenced domain is faz.net (website of Frankfurter Allgemeine Zeitung) with 52 links, followed by bildungsbericht.de (the official report website) with 38 links (cf. table 3). Among the ten most mentioned domains there

are seven links to established mainstream news sites. This points to an extra-scientific attention of the report and indicates an impact on a discourse level. Already (Costas, 2015) found out that multidisciplinary topics tend to draw the attention of discourse oriented media like news and blogs

*Table 3: The ten most frequently mentioned domains*

| Domain | No. of tweets | Category of domain |
|---|---|---|
| faz.net | 52 | Newspaper |
| bildungsbericht.de | 38 | Website of the education report |
| spiegel.de | 35 | News magazine |
| tagesschau.de | 17 | Television news service |
| sueddeutsche.de | 16 | Newspaper |
| feedburner.com | 14 | Web feed management provider |
| zeit.de | 14 | Newspaper |
| bildungsserver.de | 13 | Information portal for education |
| deutschlandfunk.de | 12 | Broadcasting radio station |
| tagesspiegel.de | 9 | Newspaper |

At the day of the publication of the report there was a big blip in the amount of mentions that dropped the following days. 65.5% (558) of the collected tweets were created on June 16, 2016; 14.1% (120) tweets were created the day after the publication on June 17, 2016. 640 persons were identified as active, 302 of whom sent tweets and 361 sent retweets. 43% (302) of the active persons just posted tweets, 53% (361) only retweeted, and 4% (23) did both. These results confirm altmetrics as an extremely real-time indicator of communication about publications evoking high societal attention. But the attention of societal groups may also be rather short-winded, whereas scholarly resonance will follow later, and it is still questionable whether altmetrics will cover intra-scientific resonance (citations) sufficiently.

# 5    Discussion

In this study, we analyzed the coverage of altmetrics with respect to heterogeneous publication practices and outputs in a transdisciplinary field, namely educational research. Instead of high percentages (39%) of altmetric

coverage like at WoS articles with DOI matchings with Mendeley readers data (Mohammadi & Thelwall, 2014) or 30% of altmetric data for articles with DOI of an educational research institute (Peters et al., 2014), 21% of all publications with DOI in the German Education Index (2010–2015) and therefore just 2.5% of all publications in the German Education Index (2010–2015) have measurable altmetric data. The fact that the German database GEI comprises a high majority of German language publications and a relatively low number of journal articles with DOI obviously diminishes the share of altmetric data.

On one hand, this indicates that the population and the specific publication culture of a discipline (here educational research in Germany) has to be considered in altmetrics studies. On the other hand, it shows the need that altmetric aggregations like Altmetric.com have to extend the restricted range of the single identifier DOI. For the time being the collection and aggregation process of altmetrics excludes major parts of the heterogeneity of publication practices in a transdisciplinary research field. Further, multilingual and book oriented publication cultures are disadvantaged by altmetrics' predominance of journal articles and English language publications. Currently altmetric studies deal with similar problems as bibliometric studies in terms of data collection and their limitation to journal articles. A central goal of altmetrics, i.e. addressing practice-oriented areas and locally oriented publications (cf. Koier & Horlings, 2015), is thus constrained.

Nevertheless, the study indicates potentials of social media analytics for transdisciplinary research outputs, exceeding traditional bibliometric. On the basis of an extended future set of measurable identifiers the communication of transdisciplinary publications will be covered much better and allow a monitoring of a much broader attention. The example of the report for education shows that extra-scientific discourse on research outputs referenced by mainstream media and beyond can be made visible and assessable.

A range of circumstances give reason to anticipate positive developments for more descriptive approaches in prompt monitoring of discourses about transdisciplinary research fields and outputs. In longer time periods trend identification or contextual enrichments of research outputs can be implemented in research infrastructures (e.g. reference databases). Coverage of altmetric instruments is still growing, altmetrics aggregators like Altmetrics.com involve further identifiers like the URN and short messages are increasingly being used at international conferences. Altmetrics thus face big

challenges but also bear potential for analyzing scientific outputs beyond scientific impact.

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