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On the bibliometric nature of a foreseeable relationship: open access and education

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Abstract

The open access (OA) publication model is evolving and gaining support in the international scientific community. However, there is no evidence regarding the open access pathways being used in educational research or regarding the relationship between its subject categories and various scientometric indicators. The objective of this study was to use *InCites* to analyse documents published in journals from 2010 to 2016 in the SSCI categories of 'Education and Educational Research', 'Education, Scientific Disciplines' and 'Education, Special'. The percentage of documents published in the Gold OA model increased gradually over the period studied and was higher than in the Green OA model. 'Education, Scientific Disciplines' was the subcategory with the highest percentage of documents published in the Gold OA. There was greater international collaboration on articles and reviews in Gold OA, especially in the pure model (publications in Gold Open Access journals), and the percentage of articles cited was higher in the Green OA and Gold OA models than in a non-OA model. There was no evidence that the Gold OA hybrid was cited more often than Green OA, and both had more impact than Gold OA pure. The Category Normalized Citation Impact values and the presence of documents in first quartile journals were higher in OA than in non-OA models. A more detailed analysis of the percentiles of the most cited publications clearly demonstrates that OA publications dominated the top percentiles of most cited articles to a greater degree than non-OA publications. The 'Education, Special' subcategory showed the greatest international collaboration and the highest percentage of cited documents.

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Introduction and research questions

Determining which method of information transfer to use has become vital in all scientific fields because the means by which scientific information is transferred is a determining factor (Tominac and Zubac 2012). Scientific journals stand out, then, as channels for disseminating science, and the open access (OA) publication model is evolving and winning support in the scientific community (De Silva and Vance 2017). This model is becoming an increasingly common and necessary route among scientists for the dissemination of scientific and academic research results (Björk et al. 2010; Picasso and Phelan 2014; Suber 2015; McKiernan et al. 2016), to increase their visibility and their impact (Eysenbach 2006; González-Betancor and Dorta-González 2017). OA has become an important policy objective for many countries, funders of research, and institutions, often with such lofty goals as increasing speed, collaboration and innovation in research (Bosman and Kramer 2018).

Thus, various institutions promote OA, especially for scientific information based on publicly funded research, such as the U.S. National Institute of Health, the Bill and Melinda Gates Foundation, the European Commission, the U.S. National Science Foundation and the Wellcome Trust (Antelman 2017; European Commission 2017; Piwowar et al. 2018; Gumpenberger and Gorraiz 2018).

All this has led to the proliferation of OA journals (Björk et al. 2010; Laakso et al. 2011; Van Noorden 2013; Khabsa and Giles 2014) that facilitate access to scientific literature (Björk et al. 2014; Swan et al. 2015), echoing the scientific journals on education that engender greater internationalization (Diestro Fernández et al. 2017; Bedenlier and Zawacki-Richter 2015) and new learning opportunities (Zawacki-Richter and Naidu 2016).

A study with a sample of 1.5 million documents published between 2007 and 2012 estimated that more than 50% of scientific articles were freely available on the Internet (Archambault et al. 2014). Similarly, the report titled "Analytical Support for Bibliometrics Indicators-Open Access Availability of Scientific Publications" (Science-Metrix 2018) indicated that the percentage of OA articles available on the Web of Science (WoS) between 2006 and 2015 ranged from 50% to nearly 60%.

The report cited above highlighted how the health sciences had the most articles available for free through OA, with 59% of articles published in 2014 available for free in 2016, followed by the natural sciences (55%), applied sciences (47%), economic and social sciences (44%) and arts and humanities (24%).

However, although the scientific literature confirms the influence of the international OA movement in many areas of research (Suber 2015; Archambault et al. 2016), it should be noted that in scientific research on education, the OA initiatives are less mature (Picasso and Phelan 2014). However, OA does influence education publications (Zawacki-Richter et al. 2010). There remains little evidence of the extent to which educational research is following an internationalization process similar to the process used by other disciplines (Knaupp et al. 2014) despite efforts made with government funding or by academic organizations (Aman and Botte 2017). Australia and the United States stand out in this regard, having developed well-established OA systems not only in scientific areas but also in culture and education (Cabrera-Peña 2014).

While it is true that OA levels are increasing in all disciplines, the precise levels and patterns of OA have been difficult to determine, and detailed quantitative studies remain scarce (Bosman and Kramer 2018). It is worthwhile explaining a number of specific studies in which the two most widely disseminated OA roads differ from the results

of the scientific research (Gold OA and Green OA) (Budapest Open Access Initiative 2002; Laakso et al. 2011). Other studies also highlighted differences in the development of the two roads, green and gold, depending on the discipline and the country (González-Betancor and Dorta-González 2017).

Björk et al. (2010) determined that for articles published in 2008, OA availability was 20% on average for all areas. In medicine, specifically, 21.7% of articles were available through OA, 13.9% of which were via the Gold OA and 7.8% via the Green OA.

Similarly, Gargouri et al. (2012) studied the growth rates of both the Green OA and Gold OA for articles in fourteen disciplines published in journals indexed by Thomson-Reuters-ISI from 2005 to 2010. They determined that in most disciplines, 97% of the articles in the sample were published in subscription journals, with 21% freely available on the Internet (Green OA) and 2.4% published in journals using the Gold OA, for a total of approximately 24% available through OA. The fields with the highest percentage of OA articles using the Gold OA were biomedical research (7.9%), clinical medicine (5.1%) and health (4.6%).

The data collected by the recently published Science-Metrix report (2018) show that the Green OA is the preferred route for making OA articles available worldwide. This route represents approximately 35% of the OA content while the Gold route (OA journals) represents nearly 25%. As one of the first studies on the availability of Gold Open Access journals in different areas, this report revealed that "Gold Open Access journals remain outnumbered by traditional journals and that the availability of Gold OA journals differs from discipline to discipline and often leaves scientists concerned about the impact of these existent titles".

The lack of journals that are purely OA and with significant impact in many areas led to a variation on this model—the hybrid. This is a model in which OA is granted to traditional, subscription-based journals that are not fully OA if its authors (or actually their institutions) agree to pay additional fees—Article Processing Charges (APCs). One of the first and most ambitious projects, Sponsoring Consortium for Open Access Publishing in Particle Physics (SCOAP³), pursued the conversion of traditional journals with high impact factors in the area of particle physics and was based on a 'partnership of over three thousand libraries, key funding agencies and research centres in 44 countries and 3 intergovernmental organizations' (see https://scoap3.org/what-is-scoap3/).

The hybrid model was the intelligent wager of the publishing world on the OA movement that, paradoxically, even enjoyed a rather premature, hasty approval and recommendation from some funding agencies without considering the so-called 'double dipping' (amount was paid in the end for both the subscription and for the OA benefitting the publishers). This grievance is currently being addressed by committed librarians who have already successfully negotiated the first 'read and publish' and 'offsetting' deals with major publishers to avoid paying twice for the same content (Gumpenberger and Gorraiz 2018). The hybrid model found wide acceptance because it is much quicker and easier to use than the Green OA, but it is also more expensive. Thus, the number of journals offering the hybrid option has increased from approximately 2000 in 2009 to nearly 10,000 in 2016, with an estimated 8000 articles in 2009 and 45,000 in 2016 (Börjk and Salomon 2012).

Recently, a plan to decisively advance towards the OA of scholarly publishing by 2020, currently called 'Plan S', was jointly developed by Science Europe and foresees that from 1 January 2020, all scholarly publications resulting from public research funding must be published in OA journals or on OA platforms (see https://www.scienceeurope.org/wpcontent/uploads/2018/07/Plan_S_Communication_110718.pdf).

Whether it is the Green OA or Gold OA, or even the hybrid model, it is clear that OA was one of the great gambles at the beginning of this century because the European Union seeks 100% OA of scientific publications by 2020 (Enserink 2016).

There is a lack of scientific evidence in previous studies dealing with the impact of the different OA models for scientific publications in education as research area. This is something that should be studied, given that OA in education can become an opportunity for growth and resources for the educational community. This opportunity is the result of its potential for students, teachers, researchers and managers of educational institutions (Zawacki-Richter et al. 2010; Ramírez Montoya 2015) to increase effectiveness and efficiency in the field of education (Aman and Botte 2017).

Regarding international collaboration, effects such as globalization and the rapid development of open scientific communication have resulted in an increase in international co-authorship in scientific communications and publications (Yun et al. 2014). This is because knowledge development is viewed as a collaborative process in which any research initiative involves a growing number of researchers, institutions, disciplines and countries (González and Gómez 2014). In the field of education, there is no discernible evidence of the extent to which internationalization and scientific collaboration have spread in educational research (Knaupp et al. 2014).

Nevertheless, there is widespread agreement on the importance of international educational research, especially in a globalized higher education landscape (Kosmützky and Krücken 2014). In higher education, its importance is indisputable due to the need for the comparative evaluation and identification of best practices (Teichler 2014) and to foster an international vision for educational research with the goal of identifying effective educational outcomes from the policies implemented (OECD 2013; UNESCO 2014). However, it seems that one of the unresolved issues that research on scientific collaboration must address is to identify and assess the role of the OA movement because it has been less studied than other types of collaboration in the academic, business or industrial areas (González and Gómez 2014).

Due to the recent inclusion in the Web of Science (WoS) of a tool using newly available OA status data from oaDOI in WoS, it is possible to explore year-over-year OA levels across research fields, languages, countries, institutions, funders and topics and attempt to relate the following OA patterns to disciplinary, national and institutional contexts that have not yet been conducted (Bosman and Kramer 2018).

The objective of this study is to explore the evolution between 2010 and 2016 of OA contents in the Web of Science categories referring to Education, and to analyse in detail their volume, visibility and impact.

Research questions

Our study seeks to answer the following research questions:

1. How have Gold OA, Green OA and non-OA evolved from 2010 to 2016 in the area of education? Has the Gold/Green OA ratio increased? What is the annual growth?
2. Are there differences in the percentages of first quartile (Q1) journals due to the model used? When analysing in detail the Gold OA and differentiating between hybrid and pure Gold OA journals, what is the percentage of Q1 journals for each model?

3. Are there differences in the percentage of international collaboration? Does international collaboration favour OA?
4. Considering the effects of publications measured by number of citations, what are the percentile distributions of citations in both models? Is there any evidence that Gold OA pure, Gold OA hybrid or Green OA articles are cited more often?
5. Finally, for all these questions, are there differences among the different education sub-fields, especially if they are more related to the hard sciences or other social sciences and humanities? Can we determine any general trends in the publication output of the education field?
6. Are there significant differences when examining all document types or only when reducing to articles and reviews?

Methodology

For this study, we used as a data source the Web of Science Core Collection (WoS CC) including all available indices as well as the analytical tools Journal Citation Reports (JCR) and InCites. We focused on all publications related to education based on the scope of the journal in which they were published. For this purpose, all the publications from the years 2010[1] to 2016 assigned to categories 'Education and Educational Research', 'Education, Scientific Disciplines' and 'Education, Special' were downloaded and analysed by the end of February 2018. The differentiation among these subcategories sought to analyse in detail the peculiarities within the same discipline. Thus, journals from 'Education and Educational Research' were more concerned with theoretical issues, while the focus of the journals indexed in the other two subfields, 'Education, Scientific Disciplines' and 'Education, Special', was more related to educational applications and interdisciplinary aspects.[2] A previous analysis performed by the authors in WoS CC for the publication years 2010–2016 showed that nearly 60% of the publications assigned to the category 'Education and Educational Research' belonged uniquely to this category while this percentage diminished to approximately 6.5% and 19% in the categories 'Education, Scientific Disciplines' and 'Education, Special', respectively.

A third of the publications included in 'Education, Scientific Disciplines' were also part of the category 'Education and Educational Research', and 82 more WoS subject categories were involved, the majority related to the hard sciences, especially to Health and Engineering.

In the case of 'Education, Special', only 5.5% of the publications were also part of the category 'Education and Educational Research', and 32 more WoS subject categories were involved, the majority related to psychology, the social sciences and the humanities, and especially to rehabilitation (approximately 69%) and psychiatry (30%). There was nearly no overlap between 'Education, Special' and 'Education, Scientific Disciplines' (less than 0.3%). In order to prove the distinctiveness of the sub-fields, an analysis of the categories on journal level has also been conducted. According to the JCR Edition, the categories "Education and Educational Research" (239 journals) and "Education, Scientific Disciplines" (41 journals) share 10 journals, i.e. <25% and 5% respectively. The category

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[1] OA differentiation in WoS CC is only available for publication years since 2010.

[2] The category 'Psychology Educational' was not considered in this analysis because it is more related to psychology and because there is a large overlap coverage with the previously selected categories.

"Education, Special" (40 journals) shares only one journal with the first mentioned one and none with the second one. Therefore, it is justified their differentiation and consideration in this study.

The analyses were performed for all document types as well as for 'articles and reviews' according to the document type assignment from InCites. The OA status is provided by the Web of Science platform as a result of a partnership with ImpactStory, a not-for-profit organization that recently launched oaDOI, a knowledge base of OA content.[3] This knowledge base makes it possible to differentiate between the following OA status and contents:

- Gold[4] is a freely accessible final version of an article. Consult the copyright owner for any re-use or licensing requests. Articles are located at a publisher website in one of the following: (a) a journal that publishes only OA articles [= Gold Open Access Journal, GOA journals (pure model)]; (b) a journal that allows individual authors to pay an article-processing charge for their research to be OA in an otherwise subscription-based journal; and (c) a journal that allows archival content to be OA after a period of time.
- Green is a freely accessible version of an article located in a subject-based repository such as PubMed Central or in an institutional repository. This version of the article may vary from a peer-reviewed accepted manuscript to the final published version based on the journal's policies. Because the accepted manuscript may vary from the final published version, they are labelled distinctly as Green Accepted and Green Published, respectively.
- Non-OA: Only subscribers may access the full-text of the article.

We employed the same OA terminology in this study. These values are also available for export as part of the full record. In the second part of our study, we also differentiated the OA Gold status between publications in Gold OA journals ('Gold in GOAJ') (pure model) and non-GOA journals that we designated 'hybrid' content.

To achieve this differentiation, we used the Directory of Open Access Journals (DOAJ).[5] All journals indexed in this directory are considered to be Gold OA journals. It should be noted that we could only check publications in journals or serials including an ISSN or a DOI in WoS CC. According to our match, approximately 5% of such publications were unidentifiable for all document types and 3% for articles and reviews. These publications were also analysed in InCites, and according to this tool, any of these publications were published in journals indexed in JCR.

From a scientometric point of view, the visibility of a publication is determined by the reputation or the impact of the source where it was published. It reflects the editorial barrier and unveils publication strategies. The identification of the top journals is normally based on journal impact measures. The most common impact measure is the journal impact factor (IF). Thus, a document has a high visibility in one research field, if it was published in a journal with a high IF in the corresponding subject category. In this study we are using the number of publications in Q1 journals (Top 25% according the IF in the corresponding subject category) to assess the visibility of each OA content.

The distribution of publications according to the impact factor (IF) quartiles assigned to the corresponding source titles is given for all publications as well as for the GOA (pure

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model) and the non-GOA journals between 2010 and 2016. The Q1 were calculated based on the IF of the publishing journal in the corresponding WoS CC category for the JCR Edition corresponding to each publication year. This provides information about the visibility of the publications according to the sources in which they were published, and the visibility is considered to behigher with an increasing number of publications in Q1.

The citation analysis provides an assessment of the impact (number of citations) at publication level. It includes the percentage of documents cited. All normalized citation indicators including percentiles data were retrieved from the analytical tool InCites.[6] The data were often based on a slightly smaller set of publications compared with WoS-CC due to an indexing delay in InCites, but the differences remained insignificant. The citation window is specified by the last InCites update, in this case, until February 2018. The InCites dataset at this time includes Web of Science content indexed through 2016-12-31.

Normalized citation indicators are the 'Category Normalized Citation Impact' (CNCI) and the total number and percentage of publications in the top 1% and top 10% most cited publications of the same document type, in the corresponding WoS Category and in the same publication year (percentile scores). The CNCI provides the citation impact (citations per paper) normalized for subject, year and document type. A publication with a CNCI value of 1.20 is 20% over the world expected citation rate in the corresponding WoS Category and in the same publication year, and a publication with a value of 0.80 is 20% below the world expected citation rate. For a collection of publications, the average value of all CNCI is calculated and designated 'Crown Indicator'.

Percentile scores are calculated according to the baselines published in InCites for the corresponding WoS Categories. The percentiles represent the citation count threshold for different percentile cuts for each field and year. For example, the 10th percentile represents the number of the top 10% most cited papers in the corresponding category for the current publication year. The top 10% are generally considered to be a measure of 'excellence'.

The consideration of normalized citation indicators is particularly important to accommodate the publications' diverse citation windows ranging to nearly 7 years (publication year 2010). However, the results for the most recent years should nevertheless be taken with a pinch of salt because the citation window was not sufficiently large to provide significant results. It should be considered that the cited and citing half lives in these categories varied between 7.6 and 9.8 years, according to the last JCR Edition (2016). Therefore, a most detailed analysis of the percentile distribution was only performed for the most relevant years (2010, 2011 and 2012) and is represented in the form of a pie chart for the years with the most significant citation window (2010–2012). Note that in this case, the values of the top counts were not aggregated. We therefore used open and closed brackets for representation and pie charts.

Furthermore, the number and percentage of publications with international affiliation (International Collaboration) were also retrieved from InCites. According to InCites, "International Collaboration" are papers that contain one or more international co-authors (e.g. authors with different country affiliation).

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[6] It should be considered that not all WoS CC document types are indexed in InCites (see Table 2).

Table 1 Total number of documents analysed per year and subcategory (2010-2016)

	2010	2011	2012	2013	2014	2015	2016	Total
Total documents	30,639	38,279	36,735	37,818	39,596	41,745	45,005	269,817
Total—Education & Educational Research	24,251	31,104	28,843	30,055	32,154	34,426	35,731	216,564
Total—Education, Scientific Disciplines	7252	8849	8298	8243	8412	7035	11,242	59,331
Total—Education, Special	1603	2181	2662	2082	2244	2095	2695	15,562
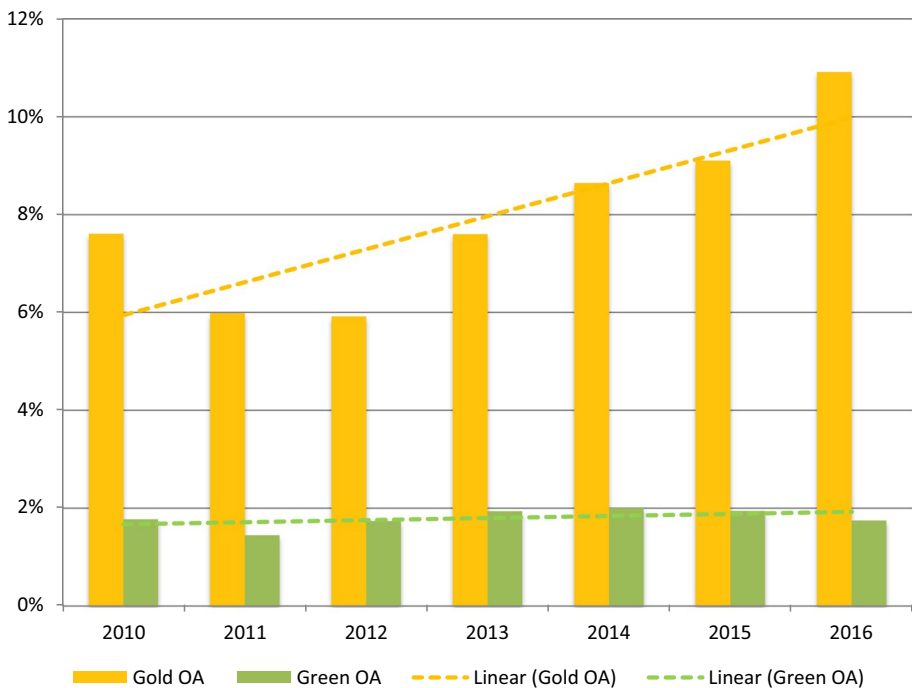
Fig. 1 Percentage of articles and reviews according to their OA content (Gold or Green) (2010–2016). (Color figure online)

Results

The complete data are presented in the supplemental material to this article. Table 1 summarizes the total number of documents retrieved and analysed per year and per sub-category. The complete data including differentiation between document types and OA contents or models are presented in the supplemental material.
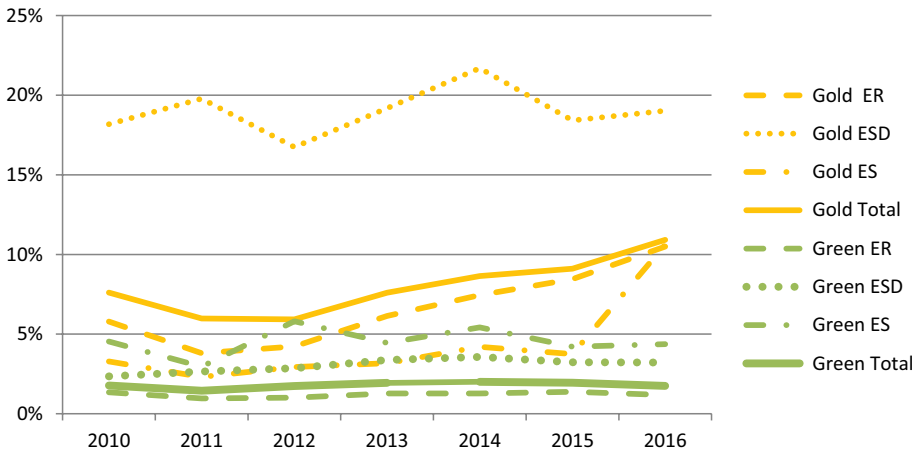
Fig. 2 Percentage of articles and reviews by the Open Access models and subcategories (2010–2016), ER: Education and Educational Research. ESD: Education, Scientific Disciplines. ES: Education Special

Document distribution by OA content

The analysis of the distribution of articles and reviews by OA content models and year of publication indicates that Gold OA, Green OA and non-OA all experienced variations throughout the period studied. The Gold OA and Green OA shared similar trends, both dropping in 2011 from 2010 levels, but then the Gold began growing while the Green OA remained more stable. The percentage of Gold OA ranged from 6 to 11% and the Green OA from 1.5 to 2.0%. In the peak year of 2016, Gold OA and Green OA together did not reach 13%. Figure 1 provides details of the evolution of Gold OA and Green OA content for articles and reviews over time. This growth trend was not observed when all document types were considered, remaining more or less stable. The percentage of all document types in the Green OA was lower than when only articles and reviews were considered (from a minimum of 0.8% in 2011 to a maximum of 1.1% in 2014). The Gold OA was higher when all document types were considered (a minimum of 8.1% in 2011 and a maximum of 14.9% in 2014).

Figure 2 shows that there were major differences in the percentage of all document types according to the subcategory and OA model used in the articles and reviews. The percentage of Gold OA was higher in the 'Education, Scientific Disciplines' subcategory. This difference was much smaller when all types of documents were considered because the Gold OA percentage of the 'Education and Educational Research' and 'Education, Special' subcategories was higher. In the Green OA, the percentage was higher in the 'Education, Special' subcategory and did not have the conspicuous percentage differences of the Gold OA. The percentages of each subcategory in the Green OA remained the same when all document types were considered.

When examining the subcategories for both OA models (Gold OA and Green OA), the subcategory of 'Education, Scientific Disciplines' had the highest percentage of documents throughout the period (ranging from 19.6% in 2012 to 25.3% in 2014), followed by 'Education, Special' (ranging from 5.3%, in 2011 to 15% in 2016). For the 'Education and Educational Research' subcategory, the range was 4.8% (2011) to 11.7% (2016).
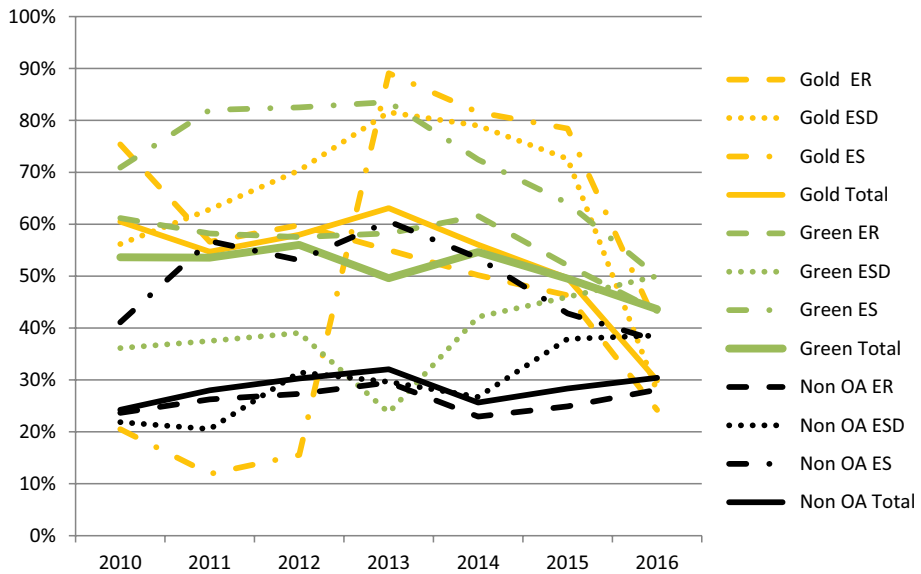
Fig. 3 Percentage of Q1 articles and reviews by the Open Access Model and subcategories (2010–2016) ER: Education and Educational Research. ESD: Education, Scientific Disciplines. ES: Education Special

Percentage of publications in Q1 journals using the OA model

For the period studied, the percentage of articles and reviews in Q1 journals was higher for the Gold OA content model than for the Green OA (Fig. 3). Over time, the percentage of these two models remained between 49.5% and 63.1% of articles and reviews in Q1 journals, except in 2016, when there was a significant drop to 29.9% for the Gold OA, which was 13.7% less than the Green OA. The percentage of articles and reviews in Q1 journals was higher for Gold OA and Green OA than for non-OA (closed access), where the percentage fluctuated between 24.2% and 32.3%. Like in the other two models, the percentage was similar when considering all document types and not just articles and reviews. When examining the subcategories, those with the highest percentage of articles and reviews in Q1 journals for the Gold OA were 'Education and Educational Research' in 2010, 'Scientific Disciplines' in 2011–2012 and 'Education, Special' from 2013 to 2016. Considering all document types, the 'Scientific Disciplines' subcategories had the highest percentage among the Gold OA from 2010 to 2015, and 'Education, Special' was the highest in 2016.

The abrupt changes in the categories "Education, Special (ES)" and "Education, Scientific Disciplines (ES)" are mainly due to the rather small number of journals comprising these categories (around 40 journals). Therefore, relatively small annual changes cause big variations of the percentages.

The articles and reviews in the 'Education, Special' subcategory had the highest percentage in Q1 for those using the Green OA and non-OA models. 'Scientific Disciplines' was the subcategory with the lowest percentage of documents in Q1 for those using the Green OA. This was also the case for those using the non-OA model in 2010 and 2011, whereas in 2012, the subcategory with the lowest percentage was 'Education, Research'. These Q1 subcategory results for the non-OA and Green OA are very similar when considering all document types instead of merely articles and reviews.
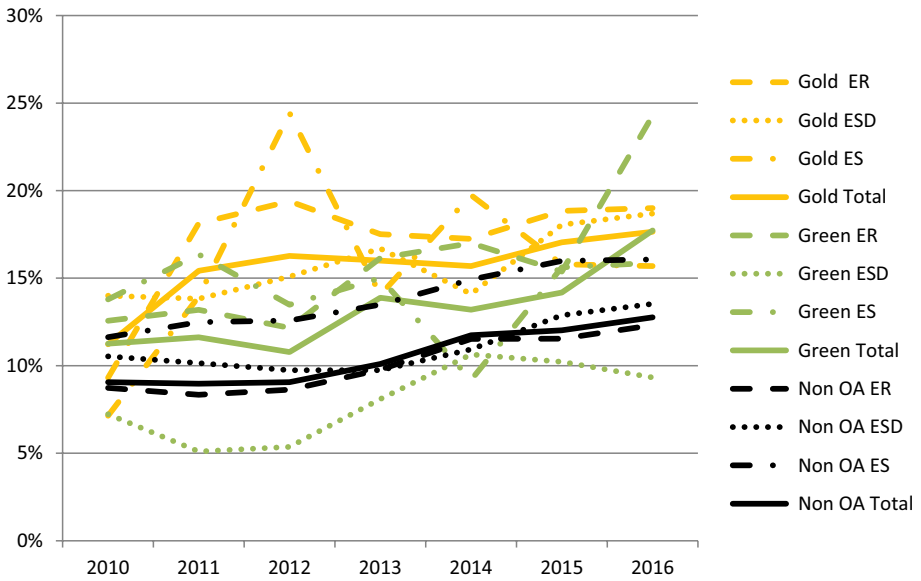
Fig. 4 Percentage of International Collaboration of articles and reviews by the Open Access models and subcategories (2010–2016) ER: Education and Educational Research. ESD: Education, Scientific Disciplines. ES: Education Special

International collaboration

The percentage of articles and reviews with international collaboration was slightly higher for the Gold OA model, reaching a maximum of 17.7% in 2016, which is the same percentage as for the Green OA model (Fig. 4). When considering all document types, the percentage of documents with international collaboration in the Green OA model was similar to the percentage of articles and reviews whereas the percentage of international collaboration in the Gold OA model dropped between 4.1 and 8.9 percentage points. For the non-OA model, it dropped between 2.6 and 3.9 percentage points.

By subcategory, the highest percentage of international collaboration in articles and reviews was observed in 'Education, Special', followed by 'Education, Scientific Disciplines' and 'Education and Educational Research'. The distribution by model type does not reveal any significant pattern, having multiple fluctuations. There is no difference when taking all document types into account.

Impact

Due to the progressively shorter 'citation window', the percentage of articles and reviews cited from 2010 to 2015 decreased from 97.6% (2010) to 90.3% (2015) in the Green OA model and from 94.2% to 73.1% in the Gold OA model. In 2016, 71.7% of articles and reviews in the Green OA were cited whereas 59.2% in the Gold OA. In the non-OA model (closed access), the percentage of documents cited ranged from 71.5% in 2010 to 39% in 2016. If all document types are considered, there was a decrease in the percentage of
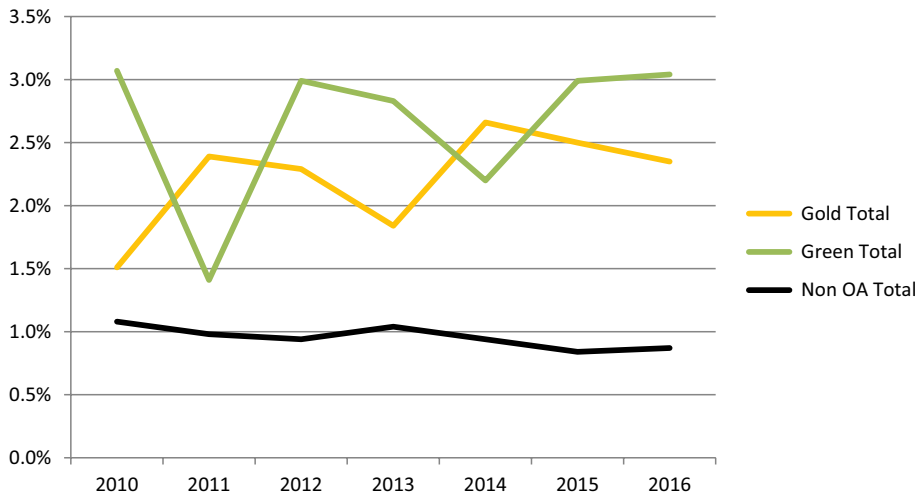
Fig. 5 Percentage of top 1% most cited articles and reviews by the Open Access models (2010–2016)

papers cited (110,756/269,817; 41.1%), 20.9 percentage points less than for articles and reviews (86,209/139,092; 62%). This analysis is in line with the well-known fact that articles and reviews attract the most citations. Regarding the subcategory analysis, 'Education, Special' had the highest percentage of cited documents, followed by 'Education, Scientific Disciplines' for all OA models.

The CNCI analysis of the articles and reviews reveals that the average value in the Green OA model fluctuated between 1.5 and 1.8, slightly higher than in the Gold OA, which ranged from 1.4 to 1.5. Both values were considerably higher than the one for the non-OA model (0.9). These data remained more or less constant over time. If all document types are taken into consideration, the CNCI of the Gold OA model increased (a minimum of 1.6 and a maximum of 2.7). The CNCI of the Green OA model remained stable (a minimum of 1.5 and a maximum of 2), and the CNCI of the non-OA model dropped to 0.8.

The subcategory with the highest CNCI value for articles and reviews only was 'Education and Educational Research' in all the models. In the Gold OA model, the second highest subcategory was 'Education, Scientific Disciplines', and in the Green OA and non-OA models, 'Education, Special' was the second highest. This result persisted when all document types were considered. CNCI data are included as supplementary material.

When analysing the Top 1% of articles and reviews, the percentage of Top1% was higher for the Gold OA and Green OA models than for the closed access (Fig. 5). The percentage of Top 1% articles and reviews in the Green OA model was greater than 2% in all years except 2011.

The percentage of articles and reviews that were Top 10% was higher in the Green OA and Gold OA models than in non-OA. Figure 6 shows the distribution of the Gold OA and Green OA models for each subcategory; the Green OA model had the highest percentage—30%—of Top 10% articles in 2010. Regarding disciplines, the articles and reviews of the 'Education and Educational Research' and 'Education, Special' subcategories had a greater percentage of Top 10% items in the Green OA model than in the Gold OA model. In the 'Education, Scientific Disciplines' subcategory, the percentage of Top 10% items in the Gold OA model was greater, except in 2012 and 2016.
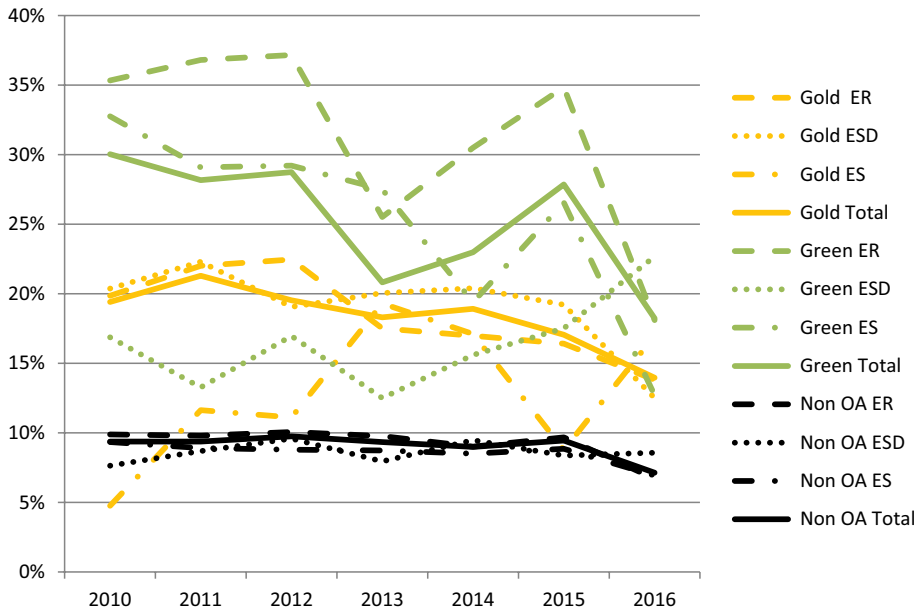
Fig. 6 Percentage of top 10% most cited articles and reviews by the Open Access models and subcategories (2010–2016) ER: Education and Educational Research. ESD: Education, Scientific Disciplines. ES: Education Special
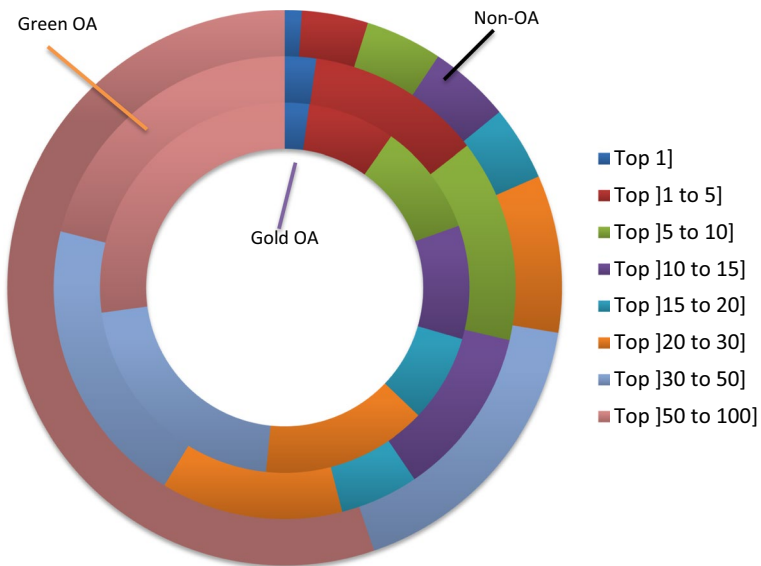

Fig. 7 Distribution of articles and reviews from 2010 to 2012 by top % position in each Open Access model

Figure 7 presents a more detailed view of the distribution of the percentiles for the years 2010–2012, in which the citations were more significant for having a citation window closer to the average life of the education articles. The percentages of articles and reviews belonging to the Top 1% through Top 15% most cited are higher for the Green OA model, whereas the percentages of Top 15% through Top 50% most cited are higher for Gold OA. When considering all document types, the same distribution persisted.

Differentiation between gold OA in Gold Open Access journals and hybrid

The results are presented in Tables 2 and 3 for all document types and only for articles and reviews according to InCites, respectively (also see the Methodology section). These tables show for each category and publication year, in addition to the total number of items in WoS CC, a short citation analysis performed via InCites and comprising (1) the percentage of documents cited, (2) the CNCI and (3) the top 1% and 10% most cited in the same WoS category and publication year. The tables also include the percentage of publications in Q1 journals and the percentage of publications co-affiliated by at least two countries (= international collaboration) for each OA model.

The total number of papers (E TOTAL) and the number of papers in the category ER are exactly the same for publications in Gold OA journals (see Table 2), because all Gold OA journals considered in the main category (E TOTAL) are also part of the category ER.

The first thing that stands out in the two tables is the low percentage of articles and reviews in the hybrid model as opposed to the Gold OA model. This is because 14,000 publications are proceedings documents, and nearly all come from the same source, 'Proceedings, Social and Behavioural Sciences', which has an International Standard Serial Number (ISSN) of 1877-0428.

Of 29,714 total documents, 15.9% were published in Gold OA journals (pure model), while 84.1% were assigned to the hybrid model. Of the Gold OA documents, 10,855 were articles and reviews (35.7% in Gold OA journals and 64.3% hybrid). There were no documents published in Gold OA journals assigned to the 'Education, Special' (Tables 2 and 3) category.

International collaboration for articles and reviews was observed in 17.6% of the pure models, compared with 15.4% of hybrid models. The same was true for all document types; international collaboration was higher in the pure model than in the hybrid (15.1 vs 7.7%) although the total percentage of documents with international collaboration was lower for all document types than for articles and reviews. This is explainable because many of the other document types (like editorials, book reviews, etc.) are not results of international collaboration. Regarding the categories, the percentage of international collaboration in the pure model was greater in the 'Education, Scientific Disciplines' subcategory, for articles and reviews (21.3%) and for all document types (20.9%). In the hybrid model, the percentage of international collaboration was higher for articles and reviews (19.1%) in the 'Education and Educational Research' subcategory. When all document types are considered, the international collaboration percentage was higher in the 'Education, Special' subcategory (12.9%).

The percentage of articles and reviews in Q1 was higher in the hybrid model than in the pure one (54.9 vs 42.6%). When all document types were considered, 41.3% of the documents published in Gold OA journals and 54.4% following the hybrid model were in Q1 journals. Regarding the subcategories, the percentage of items in Q1 was higher in the

Table 2 Differences between 'Gold in GOA Journals' and 'Hybrid' for each WoS Category and publication year for all document types

WoS category	Publication year	WoS CC # items	Times cited	% Docs cited	CNCI	% Items in top 1%	% Items in top 10%	% items in Q1 journals	% International collaborations
Gold in GOAJ									
E Total	2010–2016	4725	19,234	65.54	1.28	0.87	13.67	41.28	15.05
ER	2010–2016	4725	19,234	65.54	1.28	0.87	13.67	41.28	15.05
ESD	2010–2016	1695	9632	84.42	1.44	1.06	19.06	74.51	20.94
E total/ER	2010	468	4308	77.99	1.24	0.85	14.96	40.74	9.4
E total/ER	2011	286	2494	87.06	1.32	1.4	15.03	39.92	12.59
E total/ER	2012	342	2571	91.52	1.41	1.46	16.67	54.46	18.42
E total/ER	2013	646	3518	78.64	1.4	0.77	14.09	46.88	15.17
E total/ER	2014	846	3269	73.88	1.31	1.06	15.37	46.84	15.72
E total/ER	2015	865	2028	64.62	1.31	0.69	12.49	50.54	18.96
E total/ER	2016	1272	1046	37.58	1.13	0.63	11.56	20.77	13.6
ESD	2010	130	1907	99.23	1.62	0.77	23.08	100	13.08
ESD	2011	136	1425	95.59	1.41	0	19.85	77.21	13.97
ESD	2012	171	1595	97.08	1.58	2.34	22.81	100	23.98
ESD	2013	219	1566	92.69	1.52	1.37	18.26	100	22.83
ESD	2014	344	1611	90.99	1.32	0.87	18.02	100	17.73
ESD	2015	294	957	83.33	1.46	1.36	16.67	100	27.21
ESD	2016	401	571	61.1	1.37	0.75	18.95	0	21.7
Hybrid									
E total	2010–2016	24,989	78,157	49.08	2.14	2.31	17.07	54.44	7.67
ESD	2010–2016	6277	43,330	70.58	1.46	2.37	17.26	67.03	9.46
ER	2010–2016	18,580	33,866	41.8	2.45	2.38	17.77	40.92	6.91
ES	2010–2016	728	3587	60.58	1.15	1.65	10.85	45	12.91
E total	2010	2934	18,211	65.88	2.58	2.59	27.13	64.84	6.78

Table 2 (continued)

WoS category	Publication year	WoS CC # items	Times cited	% Docs cited	CNCI	% Items in top 1%	% Items in top 10%	% items in Q1 journals	% International collaborations
E total	2011	2698	15,551	62.42	2.94	3.49	21.99	58.45	6.93
E total	2012	3881	12,815	52.74	2.2	2.45	19.02	58.41	6.42
E total	2013	3042	11,059	52.37	2.23	1.71	16.37	70.17	7.82
E total	2014	4828	10,601	42.29	1.88	2.26	13.88	56.78	7.35
E total	2015	4864	6550	37.42	1.86	1.95	11.78	50.6	6.91
E total	2016	2742	3370	41.79	1.68	2.08	14.48	34.46	12.87
ESD	2010	1004	10,539	76	1.45	1.99	18.92	71.14	6.77
ESD	2011	914	9181	78.88	1.72	2.52	19.82	65.57	9.85
ESD	2012	977	6608	71.85	1.61	1.94	16.68	65.9	8.7
ESD	2013	1003	6953	70.59	1.4	2.29	17.05	77.91	10.67
ESD	2014	883	5708	72.14	1.4	2.94	18.46	65.87	10.99
ESD	2015	843	3183	64.29	1.33	2.85	18.03	66.43	8.66
ESD	2016	653	1158	54.67	1.2	2.14	9.65	51.61	11.33
ER	2010	1978	7758	60.72	3.26	3.19	32.66	60.12	7.03
ER	2011	1845	6529	54.25	3.73	4.17	25.37	56.48	5.47
ER	2012	3025	6043	46.71	2.51	2.58	20.69	53.01	5.29
ER	2013	1974	3759	42.6	2.68	1.57	16.26	55.37	6.43
ER	2014	3851	4432	34.8	2.01	2.08	12.98	42.16	6.26
ER	2015	3975	3406	31.67	2	1.89	10.72	34.19	6.52
ER	2016	1932	1939	36.85	1.9	1.97	16.25	25.95	13.25
ES	2010	81	525	66.67	0.68	0	3.7	24.05	4.94
ES	2011	81	711	59.26	1.37	2.47	11.11	18.75	12.35
ES	2012	90	672	61.11	1.38	1.11	13.33	21.59	15.56
ES	2013	82	594	70.73	1.54	0	14.63	75.95	10.98
ES	2014	106	586	69.81	1.28	3.77	13.21	69.81	16.04

Table 2 (continued)

WoS category	Publication year	WoS CC # items	Times cited	% Docs cited	CNCI	% Items in top 1%	% Items in top 10%	% items in Q1 journals	% International collaborations
ES	2015	84	169	57.14	0.67	0	4.76	60.71	13.1
ES	2016	204	330	50.98	1.12	2.45	12.25	42.16	14.22

Table 3 Differences between 'Gold in GOA Journals' and 'Hybrid' for each WoS Category and publication year for articles and reviews

WoS category	Publication year	WoS CC # items	Times cited	% Docs cited	CNCI	% Items in top 1%	% Items in top 10%	% items in Q1 journals	% International collaborations
Gold in GOAJ									
E total	2010–2016	3875	18,902	76.98	1.35	1.06	15.12	42.55	17.6
ER	2010–2016	3875	18,902	76.98	1.35	1.06	15.12	42.55	17.6
ESD	2010–2016	1659	9586	85.35	1.45	1.08	19.17	74.74	21.34
E total/ER	2010	381	4222	90.55	1.29	1.05	16.01	44.76	11.29
E total/ER	2011	271	2478	90.41	1.36	1.48	15.87	42	13.28
E total/ER	2012	331	2543	91.84	1.39	1.51	16.62	55.23	18.43
E total/ER	2013	588	3426	83.16	1.36	0.85	13.78	47.95	16.16
E total/ER	2014	744	3236	81.72	1.37	1.21	16.53	49.59	17.2
E total/ER	2015	719	1980	75.24	1.38	0.83	13.49	51.91	21.97
E total/ER	2016	841	1017	53.63	1.3	0.95	14.98	19.74	19.14
ESD	2010	126	1889	99.21	1.58	0.79	21.43	100	13.49
ESD	2011	135	1425	96.3	1.42	0	20	77.78	14.07
ESD	2012	169	1584	97.04	1.58	2.37	22.49	100	24.26
ESD	2013	218	1562	92.66	1.52	1.38	18.35	100	22.94
ESD	2014	336	1606	92.26	1.34	0.89	18.45	100	18.15
ESD	2015	286	951	84.62	1.47	1.4	16.78	100	27.97
ESD	2016	389	569	62.47	1.41	0.77	19.54	0	22.11
Hybrid									
E total	2010–2016	6980	60,391	82.95	1.56	2.92	20.53	54.91	15.36
ESD	2010–2016	3594	37,802	86.59	1.37	3.09	19.42	62.59	12.38
ER	2010–2016	3060	21,230	78.79	1.86	3.07	23.59	47.95	19.05
ES	2010–2016	466	3344	85.19	1.31	2.15	13.73	50.54	16.31
E total	2010	815	14,011	95.71	1.44	1.72	20.37	67.07	11.53

Table 3 (continued)

WoS category	Publication year	WoS CC # items	Times cited	% Docs cited	CNCI	% Items in top 1%	% Items in top 10%	% items in Q1 journals	% International collaborations
E total	2011	836	12,584	95.69	1.48	2.51	20.81	58.6	17.11
E total	2012	806	9462	94.54	1.44	2.48	20.72	59.02	15.38
E total	2013	935	9042	90.7	1.48	2.35	20.96	72.88	15.83
E total	2014	985	7769	86.29	1.69	3.96	23.45	60.94	15.13
E total	2015	1035	4517	78.07	1.57	3.96	20.29	48.1	15.46
E total	2016	1568	3006	60.08	1.69	3	18.43	35.35	16.2
ESD	2010	535	9303	94.21	1.26	1.5	18.69	69.38	8.6
ESD	2011	531	8252	95.1	1.34	2.82	19.4	58.9	15.07
ESD	2012	487	5812	93.02	1.27	3.08	18.28	60.08	11.91
ESD	2013	555	5978	89.73	1.42	3.06	21.98	74.28	14.23
ESD	2014	522	4836	86.97	1.59	4.41	22.99	65.45	11.49
ESD	2015	495	2623	82.42	1.5	4.24	22.22	56.77	12.32
ESD	2016	469	998	61.83	1.19	2.56	11.51	50.96	13.01
ER	2010	261	4619	98.85	1.93	2.3	26.82	72.6	18.01
ER	2011	295	4503	98.31	1.87	2.71	27.8	69.05	22.71
ER	2012	288	3288	96.88	1.83	2.08	27.78	64.77	20.49
ER	2013	335	2717	91.94	1.68	2.09	20.6	68.27	19.7
ER	2014	392	2446	83.67	1.88	3.32	26.02	51.3	18.88
ER	2015	516	1930	73.84	1.75	4.65	20.16	38.82	18.41
ER	2016	973	1727	58.27	1.96	3.08	22.1	28.09	17.99
ES	2010	41	473	97.56	0.76	0	2.44	20.51	7.32
ES	2011	43	568	88.37	1.19	2.33	11.63	11.9	13.95
ES	2012	45	633	97.78	1.28	0	11.11	15.56	24.44
ES	2013	57	590	94.74	1.38	0	19.3	89.09	14.04
ES	2014	76	585	96.05	1.52	5.26	17.11	81.58	19.74

Table 3 (continued)

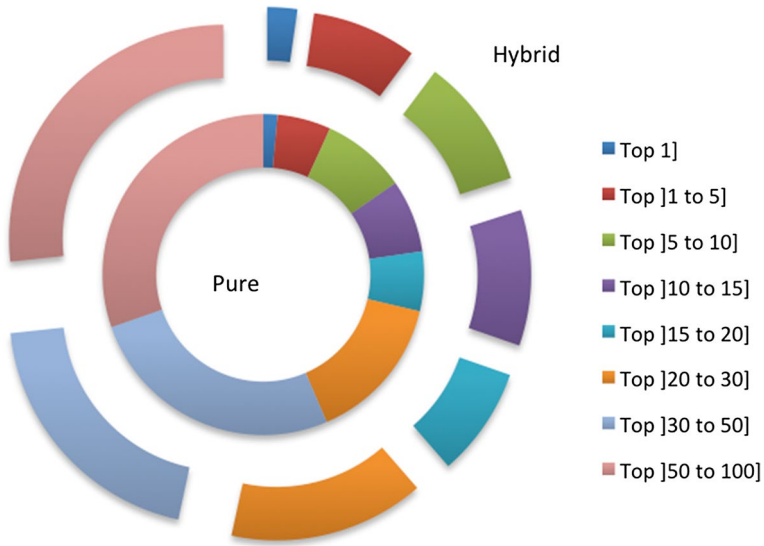| WoS category	Publication year	WoS CC # items	Times cited	% Docs cited	CNCI	% Items in top 1%	% Items in top 10%	% items in Q1 journals	% International collaborations
ES	2015	51	167	90.2	1.03	0	7.84	78.43	17.65
ES	2016	153	328	66.67	1.46	3.27	16.34	40.52	15.69

Fig. 8 Distribution of articles and reviews by top percentile for hybrid and Gold model in GOA Journals, 2010–2012

'Education, Scientific Disciplines' subcategory, for articles and reviews as well as for all document types.

When analysing the percentage of documents cited there was a higher percentage of hybrid type items cited (83% hybrid vs 77% pure) for articles and reviews. If all documents types are considered, a higher percentage of the pure model items were cited (65.5% pure vs 49.1% hybrid). The 'Education, Scientific Disciplines' subcategory had the highest percentage of documents cited in both models: articles and reviews (85.4% pure vs 86.6% hybrid) and all document types (84.4% pure vs 70.6% hybrid).

The hybrid model documents had a higher CNCI than pure documents for all document types as well as for articles and reviews. The CNCI was 1.6 for the hybrid model for articles and reviews and 2.1 for all document types.

In the Top 1% analysis, the percentage in the hybrid model was higher than in the Gold OA pure model for all document types (2.3% hybrid vs 0.9% pure) as well as for articles and reviews only (2.9% hybrid vs 1.1% pure). The highest percentage of documents in the Top 1% was claimed by the 'Education, Scientific Disciplines' subcategory, followed by 'Education and Educational Research'.

Articles and reviews had a higher percentage of documents in the Top 10% most cited in the hybrid model than in the Gold OA pure model (20.5% hybrid vs 15.1% pure). When all document types were considered, the differences remained (17.1% hybrid vs 13.7% pure). The 'Education, Scientific Disciplines' subcategory had a higher percentage of Top 10% documents in the pure model, both for all document types and for articles and reviews only. However, 'Education and Educational Research' dominated the Gold hybrid model.

When analysing the percentiles in terms of Gold OA hybrid or pure models, it was observed that the hybrid model had a higher percentage of items than the pure model all the way up to the 20th percentile. They were equal in the 20th–30th percentiles, and the pure model had a higher percentage from the 30th percentile on up (Fig. 8). The distribution for the hybrid model approximates that of the Green OA model for the same period.

Conclusions and discussion

The analysis of the distribution of articles and reviews by OA models in this research study shows a slight upward trend for OA publications during the period studied (2010–2016), ranging from 6% to 11% and 1.5% to 2% for the Gold OA and Green OA models, respectively. There was a turning point in 2011 (see Fig. 1) that could coincide with a similar situation in OA research due to the embargo imposed by the editors and the delay in self-archiving caused by the authors themselves (Nassi-Calò 2018; Science-Metrix 2018).

However, these data show that OA initiatives in the scientific field of education are less mature than in other scientific areas (Picasso and Phelan 2014), given that the average of OA scientific literature stands at 28% (Piwowar et al. 2018).

If all document types are considered, the Gold OA model nevertheless has a higher percentage than the Green OA model, which is notable because this result contradicts data presented in the Science-Metrix report (2018), in which the Green OA was preferred for making OA items available worldwide, but it is in good agreement with posterior studies conducted in WoS Core Collection (Bosman and Kramer 2018). A possible explanation for this discrepancy may lie in the different definitions of the green model as well as the different identification methodologies used in each of these studies.

The annual growth rate of OA publications and in particular those using the pure and hybrid Gold OA models did not exceed 3% for all of OA, and in 2016 the total percentage of OA publications indexed in WoS Core Collection is not higher than 13%. According to these data, it would take approximately 30 years to reach the 100% OA mark that the EU proposes for 2020 (Enserink 2016), which is too long for a model that describes itself as transitory. As such, one must ask if we are truly on the right path by promoting the hybrid model and ignoring the Green OA (Gumpenberger and Gorraiz 2018). This fact also corroborates the need to expand and strengthen OA strategies and develop more efficient policies and recommendations in order to achieve that goal, as it is the case of the recently started Plan S.

In this study on the field of education, the percentage of the Gold OA hybrid model is higher than the one of the Gold OA pure and the Green models, which aligns with recent global studies showing the same trend (Nassi-Calò 2018). It should be noted here that the 'Education, Scientific Disciplines' subcategory had the highest percentage of documents published using the Gold model throughout the period studied (ranging from 19.6% in 2012 to 25.3% in 2014). This may be because this is a category linked to scientific disciplines such as biology, pharmacy, biochemistry, engineering, chemistry, nutrition, and medicine in which OA publishing has obtained wider acceptance than in the pure education sciences. In fact, 94% of the publications in the 'Education, Scientific Disciplines' category were in pure science fields such as medicine or physics. Nor can it be ignored that the OA movement has evolved further in the fields of science and medicine than in the humanities and social sciences (Tomaszewski et al. 2013). Therefore, when 'Education, Scientific Disciplines' is a category indexed in a database specializing in science and technology such as the Science Citation Index-Expanded (SCI-E), it can positively influence data on OA publications in other databases such as the Social Science Citation Index, specializing in the social sciences, in which the rates of publication using OA are lower.

Concerning international collaboration, the percentage of international collaboration is also constantly increasing for all OA models and could be related to the increasing percentage of OA publications. The results of this study show that the percentage of articles and reviews with international collaboration in the field "Education" was slightly higher in the

Gold OA model, measured at 17.7% in 2016. The Green model had the same percentage of international collaboration in 2016. The Gold OA pure model had the highest percentage of articles and reviews with international collaboration, 2% higher than the hybrid model for articles and reviews and 8% higher when all document types were considered. This higher degree of internationalization in the Gold OA, may be because a collaborative effort renders it easier to find a partner that can pay for research costs by taking advantage of one of the policies of its institution, country or region. International cooperation would thus promote the use of the Gold OA and would favour the least wealthy institutions or countries. These data do not differ from a previous study (Kuzhabekova et al. 2015) that identified the top countries contributing to research in international higher education. This study determined that only 11.3% of articles are written by researchers from two or more countries. If one considers that educational research is inherently interdisciplinary and diverse in content (Goodyear et al. 2009), these data may reflect the need to foster an international vision for educational research (OECD 2013; Teichler 2014). It may also reflect the low opinion of the potential of open science for this task.

Regarding subject categories, the highest percentage of international collaboration on articles and reviews was observed in 'Education, Special', with no notable differences when analysing for all document types. The fact that 'Education, Special' is a multidisciplinary scientific discipline (Granados 2006; Euan-Braga and Echeverría-Echeverría 2016) could validate the data obtained because of the discipline's inherent need to rely on other scientific fields such as medicine, psychology, sociology, and education (Hegarty 2008). However, when examining the pure and hybrid Gold models, the 'Education, Scientific Disciplines' subcategory had a higher percentage of international collaboration in the pure Gold OA whereas 'Educational, Education Research' was higher in the hybrid Gold model.

In terms of visibility, as we have defined it in this study, the hybrid model is ahead of the pure model. Our study reveals a clear preference for the Gold OA in high-impact journals: more than 50% of the "hybrid" publications are in Q1 journals and the percentage of publications in Q1 journals is considerably higher in the hybrid model than for publications in Gold Open Access journals (see Tables 2 and 3). As it is not restricted to the number of Gold OA journals available in each field, which is usually quite reduced in many of them, the hybrid model is mostly applied to high-impact journals. However, interestingly, it is not an increasing trend. 2016 stands out showing a strong reduction. This merits further study.

Our study also indicates that in the field of Education, there are no notable differences between the percentage of publications in Q1 journals for Gold OA or Green OA (see Fig. 3).

This contradicts the general perception that Green OA is only reduced to low impact journals.

One of the most controversial and crucial points in the scientometric literature—whether OA publications are truly cited more often than non-OA publications—is also one of the central themes of our study. For this, we used several indicators to obtain a more complete view of this process.

When looking only at the percentage of articles and reviews (because these are the most often cited document type) cited for each model, the percentage of cited articles was much lower for closed access articles than for OA articles. The percentage was somewhat higher in Green OA than in Gold OA and also higher in the hybrid model than in Gold OA. The differences between the Green OA and the hybrid were nearly insignificant.

Concerning subject subcategories, 'Education, Special' had the highest percentage of cited documents followed by 'Education, Scientific Disciplines'. The latter had the highest percentage of cited documents for both the pure and hybrid Gold OA models, which is

consistent with the fact that the 'hard sciences' attract citations faster than social sciences and humanities.

With regard to the average number of citations in each category by document type and by year of publication, the corresponding CNCI values obtained for each OA model were all much higher than for the non-OA model. The CNCI values of the Green OA model were slightly higher than those of the overall Gold OA and even higher than the values reached by the hybrid model.

A more detailed analysis of the percentiles of the most cited publications clearly indicates that OA publications are much more prominent in the most cited Tops than non-OA publications and that the Green OA publications clearly outstrip those of the overall Gold model (see Fig. 6).

One must consider that the higher number of non-OA and Gold publications compared with Green OA publications could somewhat distort these comparisons even though percentages are being used.

These results validate the potential benefit of OA regarding citations in the field of education, which is consistent with recent studies (Archambault et al. 2014; Zhang and Watson 2017; Science-Metrix 2018; Zawacki-Richter and Naidu 2016; Piwowar et al. 2018).

Our study in the field of education shows that, as measured by number of citations, the Green OA model had a greater impact than Gold OA or hybrid models. A similar result has been observed in several studies (Björk and Solomon 2012; Zhang and Watson 2017; Piwowar et al. 2018). This finding is contrary to what one would assume and does not exclude this model from consideration (Zhang and Watson 2017; Gumpenberger and Gorraiz 2018). Last but not least, our data also corroborate the increase over time in the impact of hybrid OA documents because of their greater growth compared with the Green model (Nassi-Calò 2018; Piwowar et al. 2018).

Limitations

The first and biggest constraint on this analysis is that it is limited to publications in the field of Education stored in the WoS CC database. Admittedly, this is not one of the most complete data sources for this area, but it is one of the most appropriate for analysing impacts measured by citations received.

In any case, an analysis of the social sciences and the other knowledge areas would be valuable for comparing results to generalize our conclusions.

Another constraint is that the sample sizes for each model are somewhat disproportionate, which is why the comparisons should be viewed with a critical eye. The number of "no open access" publications in this field was around 27,000 and it is much bigger than the number of publications assigned to Gold OA (around 3500) and to Green OA (around 300). Therefore, comparisons should be taken with a pinch of salt. For example, while it is true that the proportion of articles and reviews in Q1 journals is higher in the Gold OA model, it should not be forgotten that approximately 3/4 of the total number remain still closed access.

Finally, we used the new WoS CC tool to differentiate between different types of content (Green OA and Gold OA), but the tool's reliability, accuracy and especially its stability over time have not yet been studied. For this reason, an additional study was conducted in June 2018 in which we retrieved documents belonging to the three subject subcategories for education from the Web of Science from the odd-numbered years of the study and

observed that the total number of documents increased every year although the percentage of documents in the Gold and Green models never exceeded a 1% increase. The greatest change in the percentage of articles and reviews in the Gold OA occurred in 2011, going from 6% in the first analysis to 6.8%.

A final limitation is the importance of publications in journals specializing in education because there are many other publishing channels more appropriate for using OA and sharing practices. In any event, the world of education is one of the most promising fields for establishing the OA paradigm because it is not highly competitive and is more oriented towards sharing.

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