

AltOA: A Framework for Dissemination Through Disintermediation

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ABSTRACT

Scholarly discourse is a complex and valuable process which the Web is in a prime position to revolutionise and improve. Yet due to the intricate network of stakeholders in academic publishing, the Web's power to disrupt has been less influential than in other markets or industries. Whilst the current publishing systems satisfy many of the requirements of the process there are still some problems left unaddressed. The purpose of this paper is to take a holistic view of academic publishing, identifying problem areas and to devise a framework which takes advantage of the affordances of the Web, namely its ability to disintermediate markets and present new methods of interaction, to enhance scholarly communication. By examining the issues from the perspective of academic disciplines, researchers, research councils and publishers; new approaches to presenting scholarly artefacts, recognising researchers' contributions and demonstrating impact are developed. The paper concludes with a case study that examines how the new framework, named AltOA, applies to the field of Chemistry.

Author Keywords

Academic publishing; disintermediation; open access

ACM Classification Keywords

H.4.3. Information Systems Applications: Communications Applications

INTRODUCTION

Initially conceived as a tool for facilitating academic collaboration, the Web has since gone on to be shaped by both social and technical forces into a number of unforeseen directions. It continues to impact upon academic collaboration and communication, yet due to the complex network of stakeholders that has formed around the industry; the Web's impact remains a little unsatisfactory for many academics. The Web provides the capacity to not only communicate ideas to an audience of any size, but to allow audiences to form around the content they search for, and as such is a powerful tool for dissemination. Despite these affordances however, academic dissemination is plagued by many of the problems it has faced for decades. The purpose of this paper is to examine why the Web has failed to revolutionise academic publishing, and instead facilitates many of the processes that came before. The arguments made here are framed in the context of the physical sciences, disciplines with complex and diverse approaches to knowledge representation and thus have

much to gain from new approaches to scholarly discourse. Nevertheless many of the points made can apply across a range of disciplines and it is hoped the new approach will complement existing systems whilst also building upon them to take full advantage the Web permits.

BACKGROUND

Academic dissemination, has for nearly four centuries lay in the hands of journal publishers – in a time before the Web, journals were the only medium through which to communicate ideas, moderately quickly, to a wide audience and, having been quite successful at this, they have gone on to define the academic community's perception of publishing. As academic communities grew, publishing went on to become not only a medium for communication but a mechanism for ranking researchers and institutions (and in turn for advancing careers). Now, although much scholarly discourses is conducted via the Web, the underlying business model of journal publishers persists, resulting in large swathes of knowledge being closed off to all except those who can afford the subscription fees and the continued use of an outmoded communication medium unsuitable for modern research methods.

As the disruptive nature of the Web makes its presence felt in other markets, the anachronism of scientific publishing becomes clearer. This in turn has led to some academics taking action – most notably those behind the Open Access (OA) movement and others, such as those who have signed the Elsevier boycott [12]; but scientific publishing is so entrenched in the wider academic community, these attempts to leverage the Web have led to limited progress.

Open Access

The Web combined with scholars' immutable desire to push the boundaries of their fields should allow an "unprecedented public good"- the intent of the Budapest Open Access Initiative [6], which envisaged a two-fold approach to opening academic discourse: through author self-archiving after conventional publishing (green OA) or via author-pays OA journals (gold OA). As the disruptive effects of the Web become increasingly apparent in other markets, and researchers frequently find themselves unable to access the articles they wish to read, the debate around OA has grown, ultimately leading to a number of developments. Most recently, the UK government accepted the recommendations of the Finch report to support 'Gold' OA [34], a significant step forward for OA, although one

not without concerns from those who would rather see 'Green' OA supported [38].

Whilst the benefits of OA are well documented, this paper aims to examine OA from an alternative, questioning perspective: if OA makes research accessible to all, and researchers are driven by their "willingness [...] to publish the fruits of their research [...] without payment, for the sake of inquiry and knowledge" [6], then why is OA not more prolific? Similarly, why is the Finch report required 11 years after the Budapest Open Access Initiative? The answer to these questions likely lies in the mutually dependent relationship that exists between researchers and journal publishers. If we are to assume that researchers are self-interested economic agents, their actions will reflect what is best for them; in the instance of the publishing researcher this would be securing a publication in a high impact journal, enhancing their reputation and status in the community (which in turn will lead to increased pay too).

A counter to this argument would be that an OA article may receive more citations than a non-OA article [42], thus broadening and enhancing recognition, but ultimately it is the power of a journal's brand and its history that influence publishing academics. Gold OA journals are often expensive to publish in and being relatively recent additions to the publishing ecosystem, are often yet to attain high impact factors and thus are not pursued by researchers.

The alternative is green OA in which a journal permits the author to self-archive their paper in an OA repository. Green OA serves to illustrate how OA has mischaracterised the problem that afflicts scientific publishing – being so heavily dependent on journal publishers to carry out the tasks they already conduct, cementing their traditional role in scientific publishing, and thus simultaneously dampening the disruptive effects of the Web.

OA has done much to improve academic publishing, but by viewing it through the lens of the academic journal, will fail to revolutionise scholarly discourse, disregarding many other facets of the problem – principally the long established relationships between the various stakeholders in academic publishing and the important, yet flawed role it plays in ranking researchers and institutions.

Dissemination Developments

As already touched upon, whilst the journal distribution method is still the primary route for disseminating ideas, the actual medium through which this occurs has changed, with the Web being the dominant channel. The medium through which a resource is accessed can change the way in which individuals interact with these resources, the way they think about them and what they come to expect, ultimately resulting in new behaviours – a concept neatly phrased by Marshall McLuhan in *Understanding Media: The Extensions of Man*, "The medium is the message" [23]. The Web changes the manner in which journal articles are consumed, allowing researchers to work more efficiently:

"As indexing, recommending and navigation has become more sophisticated...strategic reading practices have intensified" [31]. As outlined by Renear et al. a network of articles has begun to emerge, with researchers "chaining references backward and citations forward", creating an every growing body of literature; which in turn has affected the manner by which researchers make judgements of "relevance, impact and quality" [31].

Evolving reading practices in turn affect the way in which researchers communicate their own findings. With reading and analysis getting quicker, new ideas and findings are being generated quicker too, which in turn creates a demand for hastier communication. Blogging platforms and social media sites offer a speedy alternative and provide opportunities for discussions and feedback, adding further value [22]. The digital format also allows for greater flexibility in what a researcher can publish, no longer restricted by the formats imposed by journal publishers: findings of any type, size or scope can be shared and discussed, be it vast datasets or simple Tweets. To reflect the changing nature of scholarly discourse, to an increasingly dynamic network of interactions among many different researchers and stakeholders, new metrics for measuring success are being proposed, such as those outlined by the AltMetrics manifesto [30].

It is clear then that the Web is influencing certain aspects of academic publishing, but its effect has mostly been to merely hasten the long established processes of journal publishers rather than to change the manner in which the sector operates. As previously discussed, the journal article is still viewed as the principal measure for success in an academic field, and whilst the publisher provides some benefits, such as a recognised reviewing system, their lack of flexibility may be hindering scholarly discourse.

A New Approach

The Web's potential for disruption in academic publishing is restricted by familiarity and stability of the current system, established by the interplay between journal publishers, researchers and institutes. The effects of OA were limited by viewing academic publishing as a mechanism for simply disseminating research, but in reality its role is far greater serving to judge individual's contributions to the community and, perhaps most crucially, serving this purpose when researchers have little interest in managing these tasks themselves, instead favouring their research. Thus, if the Web is truly to have a disruptive impact on academic publishing the dominant roles of journal publishers needs to be removed, as it these stakeholders that underpin the stability of the current system and withhold a raft of benefits that the Web can bring, namely more accessible research, better and more usable formats and improved metrics for measuring impact and recognising a researcher for their contributions.

Therefore the purpose of this paper is to propose a framework that uses the concept of disintermediation to illustrate a new approach to academic publishing: the journals can be seen as intermediaries, distributing the work of others yet crucially they add little value to the process themselves. It is ultimately the researcher who is responsible for producing, reviewing, consuming and building upon, academic content [10]. The framework should establish pathways to a number of goals: helping researchers be better recognised and rewarded for their original contributions to their academic community; making research results, of any size or scope available to relevant audiences; and developing new, pertinent ways of measuring impact in an increasingly dynamic research landscape. These goals are not wholly unlike those of OA, but approach the Web's ability to communicate knowledge from an alternative perspective, leading to the title AltOA, to coin a name from those working in the related area of AltMetrics [30]. It should be made clear however that AltOA is not intended to replace the existing systems in place, but to complement them and to recognize the new approaches to communication that have gained traction – whilst the Web may be able to have a disruptive impact, established systems and networks will not simply vanish.

FRAMEWORK

As previously established, the current approach to academic publishing is firmly rooted in the interplay between the actors that partake in the overall process of knowledge creation. Knowledge creation varies among academic disciplines to reflect their different natures, yet a number of common elements are present, such as data collection, processing, enriching, archiving and re-using [24]. Each stage is conducted in its own discipline's manner, but there are similar actors present in each: the discipline itself, which needs research to mature and reveal more about its area of study; the research councils that fund research (from a UK perspective) and expect to see some beneficial academic, economic or societal impact; the researchers themselves who actually perform the research in the hope of not only contributing to shared knowledge of the community, but also hope to progress in their careers and gain recognition from their peers; and finally the journal publishers who are responsible for distributing the work of researchers among the community, organising the peer review system and editing and packaging together researchers' outputs, in exchange for profits. Whilst other actors may also be present in the knowledge creation process (conference organisers, industry partners and other consumers, such as government or hospitals, etc.), this simplified view of four primary actors allows for a more efficient analysis that can be applied to a range of disciplines and takes into an account the major knowledge creation mechanisms. The interactions of these four actors are illustrated in Figure 1.

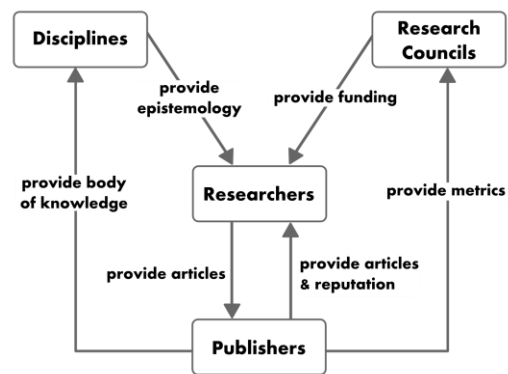


Figure 1. A simplified view of the interactions that occur to produce and disseminate new knowledge.

With this condensed view it is now possible to apply the concept of disintermediation. Removing the costly, and sometimes limiting effects of the publishers (serving as intermediaries for the other actors), three functions remain that need to be accounted for: the discipline needs a body of knowledge; researchers need to build their reputations; and research councils need to see that they are getting value for money. With publishers no longer present to facilitate these functions, the responsibility falls more directly on the researchers to establish new mechanisms for providing these services. However, whilst it may be desirable to introduce the concept of disintermediation, in reality the current publishing landscape will not disappear and will continue to have an impact upon academic communities and thus should be factored into the framework. Therefore to set an agenda for AltOA, the transitions of the interactions amongst actors need to be outlined; discussed below from the perspective of each actor.

Disciplinary Requirements

As in Figure 1, the role of the discipline is to provide a body of knowledge and an epistemology that allows researchers to contribute knowledge to an ever increasing pool. The body of knowledge for a discipline is codified in a variety of locations: books, journals and researchers' personal documents for on-going work that has yet to be published. It is this codification of knowledge that provides the necessary breeding ground for ideas; the "conceptualising" phase as described by Charles Humphrey's Knowledge Transfer Cycle [33]. With the disintermediation approach proposed by AltOA, this breeding ground of ideas is still required, yet with a diminished role by traditional published literature and with greater prominence given to other channels. At this point it is worth noting that the way in which knowledge is codified varies significantly between disciplines, typically dependent on their methodologies, and often a research project will mix methodologies to tackle problems that span traditional disciplinary boundaries. As a result the body of literature and other useful data looks different for each discipline, with artefacts that researchers use coming in a plethora of

formats and sizes. This leads to two important points that AltOA has an opportunity to address: where and how should knowledge be stored online to preserve records and accessibility; and can knowledge be communicated in more convenient and appropriate formats, and yet continue to be recognised as an impactful item of work, now that the constraints of the journal article format no longer hold?

There are two possible answers to these questions, but at present these solutions lead to further questions. One approach is to take advantage of green OA and use repositories, although unlike green OA, AltOA deposits would not undergo conventional peer review. Repositories such as ePrints are increasingly common, with many research institutes and funders mandating that articles must be deposited [44] and repositories typically provide some flexibility for the types of artefacts that can be deposited [9]. However repositories are not substitutes for journals as illustrated by green OA's dependence on journals to conduct the peer review process and provide an indicator of impact. With AltOA, these processes will still need to be performed, but become a more direct concern of researchers, discussed in more detail later.

The other solution is to allow researchers to be responsible for managing their own data. Naturally such an approach would require a sophisticated degree of digital literacy, with researchers being required to maintain and manage an online presence that would be critical to how others in their field perceive them. Alternatively, researcher's outputs could be managed for them via independent third party organisations such as learned societies, or websites such as ResearchGate (which could profit from researchers' needs to disseminate, but still allow a degree of author control and flexibility). Whatever option is chosen, some computing infrastructure will be required and it is unlikely that researchers will provide this themselves. The accessibility and type of data available to the academic community is entirely in the hands of the researcher however.

This leads on to another concern of the discipline: curation, a service currently provided by journal publishers. With universities being the most likely candidate for hosting their researchers' work (and likely being more permanent fixtures in the academic landscape than an arbitrary journal publisher, thus ensuring the research persists over time), they provide a suitable environment for storing research. A more open and distributed approach to hosting content also allows for greater opportunities to build value adding services, linking data and articles together to create a mixed corpus of knowledge of different data types.

The two solutions proposed sidestep the problem of peer review, a fundamental art of scholarly discourse. Traditionally peer review is organised by the journal publishing the article. With the case of AltOA however, we may not have journal articles that lend themselves to conventional peer review, nor an intermediary to organise the peer review procedures. Thus alternatives must be

found; a debate which has been on-going since the Web first started increasing the rate of scholarly discourse, with open peer review and crowd sourcing both topics of much discussion. Experiments have been conducted that both point towards open peer review working (albeit from the ethical perspective of a large medical journal) [36] and showing it to be insufficient, receiving much interest but failing to convert this interest into a feasible reviewing system [14]. Alternatively the Web could be used to harvest the power of the wider community, with social media sites acting as a channel of debate. Such tools may have the power to "weed out sloppy work" [22], but a post-publication review system using the many eyes of the Web may result in a deluge of publications from which it might be difficult to identify the high quality pieces of work [40]. It is clear when reviewing cutting edge research few alternative approaches exist – only peers are capable of judging what makes for a valuable contribution, and the reliability of their judgements is not guaranteed [28] – as commented upon by one author (paraphrasing Winston Churchill on democracy) it is "seriously, almost fatally flawed, but better than any alternative" [15].

Whilst opening up the peer review system tends to generate mixed results, there is at least one notable exception where a more open approach has flourished; the preprints repository arXiv, where research groups making deposits are largely "self-policing" [41]. Papers deposited can still acquire a significant degree of influence without being published in a peer reviewed journal, with conventional publishing being used when aiming to reach a wider audience [41]. As discussed by [41], there is a difference between the work we need to communicate among our peers on a daily basis and that which we present to a wider audience, and thus the manner in which we review these different types of scholarly artefact should adapt accordingly – a more decentralised, open peer review system may work on the community level, whereas a more rigorous and authoritative approach may provide reassurances on an interdisciplinary level.

Thus AltOA proposes a synthesis of mechanisms based upon a "publish then filter" approach [19], trusting the community to bring to attention good research. This style of reviewing, whereby good research has a higher profile than bad research, which should fade away, is enabled by the need to cite one's influences when conducting research. AltOA has the ability to make this process more effective by removing restraints on the way research is published and allowing metadata such as provenance information to be published alongside, helping to establish trust in the research [26] when a journal is not present to lend its brand value. Such reviewing methods actually use the Web by exploiting digital distribution rather than simply mimicking paper based alternatives, enabling greater value to be attained from the published work. However it is understood that for such a process to be successful it demands increased researcher engagement and so incentives may be

required to provide the degree of interaction necessary. With AltOA providing researchers with an opportunity to more able demonstrate their skills and impact, it is hoped this in turn will encourage a variety of ways to engage with the community, of which reviewing contributions may be a valuable one. This process can be streamlined and convenient for researchers to encourage participation, although this paper recognises that more discussion is required when considering how to incentivise and recognise less conventional contributions to the academic community.

AltOA should result in a body of knowledge that is much wider and represents information in a way which suits researchers, operating at a pace that facilitates day-to-day research. Before this can be achieved however, the types of scholarly artefacts that AltOA permits need to be more readily recognised and accepted by academic communities. It is also clear that, whilst the peer review approach adopted by arXiv might be ideal, a preprints repository is not suitable for all disciplines (or else all other disciplines would have equivalents). The rapid approach to dissemination and the demand for collaboration in the fields that use arXiv explain how this approach to scholarly discourse is viable; in other disciplines other demands set by researchers and research councils, may be prioritised.

Researcher Requirements

As illustrated in Figure 1, the researcher has four requirements: epistemologies from the discipline; funding from research councils; and, from the publishers, access to the body of knowledge and an authoritative statement that gives an indication as to their status and reputation in the field. It can also be assumed they have another, less explicit requirement: the desire to focus on research and avoid the administrative overheads of research. If disintermediation is to occur, then alternatives need to be found to access the body of knowledge and for a provider of status; with the first issue already having been addressed, how a researcher is formally recognised for their work is another concern.

At present, researchers strive to publish in high impact journals in a bid for recognition for their work, a process which is often time consuming and detracts from getting on with further research. Journal impact factors are however known to have some flaws - considered to be slow, open to gaming and failing to truly reflect the value of the articles within [29]. This approach to bestowing recognition is also quite narrow, recognising researchers for just one type of output when in reality researchers make contributions to their field in their own way: be it by producing lots of datasets, journal articles, or by networking with other projects. All styles may be valuable, but are not recognised equally [7], a problem AltOA may solve.

Therefore the process of bestowing recognition (and the rewards that recognition goes on to bring) would need to change if journal publishers and their editors and reviewers are no longer present to choose which submissions best

represent the cutting edge of the field. Being published in a high impact journal leads to more people reading an author's research and by extension, if more people are reading one's work, more people will likely be citing it too. Citations not only allow readers to verify an author's assertions, but they also provide a mechanism for researchers to recognise the work of others and its influence. Without journals citations would still be required to allow the community to identify its best scholars, but the range of artefacts that can be cited would have to become broader, allowing research outputs of any kind to be citable. To truly disintermediate scholarly discourse, any valued contribution would be citable, regardless of its size or scope, with citable artefacts ranging from Tweets, blog posts, experiment plans or datasets - anything which informs the argument being made. As already hinted upon, a certain degree of disintermediation is already occurring and as a result new formats for citing are beginning to emerge, such as one proposed by the Modern Language Association that describes how to cite a Tweet [25].

As previously discussed, the existing publishing ecosystem will not disappear as disintermediation takes place. It may be fair to assume that ultimately researchers will aspire to publish in a high impact journal to best enhance their status. As a result, the degree to which disintermediation and self-publishing is adopted will be determined by the balance between the risks it brings to one's conventional publishing ambitions and the benefits and rewards it may provide. This dilemma is not unlike the prisoner's dilemma or that posited by Loebecke et al. concerning firms who wish to both cooperate and compete with each other [21] - a scenario common to researchers. The similarity to these other dilemmas would suggest that researchers will take a personally dominant rather than a socially optimum strategy, retaining knowledge to fully take advantage of its "monopolistic" value [21]. The "rational, self-interested individual" [27] will pursue the free rider approach acting in their own interest rather than, taking advantage of other researchers making their work available to build upon it and gain credit over the original author. Collective behaviour theory also shows us that despite our individual preferences, some may not pursue certain options until a required number of others are observed taking a similar course of action [13]. In short, unless a vast majority are publishing via disintermediation, no-one will.

Thus for disintermediation to be successful it needs to provide advantages over traditional journal publishing, whilst also complementing it. Disintermediation may result in a researcher's work being available across a range of outlets, changing the publishing landscape, and it is these changes which can be taken advantage of to provide new services to researchers. The current approach to publishing simply allows indices such as the Hirsch index to be calculated, which is not without its flaws [8]. As the Web affects approaches to research, new metrics are being developed, which better reflect the way researchers use

each others' findings. More papers are read, with less time dedicated to any single paper, hastening the rate at which researchers work their way through the literature [29]. Scientometrics provides opportunities to refine the manner in which we "evaluate", "filter" and "map" scholarship [29] and ultimately determine an individual's influence. The disintermediation of scholarly discourse will only intensify the need for these alternative metrics and give them more data to work with, improving their effectiveness.

This leads to another AltOA proposition. With a myriad of metrics to indicate the various impacts in their field, and with research outcomes despatched to numerous outlets, researchers need to more easily and accurately reflect their impact. If properly supported with the appropriate infrastructure, disintermediation may allow researchers to create a portfolio of their research outcomes, from which they can draw attention to their various outputs and network of affiliations, in a manner appropriate for the intended audience. Such a system will allow researchers to essentially create a journal of their own content, which combined with the flexibility of AltOA artefacts may allow researchers to better demonstrate their skills and capabilities. However, whilst maintaining an online presence is an increasingly important concern in academia [11], adding another website with which users can manage their online persona to the plethora currently available may not be helpful – if we are to encourage knowledge sharing then we want to minimise the time and effort required to do so [2]. Nevertheless, those who carefully construct their online profiles to reflect their work in the field may find they attract more attention, achieving greater acclaim yet also greater scrutiny – an opportunity which should be taken advantage of by early career researchers who stand much to gain by increasingly their visibility [11]. As discussed previously, this may be an opportunity for sites such as ResearchGate [35] or learned societies to add value to scholarly discourse and reap the rewards as a result.

Research Council Requirements

In the context of research in the UK, publicly funded research councils are responsible for funding research and thus are burdened with the difficult choice of determining where best to invest money to ensure a suitable return of investment – a role that traditional publishing facilitates by highlighting high impact research. Research councils need to have a precise definition as to what they consider to be impact, with Research Councils UK (RCUK) identifying two different types: "Academic" and "Economic and Societal" [32]. Academic impacts concern aspects such as "worldwide academic advancement" and "contributing towards the health of academic disciplines"; whereas economic and societal impacts focus on "wealth creation, economic prosperity and regeneration" and "improving social welfare, social cohesion and/or national security", amongst many other facets [32]. Yet the manner by which impact is measured, via the Research Excellence

Framework (REF), whilst not formally recognising metrics such as journal impact factors, is nevertheless influenced by them, with the reviewers being biased towards articles from high impact journals and those responsible for submitting articles to the REF process picking the highest impact and most cited papers [43]. Clearly there is a mismatch between how impact is defined and how it is measured.

AltOA provides an opportunity to rethink the way in which impact is measured to ensure that funds are allocated to the appropriate projects. The problem of identifying projects is twofold. First the time between a project commencing and any impact being realised "may be decades", whereas "other research that is unlikely to be judged as high quality by scientists – say, on the cost effectiveness of different incontinence pads – may have immediate and important social benefits" [39], illustrating that whilst successful research projects are important, more glamorous (academically) projects are likely to be held in higher regard. This may skew the allocation of funds such that, quicker and cheaper projects that nevertheless wield useful results, may miss out on funding opportunities simply by failing to carry a high degree of complexity. The second problem, related to this issue, is the fact that funds have to be allocated to projects often before any meaningful results have been found, so that the research can continue and develop. Yet the problem often facing researchers is how to ably demonstrate that the project proposed has the potential to have a future impact on a national scale across a range of different areas, throughout the lifetime of the project?

The research impact advantages of OA are well documented [1,16], but the advantages of OA focus around the speed, access and affordability OA lends to the publishing process [16]. AltOA, is still able to provide these benefits, yet should also assist in demonstrating the social and economic impacts of the research that journals find harder to illustrate. AltOA provides a degree of freedom which allows researchers to disseminate their outputs in a format they deem appropriate, at a desirable pace and to a targeted audience, all of which provides opportunities for new indicators of impact to be utilised [20]. AltOA presents different methods of dissemination on an equal level; from journal articles, through to relevant and accessible policy advice and industry or public engagement. Thus researchers who have written few journal articles, but have worked on projects with close ties to public or industry, will be recognised in the same manner as researchers who conduct high level research published in prestigious journals, but with niche impact. The portfolio approach offered by AltOA, allows researchers to draw attention to a wide range of outputs produced, a tool which may be particularly powerful when the focus of the research has been on producing outputs beyond the conventional journal article and interacting with a wide range of research stakeholders.

Another powerful property of AltOA is the manner with which networks may form among researchers and other

research stakeholders, such as research collaborators from other disciplines, institutions or industries, or members of society who may directly benefit from the results. Being able to demonstrate a network of contacts may be an important consideration when research councils are assessing the potential for impact – project proposals which demonstrate researchers with interdisciplinary links, or links with industry, may be a sign of good potential [20]. Whilst metrics of this sort may already be available these tend to focus on project collaborators or co-authorships, being generated from data held by research councils or journal publishers. With AltOA a researcher can form their own network of collaborators and citations, along with links established more directly by the researcher over the course of the project, linking to non-academic stakeholders where appropriate. Being able to demonstrate a network of contacts is an important skill for researchers as interdisciplinary, large scale projects become increasingly common in an attempt to tackle many of society's grander problems. Showing oneself to be in a position to draw on a range of contacts from different disciplines and communities may be a strong indicator of competence for research councils to use when making their decisions.

Existing Publisher Requirements

Whilst the role of the existing publishing system can at times be detrimental to overall knowledge sharing, it is one which will not disappear and rightly so. Publishers at present have many important roles to play, organising the peer review process and bringing the wider community's attention to important areas of research. However, it has become clear that in some cases a research community is able to carry out these roles themselves, as demonstrated by the arXiv repository. The lack of success for this model in other disciplines is a clear indicator that the role of journal publishers is still a necessary one, but one which may have to adapt if the publishing landscape is to improve.

The two interconnected requirements publishers have are a flow of articles to publish and subscribers to pay for access. The degree to which these two requirements will continue to be fulfilled will depend upon the publisher's history and the reputation they have acquired: bigger publishers such as Nature will likely have no problem continuing to attract articles and subscriptions, however there is a possibility smaller publishers may eventually face a lack of submissions. This change in the journal landscape will likely reflect the demands for different research outputs. There are subtle differences between data, information, knowledge, understanding and wisdom [4] and it is researchers' different demands for these outputs that may reflect the future use of journals: data, information and knowledge would ideally be communicated via the Web to take advantage of the digital medium and to facilitate daily working practice, whereas understanding and wisdom, whilst ideally would be open, may continue to be disseminated in journals to maximise the author's reward

for their insight and widen the audience. AltOA may signal the demise of the journals which distribute research but fail to make a significant contribution to an author's standing.

Therefore as disintermediation occurs two types of publications may emerge: conventional articles which garner a lot of attention and scrutiny and have a significant impact; and researcher artefacts, which despite not conforming to any one format should have a relevant impact in the research area along with being more open and usable by the community. Such a system should prove ideal, with the journal level publication providing a goal for aspiring researchers whilst also providing a platform from which others in the community can find interesting results and dig down to find more information from a range of artefacts made available via disintermediation.

Whilst AltOA may not be beneficial to all publishers, opportunities exist for them to adapt their business model to counteract the disruptive effects of the Web, particularly those which hold a degree of respectability in their discipline, such as the learned societies. As researchers create their portfolios, technical infrastructure will be required for hosting researchers' output and tools may be needed to help researchers create presentable packages of knowledge which can be disseminated to the wider community. This may seem to be an eerily similar role to that played by journal publishers at present, but it extends the areas where publishers do add value, whilst attempting to remove the problems they create by limiting access.

Of course it is a mistake to believe that the existing publishing ecosystem simply concerns the activities of journal publishers; in reality a number of distribution mechanisms are already available, such as conference proceedings, magazines, posters and other media. The need for academics to meet, network and discuss their ideas will persist and thus conferences will continue to be held. Similarly magazines provide suitable opportunities for public engagement and widening the potential audience of one's research. However what is key with AltOA is that these outlets provide platforms from which the researchers can not only push their content, but also places which link back to the author and allow readers to follow up the researcher's work in the field and be influenced by (or perhaps provide a critique of) the author's other findings.

CHEMISTRY CASE STUDY

In order to illustrate some of the ideas presented here, the subject of chemistry will be used as a case study for AltOA. Chemistry provides a useful background, presenting a number of challenges, including a competitive research environment which places significant emphasis on securing patents and high impact journal articles, and a wide range of data types and research outputs to present. Being a natural science, chemistry follows the rigours and procedures of the scientific method. As a result knowledge is produced at numerous stages, providing plenty of

opportunities for it to be collected and disseminated. Thus AltOA has much to provide by offering flexibility in scholarly discourse and an opportunity to communicate knowledge which would otherwise remain inaccessible via traditional publishing, such as unexpected or negative results, allowing researchers to more readily learn from the errors of their predecessors. [3].

With so much data and knowledge available in chemistry, the landscape for cultivating a body of knowledge becomes complex. Chemists manage the demands of numerous data types combined with spending time in the lab through their lab notebook, a place where thoughts, plans, experiments and observations are recorded, and which, if collected together over time, would likely consist of the majority of a chemist's contribution to the field. But ultimately the lab notebook remains a personal collection of knowledge, typically only available to the author, perhaps with extracts being made available to supervisors where appropriate; with most thoughts and ideas only being made available to the wider community via journal articles (Figure 2).

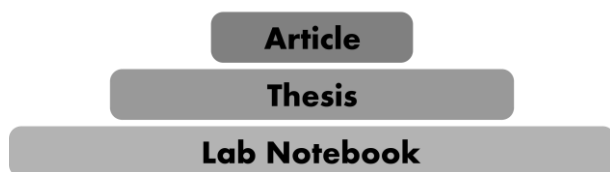


Figure 2. A simplified hierarchy of knowledge distribution during the completion of a chemistry PhD. The lab notebook contains almost all of the work conducted over the course of the PhD. The thesis contains a discussion of much of the work, but some research outcomes that do not contribute to the ultimate goal of the research may be omitted. The journal article is a refined format, which displays key content the researcher makes more widely available.

However journals have changed very little in their near four-hundred year history, whereas the manner in which researchers conduct science has changed immeasurably, with vast amounts of data now being produced (often referred to as the “data deluge” [17]). This results in the knowledge generated by today's researchers not being presented in its clearest form, with complex chemical data presented in line with descriptive prose, making it harder to interpret results and repeat experiments; often inconveniencing scientists and impinging upon research.

The repeatability, and hence veracity, of research could be more easily assured by allowing greater access to the content of the lab notebook itself – a technological possibility with the rise of electronic lab notebooks (ELNs). ELNs provide a wealth of benefits to scientists and simply the potential to share one's results more easily has led to researchers taking greater care when recording their results [5]. The power of ELNs combined with AltOA would allow the author to retain control over the accessibility of their work, with respect to ownership and distribution, enabling the potential for granting wider access to the lab notebook

at the author's behest. Research outputs that the author makes available in different repositories or sites, could point back to their origins in the ELN (where the author has chosen to make this content available) providing greater detail and a wider body of knowledge for the research community to take advantage of, whilst still maintaining the pyramid structure of Figure 2 that is required for researchers to make their work more consumable.

An important facet of chemistry that cannot be ignored is its competitive nature, where the pressures of intellectual property and patents, dictate the openness of scholarly discourse. Thus, in practice, the demands of the researcher may trump those that would most benefit the discipline, requiring careful management of the costs and benefits of greater accessibility. Chemistry research often has an impact in a number of highly valuable industries, such as medicine and materials. As a result, chemists, perhaps more so than researchers in some other disciplines, are less likely to make their research available until they can be sure they have fully capitalised on it [10]. However it is likely over the course of a research project that numerous findings may either fail to contribute to the final product of the research or the chemist will develop skills that would be desirable to demonstrate but would not feature in a journal article. It is these aspects that AltOA aims to provide as advantages alongside the current system, attempting to elicit small outcomes which take little effort to contribute, and may only be of interest to a small section of the community, but when applied on a Web scale result in a significant degree of information added to the overall corpus of knowledge.

The concept of a portfolio backed up by an ELN is a powerful one for early career researchers in chemistry, for whom it can be difficult to build an initial publication record, but may still be required to demonstrate their competencies and results. From the ELN a chemist could push out their results to various outlets (for example sending data to the free and open database ChemSpider [37]) from which they could be cited. Similarly this provides ample opportunity for networks to form around researchers, with small scale networks already forming on an informal level [10], these could be expanded upon as a chemist attempts to increase their visibility in the field and work with different communities. A portfolio which links out to one's various contributions and network of contacts is also a technological possibility with the Semantic Web, providing a suitable project to build upon the work of the oreChem project [18], with chemistry lending itself nicely to automatically creating networks as chemicals are passed among collaborators and users through their lifespan, leaving a trail of connections as they go.

Not only do the ideas presented here benefit chemists in demonstrating their skills whilst making more knowledge available to the community, they should also assist research councils in assessing impact. Networks of contacts and demonstrations of skills should help to assure research

councils that further impacts will be made in the future and present opportunities for industrial or multidisciplinary collaboration.

CONCLUDING REMARKS

Academic publishing is a complex procedure that faces many challenges. It needs to ensure that researchers can continue pushing the boundaries of their disciplines on a firm foundation of high quality research, that individuals are rightly recognised for their contributions and rewarded appropriately, and that the research conducted represents value for money. These are challenges that the current system endeavours to solve and achieves to some success. Yet nothing is perfect and some problems remain unaddressed, most significantly how to handle the vast amounts of research produced today, the pace at which research needs to be communicated and assessing an individual's contributions and impacts. The Web has the ability to transform scholarly discourse but its disruptive effects, felt so keenly in other sectors, are repeatedly dampened by the stability of the system that has arisen in recent years. OA attempted to address the problems, but its potential for impact was limited by mischaracterising the problem. AltOA proposes a new way of utilising the Web by bypassing the effect of the journals and looking at academic publishing from a number of perspectives, to outline a number of propositions.

Firstly researchers disseminate their own work, retaining ownership and distributing in a format which suits their fellow researchers. This process would be facilitated by a robust infrastructure of disciplinary repositories and online researcher portfolios, which collate a researcher's outcomes to present as the researcher sees fit. The process of peer review becomes a post-publication effect, which also enables more informed judgements as a result of clearer communication and provenance metadata. It is key that the processes required here are implemented into a researcher's daily practice, minimising the disruption to their work, thus demanding greater analysis on a disciplinary basis. Finally, AltOA will unlock new methods of measuring impact that better reflect the range of effects research can have and should result in a more efficient allocation of research council resources.

The future of AltOA will not be without its concerns however. For example, whilst a portfolio system will be beneficial to researchers and may be considered a vital tool for researchers in the age of the Web, it also represents a paradigm shift in how researchers present themselves. Technical difficulties may also need to be overcome to ensure that AltOA works smoothly and minimises the impact it has on a researcher's day-to-day work, ultimately leading to researchers being able to spend more time and effort conducting research than the current system permits. The benefits that research communities stand to gain are much greater than the potential concerns however, and only by continuing to take a holistic approach to academic

publishing will the Web have a disruptive influence and revolutionise scholarly communication in such a way as to mirror the changes experienced in other sectors.

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