

A Glass Ceiling in AER?: A preliminary glimpse at the distribution of authors by gender in the iSTAR (istardb.org) database

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Abstract

In this article, we briefly summarise what information we have available about the distribution of authors by gender of articles contained within the international STudies of Astronomy education Research database (istardb.org). These articles represent a nearly, but not totally, complete population sample of published Astronomy Education Research. There are some indications, although lacking statistical power to decide if it is a true effect, that the top ten authors, first authors and authors by h-index have seen a slight increase in the proportion of women in the last 5 years compared to the all-time levels. Women have also submitted the majority of AER dissertations in the last 5 (~ 56%) and 10 (~ 52%) years compared to all time (~ 41%).

Keywords

Gender — Research Database — Astronomy

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Introduction

It was a cold, rainy day, during a lunch break at a conference. Three individuals of much astronomy education research experience were seated around a table in a hotel lobby discussing the pursuit of knowledge in the context of Astronomy Education. One a world-renowned cognitive scientist, the other two astronomers, however, all three with a shared passion for Astronomy Education.

To understand the complexity of the discussions, we must address one key definition “Astronomy Education Research” (AER), which is empirical and theoretical research into the teaching and learning of astronomy content across diverse settings. It is a discipline which traverses the boundaries of other traditional fields, for example: astronomy, educa-

tion and psychology (Slater et al. (2016)). Therefore, the individuals who work in the field of AER, are from a myriad of settings academic, industry, NGO and community organisations, which covers astronomers all the way to policy makers and beyond (Bailey and Lombardi (2015); Slater et al. (2015)).

Back to the hotel lobby, over pints of beer, glasses of red, cups of coffee, nachos and other nibbles, our three protagonists of AER, debated and philosophized, as to the nature of AER and how to accurately map and describe the landscape of the field. Although, they concurred that previous reviews of AER did exist, the actual content which gives life to the landscape, encompassing journal articles, grey literature, working papers, dissertations, resource guides, newsletter articles (like this one!), conference proceedings, books & book chapters, were

spread across varying disciplines and a concerted effort would be needed to bring them together into one location – A Great Library of AER, inspired by the Great Library of Alexandria, or an Agora of AER.

The cumulative skills of these three individuals, allowed them to instigate what was to be called iSTAR (International STudies of Astronomy education Research) (Slater et al. (2016)). A repository of AER in all its forms, from across the globe, thereby signifying that we live under a shared “sky”, on a blue marble, whizzing around a middle-aged star, in a relatively “cool” galaxy.

We presented the current status of iSTAR, at the recent RTSRE & iNATS conference in Hilo, Hawai’i, a [recording of the talk is available here](#). In this paper, we will present a brief overview of some of the pertinent aspects of iSTAR in the context of Women in Astronomy, so as to provide a comparison with the landscape of astronomy research. These are preliminary results that will be more fully expanded on in a future endeavour describing the field as a whole from the perspective of the literature. To keep informed about this article and other iSTAR information, please sign up to the newsletter [here](#), or email the author.

Results

Over the years, iSTAR has grown to contain, or link to where appropriate, more than 1800 publications. These have drawn from major literature searches throughout the mainstream astronomy, astronomy education and science education journals, major conference proceedings and thesis collections. It is very difficult to estimate what percentage of the total real AER literature has been catalogued, especially as new articles and volumes are discovered fortuitously on a weekly basis. It can safely be claimed, though, that for the major publication locations for AER in the English Language, using a similar rationale to that outlined in Fitzgerald et al. (2018), it is largely complete and approximates a total population sample.

Any missing articles in this population sample are very likely to be either in low impact journals, rarer conference proceedings or in the grey literature. This will have minimal effect on the authors considered here who tend to publish in higher impact journals and have no effect on the Scopus h-index analysis as this index rarely includes anything other than long-established and manually vetted peer-reviewed journals, books and some higher-end conference proceedings.

Looking at the distribution of these articles over time, we see an increasing trend in publications over the years, with a major increase occurring in the year 2007 (Figure 1). The spikes in the distribution tend to be years where there are major conference proceedings, particularly those surrounding the IAU (Bretones and Neto (2011)), are released. Nearly 50% of the overall publications are journal articles, the other two major publications are conference proceedings/book sections and dissertations, respectively (Figure 2).

We have pulled out of the database what frequencies we have on publication rates by gender and crossmatched these to h-indices available in the literature or calculable via Publish or Perish (Harzing (2010)) or SciVal. Google Scholar is usually seen as a better indicator of true h-index for education researchers (Harzing and Alakangas (2016)), whilst Scopus is more often used in appraisals for promotion at various institutions. Whilst h-index isn’t a good indicator of the inherent *quality* or *impact* of the research undertaken by a researcher, especially in education, it is certainly an indicator of whom is citing whom, which, in this short preliminary article, is of more concern.

In our analysis here, we mostly consider all time performance as compared to performance within the last 5 years with a few extra added statistics of interest. This allows a rough glimpse at what direction the statistics are taking over time and which way things seem to be trending. We are prevented from taking a more fine-grained analysis due to small number statistics. There are only 119 authors

A Glass Ceiling in AER?: A preliminary glimpse at the distribution of authors by gender in the iSTAR (istardb.org) database — 3

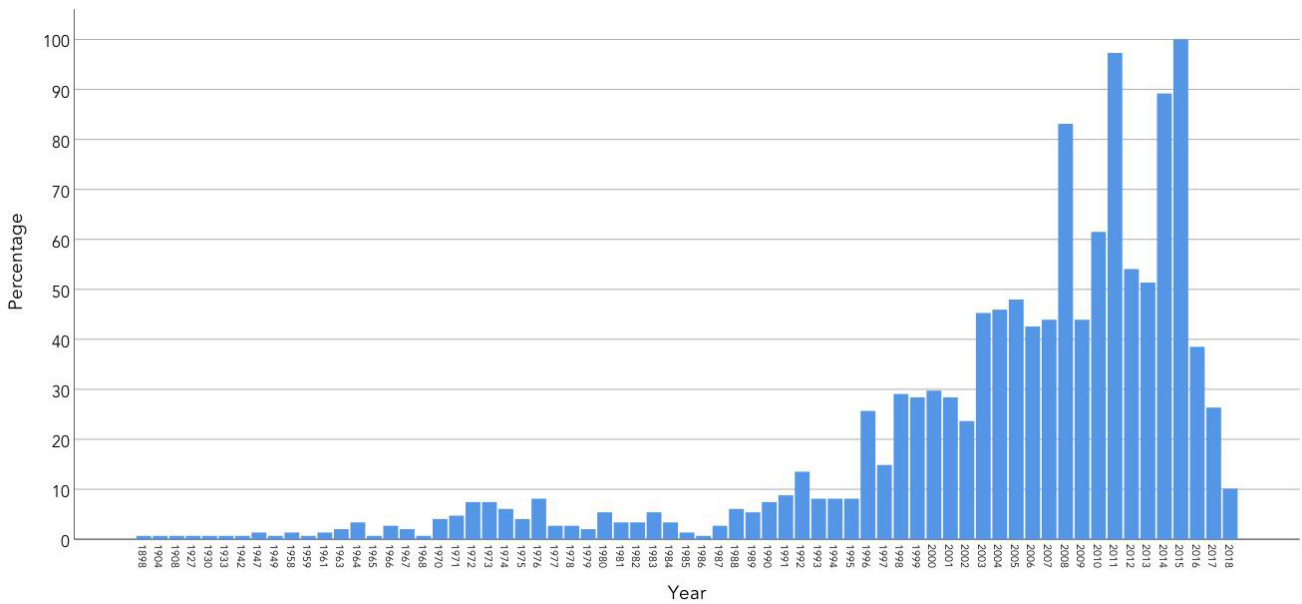


Figure 1. Relative percentage of publications over the years starting at 1898, where 2015 is 100%

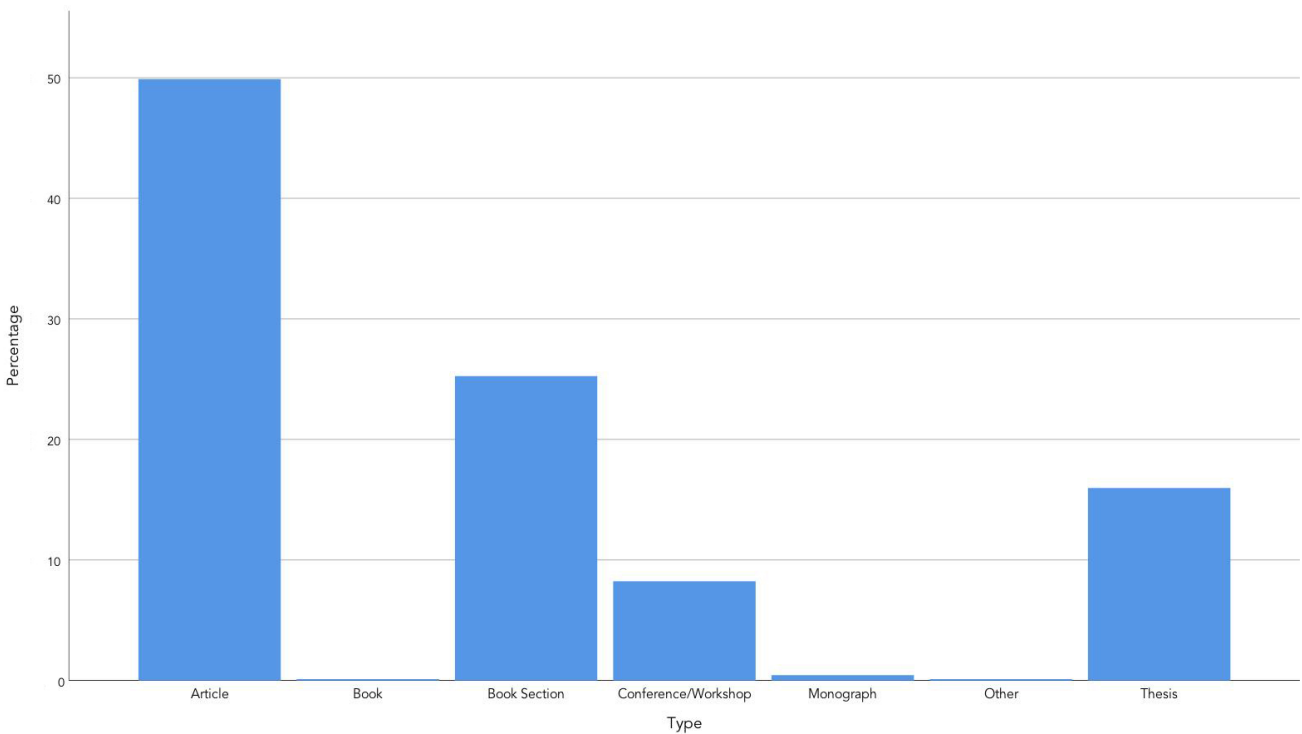


Figure 2. Percentage of publications by type

who have published in the AER literature more than three times with only 30 authors having 6 or more articles in AER. Most authors publish in multiple domains, including Physics Education Research, General Science Education and mainstream Astron-

omy.

The results for the following discussion are visually represented in Figure 3. In terms of number of articles published by first authors, there were 3

women in the top ten authors in the past 10 years, 4 women in the top ten authors in the last 5 years compared to 3 women in the top top ten over all time. When limiting the publications to only peer-reviewed articles, we find that 26.5% of the first authors are women over all time, while in the case of first authors over the past 5 years, this increases to around 57% women. Considering the number of total publications per author, in the top 50 all time, there were 20 women, in the past 10 years there were 21 women, and in the past 5 years, there were 23 women. Comparing this to first authors for any publication, there were 17 women authors all time and in the past 5 years, there were 21 women. In the top 20 authors, all time, there were 6 women authors and in the past 5 years, there were 10 women. Again, both statistically insignificant but also lacking the statistical power needed to see significance.

We found that in the case of the top 10 authors in terms of h5-index using Google Scholar, 3 were women, whilst in the case of Scopus, 4 were women. This is in comparison to all-time h-index, where only 2 women were in the top ten for either database. The discrepancy between the two citation databases indicates that women seem to have published more frequently in recent years than men in the more restricted list of high impact journals in Scopus. However, due to small numbers, we do not have the statistical power to say whether this is a real difference.

The interpretation of h-index also needs to be treated with some caution as this is not the author's h-index based on AER alone, but is based on their publications in all fields. Each field has different average citations rates, so an astronomer crossing over into AER will have a naturally higher h-index than a science education researcher doing the same. A more robust index would be using a field-weighted citation impact metric based purely on AER articles that is beyond the scope of this preliminary exploration.

Dissertations are the third largest contributor to the iSTAR database. We found that over the past

5 years, nearly 56% of theses published were by women, whilst over the past 10 years, just over 50% were by women. In 2006, just over 80% were by women. Over all time, we found that just over 40% of all dissertations in the database were by women, with the earliest dissertation by a woman going back to 1942.

Discussion

What do the above stats tell us about gender in the landscape of AER? Like many other landscapes (Barthelemy et al. (2016); Durndell (1991); Seymour (1995); Skibba (2016)), women are still under-represented, or rather there is not an equal distribution. However, it is interesting to note that in the case of dissertations in the past 10 years, we see that nearly 52% of the dissertations published were by women despite lower than parity frequencies in all other considered measures. This distribution coincidentally mirrors the data released by the Department of Education and Training, Higher Education Research Data, 2014 in Australia, which highlights the notion of the “leaky pipeline”. Wherein, the distribution of women and men post PhD starts to diverge with the proportion of men holding more senior positions in academia increasing significantly beyond the typical entry level (B) position (Figure 4).

Whilst we have attempted some simple frequency statistical tests on the data to estimate whether the differences are truly significant or could be explained just by statistical fluctuation, this analysis is not enough to draw a complete picture. A truly complete picture would include an analysis of each author with respect to both their AER and their non-AER publications and also each author's relation to each other and through the lens of multiple academic indices. This would require a careful classification of each author's publication into their broad fields and then a recalculation of their publication statistics in each field, segregating and comparing AER publications to non-AER publications. Such an exploration of the AER academic network is possible, and is being prepared, but is far outside the scope of the preliminary broad glimpse presented

A Glass Ceiling in AER?: A preliminary glimpse at the distribution of authors by gender in the iSTAR (istardb.org) database — 5

Top 10 authors ranked by h-index (GoogleScholar) - 2 women



Top 10 authors ranked by h5-index (GoogleScholar) - 3 women



Top 10 First authors - All time - 3 women



Top 10 First authors - Past 5 years - 4 women



Top 10 First authors - Past 10 years - 3 women



Top 10 authors ranked by h-index (Scopus) - 2 women



Top 10 authors ranked by h5-index (Scopus) - 4 women



Articles first author women - All time (%)



Articles first author women - Past 5 years (%)



Top 50 women Authors All publications - All time (%)



Top 50 women Authors All publications - Past 10 years (%)



Top 50 women Authors All publications - Past 5 years (%)



Top 50 women First Authors All publications - All time (%)



Top 50 women First Authors All publications - Past 10 years (%)



Top 50 women First Authors All publications - Past 5 years (%)



Dissertations by women - All time (%)



Dissertations by women - Past 10 years (%)



Dissertations by women - 2006 (%)



Dissertations by women - Past 5 years (%)



Figure 3. Key statistics from iSTAR

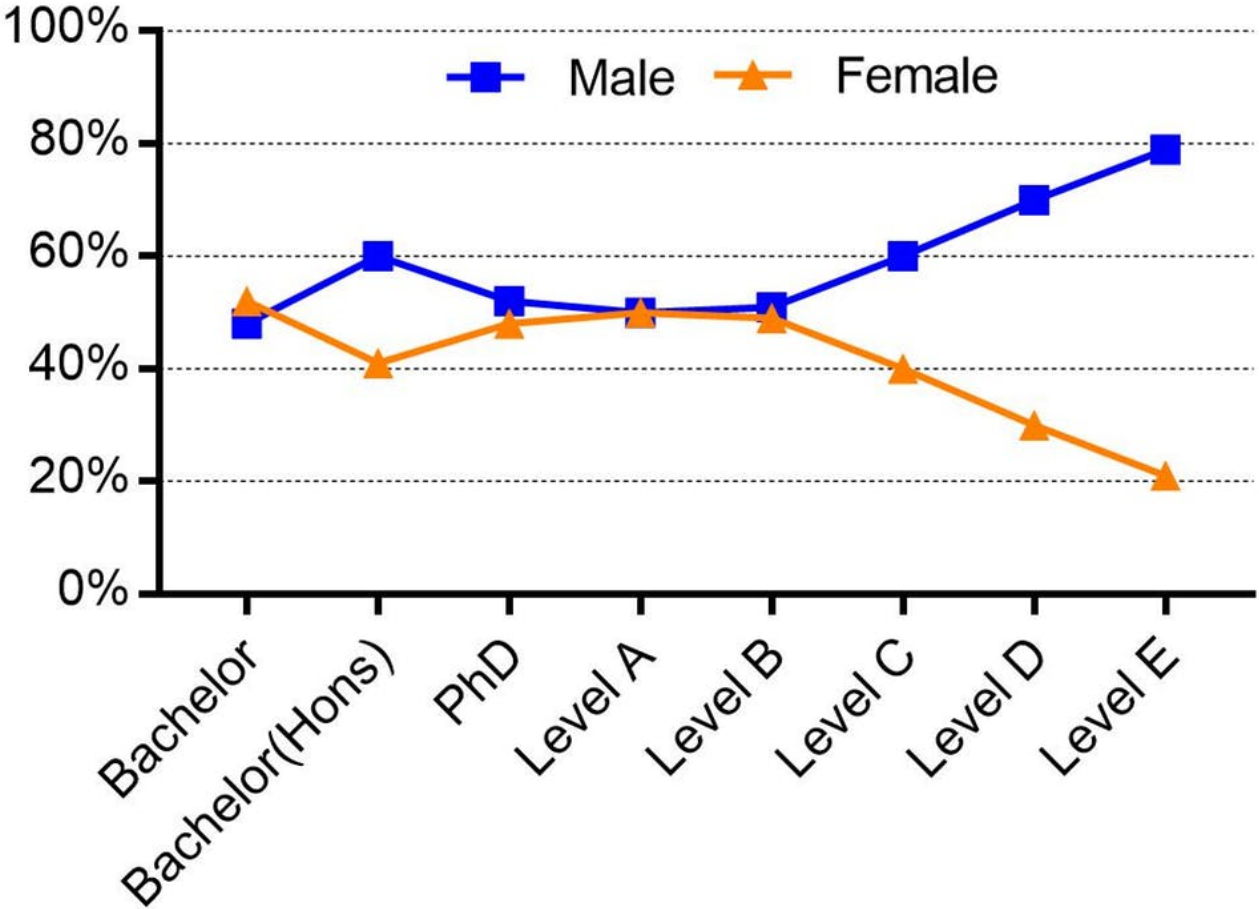


Figure 4. Gender Attrition rates for different levels in academia. Image credit: The Conversation, adapted from Department of Education and Training, Higher Education Research

here.

A recent article in *The Conversation* (Keenihan (2018)), highlighted that of all the authors who wrote for *The Conversation*, 72% were men, 28% were women. This gap in gender, is perhaps indicative of another underlying issue. Another statistic highlighted was that, since 2013, only 30% of the pitches for the Science Technology section were from women. This latter statistic is perhaps innately related to the fact that women are under-represented in Science Technology. However, these statistics have changed and a recent survey by *The Conversation* showed that in certain fields the distribution is 50:50 (archaeology, communication, innovation, physics, space, sport and veterinary science) or in favour of women (genetics, politics/society).

A recent report by IOP Publishing, reveals that 22% of the authorship in physics is from women. Although they highlight that “papers with female corresponding authors have a slightly lower chance of being accepted”, and there is lack of diversity on editorial boards from older journals. Furthermore, the report found that corresponding authors who were women had a 40% chance of their paper being accepted compared to 43%, if they were men.

The challenges relating to gender in science have been discussed in various articles spanning decades, including the most recent special issue on gender in the *Physical Review Physics Education Research* (Brewer and Sawtelle (2016)), which had 17 articles and an editorial on gender. Therefore, it is not just to confine those discussions within the limited context of the this article. Rather, the aim of this article is to highlight the landscape of gender distribution in the context of AER, and provide it as a comparison point to the STEM landscape.

This is potentially the first analysis of gender in the context of AER and as such there are no explicit theories known by the authors for the discord between women and men in AER. Furthermore, to our knowledge, most of the studies that focus on the gender equity are from the perspective of

practicing scientists or students rather than science education practitioners or researchers. Despite this, the reasons for the discrepancies could be similar to those identified by studies of gender equity in science (Brumfiel (2008); Ivie and Tesfaye (2012); Ivie et al. (2013, 2016); Sax et al. (2016); Skibba (2016)). However, within the scope of this paper, we do not posit an explanation for these differences but rather present the data as a point of comparison to other similar fields.

Conclusion

The challenges associated with gender equity and equality have been the topic of much research over many decades. In the context of science, the issue of gender is even more pronounced, this is marked by efforts to engage more girls in science, or more specifically STEM. However, the research has mostly centred around scientists and science research. This preliminary study explored the issue of gender in the context of Astronomy Education Research, which is a rapidly growing field of research drawing in, not just astronomers, but also researchers from different fields, e.g., education, psychology, evaluation. The aim of this exploration was to utilise the iSTAR database to provide a snapshot of the distribution in gender in AER. Our results indicate that although there seems to be a growing proportion of women actively publishing in the field, which has potentially increased in the past five years, the distribution is not yet an even match.

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