

# Is Math Still Just a Man's World?

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**Abstract:** Awards are important markers of success in any career, and in academia they can play an important role in hiring, promotion and tenure decisions. This study compares awards data for disciplinary societies in STEM (science, technology, engineering and mathematics) to the proportion of women in each respective field. By establishing availability pool estimates of women who should be eligible for senior scholarly awards, a comparison can be made between the proportion of female award winners and the percentage of women active in the discipline. The CBMS (conference board of mathematical sciences) survey in 2005 reported that women were 9% of all full-time tenured professors in doctoral-level mathematics departments; yet during the last decade, women received only 4.8% of scholarly awards from the AMS (American mathematical society). Similar disparities exist for scholarly achievement awards from the MAA (mathematical association of America), the SIAM (society for industrial and applied mathematics) and the ASA (American statistical association). The under-recognition of women for scholarly contributions cannot be attributed solely to low numbers of women, so further explanation must be sought elsewhere. Curiously, women received more than their expected proportion of awards for service and teaching. Decades of research in the social sciences points to “implicit associations” or subconscious social stereotypes as the mechanism by which both men and women de-value women’s intellectual accomplishments and praise their communal contributions, which may explain the gender disparity between scholarly and service awards. Gender disparities in scholarly recognition can hinder the advancement of women and limit their numbers as leaders in STEM fields. AWIS (association for women in science) is working with seven disciplinary societies (including AMS, ASA, MAA and SIAM) to identify patterns of behavior that perpetuate unconscious bias in the awards selection process and to pinpoint ways to mitigate its deleterious effects.

**Key words:** Scholarly awards, recognition, disciplinary societies, selection, nomination, implicit associations, unconscious bias, social stereotypes, broadening participation.

## 1. Introduction

Why do professional societies give awards for scholarship, as distinct from those for service, teaching and mentoring? Is it to encourage and inspire junior investigators? Do societies solely wish to showcase the best work being done in a discipline? Do they intend to congratulate the most valuable mathematicians, or simply acknowledge the most likeable individuals in a discipline? Different professional societies give awards for various reasons; yet receiving a scholarly award can add considerable value to a CV. This raises the question – should the pool of award winners for

research or lifetime achievement reflect the demographics of the discipline or society that bestows the awards? If the answer is yes, then there is much work to be done to level the playing field for female mathematicians.

The proportion of women in STEM (science, technology, engineering and mathematics) fields is quite small; thus women’s representation among scientific society award winners may be appropriately low. However, this analysis of cohort-adjusted availability pools and award winners reveals that the proportion of female awardees depends both on the type of award and the society. There are usually several types of awards, including those for service, teaching,

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or mentoring, but the awards conferring the highest prestige are for outstanding intellectual effort, i.e., scholarship.

The AMS, the ASA (American statistical association), the MAA (mathematical association of America) and the SIAM (society for industrial and applied mathematics) are all partners with the AWIS (association for women in science) on an NSF-funded project to improve the recognition of women in scientific disciplinary societies. Working with these societies to collect and analyze their awards history in the context of each association's culture has illuminated some interesting trends, some specific to the mathematical sciences and others that occur more universally across STEM disciplinary societies.

The term "scholarly awards" refers to prestigious awards that recognize individuals for significant research contributions. Scholarly awards may include but are not limited to named lectureships, recognition of outstanding research contributions in a field, or lifetime achievement awards. Early career research awards are also considered scholarly awards, but they are classified in a separate category (Early Career Awards) because they draw from a different pool of potential nominees. Additionally, many societies give awards for service, teaching and mentoring, which are categorized as "service awards". Analysis of women-only awards has been omitted from this study.

## 2. Estimating Availability Pools

This study establishes availability pool estimates of senior women researchers to determine the proportion of women expected among scholarly award winners. A standard estimate of availability pools for women faculty is based on the proportion of Ph.D.s in the discipline awarded to women in the United States. For senior scholarly awards, the pool of eligible female candidates is the percentage of women among Ph.D.s awarded several decades before the awards cycle under analysis.

In order to establish an appropriate cohort of women who would be eligible for senior scholarly awards in mathematics societies, this study refers to the proportion of women among all mathematics Ph.D.s conferred 20 to 40 years before the most recent ten-year awards cycle. All Ph.D information was retrieved from the NCSSES (NSF national center for science and engineering statistics) website. For statistics and applied math, Ph.D information does not extend back into the 1970s, but there are enough data to estimate availability pools for younger scholars.

### 2.1 AMS Annual Survey Department Groupings

The AMS annual survey of mathematics departments in the United States categorizes each doctorate-granting department into Group I, Group II, or Group III, according to "scholarly quality of program faculty" [1]. Statistics departments, applied mathematics departments, and mathematics departments that do not grant doctorates are each categorized separately by field or by highest degree granted.

AMS, SIAM, and ASA tend to give scholarly awards to faculty at Ph.D-granting institutions, so the AMS annual survey groupings are useful for estimating availability pools. The proportion of women among tenured full professors at institutions in Groups I, II and III is a possible measure of eligible female candidates for scholarly awards in these societies. The proportion of women faculty varies greatly by institution and specialty; the higher-ranked mathematics departments (in Group I and Group II) have far fewer women than Group III or applied math, while statistics departments tend to have more female faculty. Similarly, there is a smaller proportion of women among tenured full professors than assistant professors in mathematics, which is a phenomenon found in almost all STEM disciplines and is generally interpreted as reflecting hindered advancement of women faculty.

Ignoring the impact of these trends and focusing

solely on the women who have achieved the rank of full professor and/or tenured status, this cohort of women likely yields the smallest possible estimate for the pool of senior researchers who should be eligible for senior scholarly awards from AMS, ASA, and SIAM.

### 2.2 Comparing Society Awards to Availability Pools

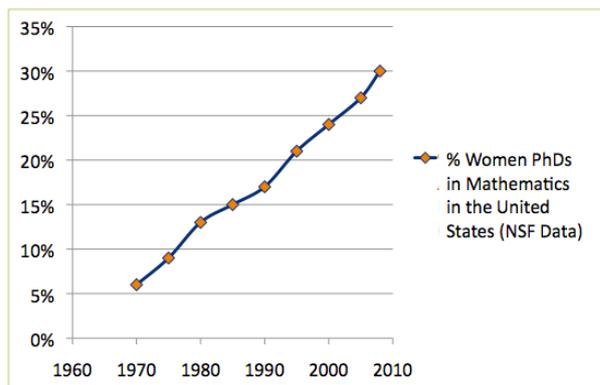
Using publicly available information as well as data provided by AMS, ASA, MAA and SIAM data has been tabulated on the last ten years of society awards: senior scholarly awards, early career awards, and awards for service. The proportion of women in each of these groups of awardees was then compared with the proportions of women in mathematics as determined by established availability pool estimates. Looking at each society's awards trends as well as the differences among sub-disciplines, several hypotheses arose about various cultural factors that may have implications for, or directly impact the status of women in these fields.

## 3. Women in Math: Trends and Awards Data

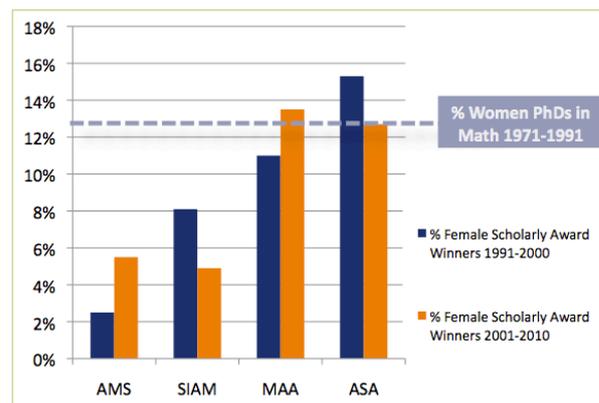
Both the number and proportion of women in mathematics have increased five-fold since 1970. Between 2005 and 2008, an average of 30% of all PhDs in mathematics in the United States went to women, an increase of roughly 25 percentage points since the late 1960s (Fig. 1).

Assuming that the low numbers of women receiving scholarly awards in mathematics is due to their lack of representation in the field, the proportion of women winning these awards should go up in parallel with their increased presence among doctoral-level mathematicians and statisticians. However, the data do not support this hypothesis.

As seen in Fig. 2, there is no consistent trend of increasing recognition of women over time among the four mathematics societies participating in this study. Although the AMS and MAA show increased recognition of women for scholarly awards over the last two decades, SIAM and ASA gave scholarly awards to a smaller proportion of women in the last ten



**Fig. 1 Growth in women's participation.** Percentage of Ph.D.s in mathematics granted to women in the United States 1966-2008 in intervals of 5-year averages. Given the increase in women Ph.D.s over the decades, a similar increase in the proportion of women receiving awards would be expected.



**Fig. 2 Comparing two decades of awards history.** In AMS and MAA, the proportion of women among scholarly award winners increased between the first decade (1991-2000) and the second (2001-2010), but, the proportion of women awardees went down in SIAM and ASA. Only MAA and ASA awards come close to matching the proportion of women earning Ph.D.s in mathematics between 1971 and 1991 (dotted line).

years than in the decade prior, despite the overall growth in women's participation. It must be noted that the absolute numbers of scholarly awards conferred on women by AMS and SIAM are in the single-digit range.

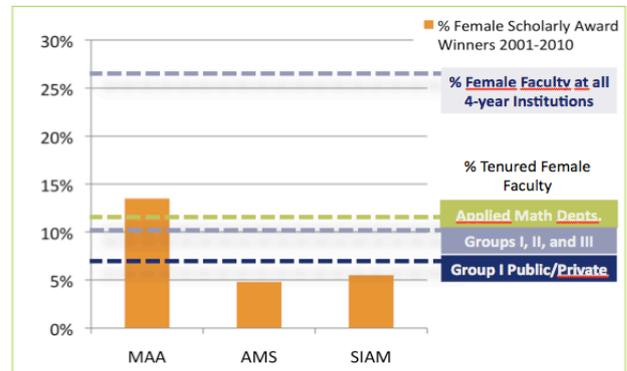
Women comprised 13% of all PhDs in mathematics fields conferred in the United States between 1971 and 1991. By this measure, three out of the four societies fail the test of matching the proportion of women among scholarly award winners in the last decade to the

availability pool estimate based on women PhDs 20 to 40 years ago. Because the growth in women's participation over the last several decades is not reflected in women's scholarly recognition, the low numbers of women in mathematics cannot be attributed as the major factor causing women's scholarly recognition.

### 3.1 Senior Scholarly Awards

Similar to the estimate of women in mathematics based on a cohort-adjusted pool of Ph.D.s, the proportion of women among tenured faculty in mathematics is generally higher than the percent women among senior scholarly award winners. The 2005 CBMS survey reported that women were 9% of all full-time tenured professors in doctoral-level mathematics departments; yet women received only 4.8% of AMS scholarly awards during the last decade. Similar disparities exist for scholarly achievement awards from MAA, SIAM and ASA. MAA mainly focuses on awards for published papers. If MAA awards were restricted to tenured faculty in doctorate-granting institutions, their scholarly awards to women would be at a higher rate than that availability pool. But nominees for MAA awards include faculty at smaller institutions that only confer masters and baccalaureate degrees. According to the 2005 CBMS survey [2], full-time faculty in all 4-year institutions is 26% female. Looking at percent women among tenured faculty in mathematics departments by rank and sub-discipline (Fig. 3), two assertions can be made. The first is that Group I math departments have the lowest representation of women while Group III and applied math departments have a higher proportion of women (10% across all math departments and 11% in applied math). The second is that the proportion of women among scholarly award winners is smaller than it should be based on the availability pool of senior women faculty in departments represented by the various societies.

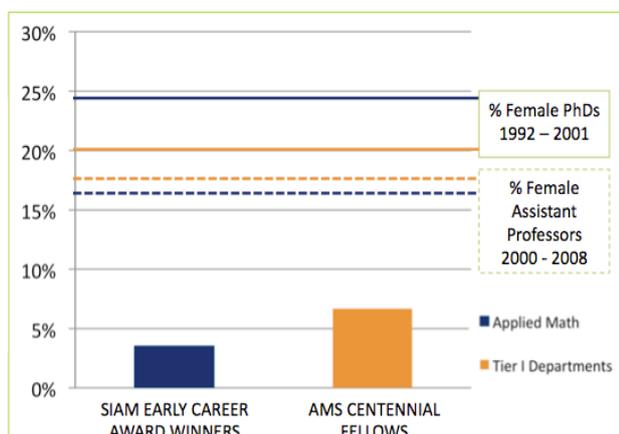
### 3.2 Early Career Awards



**Fig. 3 Scholarly awards vs. tenured faculty.** The bars represent the proportion of women among scholarly award winners within the last decade for three math societies; the dotted lines indicate the percentage of tenured faculty who are women at various types of institutions, based on AMS ranking of mathematics departments in the United States. These lines indicate targets for the various societies at expected levels of recognition. SIAM corresponds to the green line for applied math departments, and the target for AMS is Group I institutions. MAA awards are usually for published papers in MAA journals. Unlike recipients of AMS, SIAM and ASA awards, which are usually given to tenured faculty at doctorate-granting institutions, nominees for MAA awards include faculty at a broader range of 4-year institutions. According to the 2005 CBMS survey, full-time faculty in these institutions is 26% female. MAA scholarly awards are slightly over 13% women; roughly half of the target.

Although the data demonstrate that under-recognition of women for senior scholarly awards is not limited by the low numbers of women in primary reason for women's lack of recognition. An analysis of early career research awards provides additional insight, as different trends may emerge with a younger cohort of available researchers. The Fig. 4 shows percent women among SIAM and AMS early career awards given between 2001 and 2010 compared to a cohort-adjusted availability pool based on percent women Ph.D.s 10-20 years ago, and percent women among assistant professors 5-10 years prior to the awards cycle.

Fig. 4 shows averages of percent women among AMS Centennial Fellows (not more than 12 years after doctorate) and SIAM Early Career Award winners from 2001-2010. The corresponding availability pool estimates of Ph.D.s and assistant professors are shown



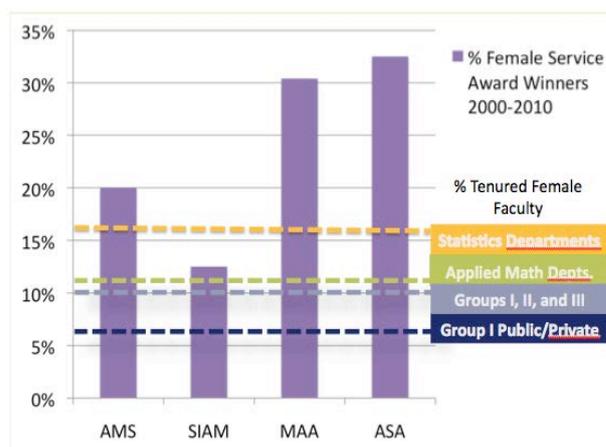
**Fig. 4 Early Career Awards (2001-2010) and target levels of women in mathematics.** The target levels for percent women among AMS centennial fellows are represented by gray lines, indicating percent of PhDs recipients from Group I departments who are women (solid line) and percent women among assistant professors in Group I departments (dotted line). For SIAM Early Career Awards, the target levels of a comparable cohort of applied mathematicians are represented in black. Neither society recognizes female early career researchers at the level we would expect, based on the cohorts of eligible women in the field.

with solid and dotted lines, respectively for applied and Group I math departments. Consistent with the findings for scholarly awards, it appears that early career awards in these two societies are not given to women at nearly the rates one would expect, based on the proportion of women in each field.

This finding is surprising for two reasons. The first is that one would expect the growth in women's participation to be reflected in more awards going to women within a younger cohort of researchers. And assuming that the culture is improving for women with the emergence of a larger pool of female mathematicians, one would expect the recognition of women to increase with each new generation.

### 3.3 Service Awards

Assuming that men are simply more likely than women to receive awards from mathematics societies, one would expect to see similar trends for service, mentoring and teaching awards as for scholarly awards. However, the data reveal a striking reversal when



**Fig. 5 Service awards vs. tenured faculty in mathematics.** The bars represent the proportion of service, teaching and mentoring awards that go to women in four mathematics societies, compared to the proportion of women among tenured faculty at each respective department. With the exception of SIAM, all societies give service awards to women at a much higher rate than would be expected based on their representation among tenured faculty.

looking at non-scholarly awards. Fig. 5 shows that women receive far more awards for service than they should, based on the proportion of women among tenured faculty in their respective disciplines. With the exception of applied mathematics departments, which have roughly the same proportion of women tenured faculty as are recognized for service by SIAM, the cohorts of women in each discipline seem to be over-recognized for their service to each field. Particularly striking is AMS, which gives 20% of its service awards to women, while less than 6% of its scholarly awards go to women. The availability pool for AMS service awards may be larger than merely tenured faculty at Group I institutions, and may include 4-year institutions that do not grant doctoral degrees.

## 4. Implicit Bias and the AWARDS Project

Because the low number of women in prestigious math departments is apparently not the limiting factor, the cause of women's under-recognition for scholarly contributions must be sought elsewhere. Decades of research in the social sciences points to "implicit associations" or subconscious social stereotypes as the

mechanism by which both men and women de-value women's intellectual accomplishments.

Research suggests [2] that everyone harbors implicit associations that subconsciously affect our decisions and opinions of others. One notable study [3] presented two identical CVs to different groups of faculty—some with the name “Karen” at the top and others with the name “Brian”. Researchers found that both male and female evaluators are more likely to hire Brian than Karen, despite the fact that they share identical CVs. Since gender of the applicant was the only variable, this experiment demonstrates clear gender bias on the part of evaluators. The fact that men and women had similar biases indicates that this is a subconscious mechanism at play, as opposed to overt gender discrimination.

In the context of selection processes of various mathematics societies, the role of implicit bias is particularly important. With the media and advertisements still promulgating the myth that men are better than women at math and science, and merchants selling pins that say “I'm Too Pretty to Do Math” the collective unconscious of our society is stuck on the notion that the best mathematicians ought to be men. Despite the significant achievements of women mathematicians over the decades, their lack of recognition for those accomplishments both reflects this attitude and perpetuates it by making visible only the notable male mathematicians.

Although many mathematicians may feel that logical aptitudes and keen intellects render them incapable of buying into these (obviously false) social stereotypes, cognitive social psychology [4] suggests that these biases operate on a subconscious level and affect all humans through emotional, rather than intellectual mechanisms. Anyone who doubts their own harboring of unconscious bias is strongly encouraged to take the Harvard IAT (implicit association test) for Gender-Science implicit biases developed by Greenwald & Banaji [5]. Since the development of this standard test for implicit associations in 1998, the

project Implicit virtual laboratory has kept a record of IAT results and researchers have tabulated those results by demographics, education, professional affiliation, and other metrics.

Recent findings [6] suggest a strong correlation between educational background, gender, and implicit associations such that women with a background in science or math are less likely to have strong male-science associations than other women, while men with a similar background are more likely to have strong male-science associations than other men with a non-science related education. Current research findings of IAT results can be found on the Project Implicit website resources section [7].

AWIS is working with seven disciplinary societies (including AMS, ASA, MAA and SIAM) to identify patterns of behavior that perpetuate unconscious bias in the awards selection process and pinpoint ways to mitigate its deleterious effects. For example, a society may choose to take a comprehensive look at its awards solicitations and review them for language that has been identified by social scientists as eliciting a masculine association. Additionally, societies may find that some of their awards are outdated and should be replaced by new awards focusing on emerging areas of research.

In the selection process, it is important for committees to be aware of the effects of unconscious bias and determine the criteria for a potential award winner before launching into a discussion of the candidates. Increasing the number of women in the nominee pool can also help, both by bringing forward more qualified women and by suppressing assumptions that the winning candidate will be male. A female committee chair is associated with an increased likelihood that a female will be selected for the award. However, the gender composition of awards selection committees seems to have little effect on the outcome, consistent with findings that women evaluators are as likely to exhibit unconscious gender bias as their male

colleagues.

AWIS has developed a series of webcasts on the awards process, with additional research on the topic of implicit bias and suggestions on how to mitigate its effects. For more information and to access these webcasts, please visit the Association for Women in Science website [8] or contact AWIS at [awis@awis.org](mailto:awis@awis.org).

## 5. Conclusions

Scholarly awards given by mathematics societies tend to single out the most highly regarded researchers in a field. However, the nomination processes and procedures for awards decisions differ by society, resulting in a spectrum of outcomes in terms of gender parity. The data reveal certain unique trends for each society examined, and discussions with society representatives have confirmed some of our suspicions based on data presented here.

For example, the AMS seems to consider the pool of eligible candidates for scholarly awards to be tenured full professors in Group I mathematics departments. Because these departments tend to have fewer women than the lower-ranked departments, the number of women considered eligible for senior scholarly awards given by the AMS is particularly low. However, even when measured against this lowest possible estimate of an availability pool (tenured full professors in Group I departments) the proportion of women who receive scholarly awards from the AMS remains below what we would expect, based on the representation of women in the pool of eligible candidates. This suggests that the climate for women researchers in the AMS may be less inclusive than in other societies.

The MAA, on the other hand, considers a much broader pool of mathematicians to be eligible for its scholarly awards, focusing mainly on published papers. This tends to include faculty from a much larger pool

of mathematics departments in the United States, regardless of their rank. This increase in the number of women among eligible candidates for scholarly awards coincides with their higher recognition for research achievements by the MAA, and one could argue that this reflects a more inclusive environment for women scholars within the society. The variation in scope and pool of candidates considered eligible for awards between AMS and MAA reflects a different focus of each society; therefore the expected availability pools are tailored to reflect these differences. Overall, women appear under-represented among scholarly award winners by each measure of availability pool estimates. Still more needs to be done in the scientific community to raise awareness about this issue and promote rigorously objective decision-making in the selection process for awards and prizes.

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