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Influence of gender bias in academia – a small experimental study on implicit association

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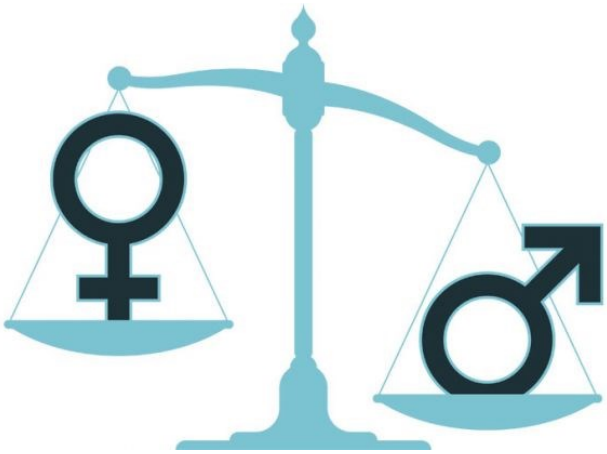


Abstract: Gender inequality is to some extent depending on subconscious gender bias, that is, automatic associations that might mis-favour women in academia. The extent to which gender bias in relation to career choices is present in the population has been investigated during many years in an American-based web project but have not yet been investigated among teachers at LTH. In this study, we let 56 teachers at LTH partake in a survey and in the Harvard Implicit Association Test (IAT), and we then analysed their results on their test in relation to their survey answers and in relation to the answers collected by Project Implicit for many years. The scores obtained on LTH was, on average, a little bit less biased than the Project Implicit scores, however the difference was not statistically significant. Furthermore, we could conclude that role models within different fields of academia did not affect the result significantly in our test, making female representation, as highlighted in previous studies, an aspect to work on, although not the only one.

Keywords: Gender, implicit bias, higher education, teaching, LTH, IAT

Contents

1. Introduction

Gender, being an *identity contingency* as coined by Claude M. Steele in his book *Whistling Vivaldi* [1], is not self-chosen, is virtually impossible to escape, and comes with a long row of expectations, prejudice and – most importantly – uneven pre-conditions for our choices in life. Gender inequality is a wide-spread problem, causing much harm on individual and societal levels, and the academic world is no exempt. One major source of gender inequality is related to subconscious gender biases that can harm the careers, work-life balance, and mental health of women, among other factors [2]. That means that – blatant sexism aside – there are mechanisms in all of our brains (see e.g. section *2.2. Biases/.../*) that will systematically mis-favour women to partake a career in a male-dominated or male-associated subject matters (see e.g. section *2.1. The gender gap*). And, by extension, this means that the university as such, and the society as a whole, will inevitably fail in the strive to produce the most competent engineers and researchers, when many of the best candidates fall away from academia on illegitimate grounds (see e.g. section *2.3. The leaky pipeline*). Our first inquiry is hence – how much does gender bias affect education? To answer this, we performed a literature review (see Appendix 1).

The results from the web-based and American-centred Project Implicit, collected between January 2003 and December 2015 (628,295 people have completed the test) shows these strong correlations: male-coded words are on average associated with STEM (science, technology, engineering, and mathematics)-subjects while female-coded words are associated with liberal arts subjects. Some local initiatives on this have been made [3] elsewhere, however, to our knowledge, no similar study has been carried out in a Swedish setting before. The extent to which teaching personnel at LTH is gender biased might influence the education they provide and is hence of great relevance to investigate. Hence, our second inquiry was to investigate how the gender biases differs at LTH, from the population at large. Sweden is, after all, a quite progressive country in many respects.

This report presents a study of the implicit association between gender and fields of study among teaching staff at Lund University's Faculty of Engineering (LTH), including 56 participants from PhD candidates to professors. The data collection was made through a Google forms survey, where the participants answered a brief questionnaire and self-reported their results from the Harvard Implicit Association Test (IAT) for Gender-Science relationships (see section *2.4. Harvard IAT* for further information on the test and Appendix 2 for a link). The reports also present a literature review on gender bias in academia.

The study has been guided by the following questions:

- How does gender bias affect education, according to literature and previous research?
- Does the implicit association concerning gender-science differ between the groups of teaching personnel at LTH and the population at large? Which factors correlates in our study?

2. Relevant theories and perspectives

2.1. The gender gap

Ganley *et al* [4] state that the gender gap within the STEM-subject in academia has for a long time been an issue for policy makers and legislators, and even if some progress has been made to narrow the gap in some subjects, such as biological sciences where nearly 60 percent or the degrees were awarded female students in 2014 (North America) and 41 percent in physical sciences, in other subject such as computer science and engineering, the same levels were 18 and 19 percent respectively. Similar situation is reported in Europe by the European Research Council, ERC, [2] stating that there is a gender disparity within academia as a whole, where Llorens *et al* [2] are stating gender bias as a reason.

In order to find an explanation for this uneven gender balance, Ganely *et al* [4] study what the determinators are, combining data from two data sets, an Educational Longitudinal Study from 2002 and the data from a survey on undergraduate students. Ganley *et al* [4] concludes that the subjects that are perceived to have the greatest potential for future income are the ones that are highly linked to math, i.e., engineering, physical science and computer science. These are the subjects with the highest perceived gender bias, reflecting an old stereotype that men are better at math, even if there is not biological reason for this [2], [5], [6]. The gender bias in academia with connection to mathematics is also visible in student feedback and evaluation of courses where female teachers, particularly junior staff, scores 37 percent lower than male staff [7], meaning that students themselves also have gendered bias negative towards female staff. Additionally, Grunspan, D. Z *et al* [8], conclude that male students tend to overestimate other male students' performance in class, with a 0.57-point overestimation on a 4-point scale, indicating a strong male bias in the study.

The above points towards that female student experience a bias in terms of entering the STEM field and in the evaluation of their study performances in terms of grades and female students' possibility to access grants, [9], [10], [11], that female teachers are perceived less knowledgeable, making the students assessment of the teachers' performance harsher [12], [13], the literature also states that female students and researchers are less likely to receive funding to go abroad, or to be promoted in academia [14], [15].

This results in a situation where females have fewer choices for making higher salary if they want to avoid subjects that has the perception of potential discrimination. If females do choose to enter the STEM fields in academia, as a student and as staff, it is likely that they will face more obstacles then their male counterparts, both in terms of gender discrimination with academia, but also from external factors [16]. Additionally, Ganley *et al* [4] state that perceived gender bias is not the most important factor that determine the gender differences in the STEM-fields. Instead, they argue that perceived gender representation is a more important factor deciding the gender balance within academic fields, suggesting that in order to fight perceived gender bias within these fields it is important to work with female representation, something that is also recommended by Llorens *et al* [2]. Without female representation within the STEM-subjects, the gender imbalance within the student population, as well as a bias against female staff, is not likely to change[1].

2.2. Biases in general and implicit bias in specific – what do they lead to?

The awareness of implicit bias might be a way forward to reduce the systematic unfairness in academia between men and women. Implicit bias is different from blatant sexism. As opposed to deliberate, implicit biases are subconscious as a part of skewed interpretation of information. Biases, in general, take place in cognitive processes and are resulting from contextual factors and our accumulated experiences [17]. Bias is not limited to gender differences but is part of our everyday lives and might show itself in various famous biases such as availability bias, anchoring bias, and confirmation bias (see e.g., [18]). Biases and heuristics as these are used as rules-of-thumb to save energy and make short-cuts in our brains' thinking processes in lieu of activating the more energy consuming deep brain processes (sometimes this distinguishment between mental processes is referred to as System I and System II, see e.g., [19]), and in decision-making under uncertainty or from scarce information. It is not always the case that such biases lead to directly adverse effects, and we are often not made aware of minor slips and errors of thought due to biases. However, it will soon become problematic when it comes to prejudice and erroneous conclusions about a certain group of people and its' associated abilities. This is what we mean by implicit biases, as formulated well by Gvozdanović & Maes [17] in the following quote:

[1] It should perhaps be noted that the found literature seems to consist of a North American hegemony and that the literature review should not be understood as something that is directly transferable to a Swedish context.

"/.../ the term implicit bias is used to mean that human beings are not neutral in their judgement and behaviour but instead have experience-based associations and preferences (or aversions) without being consciously aware of them" (Gvozdanović & Maes, 2018, page 3)

While blatant and pure sexism still might be part of the explanation on gender differences in academia, the concept of implicit bias suggests that this is not likely to be the only explanation for injustices. As human's cognitions and behaviors being shaped by both nature and nurture, we are all subjected to our upbringing conditions, our current and past contexts, our present or non-present role models and to the prevailing societal climate and its associated norms. In such a setting, it is not surprising that prejudices, however outdated they may be, might flourish and have impact on even unsuspecting and highly educated people considering themselves fair, enlightened, and just.

One devastating manifestation of implicit biases and the systematic discrimination of women in academia was observed and reported in 1997, when Wennerås and Wold published their much-appraised study on nepotism and sexism in peer-review in Nature [20]. In their examination of the peer-review process at the Swedish Medical Research Council for postdoctoral fellowship applications, they found that the merits were not valued the same, were they associated with a female or male researcher. The numbers are horrific: a woman needed to have been publishing more than twice as many articles of equivalent quality to be viewed equally competent to a similar man [21]. This clearly undermines the Meritocratic Principle [17]. Wennerås and Wold [21] further concludes that:

"The systematic underestimation of female performance is particularly deleterious in fields such as science, where individuals are constantly evaluated. Repeated small injustices accumulate to produce visible differences in career paths between the sexes. Only if she has excellent contacts can a woman compete on equal terms with a man" (Wennerås & Wold, 2000, page 647)

The above is emphasizing the need for understanding and dealing with these issues at a LTH, as it is being a faculty specialized on STEM-subjects' education and research. We find ourselves in a situation where half of the population are at risk of being stigmatized, discriminated, and unjustly treated and having their opportunities for pursuing a future career within their subject of choice severely diminished in comparison to that of their male peers. Another prime example of this is the John or Jennifer-study from Yale University [22] where around 100 people were to review fictive but identical résumés, and where the one's signed "Jennifer" were consequently rated less competent, less hirable, and having a lower mentoring potential. In addition, the Jennifers were offered lower salaries than the Johns [23].

It is sometimes argued that the difference in male and female career choices can be motivated with vastly different factors than the systematic mis-favoring of women in certain fields. Sometimes it is argued that men and women are naturally making different life priorities, and often does these have to do with family aspects of life. The following quote [24] might once and for all puncture that argument:

"common prejudice tells us that this is largely due to 'women's special priorities', for example that women nurture their families rather than their careers. In fact, married women with children are at least as scientifically productive as single women, and advance equally, or more, rapidly than their childless female colleagues. Further, no simple relation between the role of women in society at large and their capacity to climb the academic career ladder can be found. For example, the 'women friendly' Scandinavian countries have excellent child care and a high proportion of women politicians, but a glaring scarcity of female professors." (Wennerås & Wold, 1999, page 747)

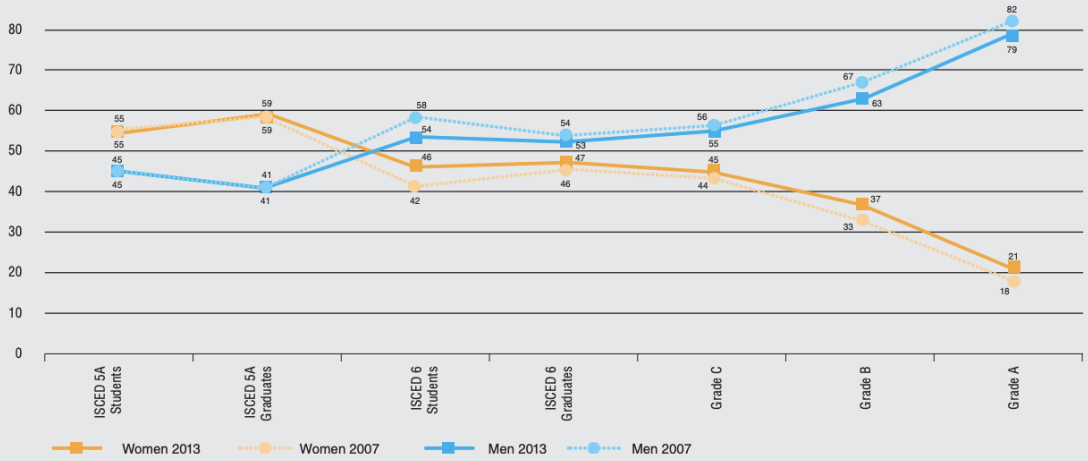
2.3. The leaky pipeline

Talking about underrepresented female professors makes us unsoughtly entering the next topic for this text: The leaky pipeline. This denotes the asymmetry in male and female academic career paths, sometimes also referred to as the 'vanish box' [17]. Despite women being overrepresented in graduating from undergraduate programs, they are later heavily underrepresented in more senior academic positions, particularly professorships, see Figure 1.

Box 1: Male and female academic career progression

The pattern whereby women in academic careers are significantly less likely to reach the top than men is referred to as the 'leaky pipeline or the 'vanish box'.[6]

Figure 1: The 'leaky pipeline' or 'vanish box' negatively affects women in academic careers across Europe [7] [8]



As Figure 1 shows, 59% of graduates but only 21% of (Grade A) professors[9] are female, whereas 41% of graduates and 79% of professors are male.

The graph also shows that progress between 2007 and 2013 has been minimal.[10] Overall growth in the proportion of women grade A academics is slow at about half a percentage point annually. The number of women employed as heads of universities or institutions entitled to deliver PhD degrees is 15% (EU-28 average, 2014) showing a similar growth rate to that of women grade A academics (*She Figures* 2015, p. 142, table 6.4.).[11]

Figure 1. The Leaky Pipeline, where it is clear that women are dropping out of academia, while men stay. Figure copied from [17].

LTH is no different but following the same pattern with a generally diminishing share of women the higher the academic rating [25], see Table 1 below. The female share of professors is notably the same in Figure 1 (European universities) as in Table 1 (LTH), namely 21%.

Despite Sweden being highly ranked in international comparisons regarding gender equality [26], it seems like the academic world is lagging behind in this progress. However, not only the academic world suffers from these issues, but STEM-associated workplaces in the industry in general are also severely affected by gender inequality partly due to implicit biases. However, our argument in this text is that it is extra important to investigate this in the university setting, since that is where all the STEM careers are set off, and fair treatment at the university might be cardinal for the students' future careers. We further argue that an Implicit Association Test might be a good tool for measuring the tacit and intangible biases lying behind many of these issues.

Table 1. Shares of Male and Female employees at Faculty of Engineering at Lund University [24] and the Newly admitted graduate students on the engineering programs at LTH [27] *indicates that there is a leaky pipeline tendency at LTH.*

Level	**Male**	**Female**
*Newly admitted graduate students**	64%	36%
PhD Students	64%	36%
Post-doc/BUL	63%	37%
Researcher/ Amanuens	70%	30%
Associate Professor/Senior lecturer	73%	27%
Professor	79%	21%

**These figures are calculated as an average of the admission numbers of 2014 to 2017 (which was the most recent updated data in the data set).*

2.4. The Harvard Implicit Association Test

As stated above, implicit in this context refers to a subconscious attitude of a subject whereas explicit refers to conscious attitudes. This of course makes it difficult to measure implicit bias and other implicit factors that could drive our actions. However, psychologist has made several attempts to be able to measure this. Fazio and Olson [28] list a few ways to measure implicit association. To mention a few: word fragmentation, linguistic level, need for explaining, name letter preference, priming and the IAT [28]. The first three methods mentioned are similar, measuring how the brain creates patterns, see [28] for more details on the different methods. The last two are more widely used, however, priming would require interviewing the subjects and carefully priming and assessing the situation. Therefore, it is not used in this study. That leaves us the IAT, that through a simple computer set-up measure to what degree a person is implicitly biased through measuring the speed of their choices. The test can measure automatic preferences for e.g., thin or fat people, president popularity and biases for a certain relationship such as Gender-Science and Race-Weapons. To perform a IAT test yourself, refer to Appendix 2 for the link.

IAT was created by the Project Implicit, a non-profit organization established by scientist from Harvard, University of Washington, and University of Virginia in 1998 [29]. The aim of Project Implicit is to educate people about biases as well as to provide an online laboratory for scientist looking to research the effects of the concept through the IAT. The IAT more specifically provides a way to measure how much we associate certain concepts with known bias. In this study it measures how we subconsciously relate male and female with science and liberal arts. The test measures the time it takes for the subject to sort correctly between the two i.e., *gender* and *science*. This simple test is based on the idea that people are quicker to sort in cases where the implicit association is the highest [30]. This is described above as bias being used as a heuristic tool, which in this test helps us sort the words and categories with minimum effort. More precisely, if we subconsciously link female with science then we are quicker to sort that correctly than male with science.

Using the above theory, the test is devised into five parts. In the first part, the test subject is asked to sort words related to the concept using the “I” and “E” key on the keyboard [30]. For example, in the chosen test for this study it would be sorting words such as “grandmother” and “grandfather” to the category of “male” and “female”. The second part is to sort words related to the bias that is being evaluated, in this case “Science” and “Liberal arts” [30]. The third part is a combination of the two, the subject is for example asked to press the “E” key for words associated with “male” or “liberal arts” and the “I” key for “female” or “science”. In the fourth part the categories switch side and in the fifth and final part the category and evaluated bias are the other way around [30]. In order for the sorting to

remain a subconscious action rather than muscle memory the category and evaluated bias are mixed differently every new test.

Before moving on to the results lets first discuss the validity of the IAT. Fazio and Olsen [28] raise the question of what is actually measured. What they imply are that it is difficult to verify that the attitude or association that is measured is actually subconscious and not in fact conscious [28], i.e., are we looking at an implicit or explicit association. However, even the explicit methods are flawed since the subject who is aware can construct the attitude which would be "correct" [28]. From this Greenwald et al. [31] discuss that in a sense the implicit test method even if somewhat explicit would be better at assessing a more honest attitude or association. Oswald et al. [32] conducted a meta-analysis in which they concluded that the IAT does not offer more information on implicit assessments then does explicit test methods. This statement has been previously discussed by Greenwald et al. [33] who argues that there might be issues with the IAT in implicit measurements, but it is proven to have a stronger predictive agreement than explicit tests in the question of socially sensitive situations. Lastly, Nosek *et al* [34] used the IAT in a study on bias in math towards females. The study showed that the IAT predicted the expected outcome well. To conclude this discussion the IAT has been debated for years but it has also been proven to work for the purpose of this study. To our knowledge, this test has not yet been used in a Swedish setting, to distinguish the results obtained by a cohort of teaching personnel on a Swedish university from the collected results from the Project Implicit as a whole.

3. Method and application

To perform this study, Project Implicit's IAT named Gender-Science was used [35], together with a brief questionnaire (see Appendix 3). The test measures the implicit association between female coded words (such as Aunt, Grandmother, Girl, Daughter) or male coded words (such as Man, Father, Husband, Male) and words belonging to two different branches of academia; natural science (such as Geology, Biology, Astronomy, Math) and liberal arts (such as English, History, Humanities, Literature) by measuring reaction time (for further information, please refer to section 2.4 above describing the mechanisms of the IAT). The brief survey was constructed in Google forms and sent out to staff (including PhD students) at the Faculty of Engineering (LTH) at Lund University. The survey was distributed to several departments at LTH in order to reach a representative group. The eligibility criteria to participate in the study was to have teaching experience, without further specification. The survey was sent out on the 8th of December 2021 and was closed one week later, the 15th of December 2021. The survey was accompanied with either a brief oral introduction or with an e-mail introducing the project and the task at hand (see Appendix 4). In total, 56 people responded to the survey. Approximately 160 people were reached by the survey via e-mail or in person, implying a response rate of around 35%.

The questionnaire included some personal information (own gender, seniority at the university, training in pedagogical practices) together with a question on the respondents' a priori attitude to gender and science ("which group do you link closest to science – men, women or neither"). After this, the link to the test and instructions how to perform the test followed. The result from the IAT was to be copied from the website into one free text answer box. The test could be made up to three times, where we asked the participants to indicate their results from the first to the third round, where the second two was indicated with "Optional". In the other half of the questionnaire, questions on role models within the different academic branches were asked together with some free text answers where we asked about the participants to reflect upon their results and comment on their ideas and experiences regarding the implicit bias role in academia. The IAT results were translated into numerical values to facilitate analysis of the results, where a strong automatic association between male with science and female with liberal arts was attributed with the highest number (7) and a strong association between female with science and male with liberal arts was attributed with the lowest number (1), see the y-axis in Figure 2.

4. Results

4.1. Descriptive statistics of the participants

A total of 56 individuals participated in the study. The participants were divided into two main groups, namely the PhD students, which normally have spent <5 years at a position involving teaching at the university, and more senior staff (from post-docs to professors) that have spent >5 years with (partly) teaching at the university, here denoted "Others". Out of these 56 entries, 5 was disqualified from the dataset (3 male "others" and 2 female PhD students) due to either taking the wrong test (n=4) or not putting the correct type of answer from the test score into the answer field (n=1). In Table 2 below, descriptive statistics of the 51 respondents that was included in the study is presented.

Table 2. Descriptive statistics of the participants.

Class	**Category**	**n**	**%**
Gender identity	Man	30	59%
	Woman	21	41%
	Other/prefer not to say	0	0%
Employment	PhD Student	29	57%
	Others (e.g., Professor, Associate professor, Senior lecturer, Post-Doc)	22	43%
Number of pedagogical courses	No pedagogical course	2	4%
	1 pedagogical course	32	63%
	>1 pedagogical courses	17	33%

4.2. Comparison between LTH and Project Implicit

The Project Implicit has been ongoing for several years and has collected a lot of data. Therefore, it is possible for us to compare the results gained from our cohort consisting of teaching staff at LTH with the population at large (that has taken the test at the Project Implicit website). A total of 628,295 scores had been collected for the Gender-Science IAT between January 2003 and December 2015. Among our participants, a majority (53%) had never taken an IAT-test before, whereas 24% had and 20% did not know if they had. The distribution of the scores can be seen in Figure 2.

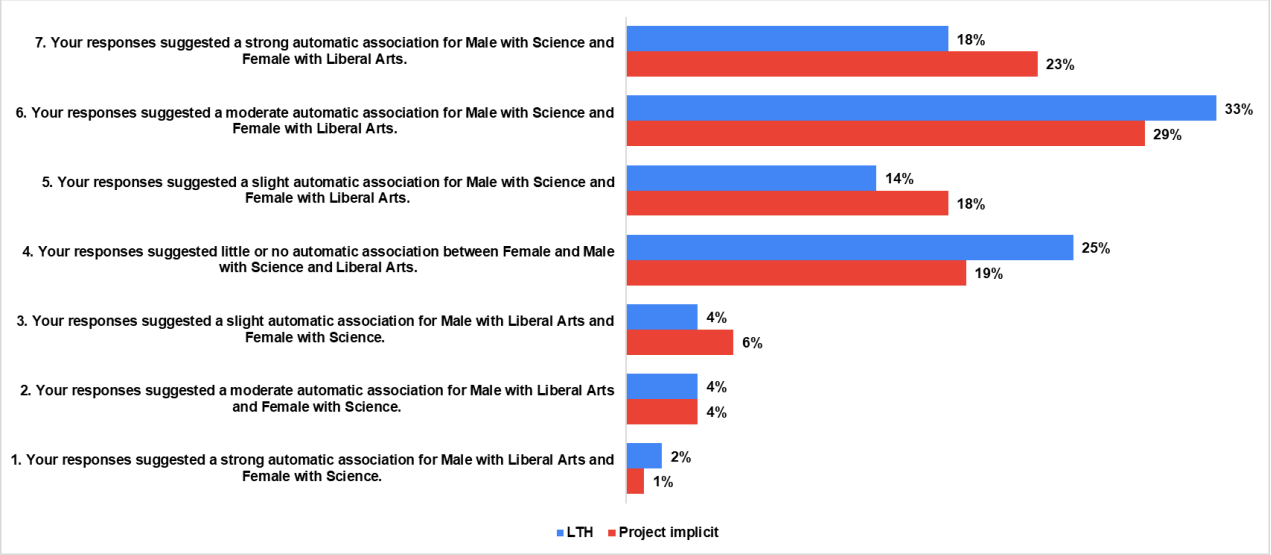


Figure 2. Distribution of scores for the Gender-Science IAT, collected between January 2003 and December 2015 in red, and for our study on teaching staff at LTH in blue. The average score is 5.28 for Project Implicit and 5.16 for the LTH study.

In Figure 2 above, a comparison of the score distributions for the two cohorts are presented. The average value for Project Implicit at large was 5.28, while the average value for LTH was slightly lower, 5.16. However, a standardized normal distribution analysis of the average values showed that the averages were not differing with statistical significance. The calculated z-score was 0.68, which is less than the reference value 1.96, which would indicate a p-value of 5% in a one-sided test. Therefore, the result of the test indicates that the average value of this study does not differ from the Project Implicit at large.

4.3. Known gender bias

In the questionnaire, we asked the respondents to answer a straight-forward question about their conscious bias to get an indication on the known bias within our sample. The question asked was "Which of the following groups do you link closer to STEM (science, technology, engineering, maths) subjects?". Out of the included participants, 39% (20 participants) responded "Male" to the question , while only 4% (2 participants) responded "Female" on the same question. This means that a majority, 57%, answered that they considered themselves linking neither of the sexes closer to STEM subjects before the test. It should be noted that this question was answered before the IAT tests were performed.

4.4. IAT score based on employment and gender

The result of the IAT is as previously mentioned a scale from 1-7, note that the scale is deterministic. The results based on gender and employment is shown in Figure 3. As can be seen in the graph the highest score comes from male PhD students. Somewhat more difficult to read from the graph is that the lowest average score is from the female PhD students. For more clarity the average score for the four groups as well as gender can be seen in Table 3. Note that the highest average score was by male PhD students. However, note that the difference is 0.26 between male and female PhD students. Disregarding the employment type, it is still indicated that the average male score is somewhat higher than the female. Among the participants, 11 chose to perform the test more than once, and two participants performed the test three times. The scores on the second test were higher than the first test in two of the cases, lower in four of the cases, and identical in four of the cases. The third score was identical to the second score in both cases where a third score applied.

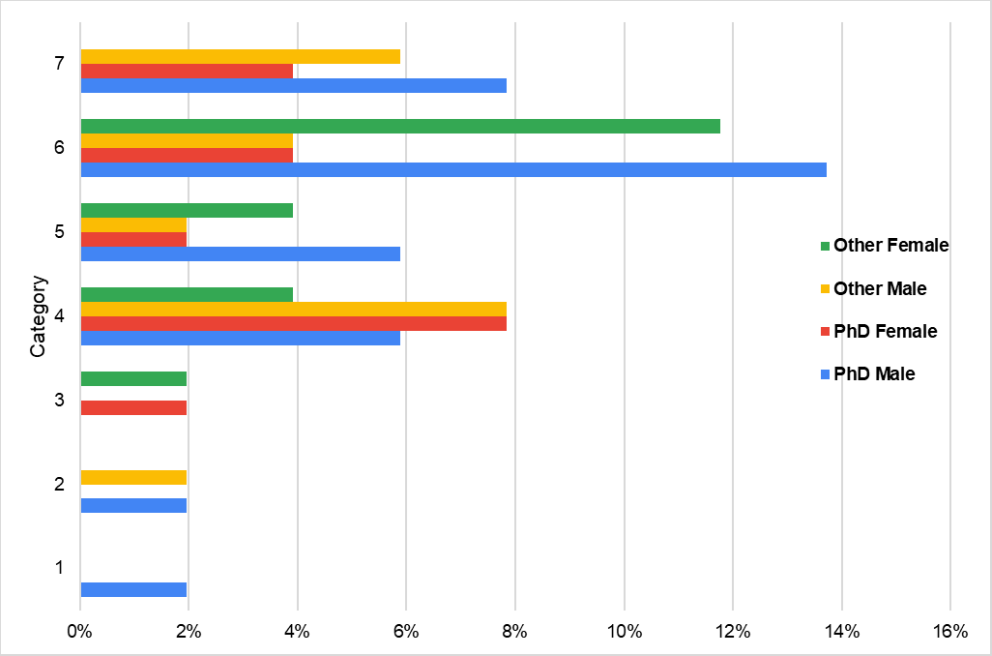


Figure 3. Distribution of scores for the Gender-Science IAT for our participants at LTH. The data is divided into female and male PhD-students and the more senior employees, here denoted "Others".

Table 2. The average scores for diverse groups in our study

AVERAGE IAT SCORE	MALE	FEMALE	TOTAL
PHD STUDENT	5.26	5.00	5.17
OTHER	5.09	5.18	5.14
ALL	5.20	5.10	5.16

4.5. Average IAT score based on role models

We wanted to investigate if respondents biased in either direction would correspond to certain role models in their childhood. Hence, in the questionnaire, the respondents were asked to account for if they have a male role model working within the field of liberal arts, or if they have any female role model working within the STEM field while growing up. The respondents could answer *yes* or *no* to these questions. 20 participants (39%) indicated that they had had a female role model in the STEM-fields, while 16 participants (31%) indicated that they had had a male role model in the Liberal arts-fields. The effect of role model on the IAT score for those respondents that got a biased score is displayed in Figure 4 below. A respondent is considered biased if their score is either below or above the neutral – unbiased – score of 4. In the figure, red shows the respondents that were biased with male to STEM (> 4), and blue shows the respondents that were biased with female to STEM (< 4).

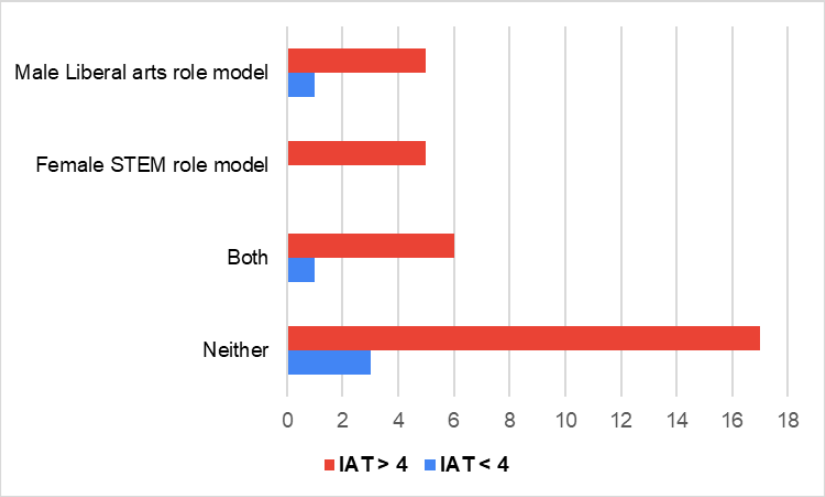


Figure 4. The effect of role model on the IAT score divided on scores biased in either direction. Note that a high score indicates a bias towards male and science and a low score indicates a bias towards female and science.

The overall male score is somewhat higher, as seen previously. However, the in the group of respondents who had neither a male Liberal Arts nor a female STEM role model the female respondents had a somewhat higher average score. Figure 4 shows the results of the PhD students in this data set. Here we can see that bias cannot be contributed with certainty to what role models the informants have, as we can see that informant with a IAT score above 4, can be found regardless of role models in an academic field. In our result, male PhD students with a male liberal arts role model has the highest average score, which also is higher than the study average (6.33 vs. 5.16). While the PhD students having a female role model within the STEM field have the lowest score.

5. Discussion

It is no longer a question if (implicit) gender biases exist in academia, numerous articles have pointed to the fact [1],[4],[5], with various implications, most notably that female students and staff within STEM is more likely to be evaluated stricter and harsher in relation to their male counterparts [8],[9],[10]. This despite female students preforms in general better than male students. Additionally, females subjected to gender bias are not only, unequally treated, they also do not treat themselves as equals and undervalues their own academic ability. This leads to less career-relevant behavior, which results in a slower career development/trajectory [36].

Implicit association tests, like the one used within this study, are not being questioned any longer, neither as an implement nor the results. The facts and trends have been determined: surely Swedish scholars (the country that scored the highest in ‘’Gender Equality Index’’ in 2021 [37]) are to dramatically differ from the crowd? The results found within this report, however, are telling a different truth. The results from our (small) investigation show scholars, at a Swedish university, scores distribute remarkably similar to the entire population of those taking the test. This means that while we can conclude that according to the literature, female students within STEM preform in general better than their male counterparts, they still face a biased teaching group. While there is a slight difference in the average bias score between female and male teachers, this difference is very little, as seen in figure and table 3. Interesting to note in table 3 is that female PhD students have a lower bias than female that has been working within academia for a longer time, whereas the opposite pattern can be found among men, where male PhD students have a higher average bias score than their more senior counterparts. What the cause of this different trend is, is not clear. It can be explained by this study’s small sample of informants and should perhaps not be interpreted as the actual situation among all teaching staff at the faculty. Further studies with a larger sample size are needed to see if the tendency that female staff increase their gender bias the longer, they have been teaching, if so, there is a dire need to investigate why this is happening in order to counteract the problem.

Regarding the importance of representation and female role models within STEM, as highlighted by Llorens *et al* [1] and Ganley *et al* [3], our results show that male PhD students with a male role model within liberal arts has the highest average bias, whereas female PhD students with a female role model within STEM has the lowest average score. From this we conclude that female role models within STEM is mostly important for female PhD students, and in the end also for female students. Female representation with the STEM field should be considered an important aspect to address the found bias, although not the only one.

How does this affect the teaching situation? The university primary purpose, to educate people into qualified professionals, whether that be in the industry, public service sector, or elsewhere. The demand of the best imaginable critical thinking, creative and knowledgeable community servants never ends. If men and women do not get the same possibilities to successfully educate themselves, injustice will follow throughout the entire society.

Findings in this report show that in all roles examined: PhD student, teacher, researcher and adjuncts gender bias towards women was found. These biases, however, were expressed in slightly different ways depending on the respondent's gender and position, e.g. PhD or other, at the faculty. However, the result is clear that there is a presence gendered bias among teaching staff, and because of this, there is a risk that female student at staff can experience of injustice and inequality at LTH, as found in [8] and [9]. This injustice will likely take the form of valuating female performance less, either students or female teaching staff, but in the longer run it can also affect possible academic collaborations and application for future projects, as presented in [14] and [15]. As the implicit gender bias is an outcome

of unconscious acting upon previously experienced associations and preferences, it is difficult to change the current state. The negligence found in coping with the current effects and future state of this phenomenon is painstakingly clear. However, increased awareness [38], suitable role models [39], anonymized CV's and tests [40] and mixed groups [41] are all great examples of tools used to curb biases.

6. Conclusion

This report set out to investigate gender bias among teaching staff within a STEM faculty at a Swedish university. The literature on gender bias within academia is vast and covers many different areas and perspectives on the subject. Most notably, that female students within the STEM field faces more challenges than their male counterparts, their study performance is examined harder, they value their own performance lower than male students, and female teaching staff is considered less knowledgeable, this despite female students in general preform slightly better than male students. These different types of findings highlight that there is a gendered bias within the STEM field, and that female students and teaching staff faces more obstacles, and this affects female career trajectories.

Our result does not indicate any major differences between our population, teaching staff at LTH, and the larger population that has taken the IAT gender bias test. The average score is slightly lower in our population; however, this could not be proven with statistical significance. Male PhD students and other have a higher average than female, but with little difference. All different groups fall, on average, within the category 5 "Slight automatic association for Male with Science and Female and with Liberal Arts". The results indicate that there is a need to continue addressing the issue of gender bias within the STEM field, also at LTH, in order to not discriminate female students and staff.

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Appendices

Appendix 1 – Search strategy for the literature study and our findings

Research question

Research question: What is research telling us about the influence of gender bias in academia especially referring to teaching?

To further specify the research question the "SPICE-model'' is used [42]:

S	**P**	**I**	**C**	**E**
Setting (where?)	Perspective (for whom?)	Intervention (what?)	Comparison (compared with what?)	Evaluation (With what result?)
Within LTH, especially; STEM (science, technology, engineering and mathematics).	For female; students, researchers, teachers and employees.	Gender bias	For male/other; students, researchers, teachers and employees.	To quantify the *influence* of gender bias, as it is known to be present. To what degree.

The reformulated research question is: What influence does gender bias have on the education/teaching roles of: students, researchers, teachers and employees within STEM (science, technology, engineering and mathematics).

Key concepts

Concept 1	Concept 2	Concept 3	Concept 4
Gender bias	Education	Roles	Impact
Main concept for the study.	The scope is to find gender bias influence within ''higher education'', specifically STEM.	Gender bias is present within different *relations,* that is between different roles within academia.	What effect / influence does this bias have.

Search matrix

Concept	Gender bias	Education	Roles	Impact
Alternative / Inflected forms	“Gender bias*”	Education*	Role*	Impact*
Synonyms	Prejudice*, preconception*	Learning, schooling, teaching, tutoring	Function, part, task, work, employment, occupation, post	Consequence, effect, fallout, result, outcome
Related terms	Bigotry, discrimination, sexism, ‘’gender gap*’’	Knowledge, school, academia, test, examination	Duty, leadership, career, position	Reaction
Broader terms	Partiality, favoritism, Predispose*, Predilection, gender*, women, men, inequality, ‘’gender diversity’’, imbalance	Instruction, enlightenment, guidance, mentorship	Office, prestige, reputation	Significance
Narrower terms	Nepotism, chauvinism, network	University, college, STEM, faculty	Student, teacher, employee, researcher	By-product

Search string

The search was conducted 2021-12-26 in the Scopus database, this database is a deemed suitable for this search as trial searches were made and key articles were found. The search was made in the: article title, abstract and key words.

Iteration 1 (Concept 1 AND Concept 2 AND Concept 3 AND Concept 4)

((TITLE-ABS-KEY ("Gender bias*") OR TITLE-ABS-KEY (prejudice*) OR TITLE-ABS-KEY (preconception*) OR TITLE-ABS-KEY (bigotry) OR TITLE-ABS-KEY (discrimination) OR TITLE-ABS-KEY (sexism) OR TITLE-ABS-KEY (‘’gender AND gap*’’) OR TITLE-ABS-KEY (partiality) OR TITLE-ABS-KEY (favoritism) OR TITLE-ABS-KEY (predispose*) OR TITLE-ABS-KEY (predilection) OR TITLE-ABS-KEY (gender*) OR TITLE-ABS-KEY (women) OR TITLE-ABS-KEY (men) OR TITLE-ABS-KEY (inequality) OR TITLE-ABS-KEY (‘’gender AND diversity’’) OR TITLE-ABS-KEY (imbalance) OR TITLE-ABS-KEY (nepotism) OR TITLE-ABS-KEY (chauvinism) OR TITLE-ABS-KEY (network))) AND ((TITLE-ABS-KEY (education*) OR TITLE-ABS-KEY (learning) OR TITLE-ABS-KEY (schooling) OR TITLE-ABS-KEY (teaching) OR TITLE-ABS-KEY (tutoring) OR TITLE-ABS-KEY (knowledge) OR TITLE-ABS-KEY (school) OR TITLE-ABS-KEY (academia) OR TITLE-ABS-KEY (test) OR TITLE-ABS-KEY (examination) OR TITLE-ABS-KEY (instruction) OR TITLE-ABS-KEY (enlightenment) OR TITLE-ABS-KEY (guidance) OR TITLE-ABS-KEY (mentorship) OR TITLE-ABS-KEY (university) OR TITLE-ABS-KEY (college) OR TITLE-ABS-KEY (stem) OR TITLE-ABS-KEY (faculty))) AND ((TITLE-ABS-KEY (role*) OR TITLE-ABS-KEY (function) OR TITLE-ABS-KEY (part) OR TITLE-ABS-KEY (task) OR TITLE-ABS-KEY (work) OR TITLE-ABS-KEY (employment) OR TITLE-ABS-KEY (occupation) OR TITLE-ABS-KEY (post) OR TITLE-ABS-KEY (duty) OR TITLE-ABS-KEY (leadership) OR TITLE-ABS-KEY (career) OR TITLE-ABS-KEY (position) OR TITLE-ABS-KEY (office) OR TITLE-ABS-KEY (prestige) OR TITLE-ABS-KEY (reputation) OR TITLE-ABS-KEY (student) OR TITLE-ABS-KEY (teacher) OR TITLE-ABS-KEY (employee) OR TITLE-ABS-KEY (researcher))) AND ((TITLE-ABS-KEY (impact*) OR TITLE-ABS-KEY (consequence) OR TITLE-ABS-KEY (effect) OR TITLE-ABS-KEY (fallout) OR TITLE-ABS-KEY (result) OR TITLE-ABS-KEY (outcome) OR TITLE-ABS-KEY (reaction) OR TITLE-ABS-KEY (significance) OR TITLE-ABS-KEY (by-product)))

Findings*

	Bias against female students	**Bias against** female teachers	**Bias against** female researchers	**Bias against** female employees
Students	Female students subjected to gender bias, assess their academic ability negatively [36].	Perceives male teachers as more knowledgeable and with better leadership skills [43]. Scores female teachers lower at SET** [12], [13]. Scores female teachers lower in course content and pedagogical skills [44]. Students show greater hostility towards female teachers that does not meet student expectations [45] .		
Teachers	Gives female students lower grades, and are, gender and subject, specific in giving feedback [10]. Are less likely to grant access *to gifted and talented* programs [11].	Assign women ‘’nurturing’’ roles that includes more service work. [46]		
Researchers	Are less likely to grant funding for female students for research or study abroad [14].		Do not acknowledge female researcher competence to an equal degree as men. Female researchers are either; liked **or** respected [47]. Female PhD’s and academics spend less time presenting at conferences [48]. Female researchers are more scrutinized than male authors [49].	
Employees / Employer	Are less likely to be promoted, (including to be granted PhD) [15], [49]	Female teachers earn less [15].	Female researchers are more likely to be isolated socially and ‘’tokenized’’. [47]. Female researchers are being less published [15].	More likely to hire a male candidate in favor of female, despite identical CV. [50] With lower pay and less mentoring [46]. Female employees hide the fact that they have children as it has a negative effect on their career. [47].

*The matrix above concludes that there is evidence of gender bias within academia; female students, researchers, teachers, and employees are all affected. Some of the relations are left blank in the matrix as there could not be found evidence that, in example; ’’Researchers’’ showed bias against ‘’Female teachers’’. As this is a quite rare situation, the boxes are left blank and focus is instead on more relevant relations, in example; ‘’Students’’ that have bias against ‘’Female teachers’’. Some evidence found are outside the scope of STEM, in example medicine. Some evidences were found in lower education than university/academia, but these findings are considered appliable to the conclusions made. **SET student evaluation of teaching.

Findings from literature study

Gender bias can be found in academia, and is represented towards female: students, researchers, teachers, and employees. The manner in which it is displayed varies within the different roles, (a scholar often has more than one role).

Student ratings of teachers play an important role in future career of every teacher, the presence of gender bias makes it less likely for a woman to reach tenure and/or promotion. A more diverse work force is proven more successful within industry, but also in academia. Even though it is easier to measure, financial, success within the industry, it is also proven that diverse research teams differ in comparison to more homogenous groups in citation count, [41].

Females subjected to gender bias are not only, unequally treated, they also do not treat themselves as equals and undervalues their own academic ability. This leads to less career-relevant behavior, which results in a slower career development/trajectory [36]. The lack of female role models/management and lower starting salary [46] makes females lag in their career and experience they must work harder to be considered legitimate scholars (Often described as the ‘’Matilda effect’’ [51]). To have gendered hierarchies interfere with female academic careers and teaching, leads to: a loss in perspective, higher rates of burnout, salary inequities, fewer female leadership positions and professional isolation [52], [53] , [54]. To have a diverse work force will lead to a better decision-making process, stronger results, promote innovation and better organizational strategies [53], [54].

Teachers tend to be subject specific in their feedback and grading. Which can result in (A in the case of encouraging subject-bias): lowered self-esteem, lack of motivation and feeling inadequate when transgressing the gender stereotype subject boarders. (Or B in case of trying to overcompensate) which can result in overconfidence, grading inflation and a decreased trust. Both matters of injustice can severely damage the teaching situation.

Even though, more female students are, in example, graduating as a Master of Science in engineering [21] [55], the progress is slow, this is a product of all the findings of gender bias. Academia has deeply rooted culture and history of being male dominated but is also known to be the home of cutting-edge knowledge and innovation. The rate of change should be unsurpassed in academia compared to other institutions or industry. However, it is shown that being in a diversified / multicultural environment reduces class and ethnic prejudice, let us hope that more female scholars reduce gender bias in academia.

Considering that; Sweden, has since 2010, been ranked first in the EU on the Gender Equality Index [37], and as, generally, the teaching of young children has been dominated by women [56], (therefore not lacking a female role model) and that the AIT is given to progressive scholars of a highly world ranked university [57]. One might suspect a score that differs from the crowd.

Appendix 2 – Link to the IAT test

if you wish to perform the IAT test yourself, please visit the following website, and follow the instructions.

https://implicit.harvard.edu/implicit/takeatest.html

Appendix 3 - Questionnaire

Part 1 - Some initial questions

To be part of this study, you need to have teaching experience.

Please fill in the following questionnaire as honest as possible. The test and this questionnaire is anonymous.

*Required

1. What do you identify as? *

Mark only one oval.

- Man
- Woman
- Other/prefer not to say

2. What is your employment/title? *

3. Have you taken any teaching and learning course at University level? *

Mark only one oval.

- Yes, one
- Yes, more than one course
- None

4. Which of the following groups do you link closer to STEM (science, technology, engineering, maths) subjects? *

Mark only one oval.

- Men
- Women
- Neither

5. Have you ever performed an Implicit Association Test (IAT) test before? *

Mark only one oval.

- Yes
- No
- I don't know

Part 2 - The Test!

Now we ask you to perform a short test on implicit associations regarding GENDER and SCIENCE. Follow the list below:

- Go to https://implicit.harvard.edu/implicit/takeatest.html
- Press "I wish to proceed" at the bottom of the page (if you wish to proceed of course)
- Choose the test named "Gender - Science IAT" - This is important, choose the right test please!
- Take the test (you might, on the test page, press the "Decline to answer"-button on the questionnaires on the test homepage, including the demographic information and the like. The questionnaire part might come either before or after the Implicit Association Test-section)
- Note your result on the test in the corresponding boxes below. the result will show in a gray box on the top of the page (see figure below).
- The test and this questionnaire is anonymous

You can perform the test multiple times, and report up to three of your results (the first three).

The result of your round will show like this (in the white box) starting with Your responses suggests... Please copy the whole sentence in!

You have completed the study.

During the Implicit Association Test (IAT) you just completed:

6. What was the result on your first round? (of completing the entire test). To identify what is your result, see figure above! *

7. What was the result on your second round? (Optional) if you want to make the test more than once

8. What was the result on your third round? (Optional)

9. Did your result(s) surprise you? Why/why not?

10. Did you have any female role models (parents, elderly relatives or the like) who work in any STEM (science, technology, engineering, maths) profession growing up? *

Mark only one oval.

- Yes
- No

11. Did you have any male role models (parents, elderly relatives or the like) who work in any Liberal Arts profession growing up? *

Mark only one oval.

- Yes
- No

12. Do you have any comments/ideas/reflections of the test, the questions, and/or its implication in teaching and learning in higher education?

13. Do you have any ideas on how to reduce implicit bias or the effects from implicit bias at the university?

14. Thank you very much!!

Appendix 4 - Accompanying E-mail

The following is the e-mail sent out to our potential participants. For those participants approached in person, similar information was given.

Hi! We are a group of PhD students currently taking the introduction to teaching and learning in higher education-course.

In this course, our project work is to investigate the impact of implicit gender bias in higher education settings by conducting a small study in which we need participants. We want the participants to complete a brief questionnaire, and conduct a small association test, it will take you about ***10-15 minutes to complete.***

To participate, you need to have ***teaching experience.*** The test and the questions are in ***English*** but you can write the answers in Swedish if you wish.

The test and its associated short questionnaire can be found here: https://forms.gle/pFVrPYuUCeUHnPsd8

Please ***follow the instructions*** provided in the Google forms questionnaire closely, especially on which test to choose on the external website. E-mail us (xxxxx.xxxxx@xxx.lth.se) would there be any unclarities. However, please note that you can press "decline to answer" on all questionnaire-questions ***on the actual test website*** (not in the google forms) if you wish to save some time 😊

Thank you so much!!

//Josefin, Jakob, Joakim, Benjamin and Axel