

## Mathematics

Course: Mathematics

Group of courses: Mathematics, Natural Sciences

Provided by: Prof. Dr. Andrea Blunck

Last edit: Prof. Dr. Andrea Blunck, July 2018

### Table of contents

<b>Course objectives</b> .....	2
<b>Teaching content/subject-specific gender studies content</b> .....	2
<b>Integration of gender studies content into the curriculum</b> .....	4
<b>Degree Stage</b> .....	5
<b>Basic Literature/Recommended Reading</b> .....	5

## Course objectives:

The integration of gender aspects into mathematics curricula primarily aims at making students aware of the significance of gender as an issue in mathematics. Linked to this integration is a reflection of mathematics as a discipline influenced by cultural and historical contexts. Such reflection also serves to convey a broader picture of mathematics and possibly provides a special motivation for women to study maths.

Gender competence as a key qualification related to the professional practice is of relevance for the later professional life of mathematicians, e.g. with regard to establishing a gender-sensitive work environment. Gender competence is of particular importance for mathematics teachers since mathematics education should be gender-sensitive in all its facets (from teaching concepts to the behaviour of teachers in the classroom).

Gender competence implies on the one hand knowledge about gender in general and gender aspects of mathematics in particular and on the other hand the ability for (self-)reflection regarding attitudes towards and stereotypes on mathematics and gender.

## Teaching content/subject-specific gender studies content:

Mathematics as a "strictly logical", "objective" science is difficult to access for gender research. To analyse it from a gender perspective, mathematics must be put into a more general context and an "external", e.g. historical, sociological or pedagogical, perspective should be taken. Here, the focus of research is usually on "women (and men) in mathematics" or "girls (and boys) in maths education".

In the following, two subject areas regarding "women (and men) in mathematics" are presented, which can provide important teaching content of gender-related mathematics. Some critical approaches to gender-related mathematics research that go beyond studying are presented. The practical field of classroom lessons and its content with a special focus on didactics will be dealt with at the end of this section.

### Mathematics as a field of study and work of women and men

Starting point are first of all numbers and facts, i.e. current statistics on the share of male and female students of mathematics and of professional mathematicians (e.g. in academics) in Germany and worldwide and in comparison to other subjects.

Several studies that have been conducted in Germany over the past years provide detailed analyses of gender aspects in mathematics taking sociological or socio-psychological approaches. For example, students of mathematics were asked about their attitude towards the subject, on how they assess their own performance and about their career planning, etc. Results show gender differences as well as (larger) differences among students of different degree courses (teaching mathematics, diploma/Bachelor and Master). There are fewer female than male students who decide to do a doctorate in mathematics, among other reasons because it does not seem to be a safe choice. In addition, career paths of graduates and wage differences or difference with regard to areas of activity were explored and comparisons with graduates of other subjects such as physics were made.

Another renowned study deals with successful women in mathematics and the conditions that have

made their careers possible. Results of the study based on interviews with 65 female mathematics professors in Germany (and habilitated lecturers with a permanent position) show that most of these women had been promoted at an early stage of their studies and had access to a mathematical working group. At the same time, many of these women pointed out that they experienced discrimination throughout their careers.

An international comparison is not to be missed. The share of women in mathematics is not as (relatively) low in all countries as it is in German-speaking countries. Various reasons for this have been discussed in the respective literature.

### **Women in the history of mathematics**

The history of mathematics has seen a number of women who have made significant contributions. Historical research on women in mathematics has revealed many of these scientists and their mathematical achievements. Today, there are numerous biographies of female mathematicians available dealing with the lives and achievements of these women, including the obstacles they had to overcome. A new biography on Emmy Noether points out the relationship between her outsider status as a woman in mathematics and her unusual teaching and research methods.

There are also group biographies, e.g. on the first female doctors of mathematics in Germany, that are embedded in a comprehensive account of the specific difficulties women have dealt with in the subject (e.g. access to study courses). For example, non-Germans were the first women to study mathematics in Germany, demonstrating that women can be successful in mathematics.

The history of women in mathematics must always be linked to the history of scientific institutions and working practices (universities, academies, publications) and the exclusion of women from institutionalised science. Furthermore, access to education is also a crucial topic, e.g. examples of the history of mathematics education especially for girls.

### **Gender-critical approaches to mathematics**

In German-speaking countries, the UK and the US, mathematics is considered a male discipline. The male image of mathematics and the lack of interest many girls and women show for this subject are mutually dependent. Research often speaks of a "vicious circle". Occasionally, the question is raised, whether and to what extent the discipline itself adds to this, as the predominantly male subject culture and ways of teaching math in school are regarded as influencing factors.

Feminist criticism of natural science (also referred to as Gender in Science) deals with the question of the extent to which gender is an influencing factor in natural sciences and research. This question has been successfully explored in other disciplines, e.g. biology and physics. A gender approach to mathematics seems to be more difficult. A possible approach could be studies that explore "typically female" activities as possible sources of mathematics, e.g. pattern weaving as a starting point for the (seemingly) inapplicable arithmetic of Euclid. In ethnomathematics, for example, mathematical activity that is implied in art and craft – fields with many female "experts" – is subject to analysis.

### **Mathematics education and gender**

Knowledge of mathematics education and gender is indispensable in school practice. Various study results from subject didactics and related disciplines are available here. Comparison studies of student performances such as TIMSS and PISA have found gender differences in math performance as well as in students' attitude towards math. In Germany and most other countries, boys achieve better

performance and have a more positive attitude towards mathematics, less mathematical anxiety, a better self-concept, etc. However, there are also countries in which this is different. Analyses show a correlation between the gender gap index of a country and the gender differences in mathematics performances identified by PISA.

These gender differences have been widely discussed in research literature and are explained with gender stereotypes among parents, teachers, peers, in teaching methods and materials as well as with unconsciously 'doing gender' in maths education. Furthermore, there are approaches for gender-sensitive math education concepts, often following didactic approaches for "good mathematics education" (variety of methods, embedding in everyday contexts, etc.) and ways that enable teachers to reflect on their own behaviour and their own (implicit) assumptions.

## **Integration of gender studies content into the curriculum:**

Gender modules can be integrated into mathematics curricula in various forms.

If history of mathematics (or similar) is provided/eligible:

- Module "Women in the History of Mathematics": This module should be offered as seminar or lecture, presenting the life and work of female mathematicians, embedded in a presentation of the history of mathematics, the history of scientific institutions, and especially the history of women's education. The focus of the course may also be on mathematical content, and accompanying exercises could deal with mathematical topics that refer to the research fields of selected female mathematicians.

If modules on mathematics and society (or similar) are provided/eligible, courses with a gender focus could also be offered, preferably in the form of a seminar. With regards to methods, presentations could be combined with group work, discussions of texts and other forms of teaching/learning. Possible seminar topics are:

- Seminar "Women and Mathematics": Possible contents: Women in mathematics in past and present, women in the history of mathematics, history of women's education, beginning of women's studies in Germany and first female graduates of mathematicians, history of mathematics education (for girls), facts and figures on women in mathematics today (e.g. at the students' university), career paths of female mathematicians, international comparison, gender stereotypes in mathematics textbooks, the male image of mathematics.
- Seminar "Mathematics and Gender": An interdisciplinary seminar with students from mathematics as well as from the humanities or social sciences (students of gender studies, if available) to discuss issues from different perspectives and different knowledge backgrounds. Possible contents (besides women and math): What is gender? What is mathematics? Feminist epistemology and critical gender-related approaches to mathematics.

The modules mentioned above are suitable for both the mathematics degree course and the teaching mathematics degree course. Especially in the teaching mathematics curriculum, gender modules can be included (also in cooperation with didactics), e.g.:

- Seminar "Mathematics Education and Gender": Since methodological variety is regarded as an important contribution to gender-sensitive mathematics education, we recommend using many different teaching methods in the seminar (e.g. jigsaw technique, museum tour). Another

possibility is that groups of students set up a small, gender-sensitive teaching unit. A possible form of examination could be putting together a portfolio of collected and annotated learning outcomes.

Gender may also be treated as a cross-cutting topic in other mathematics courses. The integration of gender topics into mere maths courses is rather difficult to imagine. Here, however, it is recommendable and desirable to point out the contribution of women to certain aspects of mathematics. If "meta-mathematical" modules such as history of mathematics, mathematics and society etc. are provided/eligible that aim at reflecting on the subject, gender issues such as those mentioned above may be included here. For example, the history of women in mathematics could be a (recurring) topic in lectures or seminars on the history of mathematics, or certain female mathematicians could be introduced. In modules on mathematics and society (or similar), issues of ethnomathematics can be dealt with, putting traditional maths-related female activities into focus. A comparison of career paths of female and male mathematicians is another possible topic.

In mathematics didactics gender is obviously a cross-cutting issue. Thus, mathematics education and gender should be dealt with in introductory modules.

## **Degree Stage:**

Gender can be implemented as a cross-cutting topic from the first year of study onwards. Gender modules are recommended at both Bachelor's and Master's level. Courses that aim at a reflection of the subject may only make sense from the second year onwards. Courses that focus on mere mathematical content (and especially their repetition/refresher courses) should be offered at a later stage of studies.

## **Basic Literature/Recommended Reading:**

- Abele, Andrea E./Neunzert, Helmut/Tobies, Renate (2004): Traumjob Mathematik! Berufswege von Frauen und Männern in der Mathematik. Basel, Boston, Berlin: Birkhäuser Verlag.
- Blunck, Andrea/Pieper-Seier, Irene (2008): Mathematik: Genderforschung auf schwierigem Terrain, in: Ruth Becker, Beate Kortendiek (Hrsg.): Handbuch Frauen- und Geschlechterforschung. Theorie, Methoden, Empirie. Wiesbaden: VS-Verlag,
- Budde, Jürgen (2008): Mathematikunterricht und Geschlecht. Empirische Ergebnisse und pädagogische Ansätze. BMBF (Hrsg.) Bildungsforschung Band 30. Bonn, Berlin.
- Curdes, Beate/Jahnke-Klein, Sylvia/Lohfeld, Wiebke/Pieper-Seier, Irene (2003): Mathematikstudentinnen und -studenten – Studienerfahrungen und Zukunftsvorstellungen. NFFG Wissenschaftliche Reihe Band 5. Norderstedt: BoD.
- Curdes, Beate/Marx, Sabine/Schleier, Ulrike/Wiesner, Heike (Hrsg.) (2007): Gender lehren – Gender lernen in der Hochschule. Konzepte und Praxisberichte. Oldenburg: BIS-Verlag der Carl von Ossietzky Universität Oldenburg.
- Flaake, Karin/Hackmann, Kristina/Pieper-Seier, Irene/Radtke, Stephanie (2006): Professorinnen in der Mathematik – Berufliche Werdegänge und Verortungen in der Disziplin. Wiesbaden: VS-Verlag.
- Jahnke-Klein, Sylvia (2001): Sinnstiftender Mathematikunterricht für Mädchen und Jungen. Baltmannsweiler: Schneider-Verlag Hohengehren.
- Koreuber, Mechthild (2015): Emmy Noether, die Noether-Schule und die moderne Algebra. Zur

Geschichte einer kulturellen Bewegung. Berlin. Heidelberg: Springer Verlag.

- Lenzner, Andrea (2006): Women in Mathematics. A Cross-Cultural Comparison. Münster, New York, München, Berlin: Waxmann.
- Tobies, Renate (Hrsg.) (2008): „Aller Männerkultur zum Trotz“ – Frauen in Mathematik, Naturwissenschaften und Technik. 2. Aufl. Frankfurt/M., New York: Campus.