Physics

Course: Physics
Group of courses: Mathematics, Natural Sciences
Provided by: Prof. Dr. Monika Bessenrodt-Weberpals
Last edit: Prof. Dr. Monika Bessenrodt-Weberpals, July 2018

Table of contents

Course objectives:

Students know the theoretical basis, empirical findings and methodological concepts of women's and gender studies in relation to physics. They are able to develop and evaluate the significance of the category of gender for physics. In particular, they can apply their knowledge about approaches and methods of gender justice to their work in physics and are able to participate in subject-specific discussions and to take responsibility in teams.

Teaching content/subject-specific gender studies content:

Women's and gender studies in physics focus on the issue of interactions between gender relations in society and the content and methods of physics.
The (patriarchal) science of physics displays a lack of self-reflection by making its object absolute, losing any physical contact between the subject, the scientist, and his or her object, and by instrumentalising physics as hegemonic knowledge. The result is the "Oppenheimer effect": Robert Oppenheimer claims that he did not realise he had invented the nuclear bomb, because he said the product had taken on a life of its own. Additionally, physics tends to overvalue the intellectual and assertive aspects of students and teachers, rather than integrating their entire personalities. In line with Werner Heisenberg's dictum "science is made by human beings", physics should be a place of life, experience and action, not just one of intellectual cognition. Thus, the scientist can approach his or her subject of research to make first-hand discoveries.
These are the challenges that women's and gender studies have pursued in the history and practice of physics and in empirical research. First, there is the question of women's participation in physics and in the sciences (women in science). Second, possible consequences for the choice and presentation of physical subjects, methods and perspectives have to be analysed as well as fundamental questions of objectivity, value freedom and the validity of scientific knowledge (gender in science).

In the field of the history of (natural) sciences:
Natural sciences focus on nature and the cosmos; physics in particular deals with the behaviour of inanimate matter. Physics attempts to reduce the many different phenomena to a limited number of basic laws and natural elements. This knowledge is the result of a complex process of speculation, experimentation and discovery over the centuries. Physics is often seen as a man's field, although women have always played key roles in the discipline. In ancient times women were inventors, gatherers and healers and in the modern day women are professors of physics or even Nobel prize winners. Yet, the more important the work of physics has become in society, the more systematically society has devalued and hindered the discoveries of women physicists, or even ascribed them to men.

- In antiquity, both women and men carried out scientific practice. We have proof of 17 female Pythagoreans. Paradigmatically, Hypathia of Alexandria, a female astronomer, has to be mentioned.
- In the middle ages, women attempted to combine science and theology. One example is Hildegard of Bingen.
- In the early modern period, a new view of physics emerged in the 17th century. It became popular to take an interest in physics for women, too, provided such interest remained a superficial pastime. Significant female physicists include Laura Bassi in Italy and Emilie du Chatelet in France ("She was a great man whose only mistake was being a woman", a quote that has been attributed to Voltaire). As part of the process of professionalisation, men increasingly appropriated women's knowledge, preferably denying the existence of female

physicists. It is striking that women astronomers, who have pushed their cosmological challenges with patience and endurance, are often working along with men (e.g. Karoline Herschel with her brother or Maria Cunitz with her husband).
- In the modern period, female physicists continued to publish under male pseudonyms in the 19th century, but succeeded in emancipating themselves from this convention in the 20th century. Women's share of public recognition, such as awards and prizes, remains very small. In Germany, in particular, the percentage of female physicists holding professorships and seats on committees is below international average.

In the field of (empirical) research, extensive work has taken place. This is particularly related to:

- gender conceptions in physical knowledge
- gender-inclusive physics teaching in school
- gender-inclusive physics studies
- gender-inclusive career orientation

This work increasingly integrates the interaction (intersectionality) of gender and other social differentiations (such as class/social stratum, ethnicity, origin, race, sexual orientation, age, etc.).
Studies relating to the practice of physics in women's and gender studies are very wide-ranging. They analyse gendered effects of mainstream concepts against the backdrop of concepts such as diversity management, developing specific concrete suggestions for new approaches on the basis of this analysis. The aim is to help break down hierarchical gender relations.
Further practice-related studies focus on changing the practice of physics by means of gender mainstreaming, integrating participation models for overcoming gender bias.
A third area of practice-related work is the professional practice of male and female physicists, highlighting gender differences and women's contributions to the development of physics. This provides indications for designing degree courses (by placing greater emphasis on working areas in which women are particularly relevant in professional practice).
The above list of subjects should not be regarded as a conclusive canon of knowledge in the area, but as an indication of the broad spectrum of women's and gender studies in physics. The field is constantly growing and changing and subject to a lively academic discourse. Current discussions focus particularly on the issue of differences between women (and between men) and the intersectionality of various social differentiations, as well as the significance of processes of social construction of gender, which no longer allow simple answers to the question of gender-inclusive physics. It is therefore even more important to integrate social differentiations and hierarchies into the theory and practice of physics.

Integration of gender studies content into the curriculum:

The gender issue is fundamentally relevant to all areas of physics. The above-mentioned competencies should therefore ideally be integrated into all modules. Under the current conditions, however, this is unlikely to take place.
If content related to women's and gender studies in physics cannot be integrated into all modules, offering a "gender module" or gender elements is recommended. In times of digitisation, online resources, especially Open Educational Resources (OER), are of increasing interest.

Such gender elements could be:

1. "Women physicists in the history of physics" – dealing with the historical foundations of women's

studies in physics.
2. "Scientific couples in physics" – covering the history of gender studies in physics.
3. "Scientific critique in physics" – dealing with feminist critique of natural and technical sciences.
4. One or several seminars on "gender-inclusive physics" (e.g. girls and physics, gender-sensitive career orientation in physics, etc.), presenting the empirical findings of women's and gender studies and "gender-inclusive" concepts based on these findings.

Degree Stage:

The above content should be integrated into basic courses (Bachelor's phase). The first module is suitable for the second or third semester, with the other modules following on. More in-depth studies are recommendable for the Master phase.

Additional competencies offer further possibilities to connect. Competence-oriented learning, teaching and examining offer opportunities for gender-inclusive physics putting the interests of all students into focus instead of acting normatively. In line with the concept of constructive alignment, competence-oriented learning, teaching and examining focus on the learning objectives choosing appropriate teaching, learning and examination scenarios. Competency orientation aims to encourage greater self-reflection and self-responsibility among students and to promote a change of roles of teachers from "knowledge broker" to "learning coach". Activating and context-oriented learning scenarios enable students to develop their competencies in gender-sensitive physics more individually and to transfer them to interdisciplinary topics such as those mentioned above through communication and interaction with others in team-oriented projects.

- An exemplary lesson plan
- An exemplary summerschool curriculum about diversity in the dultures of physics

Basic Literature/Recommended Reading:

- Karen Barad: Meeting the Universe Halfway: Quantum Physics and the Entanglement of Matter and Meaning. Durham: Duke University Press (2007).
- Ilse Bartosch: Entwicklung weiblicher Geschlechtsidentität und Lernen von Physik - ein Widerspruch? Münster: Waxmann (2013).
- Robin Bauer und Helene Götschel: Gender in Naturwissenschaften. Ein Curriculum an der Schnittstelle der Wissenschaftskulturen. Mössingen-Talheim: Talheimer Verlag (2006).
- Monika Bessenrodt-Weberpals: Physikerinnen in Deutschland: Potenzial und Fakten. Phys. J. 2,11 (2003).
- Monika Bessenrodt-Weberpals: Reflexive Koedukation im Perspektivrahmen Sachunterricht in der Grundschule. In: Lisa Glagow-Schicha (Hrsg.): Schule im Gender Mainstream. Denkanstöße – Erfahrungen – Perspektiven. Düsseldorf: Ministerium für Schule, Jugend und Kinder NRW (2005)
- Monika Bessenrodt-Weberpals: Geschlechtergerechte Lehre in der Physik. Kontextorientiertes Lehren und Lernen in Naturwissenschaft und Technik. In: GeZeitenwechsel. Oldenburg: BIS-Verlag (2006).
- Martina Erlemann: Menschenscheue Genies und suspekte Exotinnen. Mythen und Narrative in den medialen Repra?sentationen von PhysikerInnen. In: Torsten Junge & Do?rthe Ohlhoff (Hg.): Wahnsinnig genial. Der Mad Scientist Reader. Aschaffenburg (2004).

- Helene Go?tschel: Die Welt der Elementarteilchen. Geschlechterforschung in der Physik. In: Smilla Ebeling & Sigrid Schmitz (Hg.): Geschlechterforschung und Naturwissenschaften. Einfu?hrung in ein komplexes Wechselspiel. Wiesbaden (2006).
- Helene Go?tschel: Image, Fachkultur und Wissen. Wechselwirkungen zwischen Physik und Gender. In: Corinna Bath, Go?de Both, Petra Lucht, Ba?rbel Mauß und Kerstin Palm (Hg.): reboot ING. Handbuch Gender-Lehre in den Ingenieurwissenschaften. Berlin u.a.: Lit Verlag (2015).
- Helene Go?tschel: Queere Physik. In: Martin Lu?cke, Sarah Huch (Hg.): Diversity und Sexuelle Vielfalt als pa?dagogische und didaktische Herausforderung – Anregungen fu?r die schulische Praxis und die Lehrer_innenausbildung. Bielefeld: Transcript (2015).
- Go?tschel, Helene: Drehmomente fallender Pinguine. Queer-dekonstruktive Perspektiven in der Physik. In: Nadine Balzter, Florian Cristobal Klenk, Olga Zitzelsberger (Hg.): Queering MINT. Impulse fu?r eine dekonstruktive Lehrer_innenbildung. Leverkusen-Opladen: Budrich UniPress 2016.
- Petra Lucht: Zur Herstellung epistemischer Autorität. Die Konstruktion des Wissenschaftsverständnisses der Physik von DoktorandInnen einer renomierten Universität der USA. Herbolzheim: Centaurus (2004).
- Elizabeth Potter: Gender and Boyle’s Law of Gases. Bloomington/Indianapolis: Indiana University Press (2001).
- Helga Stadler: Konsequenzen aus TIMSS und PISA für einen geschlechtergerechten Physikunterricht. In: Dorothea Kröll (Hg.): Gender und MINT. Schlussfolgerungen für Unterricht, Beruf und Studium. Kassel: Kassel University Press (2010).
- Rita Wodzinski: Ma?dchen, Frauen und Physik – wie kann Unterricht Einfluss auf das Interesse von Ma?dchen an Physik nehmen? In: Dorothea Kröll (Hg.): Gender und Mint. Kassel: Kassel University Press (2010).

Journals:

- Sonderheft "Frauen in der Physik" Physik Journal 2,11 (2003) | Website