International Journal of Gender, Science and Technology
http://genderandset.open.ac.uk

Selected papers presented at the 7th Network Gender & STEM Conference, 18-20 July 2024 in Heidelberg, Germany

In association with

NETWORK GENDER & STEM
educational and occupational pathways and participation

How gender differences divide physics classroom practices: Focus group discussions with teachers and students

Natascha Musters[1], Rian Aarts[1,2], Marije van Amelsvoort[1,3], & Marc Swerts[3]

[1]Tilburg Center of the Learning Sciences (TiCeLS)
[2]Department of Culture Studies (DCS)
[3]Department of Communication and Cognition (DCC)
All part of Tilburg School of Humanities and Digital Sciences (TSHD), Tilburg University, The Netherlands

Corresponding Author* Contact: n.musters@tilburguniversity.edu
ORCID: Musters, Aarts, van Amelsvoort, & Swerts

ABSTRACT

Discrepancies in educational outcomes and school career opportunities between boys and girls exist. Physics has long been perceived as a male-dominated field, with persistent gender differences in participation, performance, and attitudes toward the subject. Despite extensive studies, there is no comprehensive understanding of the inequities in education based on gender. Research comparing physics classroom practices of teachers and students in addressing gender differences is particularly lacking. The personal experiences of teachers and students regarding gender differences in upper secondary Dutch physics education are the scope of this study. Data were obtained from focus group discussions with teachers and students in which their experiences on gender differences in the physics classrooms were discussed. The subjects covered student learning characteristics, teachers and teacher–student interactions and learning materials. Overall, gender differences were mentioned primarily in teacher–student interactions (e.g. girls asking more questions) and in different student learning characteristics (e.g. girls demonstrating more effort, boys overestimating themselves more). Gender differences in learning materials were only addressed by teachers, not by students. Suggested improvements, by students and teachers, for physics classroom practices are discussed. These findings address the aspiration of students and teachers to receive and use practical guidelines for gender equitable physics education in their classrooms.

KEYWORDS: Gender equity; Classroom practices; Secondary education; Physics; Teachers; Students; Qualitative research; Focus groups

How gender differences divide physics classroom practices: Focus group discussions with teachers and students

INTRODUCTION

> "An education system cannot be deemed successful if it does not offer all students the same opportunities or lacks inclusivity." (OECD, 2024a, p.7).

Since the last century, there have been discrepancies in educational outcomes and career opportunities between boys and girls[1] (Buchmann et al., 2008; Matthews et al., 2009; United Nations, 2022; Voyer & Voyer, 2014; Watt & Eccles, 2008). Gender differences in education are a long-standing and ongoing area of study in the Netherlands (Belfi et al., 2015; Coenen et al., 2011; Driessen & van Langen, 2013; van der Vleuten et al., 2016; Woltring & van der Wateren, 2019). According to a study by the Dutch Education Council (Onderwijsraad, 2020), girls progress more positively through secondary education, while boys more frequently repeat a year, drop out, or continue at a lower level. Regarding motivation and attitude toward homework and learning, boys may struggle more than girls (Van Maele et al., 2015), yet in the Dutch physics final exams, boys on average perform better than girls. This was confirmed in our earlier study, in which gender differences were examined in the physics exam results from 2013 to 2019 from a school consortium of 68 schools in the south of the Netherlands (Musters et al., 2024). Boys significantly outperformed girls in terms of grades. These findings indicate a strong association between gender and exam results in physics.

One of the possible explanations for girls' underperformance in physics compared to boys is that physics education programs are lacking, insufficient, or entirely missing measures to address gender equity (Hughes et al., 2020; Traxler et al., 2016). Research regarding equity in education posits that differences in academic performance, if any, cannot be entirely explained by student's background, gender included, and researchers must consider a broader array of factors that present barriers to equitable outcomes (OECD, 2019). To this end, our literature review on gender differences in education focused on factors that are situated within the classroom and on which teachers can have an impact. We focused on these as they are likely amenable to intervention given teachers can potentially implement these practices or address these factors in order to support greater equity. Three frequently mentioned factors came up: 1) students' learning characteristics, 2) teachers and teacher-student interactions, and 3) learning materials. The discussion below of gender differences regarding these factors aims to summarize patterns reported in existing research. These findings should not be interpreted as

[1] *Boys and girls are not the only descriptions of gender (Brickell, 2006). We have adopted the World Health Organization's (World Health Organization, n.d.) definition of gender, which states: "Gender refers to the characteristics of women, men, girls and boys that are socially constructed". We refer to gender-equitable education as a learning environment that provides equal opportunities to all students, regardless of gender.*

implying that all individuals within a gender group are homogeneous or that such differences are innate or universal.

Students' Learning Characteristics

Gender differences in physics education may stem from students' learning characteristics, which relate to the individual's cognitive, affective, and contextual attributes that influence the ways in which they acquire, process, and apply knowledge (Mustafa, 2022). Several studies have shown that girls differ from boys in learning characteristics, in particular effort and motivation, participatory behavior, ambition, and self-efficacy.

Girls tend to show more effort and motivation than boys in the physics classroom (Hazari et al., 2008). Both in general and for science subjects, boys tend to be more performance-driven and competitive (Eccles & Wang, 2016; van de Wetering & Groenendijk, 2019). These differences affect study habits, with girls generally adopting more structured learning strategies for science subjects (Gerstner & Bogner, 2009) compared to boys in general education (Crott, 2011; Van Maele et al., 2015). While girls may put in more effort and strive to achieve their goals more than boys, girls do not always enjoy school more than their male peers (Havik & Westergård, 2020).

Participatory behaviour of students is reported to differ between boys and girls. Boys show more energy in the classroom in general (Woltring & van der Wateren, 2019) and therefore more likely to receive more behavioural feedback (Kelly, 1988; Klapp & Jönsson, 2021); in contrast, girls tend to behave more appropriately and exhibit greater self-discipline (Duckworth & Seligman, 2006). Conducting experiments is a vital part of the physics lesson content, in which specific skills are asked from students (Adams & Wieman, 2015; Hofstein & Lunetta, 2004). Science experiments can contribute to students' improved comprehension of scientific topics, as well as increasing their interest in scientific fields and teaching them practical skills (Pols et al., 2021). While executing and analysing practical experiments, girls tend to step back and let their male partners execute the practical handling (Danielsson, 2012; Day et al., 2016; Doucette & Singh, 2024). Girls also seem to believe that their high school physics course focuses on memorization rather than understanding, with tests based on recall (Hazari et al., 2008). Uncertainty, or the lack of self-efficacy for physics, is indeed often associated with girls (Shumow & Schmidt, 2014). Students think physics requires a lot of talent which girls are more likely to not attribute to themselves (Espinosa et al., 2019; Evagorou et al., 2024; Kalender et al., 2022). Kalender et al. (2019) concluded that even when women in their first year of university physics perform equally well as men, they reported considerably poorer self-efficacy in physics. Despite these beliefs and perceptions, however, ambition for physics, or the deliberate choice to commit to physics after the obligatory phase, is more prevalent for girls than for boys. The findings of Van der Vleuten et al. (2016) show that choosing STEM subjects (like physics) is becoming more acceptable for girls in the Netherlands. Girls choose STEM subjects mainly to be able to study medicine and healthcare (Qompas, 2025).

Collectively, these studies outline students' motivation, participatory behaviour, ambition, and self-efficacy as potential explanations for the gender differences seen in physics education. Girls generally show more commitment and structured learning strategies than boys. Boys tend to report stronger self-efficacy in physics, but girls tend to have clearer future plans which may make them more focused in the physics classroom.

Teachers and Teacher-Student Interactions

In the physics classroom, gender differences can also arise from the way teachers interact with boys and girls. Here, interactions are considered in a variety of different ways. One relevant form of interaction is question asking and how teachers respond to students. Students asking questions plays a crucial role in learning in general: it stems from curiosity, deepens understanding and encourages critical thinking (Bean & Melzer, 2021). However, there are gender differences in the frequency and nature of questions students ask. Boys tend to ask questions more easily in science classes, often focusing on technical details and problem-solving strategies, while girls are more likely to ask conceptual, clarifying and confirmatory questions (Eliasson et al., 2016; Wambua et al., 2015). There can also be gender imbalances in how teachers' behaviours and responses towards students (Van Houtte, 2025) that can impact students' interest and pursuit of STEM careers (Evagorou et al., 2024). Boys receive more praise than girls, more academic criticism, more complex questions and more instructional encounters. When a teacher asks a question, boys are far more likely to answer in a loud voice and girls are equally likely to answer but are heard less by their teachers (Kelly, 1988; Klapp & Jönsson, 2021). Male science teachers interact more with boys rather than girls (Eliasson et al., 2016). Stadler et al. (2000) discovered that girls answer more to open questions (longer phrasing which may be more challenging for the teacher to take up) while boys answer more closed questions (shorter answer in technical terminology).

In sum, research on interactions shows gender-based interaction patterns in physics classes. Boys and girls differ regarding the kind of questions they ask, the kind of questions they answer and how they answer them. In addition, there seem to be gender biases in how teachers interact, for example in how they ask questions, give room to student contributions and praise students.

Learning Materials

Learning materials are resources used directly by the teacher, by the whole class, and by the students individually. In science, examples are (digital)boards, instructional videos, (demonstration) lab materials, textbooks, worksheets and tests. These learning materials can potentially be gender-biased. For example, there is some evidence that gender representation in learning materials is not equal. Higher male representation was found in the Netherlands in mathematics textbooks for first-year students in secondary education (van de Rozenberg et al., 2023) and in upper secondary physics books (Bax, 2021). The underrepresentation of girls in science textbooks may strengthen gender-stereotypical views on STEM, have a negative influence on girls' understanding of physics (Good et al., 2010) and the likelihood of pursuing a career in STEM (Driessen & van Langen, 2013).

Next to images and representations, the extent to which physics content aligns with students' personal interests also plays a role in gender differences. In the Netherlands, there is a fixed content for physics, which is set out in the national syllabus (College voor Toetsen en Examens, 2023). However, some of these are optional modules which may be chosen by the school/teacher (e.g. geo physics or relativity). Reid and Skryabina (2003) concluded that adjusting the physics syllabus by taking the preferences of girls towards certain topics into account, can keep them more committed. For example, Reid and Skryabina found that girls showed a higher level of interest than boys in the topic "earthquakes". In their study on mathematics education, Zohar and Gershikov (2008) concluded that the context of an assignment, which is the story around a task, can influence girls' performances. The authors argue that this context can be interpreted as more masculine (e.g., cars and airplanes) or feminine (e.g., dolls, clothes and jewelry). Zohar and Gershikov (2008) advised to use gender-neutral contexts (e.g., animals, plants and fruits) because these had no negative effects on boys or girls. Taken together, the evidence reviewed here seems to suggest that learning materials often exhibit gender bias through unequal representation and topic selection that is more attuned to boys, which may thereby negatively influence girls' engagement and performance in STEM.

The Present Study

Despite these previous studies that report on gender differences in education, we lack sufficient insight into the actual experiences of physics teachers and students themselves regarding gender differences in their classrooms (Bustamante et al., 2024; Masri et al., 2024). What appears to be missing is more detailed information, both from a teacher and student perspective, on the actual experiences and preferences regarding gender-related issues in physics classes. To deepen our understanding of how learning characteristics, interactions and learning materials may explain gender differences in physics education, we investigate personal experiences of Dutch upper secondary physics teachers and students regarding these factors.

In the Netherlands, physics is an obligatory subject for lower grades in the two highest levels of secondary education: pre-university education (VWO) and senior general secondary education (HAVO). Students have the option to (dis)continue physics in their fourth year (grade 10). Our study focuses on the education for students from their fourth year onwards who have made the choice to pursue physics education.

Contrary to past studies that were mostly based on questionnaires distributed among various populations (e.g., Gray & Leith, 2004), we collect more in-depth data on personal experiences of Dutch upper secondary physics teachers and students in focus groups. In these groups, gender issues in real-life education from participants' own experiences and means to enhance gender equitable physics education are discussed. The added value of this research method was that group discussions offered the opportunity for the participants to be more open and nuanced, as well as to complement and build on the contributions of others in an environment where it was safe for these discussions to take place. Through this method, we seek answers to the following research questions:

> **RQ1:** Which experiences of gender differences in current classroom practices are indicated by teachers and students in upper secondary physics education?
>
> **RQ2:** Which interventions for the classroom context are suggested by teachers and students to create a more gender equitable upper secondary physics education?

METHODS

Design

A qualitative methodology is employed in this study. To gain insights into the personal experiences and educational practices concerning gender differences, we used a semi-structured approach of focus groups (FG) (Bagnoli & Clark, 2010).

Participants & Procedure

To obtain insight from both educational providers and learners, six FGs were conducted, each of which consisted of either students (see Table 1) or teachers (see Table 2). Each focus group consisted of two to four persons. In compliance with the ethical guidelines of the author University, informed consent was obtained from all participants in this study. Participation in the study was voluntary.

All students attended the highest level of Dutch secondary education (pre-university secondary education, called VWO) in the same school. Students were divided into three focus groups, based on their availability. Participating students (n=12) were approached in class and could sign up through their own physics teacher. FGs with students were conveniently organized on the students' school premises. The one-hour sessions were video- and audio-recorded and were (roughly) transcribed using the software tool Amberscript (amberscript.com, n.d.). These rough transcripts were checked manually, based on the original video- and audiotapes and the notes of the moderator.

Teachers, who were recruited from different schools and geographical areas, were divided into three focus groups, based on gender and availability. Participating teachers volunteered after calls on the Dutch Facebook-page for physics teachers ("Vaksteunpunt Natuurkunde") and via the personal LinkedIn page of the first author. Some of the teachers also participated in our earlier questionnaire (Musters et al., 2024) or volunteered directly with the researcher. FGs with teachers were organized online in order to allow all teachers to participate (and not spend time travelling). We used Microsoft Teams (provided via Tilburg University) to organize these one hour sessions. Via this platform we recorded the sessions and made transcriptions, which were checked afterwards.

Table 1. *Descriptives of students in the focus groups*

		FG1	FG2	FG3	Total
		n=4	*n*=4	*n*=4	*n*=12
Gender	Girl	1	2	3	6
	Boy	3	2	1	6
Grade	10 (4th year)	2	4	3	9
	11 (5th year)	2		1	3
Average Physics score*		6.5	5.7	5.2	5.8

**At time of the FG (On a scale from 1 to 10)*

Table 2. *Descriptives of teachers in the focus groups.*

		FG4	FG5	FG6	Total
		n=3	*n*=4	*n*=2	*n*=9
Gender	Female	3	2		5
	Male		2	2	4
Teaching qualification*	First degree	2	3	2	7
	Second degree	1	1		2
Teaching experience	6-10y	2			2
	11-20y	1	1		2
	21-30y		2	2	4
	> 30y		1		1

**First degree teaching qualification is required to teach in Dutch upper secondary education and can be obtained through a professional or university master's program. Second degree teaching qualification is required to teach in lower Dutch secondary education and can be obtained through a professional bachelor's program* (Onderwijsloket, 2023).

Method

The group interactions were stimulated by a PowerPoint presentation created by the research team, that contained citations/data from research articles, outcomes of our previous questionnaire (Musters et al., 2024) and graphics. The same presentation was used for all six FGs. To answer RQ1 we started with content on students' learning characteristics, teachers and teacher-student interactions, and learning materials. Figures 1-4 show examples of the slides of the presentation used to stimulate responses to address RQ1. For all slides, participants were asked to observe, describe, interpret, and discuss what they saw on each slide.

Figure 1. *Example of slide 1 used to illustrate general gender differences and stereotypes (Beck, 2010)*

Figure 2. *Example of slide 2 used to illustrate students' learning characteristics (Bolan & Bouderdaben, 2015).*

Figure 3. *Example of slide 3 used to illustrate teachers and teacher-student interactions (iStock, 2020).*

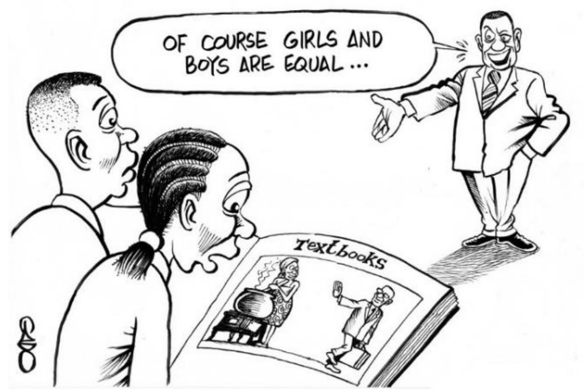

Figure 4. E*xample of slide 4 used to illustrate learning materials (UNESCO, 2018).*

In the first slide (Figure 1), a stereotyped idea of gender differences is depicted. After discussion, participants were asked to ultimately decide whether they agreed with the content. The second slide (Figure 2) focuses on students' learning characteristics. For this slide, participants were asked to discuss whether they experienced this situation in their physics classroom and what they thought might be the cause of these gender differences. The third slide (Figure 3) focuses on teachers and teacher-student interactions. The fourth slide (Figure 4) focused on learning materials. On this third topic also, participants were asked to observe, describe, interpret and discuss the content.

We then continued with the last part of the focus group discussion, which was focused on RQ2. Teachers and students were asked to think about suggestions to create a more gender equitable physics education. Figure 5 shows the image that was used as the starting point for a discussion on the meaning of equity and on how to achieve this in classroom.

During the focus group discussions, participants were given the opportunity to respond directly to the material, but also to each other's responses. Given the format of an FG, there were opportunities to talk more deeply and to complement each other. The first author was the moderator of the FG, who - being an upper secondary physics teacher herself - could directly relate to the physics teachers which minimized possible moderator bias (Smithson, 2000). The moderator was also not the teacher of the participating students. To ensure all the groups had the same content and flow, the moderator was the same person for the teachers and students.

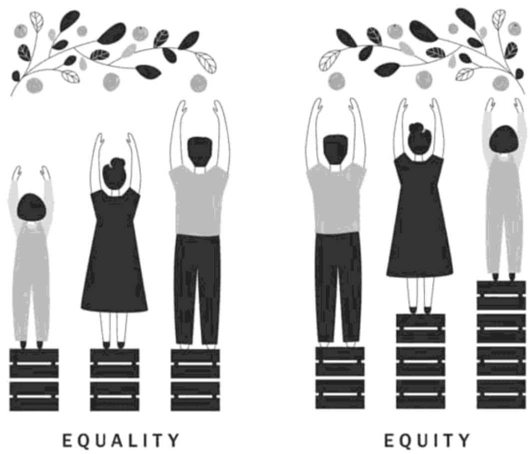

Figure 5. *Slide used to stimulate discussion and suggestions for more gender equity in physics education (Shutterstock, 2020).*

Data Analysis

Transcripts of the group discussions were analysed using an inductive coding approach. We started, using Atlas.ti (Mohr, 1993), by selecting quotations that were relevant for answering the RQs (558 quotations). Codes were assigned to the quotations using a grounded theory approach (182 codelabels, 749 codings). Some quotations were double coded as they fitted more than one theme. Subsequently, we categorized the codes into overarching themes. It then became clear that the overarching themes were closely linked to the factors we derived earlier from the literature: (1) student learning characteristics, (2) teachers and teacher–student interactions and (3) learning materials.

To establish interrater reliability, a random sample of 20% of the quotations were coded independently by both the first and second author (Friese, 2019). Initially, this first round of coding by two persons was unsatisfactory (<50%, by Cheung & Tai, 2023; Hallgren, 2012). When comparing the codings, we found inconsistencies in the code labels, which might have caused the insufficient interrater reliability. We then aligned the code labels, combining very similar codes that had different wordings, and defined the number of codings to be given for each quotation. In a second round of coding, we used a sample of quotations from one focus group discussion (15% of the total sample) instead of a random sample from different focus groups. Given that the reliability was still substandard at only 58% agreement, we did a last round of recoding. In this round we did not code independently, but we compared the codings of the second round, discussed them in order to come to agreement, improved code labels and made the necessary recodings. Discussions and further rounds of (re)coding were conducted until sufficient agreement (>90%) was met (>70% by Cheung & Tai, 2023; Hallgren, 2012).

RESULTS

In the following sections, we discuss the experiences of participants on the three factors that were retrieved from the literature and which were also established in the coding procedure: 1) students' learning characteristics, 2) teachers and teacher-student interactions and 3) learning materials. These codes are explored via statements from students and teachers. Please note that the quotes provided below are literal translations from Dutch to English. As stated before, we focus on issues that occur in the physics classroom and that can be influenced by teachers by making interventions in their teaching practice. Tangential discussion topics (e.g., reasons to choose the subject of physics, brain development and public perceptions of boys and girls), are therefore not taken into account in this section. In total, in the transcripts we found 558 quotations which concerned gender differences in the classroom. In these quotations, we made 749 codings (one quotation could receive more than one coding) which were then assigned to 182 different code labels. We will provide the number of codings that were assigned per theme. These quantitative data are supplementary and aimed at giving an impression of how often participants talked about a subject.

RQ1: Current physics classroom practices and interactions

Students' Learning Characteristics

48% of all utterances (270 quotations, 361 codings) were related to the learning characteristics of students. Within this factor, we distinguished four themes: 1) effort and motivation, 2) participatory behaviour, 3) ambition, and 4) self-efficacy

Gender differences were experienced concerning effort and motivation (90 codings in this theme), where – based on the literature discussed in the introduction - motivation refers to the internal drivers of learning behaviour, while effort represents the enacted investment of time and energy (Cook & Artino, 2016; Van Iddekinge et al., 2023). The results of our FGs indicate that girls are more likely to show higher effort during lessons (29 codings), while boys show their effort later, mainly at (important) tests or at the final exams (11 codings). This was mentioned by both students and teachers, and particularly by boys and female teachers. These stances are illustrated via the quotes below.

> *In general that boys just put less effort in because maybe they already understand better … girls just try really hard and then get slightly higher scores.* (Student, Boy)
>
> *Lots of boys who do not work hard anyway.* (Teacher, Man)
>
> *That you only do your best at the final exam.* (Student, Boy)

> *I think if boys put more time into it, maybe they would get higher grades and I think that girls have a true sense of that and so they really have to work harder to still be at that same level.* (Teacher, Woman)

> *I surprised myself that there are always boys among them who do nothing in class. Where I think, oh, what is that going to be? And then at the end score high grades. Yes, they can learn through self-study, read through it once and do a few exercises.* (Teacher, Woman)

Ambition (45 codings in this theme) denotes students' aspirations and goal orientations regarding future career paths and tertiary education (Khattab, 2015). It reflects the motivational drive to pursue desired academic and professional outcomes. The discussions arising in the focus groups indicated that girls know earlier in their school careers what they want to go for than boys (15 codings). Discussions were about boys who switched to a lower educational level (6 codings, all by female teachers). Later in their school careers, boys seem to get a clearer picture and become more motivated (9 codings). Especially for the final exam. One student elaborates on the shift in motivation for the final exams, where boys seem to do score significantly better than girls. This student (illustrated with the first quote) explains that boys start to work for exams because of what other people (like teachers and parents) tell the students about their effort for physics. The other quotes here appear to confirm this point of view.

> *Boys are told to start learning more and girls are told they are already doing well. Girls, I think, are doing a lot better now in tests. And then, maybe that final exam is just important enough, so that then the boys will learn after all and the girls will just keep doing a little bit of the same, or do less, because they already think, yes, we know this already.* (Student, Boy)

> *I think relatively speaking, a lot of boys are at a lower level than they can potentially handle.* (Teacher, Woman)

> *So the boys want to go into engineering and then they will do more for the subject with which they are going in that direction, and girls may go in the non-technology direction (healthcare) and therefore make less effort, but they have chosen physics because it is compulsory for their university application.* (Student, Boy)

The theme participatory behaviour contains different topics (119 codings in this theme, of which 51 were by female teachers). A pattern that stood out the most was that teachers described girls more as calm and serious (22 codings) and boys as laid back (15 codings, 13 by females). Another topic addressed by students and teachers was that boys seem to seek more attention from the teacher than girls (14 codings). Boys answer teacher questions more often and quicker than girls, as indicated by teachers (7 codings). Coping with physics experiments (35 codings) is a specific part of physics lessons. There were remarkable statements about division of tasks, where boys more often handle the experiment and the girls write the report (12 codings, 9 by students).

> *I did notice that my girls submitted better quality lab reports than the boys... Because they did more thorough research. Those boys just kind of rush... And they put six sentences in there and those girls who really put in the work. ...Well, those guys are taking things more easy.* (Teacher, Woman)

> *Yes especially during the whole class instruction I notice that boys seem to need more attention and then they pay attention to you.* (Teacher, Woman)

> *When I ask a question, I often get an answer from the boys and not the girls.* (Teacher, Woman)

> *If I make a lab report with someone, I usually just do almost everything, because I like to know how it is going to be and so.... Yes, if I work with a girl, she always does the layout because I am not very good at that.* (Student, Boy)

> *When I am going to do an experiment in class, I always say two girls or two boys. Never boy and girl in a mix, because then you just know the boy is going to do the practical work and the girl writes the report. But a girl should be able to do both, just like the boy should be able to write the report.* (Teacher, Man)

The theme self-efficacy received 47 codings. Girls seem more uncertain about physics, or at least express it more, according to teachers (29 codings) and students (7 codings). Stronger self-efficacy for physics is thereby attributed more to boys, mainly by teachers; this attribution sometimes manifests as boys overestimating themselves. However, two male teachers do not experience this gender difference in uncertainty.

> *Girls very quickly have the attitude: I cannot do this and I am never going to be able to do this.* (Teacher, Woman)

> *Girls may need more explanation for physics than boys.* (Student, Girl)

> *When I just started teaching, I entered the exam room and there was a boy who had already finished 1.5 hours early, "easy peasy" he said, and later I checked his score and he had a 4.8. [on a scale of 10]* (Teacher, Man)

> *The boys are like, well you know, I am going to be fine.* (Teacher, Woman)

> *I see insecure, boys, I see insecure girls.* (Teacher, Man)

Teachers and Teacher-student Interactions
37% of all utterances (213 quotations, 277 codings) concerned teachers and teacher-student interactions. Within this factor, we distinguished two themes: 1) asking questions and 2) teacher behaviour.

The theme of asking questions took up most time during the FG discussions (96 codings). Teachers expect a student to ask a question if the lesson content is unclear. However, a variety of reasons and considerations appear to play a role among students on whether or not to ask a question to the teacher, for example anxiety (8 codings), peer pressure (8 codings) and the teacher (13 codings). Girls tend to ask more and quicker questions than boys than boys (22 codings, 16 codings by teachers). Teachers discussed the reasons for girls to ask more questions and raised the idea that girls might ask questions to get confirmation instead of wanting to know more of the physics content.

> *I think girls are more likely to ask questions even though they may not need to. Boys ask less questions* (Teacher, Man)

> *I think if those boys are not in a group, it makes them different, and they dare to ask questions. It may be peer pressure, because he [a male student] himself says, 'I am hugely distracted by my peers.'.* (Teacher, Woman)

> *I do know people who find it really difficult to discuss things during class.* (Student, Girl)

The theme of teacher behaviour received 102 codings. At the start of the discussion, students (8 codings) were very firm in their opinion about their physics teacher:

> *No difference, in our class everyone is treated equally.* (Student, Girl)

However, after exchanging several examples/anecdotes by students, differences in how teachers treat boys or girls were given. Teachers also indicated at first that they themselves treat students equally (9 codings), but after discussing some examples, realized that there were (gender) differences in their class. Calling a boy's name instead of a girl's name more often (8 codings) turned out to be a noticeable issue. One female teacher identifies as a role model for the girls in her classroom through her clothing.

> *I do notice that the teacher engages with girls a lot more often, but then they genuinely ask for something. So that makes sense. The boys, he just kind of leaves us alone.* (Student, Boy)

> *I do recognize that I am addressing boys much more often in my class than girls.* (Teacher, Woman)

> *When I started teaching, I was wearing trousers and jumpers and thought, now I am really giving a very sleazy impression of what you*

> *are like as a female physicist. Then I started wearing dresses, skirts and high heels more often.* (Teacher, Woman)

Learning Materials
3% of all utterances (22 quotations, 26 codings) addressed learning materials. Participants were confronted with a provocative image showing a textbook with very stereotypical roles accompanied by a teacher saying "Of course girls and boys are equal" (Figure 4) and with previous research on overrepresentation of males in schoolbooks. Although confronted by these items, via the PowerPoint, students felt that the current learning materials were adequate (5 codings). Students also stated that learning materials did not affect their experiences regarding gender differences in the physics classroom anyway (8 codings). Teachers, on the other hand, were aware of the gender bias in their learning materials. Teachers experienced gender differences in learning materials (11 codings) and also acted on them during their own lessons. Three teachers created new gender balanced materials.

> *If I may ask, what difference does that actually make to learning and understanding physics? …. Yeah, I do not know I just pay more attention to the content myself than what names are mentioned in a book. It is much more important to me that I understand the physics content than that it says something about a boy.* (Student, Boy)

> *Well, I think this is mainly the example that books are very gender-typical and that those guys in physics books always do the cool stuff and the girl is always the cozy stuff. A girl goes boiling water for tea and a boy goes bungee jumping. It is never the other way around… in terms of ethnicity I already see that there is variation in who does what, but still not in the area of girls and boys.* (Teacher, Woman)

> *Yes or maybe I take things a little over the top because I mainly use pictures with females on them.* (Teacher, Man)

RQ2: Suggested Improvements for Physics Classroom Practices
In addition to discussing experiences on gender differences in the classroom practices and interactions, participants were asked about their thoughts and suggestions for the future physics classroom practice, which amounted to 3% of all utterances (19 quotations, 26 codings). Girls reported that they value the safety of a classroom (8 codings) and so they feel the teacher should maintain control and discipline.

> *During lessons it is very important that a teacher creates a controlled environment, because I notice that when a teacher shows that, then a student who never speaks out about something does feel more inclined to answer a certain question* (Student, Girl)

According to them, learning can only take place when there is a safe classroom climate. Both girls (4 codings) and teachers (2 codings) suggested that one way to accomplish that safe classroom is for the teacher to walk around. Students can then ask questions in a more convenient way.

> *If you have a question, that then the teacher better comes to the student him- or herself and then they can think calmly and ask the question*. (Student, Girl)

Three teachers (4 codings) view girls as more likely to learn physics by making summaries, but they do not think this is the most appropriate method and want to give the girls other options.

> *What immediately strikes me is that when a test week approaches, girls very often start making summaries*. (Teacher, Man)

The involvement and active engagement of the teacher was named by boys (6 codings) as a feature by which a teacher can make a difference.

> *That is another case of having discipline in the classroom. In our case, that woman [teacher] genuinely does not care if you are going to do something... So if everything were a little more disciplined, "you are just going to work," that would help with the results and everything, though*. (Student, Boy)

Students and teachers differ in their opinions on treatment: students experience an equal treatment for boys and girls by their teachers (see above) and they think it should be like that (3 codings, 2 by boys). Teachers debated whether it was right to treat all students the same or, on the contrary, to be more inclusive of the gender differences. Teachers are receptive to information and ideas.

> *The teacher used to be the source of information for students ... And nowadays they have YouTube, Google, and ChatGPT. You can ask them anything and they all give you real answers. They can even give you summaries and you name it, so yes..... Where are we going? And, I think that we as teachers have to evaluate our role in this and look at it like, OK, what can I do differently?..... I am open to feedback, or at least additional information for myself, because I think I can get a lot out of it for my classes*. (Teacher, Man)

Our analyses of focus groups discussions have helped us to gain insight in the experiences of teachers and students in the area of gender differences in the physics classroom with respect to 1) students' learning characteristics, 2) teachers and teacher-student interactions, and 3) learning materials. In the following section, we will discuss these results in relation to the established literature and reflect on their implications for enhancing physics classroom practices.

DISCUSSION AND CONCLUSIONS

In our previous study (Musters et al., 2024) we investigated general perceptions of teachers and students on gender differences in Dutch upper-level physics classrooms, by asking them an open question in a questionnaire. The objective of our current study was to dive deeper into the perceptions and attitudes of students and teachers. By discussing their personal experiences with gender differences in the physics classrooms in the setting of focus groups, we obtained more in-depth information, and input for classroom practices.

It was interesting to observe how the FG discussions proceeded. Often a firm position was taken first (e.g., "my teacher treats everyone equally"), then various classroom anecdotes were shared by group members. The subsequent interaction usually led to a situation where the participants agreed on a shared view, which was generally more nuanced than their initial positions (e.g., "In some cases, my teacher treats boys and girls differently"). Of course, we cannot say for sure that this consensus is based on sharing experiences, as social desirability bias might also play a role.

Our first research question aimed to establish experiences of gender differences indicated by students and teachers in current classroom practices and interactions in upper secondary physics education. Their discussions were coded, categorized into themes and then the themes were assigned to the three factors derived from the literature.

Regarding students' learning characteristics, we found that both students and teachers experience that girls show more effort than boys, which is consistent with Duckworth and Seligman (2006). Different reasons were discussed in the FGs, but one of them, experienced by students and teachers, was that girls have future plans for themselves, or at least clearer ambitions than boys. Teachers added to this that because of their lack of future plans, boys may switch to a lower educational level than they would in principle be capable of. Girls pursue physics in upper secondary education, because it is an obligatory subject for tertiary education such as medicine and healthcare. Teachers reported more effort and motivation by girls, next to typical boys' behaviour in being more attention seeking and more laid back, which is in agreement with work by Woltring and van der Wateren (2019). Gender differences are also apparent from the way boys and girls participate in physics experiments, including how they incorporate theory, problems, graphs, simulations and demonstrations. Although doing experiments is a challenging exercise for students (Adams & Wieman, 2015), teachers observed that boys just start doing without being hindered by uncertainty or fear, whereas girls tend to stick to explicit instructions provided by the teacher and writing the report, which is consistent with Day et al. (2016). Concerning self-efficacy, boys are reported to express greater confidence in their ability to succeed in physics compared to girls. This result is in agreement with prior research, which has shown that, even when performance is similar, female students tend to underestimate their abilities in STEM subjects (Kalender et al., 2019; Shumow & Schmidt, 2014).

Regarding teachers and teacher-student interactions, most striking was the substantial gender difference in the extent to which questions were asked: teachers reported that girls ask more questions to seek confirmation, whereas boys tended to refrain from asking questions because of peer pressure. This outcome is in conflict with the findings of Eliasson et al. (2016) who found that boys interact more with their teacher. Concerning gender differences in teacher behaviour, the ideas changed during the discussion. While students first indicated that their teachers treat boys and girls equally, subsequent discussions revealed that they do experience differences. Likewise, teachers typically usually first stated that there was no gender bias in how they treat students, but, when discussing the outcomes of prior research, often admitted that they address boys more, mostly because of behavioural feedback (see Klapp & Jönsson, 2021). Teachers did not point out that their teaching methods were more suitable for boys or girls but may only have become aware of differences when they were triggered by questions during the FG discussions (Madsen et al., 2013). One female teacher explained that she made conscious and more feminine choices in her clothing style, in an effort to overcome the stereotypical image of a physicist and provide a role model for her female students.

Regarding learning materials, students did not report recognizing gender differences in learning materials and state they just focus on the content. These student outcomes are in line with Good et al. (2010) who also report on the absence of awareness of image content or threat. Teachers, however, do experience a gender imbalance in such materials and try to correct this by creating their own materials, in line with the advice of Zohar and Gershikov (2008).

Our second research question was concerned with possible interventions for the classroom to create a more gender equitable upper secondary physics education. Both students and teachers agreed on the educational merit of students asking questions. In line with Kavatsyuk et al. (2022a) and Kalender et al. (2022), this underscores the importance of an educational environment where students feel safe to ask questions. The underlying reason for asking questions appears to vary between boys and girls. Girls appear to be especially eager to ask questions, because they seek confirmation by their teacher. Boys tend to be influenced by their male peers about whether or not to ask questions. Atanasova et al. (2024) therefore opt to include "gender-inclusive teaching" as a standard in educational practices, in which asking questions is appreciated. Students state that the best way to serve both boys and girls is for the teacher to walk around in the classroom. Teachers indicated a willingness to adapt their teaching methods for the benefit of the students, although they debated whether it would be better to treat all students in the same way or to differentiate because of gender differences. Overall, our findings support earlier claims by Bustamante et al. (2024) that teachers have a huge impact on how inclusive students feel in physics classes. This inclusivity can be achieved through a variety of instructional methods (Murphy et al., 2018), teacher-student interactions and by creating a positive classroom atmosphere, which is beneficial for both boys and girls.

There are important limitations to consider when interpreting the findings of this study. As Belfi (2015) suggests, focusing on individual differences in non-cognitive skills rather than on gender alone may offer a more precise explanation of performance variation. This study did not directly account for such factors, which may limit the extent to which observed experiences in gender differences can be interpreted as reflecting inherent group characteristics. Another limitation of this study is that there was no FG in which both teachers and students participated. Although this group might have given us interesting exchanges between teachers and students, the current set-up, in our view, gave a better guarantee that students (and teachers) have now been able to talk freely. It also appeared not possible to organise student FGs by gender. We did do this with teachers but this approach did not reveal any peculiarities. An additional limitation is self-section bias. It is possible that these results are somewhat biased because participants volunteered to take part in the FGs. As a result, participation was not random, and the self-selected students and teachers may have had prior knowledge or a preconception about the topic. Even though our study's findings are limited to the highest level (VWO) of the Dutch educational system, they nevertheless demonstrate that gender differences in this part of upper secondary physics classes persist and reveal varying experiences between teachers and students. It remains to be seen whether our results can be generalised to other educational levels.

To fully comprehend the distinctions between boys and girls in upper secondary physics classes, more research is required (Rivard & Straw, 2000). This research project's follow-up study will investigate actual practices in physics classrooms with physics teachers in a Lesson Study setting (Chong & Kong, 2012). In addition, we intend to examine gender-related aspects of learning materials. This was reported to be very relevant according to literature but was not mentioned during the discussions in our FGs. Therefore, we will explore and compare physics textbooks within Dutch education. For the longer term, we hope to be able to offer recommendations to physics teachers to make sure their teaching methods promote gender-equity.

ENDNOTES

Funding: This research was funded by the Dutch Research Council (NWO) under Dudoc-Bèta programme with grant number 40.5.22395.005.

Institutional Review Board Statement: This study was conducted in accordance with the ethical guidelines from the Tilburg School of Humanities and Digital sciences from Tilburg University. The study was approved by the Research Ethics and Data Management Committee of Tilburg University on 24 October 2022 with reference code REDC 2021.39.

Acknowledgements: We thank participating teachers and students for their essential input into the focus group discussions. We also thank Ingrid van Hooijdonk for helping with translations of the statements. The authors take full responsibility for the text of this article.

REFERENCES

Adams, W. K., & Wieman, C. E. (2015). Analyzing the many skills involved in solving complex physics problems. *American Journal of Physics, 83*(5), 459–467. https://doi.org/10.1119/1.4913923

amberscript.com. (n.d.). Amberscript. https://app.amberscript.com

Atanasova, S., Robin, N., & Brovelli, D. (2024). Interest, learning opportunities and teaching experience as predictors of professional vision in gender-sensitive physics education*. International Journal of Science Education,* 1-23. https://doi.org/10.1080/09500693.2024.2406528

Bagnoli, A., & Clark, A. (2010). Focus groups with young people: A participatory approach to research planning. *Journal of Youth Studies, 13*(1), 101–119. https://doi.org/10.1080/13676260903173504

Bax, J. (2021). Gender bias in secondary education (Master's thesis). Available from https://dspace.library.uu.nl/handle/1874/403321

Bean, J. C., & Melzer, D. (2021). *Engaging ideas: The professor's guide to integrating writing, critical Thinking, and active learning in the classroom*. Jossey-Bass Inc.,U.S. Retreived from: https://www.wiley.com/en-nl/Engaging+Ideas%3A+The+Professor's+Guide+to+Integrating+Writing%2C+Critical+Thinking%2C+and+Active+Learning+in+the+Classroom%2C+3rd+Edition-p-9781119705383

Beck, M. (2010). *Gender Segregation*. Melinda Beck Studios. https://www.learningforjustice.org/magazine/spring-2010/gender-segregation-separate-but-effective

Belfi, B., Levels, M., & Van Der Velden, R. (2015). De jongens tegen de meisjes: Een onderzoek naar verklaringen voor verschillen in studiesucces van jongens. ROA. ROA Reports Nr. 005 https://doi.org/10.26481/umarep.2015005

Bolan, J., & Bouderdaben, A. (2015). *Gender inequality shown in classrooms, boys left shortchanged*. The Daily Cougar. https://thedailycougar.com/2014/09/24/gender-inequality-shown-classrooms-boys-left-shortchanged/

Brickell, C. (2006). The sociological construction of gender and sexuality. *Sociological Review, 54*(1), 87–113. https://doi.org/10.1111/j.1467-954X.2006.00603.x

Buchmann, C., DiPrete, T. A., & McDaniel, A. (2008). Gender inequalities in education. *Annual Review of Sociology 34*(1), 319–337. https://doi.org/10.1146/annurev.soc.34.040507.134719

Bustamante, V. P., Blomgren, H. E., Walker, D. K., Edwards, J. D., & Frey, R. F. (2024). Exploratory analysis of students' open-ended responses describing their perception of course inclusivity in an introductory physics course. *Physical Review Physics Education Research, 20*(2), 020112. https://doi.org/https://doi.org/10.1103/PhysRevPhysEducRes.20.020112

Coenen, J., Meng, C., & van der Velden, R. (2011). *Schoolsucces van jongens en meisjes in het HAVO en VWO : waarom meisjes het beter doen* Researchcentrum voor Onderwijs en Arbeidsmarkt, Faculteit der Economische Wetenschappen. ROA Reports No. 2 https://doi.org/10.26481/umarep.2011002

Cheung, K. K. C., & Tai, K. W. H. (2023). The use of intercoder reliability in qualitative interview data analysis in science education. *Research in Science and Technological Education*, *41*(3), 1155–1175. https://doi.org/10.1080/02635143.2021.1993179

Chong, W. H., & Kong, C. A. (2012). Teacher collaborative learning and teacher self-efficacy: The case of lesson study. *Journal of Experimental Education*, *80*(3), 263–283. https://doi.org/10.1080/00220973.2011.596854

Cook, D. A., & Artino, A. R. (2016). Motivation to learn: an overview of contemporary theories. *Medical Education*, *50*(10), 997–1014. https://doi.org/https://doi.org/10.1111/medu.13074

College voor Toetsen en Examens. (2023). *Syllabus natuurkunde*. https://www.examenblad.nl/2025/vakken/exacte-vakken/natuurkunde

Crott, A. (2011). *Van hoop des vaderlands naar ADHD' er Het beeld van de jongen in opvoedingsliteratuur (1882-2005)* (Doctoral dissertation). Retrieved from https://hdl.handle.net/2066/91316

Danielsson, A. T. (2012). Exploring woman university physics students "doing gender" and "doing physics." *Gender and Education, 24*(1), 25–39. https://doi.org/10.1080/09540253.2011.565040

Day, J., Stang, J. B., Holmes, N. G., Kumar, D., & Bonn, D. A. (2016). Gender gaps and gendered action in a first-year physics laboratory. *Physical Review Physics Education Research*, *12*(2), 020104_1-020104_14. https://doi.org/10.1103/PhysRevPhysEducRes.12.020104

Doucette, D., & Singh, C. (2024). Gender equity in physics labs. *Physical Review Physics Education Research, 20*(1), 010102. https://doi.org/10.1103/PhysRevPhysEducRes.20.010102

Driessen, G., & van Langen, A. (2013). Gender differences in primary and secondary education: Are girls really outperforming boys? *International Review of Education, 59*(1), 67–86. https://doi.org/10.1007/s11159-013-9352-6

Duckworth, A. L., & Seligman, M. E. P. (2006). Self-discipline gives girls the edge: Gender in self-discipline, grades, and achievement test scores. *Journal of Educational Psychology, 98*(1), 198–208. https://doi.org/10.1037/0022-0663.98.1.198

Eccles, J. S., & Wang, M. Te. (2016). What motivates females and males to pursue careers in mathematics and science? *International Journal of Behavioral Development, 40*(2), 100–106. https://doi.org/10.1177/0165025415616201/FORMAT/EPUB

Eliasson, N., Sørensen, H., & Karlsson, K. G. (2016). Teacher–student interaction in contemporary science classrooms: Is participation still a question of gender? *International Journal of Science Education, 38*(10), 1655–1672. https://doi.org/10.1080/09500693.2016.1213457

Espinosa, T., Miller, K., Araujo, I., & Mazur, E. (2019). Reducing the gender gap in students' physics self-efficacy in a team- and project-based introductory physics class. *Physical Review Physics Education Research, 15*(1), Article 010132. https://doi.org/10.1103/PhysRevPhysEducRes.15.010132

Evagorou, M., Puig, B., Bayram, D., & Janeckova, H. (2024). 'Addressing the gender gap in STEM education across educational levels', NESET report,

Luxembourg: Publications Office of the European Union. https://data.europa.eu/doi/10.2766/260477.
Friese, S. (2019). *Qualitative Data Analysis with ATLAS.ti* (3rd ed.). SAGE Publications Inc.
Gerstner, S., & Bogner, F. X. (2009). Concept map structure, gender and teaching methods: An investigation of students' science learning. *Educational Research, 51*(4), 425–438. https://doi.org/10.1080/00131880903354758
Good, J. J., Woodzicka, J. A., & Wingfield, L. C. (2010). The effects of gender stereotypic and counter-stereotypic textbook images on science performance. *Journal of Social Psychology, 150*(2), 132–147. https://doi.org/10.1080/00224540903366552
Gray, C., & Leith, H. (2004). Perpetuating gender stereotypes in the classroom: A teacher perspective. *Educational Studies, 30*(1), 3–17. https://doi.org/10.1080/0305569032000159705
Hallgren, K. A. (2012). Computing inter-rater reliability for observational data: An overview and tutorial. *Tutorials in Quantitative Methods for Psychology*, *8*(1), 23–34. https://doi.org/10.20982/tqmp.08.1.p023
Havik, T., & Westergård, E. (2020). Do teachers matter? Students' perceptions of classroom interactions and student engagement. *Scandinavian Journal of Educational Research, 64*(4), 488–507. https://doi.org/10.1080/00313831.2019.1577754
Hazari, Z., Sadler, P. M., & Tai, R. H. (2008). Gender Differences in the high school and affective experiences of introductory college physics students. *The Physics Teacher, 46*(7), 423–427. https://doi.org/10.1119/1.2981292
Hughes, R., Schellinger, J., Billington, B., Britsch, B., & Santiago, A. (2020). A Summary of effective gender equitable teaching practices in informal STEM education spaces. *The Journal of STEM Outreach, 3*(1), 1–9. https://doi.org/10.15695/jstem/v3i1.16
iStock. (2020). Gelukkige leraar en schooljongen die elkaar high-five op een klasse geven. - Stockbeeld. https://www.istockphoto.com/nl/foto/gelukkige-leraar-en-schooljongen-die-elkaar-high-five-op-een-klasse-geven-gm1224311229-359937605?searchscope=image%2Cfilm
Kalender, Z. Y., Marshman, E., Schunn, C. D., Nokes-Malach, T. J., & Singh, C. (2022). Framework for unpacking students' mindsets in physics by gender. *Physical Review Physics Education Research, 18*(1), Article 010116. https://doi.org/10.1103/PhysRevPhysEducRes.18.010116
Kalender, Z. Y., Marshman, E., Schunn, C. D., Nokes-Malach, T. J., & Singh, C. (2019). Large gender differences in physics self-efficacy at equal performance levels: A warning sign?. Paper presented at Physics Education Research Conference 2018, Washington, DC. Retrieved November 12, 2025, from https://www.compadre.org/Repository/document/ServeFile.cfm?ID=14804&DocID=4951
Kavatsyuk, O., Ioannou, M., & Avraamidou, L. (2022). Gender-inclusive instructional practices in university mathematics classes. *International Journal of Gender, Science and Technology, 14*(2), 280–295. https://genderandset.open.ac.uk/index.php/genderandset/article/view/1400

Kelly, A. (1988). Gender differences in teacher–pupil interactions: A meta-analytic review. *Research in Education, 39*(1), 1–23. https://doi.org/10.1177/003452378803900101
Khattab, N. (2015). Students' aspirations, expectations and school achievement: What really matters? *British Educational Research Journal*, *41*(5), 731–748. https://doi.org/10.1002/berj.3171
Klapp, A., & Jönsson, A. (2021). Scaffolding or simplifying: Students' perception of support in Swedish compulsory school. *European Journal of Psychology of Education, 36*(4), 1055–1074. https://doi.org/10.1007/s10212-020-00513-1
Madsen, A., McKagan, S. B., & Sayre, E. C. (2013). Gender gap on concept inventories in physics: What is consistent, what is inconsistent, and what factors influence the gap? *Physics Education Research, 9*(2), Article 020121. https://doi.org/10.1103/PhysRevSTPER.9.020121
Masri, A., Ollis, T., & Tytler, R. (2024). "It is just how things are": physics teachers' perceptions about the gender gap in secondary school physics. *Asia-Pacific Journal of Teacher Education*, *53*(1), 80–95. https://doi.org/10.1080/1359866X.2024.2433094
Matthews, J. S., Ponitz, C. C., & Morrison, F. J. (2009). Early gender differences in self-regulation and academic achievement. *Journal of Educational Psychology, 101*(3), 689–704. https://doi.org/10.1037/a0014240
Mohr, T. (1993). Atlas.ti. https://atlasti.com
Murphy, L., Eduljee, N. B., Parkman, S., & Croteau, K. (2018). Gender differences in teaching and classroom participation methods: A pilot study. *Journal of Psychosocial Research, 13*(2), 307–319. https://doi.org/10.32381/jpr.2018.13.02.5
Mustafa, P. S. (2022). Characteristics of learners and their implications in learning. *Al-Ishlah: Jurnal Pendidikan*, *14*(4), 7043–7056. https://doi.org/10.35445/ALISHLAH.V14I4.2751
Musters, N., Aarts, R., Van Amelsvoort, M., & Swerts, M. (2024). Views on gender differences in the physics classroom. *Education Sciences, 14*(5), 457. https://doi.org/10.3390/educsci14050457
OECD. (2019). *PISA 2018 results (Volume II)*. OECD. https://doi.org/10.1787/b5fd1b8f-en
OECD. (2024). *Equity in education and the labour market findings from Education at a Glance 2024* (Issue 107). OECD. https://doi.org/10.1787/b502b9a6-en.
Onderwijsloket. (2023, December 7). *Onderwijsloket - Which teaching qualifications are there in the Netherlands?* https://www.onderwijsloket.com/kennisbank/artikel-archief/teaching-qualifications-in-the-netherlands/
Onderwijsraad. (2020). *Een verkenning van sekseverschillen in het onderwijs.* Report Nr. 20200161/1175 Retrieved from https://www.onderwijsraad.nl/documenten/2020/10/07/verkenning-sekseverschillen-onderwijs
Pols, C. F. J., Dekkers, P. J. J. M., & de Vries, M. J. (2021). What do they know? Investigating students' ability to analyse experimental data in secondary physics education. *International Journal of Science Education, 43*(2), 274–297. https://doi.org/10.1080/09500693.2020.1865588

Qompas. (2025). Trends in studieoriëntatie onder havo/vwo-scholieren. Retrieved from www.qompas.nl

Reid, N., & Skryabina, E. A. (2003). Gender and physics. *International Journal of Science Education, 25*(4), 509–536. https://doi.org/10.1080/0950069022000017270

Rivard, L., & Straw, S. B. (2000). The effect of talk and writing on learning science: An exploratory study. *Science Education, 84*(55), 566–593. https://doi.org/10.1002/1098-237X

Shumow, L., & Schmidt, J. A. (2014). *Enhancing adolescents' motivation for science: Research-based strategies for teaching male and female students*. Corwin. https://www.corwin.com/books/enhanc-adolescent-motivat-for-sc-239395

Shutterstock. (2020). equality-equity-concept-illustration-human-rights. https://www.shutterstock.com/nl/image-vector/equality-equity-concept-illustration-human-rights-1789441925

Smithson, J. (2000). Using and analysing focus groups: Limitations and possibilities*. International Journal of Social Research Methodology, 3*(2), 103–119. https://doi.org/10.1080/136455700405172

Stadler, H., Duit, R., & Benke, G. (2000). Do boys and girls understand physics differently? *Physics Education, 35*(6), 417–422. https://doi.org/10.1088/0031-9120/35/6/307

Traxler, A. L., Cid, X. C., Blue, J., & Barthelemy, R. (2016). Enriching gender in physics education research: A binary past and a complex future. *Physical Review Physics Education Research, 12*(2), Article 020114. https://doi.org/10.1103/PhysRevPhysEducRes.12.020114

UNESCO. (2018). *Meeting our commitments to gender equality in education*. Gender Review Global Education Monitoring Report. https://unesdoc.unesco.org/ark:/48223/pf0000261593/PDF/261593eng.pdf.multi

United Nations. (2022). *United Nations: Gender equality and women's empowerment*. Un.Org. https://www.un.org/sustainabledevelopment/gender-equality/

van de Rozenberg, T. M., Groeneveld, M. G., van Veen, D. P., van der Pol, L. D., & Mesman, J. (2023). Hidden in plain sight: Gender bias and heteronormativity in Dutch textbooks. *Educational Studies, 59*(3), 299–317. https://doi.org/10.1080/00131946.2023.2194536

van de Wetering, T., & Groenendijk, R. (2019). *Jongens zijn het, maar aardige jongens* | OMO Script. Script-Onderzoek.Nl. Retrieved from https://www.script-onderzoek.nl/script-onderzoek/a1298_Jongens-zijn-het-maar-aardige-jongens

van der Vleuten, M., Jaspers, E., Maas, I., & van der Lippe, T. (2016). Boys' and girls' educational choices in secondary education. The role of gender ideology. *Educational Studies, 42*(2), 181–200. https://doi.org/10.1080/03055698.2016.1160821

Van Houtte, M. (2025). School's sex-composition, teachers' accuracy and gender stereotypes: explanations for teachers' different teachability perceptions of boys and girls*. Social Psychology of Education, 28*(81), 1-21. https://doi.org/10.1007/s11218-025-10044-6

Van Maele, D., Michalak, N., Engels, N., Laevers, F., Lombaerts, K., & Van Houtte, M. (2015). *Gender op school: Meer dan een jongens-meisjeskwestie*. Leuven, Belgium: LannooCampus.

Voyer, D., & Voyer, S. D. (2014). Gender differences in scholastic achievement: A meta-analysis. *Psychological Bulletin, 140*(4), 1174–1204. https://doi.org/10.1037/a0036620

Wambua, J. M., Twoli, N. W., & Maundu, J. N. (2015). Physics classroom discourse favors boys more than girls: A myth or reality? *Proceedings of the ICE.* Retrieved from https://ir-library.ku.ac.ke/handle/123456789/18324

Watt, H. M. G., & Eccles, J. S. (Eds.). (2008). *Gender and occupational outcomes: Longitudinal assessments of individual, social, and cultural influences.* American Psychological Association. https://doi.org/10.1037/11706-000

Woltring, L., & van der Wateren, D. (2019). *De ontwikkeling van jongens in het onderwijs : Context en praktijk van primair tot en met hoger onderwijs* (2nd ed.). LannoCampus. https://www.lannoocampus.nl/nl/de-ontwikkeling-van-jongens-het-onderwijs

World Health Organization. (n.d.). *Gender*. Retrieved December 1, 2021, from https://www.who.int/health-topics/gender#tab=tab_1

Zohar, A., & Gershikov, A. (2008). Gender and performance in mathematical tasks: Does the context make a difference? *International Journal of Science and Mathematics Education, 6*, 677–693. https://doi.org/10.1007/s10763-007-9086-7