

# Inclusive STEM teaching in the European Union: relevant for our teachers, students and society.

Research Proposal by Lotte van 't Ooster

*Supervisors Thesis: Michiel Doorman and Sanne Korte*

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## Abstract

This study aimed to enhance the understanding of the influence of European Inclusion and Diversity workshop series on the knowledge, belief and practices of (student) teachers, as well as identifying the supporting and limiting factors of an online multinational workshop. Six teachers were interviewed, lectures were observed, and the assignments of participating teachers were analyzed. The category change in knowledge, belief and practices was divided into four groups; awareness, new ideas, confirmed ideas and intentions to try new practices. Awareness was reported most frequently and intentions to try new practices was reported the least. Additionally, the study examined mentions of underrepresented groups and the status of diversity to provide further support for findings on knowledge and beliefs. Post-interviews revealed an increase in mentions of underrepresented groups and a shift in the status of diversity from homogeneity and heterogeneity to heterogeneity and diversity. The results highlighted the multinational context as an important asset, although limiting factors such as the online environment and English language proficiency were also significant. This study shows the importance of fostering inclusivity in education, particularly through teacher education. However, there is a need for further information about the actions that are needed to enable educators to integrate inclusion into their practices, which is crucial for the long-term success of inclusive teaching.

## Introduction

The current society is becoming more diverse so it is important for teachers in STEM, *Science-Technology-Engineering-Mathematics*, to be equipped with the skills and knowledge to create inclusive learning environments (Costello et al., 2020). Different studies show how different students do not feel connected to STEM subjects for various reasons (McGee & Bentley, 2017; Starr & Simpkins, 2021; Dewsbury & Brame, 2019; Bhopal & Rhamie, 2014, Walton & Cohen, 2011). Social isolation, loneliness and low social status can negatively impact one's overall well-being, intellectual achievement, immune function and health (Walton & Cohen, 2011). Also, STEM education generally can be a racialized space because many ideologies still come from the European and White-centric points of view to form the basis of Western Modern Science (WMS) in context as well as content (McGee & Bentley, 2017). Conducting research, creating theories and making measurements primarily focuses on individuals who are white, cisgendered, male, able-bodied and wealthy (Pearson et Al., 2022). Only in the shadow of WMS, if you look very carefully, many contributions of non-white cultures, such as the Ethiopian descendants of Ancient Egypt can be found (Ash & Wiggan, 2018).

The dominance of a particular group can have significant repercussions. Those who don't belong may experience a sense of detachment and exclusion, contributing to an unjust imbalance in society (Walton & Cohen, 2011). Furthermore, studies of tokenism found that fields in which women make up less than 20% of students, which is often the case in STEM fields, tend to be more biased on several accounts, for example on gender (McGee & Bentley, 2017). As the article of Laws (1975) defines "tokenism is the means by which the dominant group advertises a promise of mobility between the dominant and excluded classes". The study by Castilla and Benard (2010) found these biases on gender again and especially in the fields of science and engineering (McGee & Bentley, 2017). Researchers and policy makers

believe that gender stereotypes are one of the primary explanations for the big gender gaps in STEM fields (Starr & Simpkins, 2021; Dewsbury & Brame, 2019). The gender pay gap in Europe is improving, but it still remains a persistent issue (Nimmegern, 2016). The average hourly earnings for women were an average 13% lower than men's according to a finding of the European Commission in 2021 (European Union, 2022).

Many European studies are focused on the inclusion of people with a disability, which is highly important (Lawrie et al., 2017, Ainscow, 2020, van Leendert et Al., 2022). But there are more studies showing that inclusion in Europe needs to take a broader view (Symeonidou, 2017). Given the migration crisis that Europe has faced and is still facing in recent times, Europe is getting a more diverse society (Costello et al., 2020). Internationally, this is happening as well. Therefore inclusion is seen more broadly. The study of Ainscow (2020) states that "the aim of inclusion is to eliminate social exclusion that is a consequence of attitudes and responses to diversity in race, social class, ethnicity, religion, gender and ability".

A better understanding of inclusion needs to focus on the complex and intersecting identities that all students but especially teachers bring to the pedagogical experience (Lawrie et Al., 2017). The role and responsibility of STEM faculty is often neglected, whereas STEM could actually help to cultivate a learning environment in which all students have the opportunity to succeed academically (O'Leary et Al., 2020). But unfortunately, around half of the Member States of the European Union suffer from a lack of high-qualified secondary STEM teaching staff (COM/EACEA/Eurydice 2018) or will do so in the next decade. Many teachers – both pre- and in-service – do not have the competences they need to teach in today's high-demand education systems (ET2020 2015).

As found in other research, it is not yet known how STEM-teachers can be professionalized enough to make them more competent, especially in the case of inclusion and diversity. Inclusive teaching in science needs critical teachers who continually seek to enhance their lessons and the curriculum in ways that are more responsive and inclusive (Ash & Wiggan, 2018). Positive steps towards this can be taken through collaboration between students, teachers and academic developers with the awareness of thinking about the importance of inclusion at multiple levels (Lawrie et Al., 2017).

Other essential components for inclusive pedagogy training are developing self-awareness, minding the privilege gap, and reducing implicit biases (O'Leary et al., 2020). Workshops have been shown to help with this but also to make teachers more conscious of their efforts to select content and incorporate strategies that have an influence on educational benefits for inclusive classrooms (Dewsbury & Brame, 2019). Having participated in such workshops, teachers became more self-aware of their own social identities and associated privileges, and also acknowledge and confront their own implicit biases (O'Leary et Al., 2020), which are important steps towards an inclusive environment. It is necessary because diversity and inclusion are essential for achieving excellence across various aspects such as learning, research, teaching, student development, institutional functioning, local and global community engagement and workforce development (Clayton-Pederson & Sonja, 2007). What is missing is a greater attention to international perspectives on inclusive teaching and learning (Lawrie et Al., 2017).

Which in particular is not known, is how a workshop series in a multinational context will be experienced to raise awareness about diversity and inclusion in STEM education in Europe. In 2022, representatives of a European project came together to design a workshop for (student) teachers to develop their interests in inclusion and diversity.

To address the issue of competences needed by teachers, the impact of a workshop on inclusion and diversity for (student) teachers in Europe should be examined. The focus should be on how to improve their knowledge, attitudes and practices regarding diversity and inclusion.

The aim of this study is to evaluate the workshop and to study how (student) teachers become aware of inclusion and diversity in STEM education via a European workshop. So that teachers eventually can meet the needs of all their students, regardless of their backgrounds or identities. The research questions that follow out of the literature and needs to be answered are:

- **RQ1:** “In what way does a European inclusion and diversity workshop change (student) teachers’ knowledge and belief of inclusion and diversity, as well as change their practice to foster inclusive STEM classrooms?”
- **RQ2 :**“What are supporting and limiting factors of the multinational online course for learning about inclusion and STEM education?”

## Theoretical background

To raise awareness by taking part in a workshop, it is important that the content of the workshop as well as its evaluation addresses topics that have an impact on inclusion. These topics could also help to understand why some (student) teachers react or act in a specific way. These elements will be explained in the theoretical background:

- Stereotypes
- Underrepresentation
- Inclusive classrooms
  - o Paradigm shift
- Change in knowledge, belief and practices

### Stereotypes

Stereotypes play an important role in the world of diversity and inclusion. Implicit and unconscious gender biases remains widespread, while explicit gender biases are declining (Blackburn, 2017). Implicit biases are usually thought to affect individual behaviors, but it can also influence institutional practices and structures (Blackburn, 2017). One large meta-analysis covering five decades of “draw-a-scientist” studies in the U.S., found that traditional stereotypes were more prevalent in studies conducted among older children and adolescents compared to studies conducted among younger children (Starr & Simpkins, 2021). There are different reasons for this phenomenon. First, adolescence is a period of intense identity development. Adolescents use signals and examples from society and important people in their lives, like parents and teachers, to help them decide who they are and what they should pursue. Second, adolescents have developed the cognitive skills to relate stereotypes to others and themselves. Finally, high school is a time when STEM beliefs change and students have more consequential STEM related choices (Starr & Simpkins, 2021). Stereotypes then influence their choices.

Teachers play an important role for students in creating these stereotypes. Via direct statements they could influence the thoughts and interests of their students (Starr & Simpkins, 2021). But also differential treatment among their students or demonstrating their own anxieties towards STEM courses. Teachers may be especially impactful regarding stereotypes about the subject domain that they teach (Starr & Simpkins, 2017). It is thus plausible that if teachers are aware of their own stereotypes and beliefs, they can create an inclusive classroom. A dedicated workshop can support them in doing so.

In my research, it is crucial to acknowledge both stereotypes and implicit biases. This applies not only to my own awareness and stereotypes but also to the awareness of the teachers involved. It is possible that some teachers may be unaware of their own stereotypes, so it is essential for me to formulate appropriate interview questions to address this. Additionally, it is important for the teachers to recognize the stereotypes they might hold, as well as to consider them when designing classroom activities.

### Underrepresentation

The balance identity theory is based on the feeling that people who feel that they do not match the stereotypes of a group may feel less like a member of that group (Starr & Simpkins, 2021). This can lead to minority groups avoiding STEM courses and careers. There is increasing evidence that this reduced social belonging is the cause of the departure of underrepresented groups from STEM majors, more than the preparedness to handle the material (Dewsbury & Brame, 2019). There are four groups which are most underrepresented in STEM:

- Students with disabilities in STEM education (Moon et al., 2012, Schneiderwind & Johnson, 2020)
- Racial and ethnic minority students in STEM education (Rattan et al., 2015)
- Gender gap in STEM education (McGee & Bentley, 2017, Milgram, 2011, Nimmegern, 2016, Starr & Simpkins, 2021)
- Low socioeconomic status (Gorard & See, 2009)

The study by Dewsbury & Brame (2019) defines inclusivity as the practice of including people across differences, and we assert that inclusivity implies an intentional practice of recognizing and working to mitigate biases that lead to marginalization or exclusion of some people. Still, teaching inclusion remains complex. Educators can help build interest in STEM and encourage underrepresented students to pursue STEM careers (Kricorian et Al., 2020). Part of the problem may be that the lecturers and tutors may not have sufficient knowledge of it themselves and therefore do not have enough confidence to be able to effectively support trainee teachers (Bhopal & Rhamie, 2014, Symeonidou, 2017, Costello et Al., 2020). Many programs that try to deal with diversity are simply failing because they not dealt directly with issues of diversity and inclusion (Bhopal & Rhamie, 2014). Ideally, following the workshop, the teachers should experience an increased sense of empowerment in their ability to be inclusive. This is a key aspect that the study explores during the interviews whether they feel equipped with a broader range of strategies and knowledge like the underrepresented groups to ensure the inclusion of all students.

### Inclusive classrooms

There are various studies and examples of how to make a classroom more inclusive. One case for teachers is to develop (self-)awareness (Dewsbury & Brame, 2019, O'Leary et Al., 2020).

Developing (self-)awareness has implications far beyond the STEM classroom. Understanding how the at-birth identities have formed humans social and professional pathways is important for understanding inclusive behaviors (Dewsbury & Brame, 2019). Therefore empathy needs to be developed as well. According to Freirean philosophy, dialoguing is the key. The teacher needs to know the students and their unique backgrounds (Dewsbury & Brame, 2019, O’Leary et Al., 2020). A supportive classroom climate promotes students’ sense of belonging, and their sense of belonging promotes their academic achievement (Dewsbury & Brame, 2019). Also, students educated in a more diverse institution will be more motivated and better able to participate in an increasingly heterogenous and complex society (Bhopal & Rhamie, 2014).

At present, STEM teachers have already successfully implemented curricular strategies to improve student performance (O’Leary et Al., 2020). However, many strategies are not sufficient to eliminate the equity gaps that persist across demographic groups (O’Leary et al., 2020). There is a need for professional development opportunities that support teachers in embracing inclusion and diversity as an asset and in becoming more culturally responsive in their teaching. Other research suggests that teacher education programs must take a multicultural perspective in order to contribute to principles of social justice (Bhopal & Rhamie, 2014). Therefore the workshop in this study is an important tool to create this. Also because it takes the multicultural perspective and the embrace of inclusion and diversity into account via the paradigm shift.

### Paradigm shift

The recognition of student diversity as a collective resource and facilitating students’ representation of their identities are vital in creating an inclusive classroom (Tuitt, 2016). It is then important to know if a teacher acknowledges this before and/or after the workshop. The change through various states of diversity can be described by the paradigm shift. This shift describes in which state of diversity a teacher currently is and how this teacher may shift to another state, by identifying three states: a teacher sees everyone the same (homogeneity), sees differences but as a challenge to be dealt with (heterogeneity), or sees differences as an asset and opportunity (diversity).

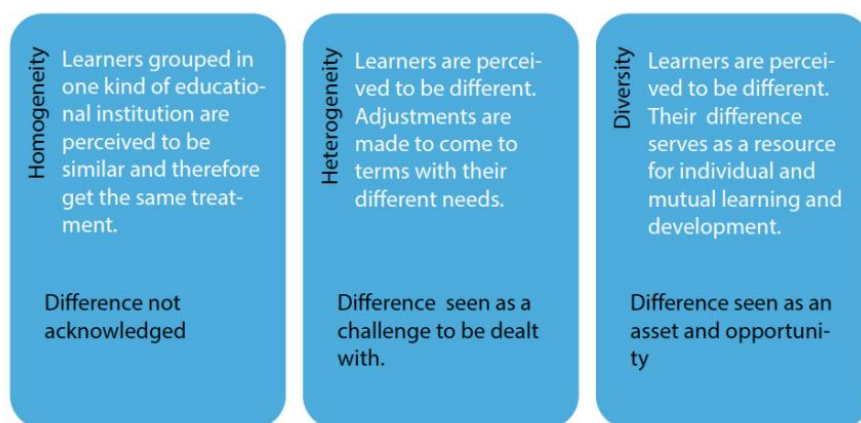


Figure 1 | Paradigm shift: from homogeneity to heterogeneity to diversity (MasDiV project)

### Change in knowledge, belief and practices

What counts as good teaching is evidently subject to change (Bakkenes et al., 2010). For inclusive teaching, you also do not want that teachers only transmit subject-matter knowledge but also facilitate, support and monitor students. The goal is to find out that something

changes in teachers' knowledge and belief about inclusion and eventually also in their teaching practices. These learning outcomes are based on the study of Bakkenes et al. (2010). Change in knowledge and belief is divided into:

- Awareness
- Confirmed ideas
- New ideas

Intentions for practice were in the study of Bakkenes et al. (2010) divided into:

- Intention to try new practices
- Intention to continue new practices
- Intention to continue current (old) practices

This study focuses on intention to try new practices in the context of a European workshop series.

Understanding the context of this workshop series is crucial for researching the questions posed in this study and grasping the specific features and circumstances surrounding it.



## Context of the study

This research has focused on the inclusion and diversity workshop hosted by the International Centre for STEM Education (ICSE) Academy, *European collaboration and mobility in professional development of pre- and in-service teachers*. The core themes of the workshop are chosen according current trends and needs at the beginning of the project. All selected from the list of EU key priorities. One workshop series looks as follows: Over the course of one semester one workshop a week, at a fixed time (Tuesday 4 pm), is organized. Each workshop is given by a different ITE/CPD provider on a different sub-topic. This allows to shed light on the core theme from various perspectives (disciplines, culture, system, demography etc.) and by employing a range of different pedagogical and didactical cultures and approaches (ICSE, 2022). The duration of the inclusion and diversity workshop series is three weeks.

In the first week, teachers receive an introduction to diversity and inclusion in STEM education. The primary objectives are to heighten awareness and explore the potential role of STEM education in teaching diversity. The focus of the second week's lecture is on analyzing and designing tasks. The goal is to help teachers understand how tasks can effectively organize activities that leverage diversity in the classroom, while also familiarizing them with design strategies. In the last week, the lecture centers on analyzing inclusive classroom practices. Teachers are encouraged to inquire and reflect on their lessons using theoretical constructs and tools derived from research on inclusive classroom practices. Due to the three-week timeframe, teachers have limited time for practical implementation, leading this study to focus on intentions to try new practices.

The ICSE Academy wants to support the EU's endeavors to minimize the low-performing STEM learners (ICSE, 2022). They want to do so by investing in high-quality STEM teachers, supporting young and established STEM teachers across Europe. Some unique features of this project are high-capacity partnership, collaborative European summer schools, peer-learning through job-shadowing and interdisciplinary European workshop series. Besides these features, the project aims to increase the attractiveness of the teaching profession and to raise and maintain the number of highly qualified teachers. This is strongly affected by how competence development and collaboration play a role in a teacher's career. Teachers' job satisfaction increases when teachers regularly participate in professional development and when they are regularly engaged in collaborative practices. So this project is not only for promoting lifelong professional learning but also for establishing collaborative structures within STEM teachers' professional learning and their practices. This is visible in five dimensions in the project 1) across countries: 13 partner countries are in the partnership 2) across career levels 3) across ways of provision 4) across disciplines 5) across education systems.

## Method

### General approach

The European workshop series aims at refreshing and deepening the knowledge of meaningful and relevant educational practices. Topics include inquiry-based learning and interdisciplinarity, diversity and inclusion, curriculum development and assessment in Europe, and the use and impact of technology on STEM education. This study focuses on diversity and inclusion. A combination of interviews, observations, homework analysis, and case studies is used to answer the following research questions;

- **RQ1** In what way does a European inclusion and diversity workshop change (student) teachers' knowledge and belief of inclusion and diversity, as well as change their practice to foster inclusive STEM classrooms?
- **RQ2** What are supporting and limiting factors of the multinational online course for learning about inclusion and STEM education?

To answer RQ1 interviews, observations, homework analysis and case studies are used. For RQ2 interviews, homework analysis and case studies are used with a more detailed focus on the multinational context.

### Participants and recruitment

In this research the focus is on (student) teachers who signed up for the workshop, in total this was around 38 participants. These participants consisted out of (student) teachers and teacher educators. Per workshop the number of participants varied slightly. Most of the teachers participated by following the whole course "EU STEM teaching: relevant for our students and for our society". Other teachers only followed some of the workshops.

In this study participants were recruited via the coordinators of the participating countries. Coordinators were sent an online letter, which they forwarded to the teachers in their respective countries (see figure 2). The teachers who eventually were included were the teachers who responded to the online invitation letter. This approach was adopted considering the hectic schedules of teachers across Europe. To ensure diversity in the participant sample, countries from different regions of Europe were deliberately chosen. Ultimately, responses were received from six teachers (see table 1). Due to time constraints of the research project, further participant recruitment was not pursued. The teachers needed to have two inclusion criteria 1) being a (student) teacher and 2) they had signed up for the workshop series.

Table 1 | Description samples

Participant	Discipline	Years of teaching	Gender (x/m/v)
1	Mathematics	>20	v
2	Biology and chemistry	3,5	v
3	Mathematics	4	m
4	(Nature) Science	+ - 2	v
5	Mathematics	2	v
6	Biology, Chemistry, English	2,5	v

## Instruments and procedure



Figure 2 | Procedure of data collection.

### Interviews

Interview schemes based on semi-structured interviews have been developed. This choice allows better comparability among teachers and also between pre- and post-interviews. Given the personal nature of the subject, semi-structured interviews were considered more suitable than structured interviews. Otherwise, important participant opinions could be missed (Zelina, 2020).

Initially, questions were derived from the validated ISCE Academy questionnaire and extended with relevant literature for this study. To further explore topics from the theoretical background but also to get a detailed view about change in knowledge and belief, questions were added based on insights from the literature (see appendix A and B). These subjects align with a great part of the theoretical background. Particular themes associated with identity, inclusion and stereotypes in relation to their roles as future teachers were examined as well.

The pre-interview scheme was tested in a pilot-interview with a participant from Summer School, an event organized by Universiteit Utrecht and the ICSE-academy for teachers around the world. As a result, some questions were modified or re-written for clarity, these were minor changes in the wording of the question. For example, asking about the environment of the school was limited to if teachers taught in a village or a city. During the pilot-interview, it became apparent that the participant encountered some difficulties with expressing herself in the English language. Consequently, it was decided to send the main questions in advance to all participants, allowing them to prepare some of their responses. The semi-structured pre- and post-interviews can be found in appendix A and B.

The pre- and post-interviews were held online via Teams. During the interviews, every participant gave verbal consent to make audio recordings. These recordings were transcribed manually. The duration of the pre-interviews was about 30 minutes. The post-interviews took longer, around 45-60 minutes, because there were more questions about the experiences of the workshops, evaluation questions and questions about how the participants felt about the multinational context overall. The quotations of the teachers incorporated in the results have been selected based on their clarity and relevance to related code.

### Observation

In addition to interviews, observations are used to observe participants interactions and engagement during the cluster. A non-participatory, semi-structured observation method was used, as there is no active involvement in the cluster itself (Denscombe, 2017). The observation is done online and allows for flexibility in capturing various (inter)actions because of the broad view of the questions in the observation scheme (see appendix C).

## Assignments

More data is gathered through the analysis of the assignments. Ten activity designs and eight reflection assignments were analyzed. The activity designs were used for RQ1 and were explained in a summary consisting of four groups; subject, topic, activity and dimension of diversity. This was filled in by the teachers themselves. The reflection assignments were used for RQ1 and RQ2. A summary of the reflection was made by the researcher of the study and related codes were attached.

## Case studies

To investigate the influence of the workshop series on the teachers more into detail, two teachers were followed which resulted in two case studies. During these studies the pre- and post-interviews were combined. The categories in the case studies were based on codes, changes in answers (pre and post) and a broader view about aspects of inclusion. These categories are; definition inclusion, biases, STEM and inclusion, students, learning goals, multinational context and changes in knowledge, belief and practices. Assigned pseudonyms were used. The teachers were chosen based on the differences they showed before and after the workshop series and they needed to have attended all lectures.

Combining interviews, observations, analyses of the assignments and case studies will provide a comprehensive overview of the participants engagement and experience of the cluster.

## Data analysis

The data analysis is based on the grounded theory, a qualitative research approach developed by Glaser & Strauss (1967) in combination with top-down and bottom-up coding (see table 2). Because of the grounded theory and constant comparative method, responses of the participants can be compared and make sense through the codes attached to them (Denscombe, 2017). This is done in Nvivo 14, a qualitative data analysis software.

Table 2 | Analysing data according to the grounded theory. The coding scheme can be found in table 5.

Steps grounded theory	Grounded theory applied to current study
Coding and categorizing data	The first step of coding was done in a MS Word document by the researcher. Reading the transcriptions answers on the different questions were roughly categorized making use of mostly bottom-up coding (see table 4). Examples of some codes were social related, geographical related and emotions.
Open coding	Codes were changed and refined into smaller categories. Codes with emotions were removed because this would not give an answer to the research question. Bigger categories, like social related and geographical related, were divided into terms of motivation, practices, racism and (pre) knowledge.
Axial coding	Links and associations were made which resulted into codes which supported more specific parts which related to each other. For some codes literature helped to give a clear view to the key components. Top-down coding was predominantly utilized in the process of axial coding (see table 3). For example (pre)knowledge and motivation became knowledge and belief which was divided into awareness, confirmed ideas and new ideas.
Selective coding	Taking the research question into account, core codes were made to give the best explanation. Underrepresented groups, status of diversity, multinational context and change in knowledge, belief and practices were decided on most important.
Concepts	Out of these codes, the relation between the results is explained which evolves in concepts for this study.

### Top-down coding

The codes derived from the literature help to understand the thought process about inclusion. They look at the teachers' perspectives on different but crucial topics that represent various facets of inclusion (see table 3). It aims to make clear whether teachers already know certain terms or have an idea of how to be inclusive. By asking specific questions in the pre- and post-interviews, the study seeks to gain insight into these aspects which provides a clear image of their knowledge and belief towards inclusion.

Table 3 | Top-down codes

Codes	Reference
Change in Knowledge and belief	Bakkenes et al., 2010
- Awareness	
- Confirmed ideas	
- New ideas	
Intentions to try new practices	Bakkenes et al., 2010
Underrepresentation groups	Gorard & See, 2009, Milgram, 2011 Moon et al., 2012, Rattan et al., 2015, Nimmesgern, 2016, McGee & Bentley, 2017, Schneiderwind & Johnson, 2020, Starr & Simpkins, 2021
- student with disabilities in STEM education	
- racial and ethnic minority students in STEM education	
- Gender gap in STEM education	
- Low socioeconomic status	
Homogeneity	MaSDiV project
Heterogeneity	MaSDiV project
Diversity	MaSDiV project

### Bottom-up coding

Incorporating bottom-up coding was essential to capture unanticipated themes that may not have been foreseen in advance (see table 4).

Tabel 4 | Bottom-up codes

Codes	Idea
Multinational experience positive	ICSE Academy
Multinational experience negative	ICSE Academy

### Researcher positionality

The researcher of the study plays a very neutral role to avoid biasness in data collection and the results of the study (Khan, 2014). Also it is important that the researcher starts the study without any fixed ideas and the aim is to approach things with an open mind. Of course it is inevitable that existing theories and personal experience will have some influence (Denscombe, 2017). Especially in this research when inclusion is the most important subject. It is very personal and therefore some important factors need to be taken into account. In this study it is important that the researcher is aware of her own possible biases and takes this into account as well as the biases of the teachers (McGill et al, 2023). This is done by being explicit about her own background and checking her own interpretations about things that were said during interviews or assignments with her supervisors or other students which are also doing research about inclusion. The teachers were asked a question if they were aware of their own biases. Reflecting on background, experience and knowledge is important in approaching the research practice. As well as respecting participants in all phases of the study, taking all responsibility, and irrespective of the participants' diversity dimensions refrain from discriminatory language (McGill et al., 2023).

The author of this study is a white, privileged female from the Netherlands interested in science communication and EDI (equity, inclusion and diversity). She did her bachelor in a STEM subject, namely biology. As a master student in Utrecht she acknowledges that she brings limited research experiences in this subject. She lives in a progressive, left political bubble.

### Supplementary data

The observations and answers of the homework are used finding support for emerging patterns or for providing alternative explanations. As well as in the observations as in the homework the themes of the coding scheme were used to analyze so it could substantiate the interviews.

### Code book

The coding book exists out of different codes, some of them are top-down and some of them are bottom-up derived.

Table 5 | The codebook

Codes	Descriptions	Example quotations
Awareness	Awareness refers to a situation in which teachers consciously noticed or detected something that they valued as important. They were not, or less, aware of it before. That which was noticed or detected, however, had not yet been analysed and converted into a theoretical or practical insight.	<i>"I have more clearer boundaries what inclusion is. So I think it is kind of shifted and is has sharper edges now."</i>
Confirmed ideas	A reported outcome was coded as "confirmed ideas" when the text of the log clearly indicated that the idea or insight already existed before, and that the result of the learning activity was that the teacher felt more strongly about the idea.	<i>"And I think that is also what I got from this cluster, more than before that it is good to talk to other teachers from other countries."</i>
New ideas	An outcome was coded as "new ideas" when the teacher's report clearly indicated that the idea or insight did not exist in this form before the learning activity had taken place.	<i>"But I will try to look more around if the scientist was not the old white men but somebody different."</i>
Intentions to try new practices	Sometimes teachers reported the intention to do things differently in the future. They specifically spoke about a practice or assignment.	<i>"I had one activity, the one with the international meals. I think it is appropriate activity for chemistry and biology and I will definitely try to do that. And see how the students react and how they corporate and learn about each other as well."</i>
Underrepresented groups <ul style="list-style-type: none"> <li>- student with disabilities in STEM education</li> <li>- racial and ethnic minority students in STEM education</li> <li>- Gender gap in STEM education</li> <li>- Low socioeconomic status</li> </ul>	This code was used when a teacher mentions an aspect about one of these groups.	<i>"Like STEM the background is different subject in it and also in the STEM career we have different, how to say that, in STEM career men have to have more jobs than woman and also someone who work in the nice country, wealth country tend to have more STEM job than in poorer country so that brings me awareness."</i>
Homogeneity	When the differences between people is not acknowledged. Humans are perceived to be similar and therefore get the same treatment.	<i>"When I see somebody I do not notice some kind of different. I perceive somebody like there are the same so when I teach I do not point on that, so I do not do anything differently."</i>

Heterogeneity	Differences between people seen as a challenge to be dealt with. Humans are perceived to be different. Adjustments are made to come to terms with their different needs.	<i>“So I think it is important to treat the students the same way but to fulfill their different needs.”</i>
Diversity	Difference seen as an asset and opportunity. Humans are perceived to be different. Their difference serves as a resource for individual and mutual learning and development.	<i>“But the idea of this paradigm shift that all these diversities can be seen as something we can build our teaching on. I think it is very powerful that now, if I work with using this diversity with my class that everyone will benefit not only the few that I had in mind that I did it.”</i>
Positive multinational	To better understand the answers to the research and its sub-question, it is crucial to figure out whether teachers see the multinational context of the professional development course as an rich environment. When the teacher clearly talks about the positive effects of the multinational experience concerning the workshop this will be coded as “positive multinational”.	<i>“If we look at inclusivity; I think it is very important again to add this multicultural and multinational context off course. It will service a lot in sharing of different situations and contact.”</i>
Negative multinational	When the teacher clearly talks about the negative effects of the multinational experience concerning the workshop this will be coded as “negative multinational”.	<i>“I do not like it. It makes sense because you are from different countries but it is a challenge, when someone has a camera but it is not working or the internet connection is bouncing off and I found it really difficult to focus.”</i>

## Second coding

To ensure validity and reliability, a second coder reliability check was conducted. Due to time limits, one post-interview (including all codes) was coded again by another thesis master student. First, the coding book and the post-interview were given with the corresponding pre-interview for context. No elaboration at the beginning was given. The second coder coded 20-30% the same.

An elaborative explanation about the code book was needed to get a better understanding of the quotes. After that the coding was discussed with the second coder. Adjustments on the descriptions of codes were made. For example, the codes “negative multinational” and “positive multinational” were not clear in explaining that they referred to the multinational experience of the workshop. To address this, clarification was incorporated into the description of the code book. This resulted into an agreement on the code book and the coding of the post-interview.



## Results

### RQ1

The analysis of the RQ1 results involves examining the outcomes of the interviews, which are categorized into three groups; mentioned underrepresented groups, status of diversity and change in knowledge, belief and practices. Secondly, the activity designs and the reflection assignments are assessed. Lastly, the results of the observations are used in the case studies.

### Interviews

An analysis of the interviews led to an overview of differences in pre- and post-interviews (see table 6). The different categories are discussed in more detail in the following sections.

Table 6 | Differences in pre- and post-interview. Total duration: 158 and 255 minutes respectively. The numbers between brackets represent how many teachers mentioned it.

	Pre-interview (f)		Post-interview (f)	
<b>Mentioned underrepresented groups</b>				
Student with disabilities in STEM	1	(1)	8	(3)
Racial and ethnic minority students in STEM education	12	(4)	20	(5)
Gender gap in STEM education	10	(5)	23	(6)
Low socioeconomic status	2	(2)	8	(3)
<b>Status/recognition of diversity</b>				
Homogeneity	6	(3)	2	(1)
Heterogeneity	19	(5)	21	(6)
Diversity	5	(2)	10	(4)
<b>Multinational context</b>				
Positive	13	(6)	10	(5)
Negative	2	(2)	6	(4)

### *Mentioned underrepresented groups*

Underrepresented groups can be divided into four different groups; “student with disabilities in STEM”, “racial and ethnic minority students in STEM education”, “gender gap in STEM education” and “low socioeconomic status”. All four groups were mentioned in both pre- and post-interviews.

As can be seen in table 6 the underrepresented groups were mentioned more in the post-interviews compared to the pre-interviews, for every category it almost doubled. Also, the number of teachers who mentioned it is larger. Teachers reported racial and ethnic minority students in STEM education the most in the pre-interview (12 times by 4 teachers). In the post-interview it shifted to gender gap in STEM education (23 times by 6 teachers) while students with disabilities was reported the least.

There was a difference in how teachers mentioned the categories. Some teachers mentioned specifically the groups:

*“But once again, inclusion is broad. For example the equity between boys and girls I think it is quite present in my mind. But some others may not be that much.”* (P3: Participant 3, code: Gender gap in STEM education)



Other teachers told an event or story which could be classified as belonging to these groups:

*“Because they are, in Czech, trying to create private schools which are so expensive but normal kids are not able to join it and that is a shame. In this moment in normal education system we give clever kids, and other kids are not that clever but they have good intention, I do not know how it is working in your country. But British international school have some different, some private American school in villages and all are, it is like every kid is famous and clever because parents are paying for it.”* (P6, code: low socioeconomic status)

#### *Status of diversity*

Status of diversity refers to teachers’ understanding of diversity and how they handle it. Teachers’ statements were divided into three groups; “homogeneity”, “heterogeneity” and “diversity”. Status of diversity is not something teachers could literally refer to, however, the things they said could be divided into these three categories.

Heterogeneity emerged as the most frequently (40 times) reported category in both pre- and post-interviews (see table 6). It is essential to note that, in the pre-interview, one teacher made seven mentions of heterogeneity, which could give a distorted image. Often the teachers reported that they saw differences between their students but were still looking for a solution to help them:

*“Differences in students with different levels of understanding or different level of needs. It is quite challenging for a teacher to give a lesson to give the same student the same opportunity.”* (P5, code: heterogeneity)

Homogeneity was mentioned less in the post-interviews and also reported by a smaller variety of teachers (2 times by 1 teacher) as can be seen in table 6.

*“For me it is the only way. I do not see why we should treat students differently on purpose”* (P2, code: Homogeneity)

For diversity, both the number of teachers who mentioned it as well as the number of times it was mentioned, doubled (see table 6). It was reported as diversity as teachers saw their students differences as a resource, as an asset:

*“I understood that different kind of students may have something new to add, to the subject. I will give another example to make myself more clear. We were together in the same group with a lady chemist, who worked for a school in Malta. She said she had a problem regarding the water, the lack of water in the world, globally but in places as well. In her class she had students who were immigrants because of lack of water. Then it came to me how important this is. we have European students who hear about the lack of water but they do not fully understand what it means. And here next to them, sits another child of another part of the world, who lives in his country with members of his family, grandparents or so on, because of this. And this has to add to the subject.”* (P1, code: Diversity)

Table 7 | Changes of thinking from participants

	Change in knowledge, belief and practices (f)	
Awareness	32	(6)
Confirmed ideas	11	(4)
New ideas	15	(6)
Trying new practices	8	(5)

### *Change in knowledge, belief and practices*

Changes in knowledge, belief and practices were split into four groups. The first three refer to different types of changes in knowledge and belief and are labelled “awareness”, “confirmed ideas”, and “new ideas”. The fourth group represents a change in practice and is labelled as “intention to try new practices” (see table 7).

When teachers reported awareness, alertness, or consciousness as something they gained during the workshop series it was coded as ‘awareness’. Something changed in their way of thinking but they could not give a typical theoretical or practical example. For example:

*“I think that I became more alert on special cases.”* (P1, code: Awareness)

Confirmed idea was coded when teachers had an idea that already existed once in their life, but the workshop series verified that idea almost in the same way. For example:

*“Yes, because in theory I have heard that before, I have been there before. Do I practice it every day? Do I search enough and study enough to do this every day? To teach in this way, that is the most important after this process.”* (P1, code: Confirmed idea)

An outcome was coded as a new idea when the idea did not exist before the workshop series. The teacher has a new idea but has not a typical idea how to put it into practice or take it with them into the classroom. For example:

*“I was kind of surprised that I got some ideas after this course in my head on how to be more inclusive in such way in chemistry and biology which are not in the social field. It definitely fulfilled my expectations.”* (P2, code: New idea)

Teachers in the study mentioned their intentions for implementing what they had learned in the workshop. In all cases, these were intentions to try new practices, since they had not yet had time to implement their practice or experiment in the classroom. For example:

*“Yes, I think the professor spoke about language games. I never realized about this, some language games try to push into class. Does not matter which subject it is, because I think language is something like what, like in general in Czech it is a problem we only have Czech language and then we have English but still a lot of people are not able to study second language.”* (P6, code: Intentions for practice)

As depicted in table 7, the highest reported group was awareness (32 times by 6 teachers), whereas the mention of trying new practices was comparatively less frequent (8 times by 5 teachers).

## Assignments

### *Activity designs*

One of the assignments in the workshop series was to design one new practice for in the classroom. The twelve assignments that were handed in are given in table 8 and provide a supplementary overview of intentions to try new practices that were designed by teachers. The categories subject, topic, activity and dimension of diversity were filled in by the teachers themselves. Therefore it could be that the dimensions of diversity are not totally right

according to literature. For example, drama is not a dimension of diversity. Most of the teachers reported cultural diversity.

*Table 8 | Activity design template summary*

Subject	Topic	Activity	Dimension of diversity
Mathematics	Geometry and measurement	Sustainable cultural park design	Culture
Science	Systems in our body	Role play in combination with circulatory system	Culture Gender Drama
Mathematics	Statistics	Recording what and how much students ate for breakfast (excel file)	Culture
Mathematics	Musical patterns	Music and algorithmic programming – recognizing periodic functions and repeating patterns	Different interests Disability
Science	Multicultural meal	Group work on deciding a healthy multicultural meal	Culture Gender Language
Technology/science	Electricity	Making a simple electricity circuit and storytelling	Culture Disability Multilingualism
Science	Workshop class	Design dream house	Culture
Mathematics	Angles	Teaching about angles through dancing	Culture Gender Achievement
Biology	Meal	Design a healthy plate	Culture Achievement
Science	Natural science	Healthy eating	Culture

### *Reflection homework*

After three weeks of lectures teachers were asked to reflect on the workshop series. Eight out of 38 teachers handed in their reflection. As can be seen in table 9 almost all reflections are related towards RQ1. Only reflection 6 is related to RQ2.

*Table 9 | Reflection of eight participants of the workshop series*

Reflection	Summary	Related codes
1	Reports gender differences. Explains that she realized that in STEM studies male and female students have differences in the things they are good at. Wants to discuss this with her students so that they also take on other tasks and not the usual preferred tasks.	Gender
2 (P1)	Reports the paradigm shift. She wants to keep practicing that diversity could be an asset and opportunity in her classroom. Second she learned that not only the content of a STEM task is to be appropriate in terms of inclusion, but also the classroom community. Finally, she learned norms that secure support and safety for all learners.	Diversity Awareness
3 (P3)	Appreciated the articulation of the three sessions. He sees the continuous self-reflection towards inclusive practice as the main tool for improving his own practice, with the help of the paradigm shift where diversity is seen as an opportunity. However, he found the sessions themselves not that inclusive and had difficulties with working with people who did not work on the same task.	Diversity New idea
4	Learned a lot on theoretical ground. The concept of inclusion and diversity related to STEM education together with the underrepresented groups. Also learned specific tasks to include in her teaching, especially through the connection of multiple representations; organized a task of teaching angles through dancing. What she wants to include as well is the reflective tool, so that she can satisfy all the needs that derive in her classroom connected to diversity and equity.	Underrepresented groups Intention to try new practices Awareness

5 (P2)	First thing that hit her was that science was done by white men, but she feels it is not right because of Marie Curie. She cannot recall a scientist that was or is ethnic, but she doubts if science education was even accessible for ethnic people back then. If not, you cannot rewrite history to have more diversity. She loved the idea about the multicultural meal and will implement it in her teaching. Especially because she thinks students will learn from each other and experience that their differences are their strengths and benefits.	Awareness Gender/racial ethnic Intentions to try new practice Diversity
6	It allowed her to learn more about diversity and inclusion in education which was not originally an area she focused on. She really enjoyed the collaboration with teachers from all around Europe. The tool ‘Creating a lesson plan’ was especially useful for her, she believes the students will benefit from it as well because she can include their different aspects of their backgrounds and cultures.	Awareness Multinational positive New idea
7 (P5)	The information is included in her case study.	
8	Teachers should consider that students in classrooms have different characteristics, different cultural background, different economic or social status or other characteristics that make them different from the majority of other students. Teachers should answer this with a variety of teaching strategies, for example algebraic representations and graphs, verbal representations, theatrical representations and open air activities. Creating connections between other STEM disciplines is important as well.	Heterogeneity Intentions to try new practices

## RQ2

To answer the results of RQ2 interviews were examined, divided into the groups; positive multinational and negative multinational. Secondly, the reflection assignments were regarded. Lastly, the results of the observations with a focus on the supporting and limiting factors of the multinational context are taken into account in the case studies.

### Interviews

#### *Positive and negative multinational*

Teachers frequently reported their opinion about the multinational context of the workshop series. In the pre-interview more positive comments were mentioned compared to the post-interview (13 times by 6 teachers), as can be seen in table 6. The number of negative statements tripled and the number of teachers who expressed negative statements doubled (6 times by 4 teachers).

An example of a positive comment about the multinational context:

*“I think it is interesting to work with teachers from other disciplines, from other countries I liked it. It was interesting, they had sometimes different points of view, sometimes the same points of view, sometimes different problems, sometimes the same problem. Actually I was very enthusiastic about this opportunity, even with you who is not a teacher. I was excited about it.” (P1)*

Negative comments were mostly related to the online learning environment or the English language, since some teachers lacked the required English language skills:

*“Actually one person in the group where I was, she said that there was a question who would be presenting our work and she said I would like to do it but I am not confident in speaking English in front of a lot of people and another person said the same. It was a problem and actually we heard the same people including me during the sessions. So it must be a hint, maybe English language is not the only cause about this, there might be others like the structure of the class or the fact that we are all behind a screen.” (P3)*

## Assignments

### *Reflection homework*

As can be seen in table 10, one reflection specifically mentions the multinational context in a positive way. She focuses on the collaboration during the workshop with teachers from all around Europe.

Table 10 | Part of table 9 where the multinational context is mentioned

6	It allowed her to learn more about diversity and inclusion in education which was not originally an area she focused on. She really enjoyed the collaboration with teachers from all around Europe. The tool ‘Creating a lesson plan’ was especially useful for her, she believes the students will benefit from it as well because she can include their different aspects of their backgrounds and cultures.	Awareness Multinational positive New idea
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## Case studies

For both RQ1 and RQ2, a comprehensive examination of two teachers was undertaken through the conduction of case studies.

*Nina (P4):* Nina is a teacher who is still doing her master in (Nature) Science. She finished a bachelor in STEM teaching. She has around two years of teacher experience, at a boarding school with kids from 16 to 18 years old and as a substitute for nature science and mathematics for younger kids. Nina was already familiar with the subject of inclusion before the workshop series. She used to go to a multicultural high school and from an early age she came in contact with different cultures. In her Bachelor she followed a course about diversity and inclusion and during her master’s she also had courses with international students. These experiences can be seen throughout both pre- and post-interviews (see table 11). She shows less change before and after the workshop series and her status of diversity is located at heterogeneity and diversity, in both pre- and post-interviews. Her change of knowledge, belief and practices is throughout confirmed ideas.

*Kim (P5):* Kim was a teacher who is now doing her master Science Education and Communication. She is not sure what she will do after this master but she already has two years of teacher experience in her own country in the discipline mathematics. Her interest is a bit more shifted in teaching students and educators than high school students because she feels she has a bigger impact then. Her goal at the moment is to know the current trends of education, especially the socioscientific approach. She did not specifically sign up for this cluster for the inclusion workshop series, she is just very interested in STEM education. Kim shows a great amount of change before and after the workshop series (see table 12). There is big increase in the mentioned underrepresented groups and her status of diversity shifted towards heterogeneity. Her change of knowledge, belief and practices is mostly throughout awareness.

### *Nina (P4)*

**Definition inclusion** Nina thinks of inclusion as something where everyone feels invited and that no one is left behind for any kind of reason.

*“I think of inclusion as where anyone has something to say and feel invited. And that is just in general, for everything, could also be in you sports team as well. That you feel welcome and a part of it as anyone else. That everyone is equal. When inclusion is good, everyone should be feeling equal.”*

In the post-interview she mentions that she did not think the workshop series changed a lot in the way she already thought about inclusion.

*“I think it might be the same as before the cluster actually. I had a focus on this from my bachelors and it was one of the subjects we had, so I think that is why I did not changed a lot for me.”*

However she thinks this workshop series would be a great starting point for teachers who do not have the pre-knowledge she already has. And for her, it is always important to keep learning but also to keep inclusion in mind.

*“So, yeah, I think it is a good starter point to make us aware and also to like research ourselves or take it to our own schools and tell our teachers about it and then have a discussion or debate and how we could change or behave in school.”*

**STEM and inclusion** She is thinking a lot about the correlation between STEM and inclusion with a specific focus on how to make sure that no student is left behind.

*“Because I feel that STEM is very open to kids that are interested in science and mathematics. But you might have kids that are more into other stuff. They might be into nature but not into science. They might be into the outdoors and not science. I think that is not very inclusive in that way. But they are trying, STEM is like the old word for it. So now you have STREAM, that is like reading and arts as well. And that is becoming more inclusive. Because some kids might be more into reading instead of doing things with their hands and then suddenly you make it clear to the teachers that they should also include that. As well as the arts. You are more aware that they have to make something also with modelling and stuff and then you would make activities where those kids are included as well and then suddenly they are the secure ones, in those lessons. So I hope it would be more inclusive over time.”*

The way she looked at STEM and inclusion did not change in the post-interview, the workshop series confirmed a lot of the way she taught about inclusion. What was new to her was that the correlation between STEM and inclusion in the classroom does not have to be difficult. The workshop series showed her that you could start easy and use other people’s techniques.

*“I think the cluster was really good at letting us know and make us aware that you could start easy, like the dinner about really common and everyday like things. So really a common grounds and have discussions about it. They made it really clear that you do not have to invent the rocket kind of thing but that you can start easy on and use other people’s techniques and that is fine. It made it easier for us to swallow the inclusion and diversity.”*

**Multinational context** The biggest advantage of the multinational context for Nina was that the other teachers who were involved from other countries, showed her the importance of inclusion in a whole different way. On the other hand, she was critical about the online environment. She found it hard to focus especially if not everyone their camera was on or the internet connection was bad. The English language was a challenge as well, many teachers were not taught in English which made the communication difficult in her opinion and she felt that the language was for some teachers the reason they did not speak.

**Change in knowledge, belief and practices** What Nina found difficult, is that the workshop series felt a bit too basic for her knowledge sometimes. That is also why her learning goals were not fulfilled:

*“Yeah, I think I wanted to learn more ways to do it or exercise in class and we got some but I do not feel we got that many. So I maybe wanted more different exercises instead there was a lot of talking about what inclusion is, but because I already had that I wanted more new exercises I think.”*

If there were exercises mentioned, she mentions that they felt as inclusive assignments and not always related to the content of STEM.

*“Uhm, I think some of the exercise were quite nice but I think I struggled a bit if you have a normal course in chemistry where you have to do like some inquiry based exercise I think I would struggle how to make that inclusive. So I do not think I learned that or see clearly how I want to do that actually.”*

*Table 11 | Results p4; differences pre- and post-interview*

	Pre-interview (f)	Post-interview (f)
<b>Mentioned underrepresented groups</b>		
Student with disabilities in STEM	1	2
Racial and ethnic minority students in STEM education	-	3
Gender gap in STEM education	2	1
Low socioeconomic status	-	-
<b>Status/recognition of diversity</b>		
Homogeneity	-	-
Heterogeneity	3	2
Diversity	4	5
<b>Multinational context</b>		
Positive	1	2
Negative	1	1
<b>Change in knowledge belief, and practices</b>		
Awareness	n/a	1
Confirmed ideas	n/a	4
New ideas	n/a	1
Trying new practices	n/a	-

*Kim (P5)*

**Definition inclusion** In the pre-interview she has difficulties with expressing how she really thinks about inclusion. Eventually she thinks about it as accepting one another, no matter what the students’ level of understanding is:

*“But maybe I can define inclusion in that case in different level of understanding. In one class that is really random, some students have low understanding and medial and higher, we really mix all the level of understanding in one class. I think that is part of inclusion. I try to include my learning in that all. So that not only the students who has higher understanding, but I tried my best to accommodate all of them.”*



In the post-interview is an interesting aspect. Kim her answers are more structured, and she can give clear examples which are in correlation with inclusion aspects. Her meaning of inclusion became broader, which included more aspects especially in relation with underrepresented groups.

*“Inclusion is when in a class we have different situations, gender, cultural, social economic and race in a class. When all the aspects of the class can ran smoothly, respect each other, listen to each other, that means inclusion for me.”*

Also she sees the importance of inclusion more than before the workshop series. She finds it so important that she considers to do her master thesis about gender equity in relation to STEM. Which is remarkable because she did not mention the gender gap at all in the pre-interview (see table 12).

**STEM and inclusion** Kim found especially the diversity of education of STEM really interesting, which she often refers to.

*“The image of STEM is inclusive enough. In STEM we try to integrate not one subject but different subjects so Science, technology and Mathematics in one lesson. We try to combine all of them, not just combine but also have to think about student understanding of each subject and we also think about the goals of each subject and then we combine them. It is not so easy to just combine. And I think that is inclusion.”*

The post-interview shows a difference with the pre-interview. In the pre-interview she especially talks about the variety of the subject which in her opinion defines inclusion. In the post-interview she sees the relation between STEM and inclusion more related to the underrepresented groups.

*“Like STEM the background is different subject in it and also in the STEM career we have different, how to say that, in STEM career men have to have more jobs than woman and also someone who work in the nice country wealth country tend to have more STEM job than in poorer country so that brings me awareness. That STEM is related to inclusion because we also work with students with different backgrounds.”*

**Multinational context** Kim is really positive about the multinational context, especially because it shows her the differences between countries. Also she felt that she got really important feedback from the other teachers as well as from the educators from the course to design tasks related to diversity and inclusion in STEM education.

*“Yeah, that is nice again especially with the discussion with the meals we have people from really different countries, we shared the culture there and not only in this task, in the next session we also discussed the designed classroom in our own country.”*

Something which could have gone better was the collaboration after the lecture. It was really difficult to contact another teacher, she wished there was an easier platform to discuss.

**Change in knowledge, belief and practices** Remarkable is that on the answer if she changed in awareness, she concludes that she has not. But her changes in knowledge and belief, but also the differences in pre- and post-interview show otherwise (see table 12). Also, she loved how the course gave her insight into the simple but very meaningful way to deal with



diversity, like the multicultural meal to deal with cultural diversity and the use of role models to deal with gender gap in STEM education.

*Table 12 | Results P5; differences pre- and post-interview*

	Pre-interview (f)	Post-interview (f)
<b>Mentioned underrepresented groups</b>		
Student with disabilities in STEM	-	-
Racial and ethnic minority students in STEM education	5	9
Gender gap in STEM education	-	10
Low socioeconomic status	-	5
<b>Status/recognition of diversity</b>		
Homogeneity	1	-
Heterogeneity	3	4
Diversity	-	-
<b>Multinational context</b>		
Positive	2	2
Negative	-	1
<b>Change in knowledge, belief and practices</b>		
Awareness	n/a	8
Confirmed ideas	n/a	-
New ideas	n/a	2
Trying new practices	n/a	2

## Discussion

The present study aimed to evaluate the inclusion and diversity workshop hosted by the International Centre for STEM Education (ICSE) Academy and to research how (student) teachers become aware of inclusion and diversity in STEM education. The first research question regarded the change in knowledge, belief and practices which teachers may experience during the workshop. The categories status of diversity and mentioned underrepresented groups provide additional support for further elaboration on the changes teachers undergo during the workshop.

The change in knowledge, belief and practices is represented in this study by awareness, confirmed ideas, new ideas and intentions to try new practices. Notably, the results of the interviews show a larger change in awareness as compared to new ideas, confirmed ideas and the intentions to try new practices. In contrast to one case study where one teacher (Nina) exhibits a lesser shift in awareness but demonstrates a more concentrated transformation in confirmed ideas. This variance might be attributed to the fact that this particular teacher already possessed a substantial base of prior knowledge, which could indicate that pre-knowledge has an influence on the four different groups of change in knowledge, belief and practices. The shift in awareness tends to be smaller and focuses more on the ideas the teacher already had. This observation is coherent because confirmed ideas is least associated with getting ideas from others, in contrast to new ideas which are closely linked with getting ideas from others (Bakkenes et al., 2010). This finding aligns with the results of the interviews, where new ideas was ranked second most frequently mentioned. This correlation is logical considering that the workshop primarily emphasized collaborative work and the exchange of ideas among participants. The other teacher (Kim) in the case study, characterized by a lower level of pre-existing knowledge, aligns more closely with this general pattern of the interviews of this study. This pattern suggests that the initial phase of becoming aware appears to be the most accessible, aligning with the study of Bakkenes et al, (2010). The present study delves more specifically into the intention to try new practices than Bakkenes et al. (2010), particularly with the examination of the design activity assignment. Results indicate that teachers outline various exercises with clear topics and assignments, attempting to connect them to dimensions of diversity. However, the transition from conceptualization to practical implementation seems challenging. The assigned tasks present difficulties in execution as can be seen in the activity design, not only due to time constraints but also because grasping the specific aspect of diversity they aim to address in their STEM lesson proves to be difficult as seen in the dimensions they fill in. Thus, progress towards awareness is evident, but translating these concepts into practical applications appears hard. A possibility could be that behavioral change requires more time and also considers multiple changes in knowledge and belief (Bakkenes et al., 2010). A three-week workshop may not suffice. However, extending the workshop series to potentially enhance its impact also poses challenges. The current curriculum is already densely packed and expanding it proves to be difficult, as this would mean existing essential courses must be removed (Forlin, 2010). The need does exist to show that inclusion and diversity courses are essential and should not depend on the individual choices of teachers. Offering inclusion and diversity courses outside the main curriculum may perpetuate the notion that only teachers with the luxury or capacity to handle additional workload can engage in inclusion, furthering a divide on this topic among teachers.

Status of diversity also sheds light on how teachers' view have transformed. The results from the interviews and the case studies indicate a shift from a focus on homogeneity and heterogeneity towards heterogeneity and diversity. This is a valuable and positive change, because it is important that lessons or curricula are designed proactively for heterogeneity (Dewsbury & Brame, 2019). This concept is not new; the Freirean philosophy from 1970 states that dialoguing is the process by which the instructor humbly gets to know the students and their unique backgrounds. Without this, the philosophy states, it would be impossible to create a classroom that truly includes diverse voices (Dewsbury & Brame, 2019, Ash & Wiggan, 2018). While this idea has persisted over time, challenges remain. Teachers, as expressed in reflections and interviews, find it difficult to integrate this approach into curricula or lack the confidence to do so. Literature echoes this sentiment, teachers must develop the courage to resist their own traditional Eurocentric perspective and develop engaged pedagogical relationships with students (Tuitt, 2016, Ash & Wiggan, 2018).

Recognizing and representing the outcomes of mentioned underrepresented groups is also an important factor in this study. Given the diversity among students, it is crucial for teachers to acknowledge that certain students may feel underrepresented at times, needing support. Helping these minorities develop strong identities and academic mindsets related to STEM is a potential opportunity to address underrepresentation in STEM (Kricorian et al., 2020). Teachers need to repeatedly send a corrective, strong, positive message to these groups (Milgram, 2011). Some participants in the interviews highlighted the importance of this approach, though some found it challenging, perhaps due to concerns about creating imbalances of attention between their students. The workshop helped them realize that this was not the case as evidenced by the interviews. This shift could prompt teachers to move beyond traditional and 'normal' role models, actively seeking role-models which provide a broader perspective, thereby creating diverse lessons that recognize and include underrepresented groups.

The current study also provides insights into the supporting and limiting factors within the multinational context of the workshop to answer the second research question. Interacting with teachers from diverse countries proved advantageous, as noted by both interview participants and teachers who completed reflections. The exposure to different perspectives fostered confidence among teachers; observing others succeed inspired a belief that they, too, could attempt similar approaches. Moreover, the significance of diversity became even more apparent. Engaging with teachers from varied backgrounds outside of their own environment, had a positive effect on the learning process and on raising awareness about the importance of inclusion. The discussions led to new insights, activities and ideas. This shows that diversity is an important aspect to create inclusive thinking, ultimately, an inclusive classroom. Such evidence emphasizes the importance for educational institutions to actively build upon diverse experiences and perspectives (Nagda et al., 2009). Several limiting factors for the multinational context were identified, particularly related to the online environment and the use of the English language. A risk arises when English-speaking institutions engage in practices of inclusive learning and teaching, while non-English-speaking institutions or participants struggle to follow. This, potentially leads to divergent paths in implementing their versions of inclusive teaching practices, which may not be genuinely inclusive (Lawrie et al., 2017). Some participants even mentioned that individuals might refrain from speaking due to discomfort with the English language, fostering exclusion. Another limiting factor is the online environment. Participants encountered challenges in maintaining focus, experienced difficulties in communication, and felt a lack of the personal dialogue that typically occurs,

for example, after a lecture. The online environment affected engagement and the quality of interaction.

The workshop has proven to be effective in raising awareness and in providing strategies, ideas and practices to foster a more inclusive classroom. This aligns with the findings of the study of O’Leary et al. (2020) which shows that workshops help teachers to become more aware of the importance of inclusive classrooms. Furthermore, through engagement in inclusion and diversity focused education courses, (pre)service teachers can gain greater critical insight into the effects of diversity upon teaching and learning (Bhopal & Rhamie, 2014). This correlation is evident in the results of this study.

Conclusively, it can be affirmed that a European inclusion and diversity workshop changes (students) teachers’ knowledge and belief of inclusion, particularly in terms of raising awareness, increased understanding of underrepresented groups, and a shift in the recognition of diversity’s status. However, transforming these newfound insights into changed practices remains a challenging step, particularly when integrating them into everyday STEM practices. As mentioned, the supporting and limiting factors are acknowledged, with a majority of teachers expressing positivity about the multinational context. While the identified limiting factors were not unexpected, it is noteworthy that, for some participants, these challenges did not counterbalance the benefits of the multinational setting.

### Limitations and implications

It is important to note that the sampled teachers in this study do not represent the entire spectrum of teachers in Europe, because only six out of 38 who participated in the workshop were interviewed. The same goes for the reflection assignment where eight out of 38 responded. Furthermore, since the teachers volunteered themselves, it is likely that they already have an interest in inclusion or are inherently more proactive. This could lead to a bias in the study.

The findings in the results of the pre- and post-interview show some remarkable differences. It is crucial to consider that post-interviews might naturally elicit more codes because they were longer. To reduce the risks of getting a wrong perspective, the total number of teachers who mentioned the code was added. This not only demonstrates an increase in mentioned codes but also reflects an increase in the number of teachers expressing these views. Additionally, certain interview questions could potentially influence coding outcomes, particularly those related to the multinational context. Participants discussing this aspect might consequently lead to specific codes being applied.

Due to the online environment, observations were much more difficult. Especially because the researcher was in a breakout-room with teachers who could not speak the English language very well. Therefore, observations were used less than expected and more information was gathered through the analysis of assignments and reflection.

Furthermore, it is important to acknowledge the study's validity. While the aim was to ensure as much validity as possible, constraints on time with the second coder and the researcher prevented the recoding of interviews. Therefore, the approach was to engage in discussions about the codes, reaching an almost 100 percent agreement on the coding process.

Future research should be directed at following the teachers for a longer period of time. The current data primarily focuses on a short period of time after the workshop series. A more

extended follow-up would likely unveil a more visible impact and change resulting from the workshop. Moreover, future research should look into the workshop series itself. Questions could be raised regarding whether the ICSE Academy should prioritize providing broader information, dive deeper into specific areas or make the workshop for teachers encountering inclusion concepts for the first time, with an emphasis on raising awareness. Additionally, studies are warranted to explore the systemic aspects of educator development. It is important that inclusion evolves into a self-evident aspect of teaching practices. Understanding how educators can seamlessly integrate inclusion into their practices is crucial for the long-term success of inclusive teaching.

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## Appendices

### A: Pre-interview scheme

<b>Questions + subquestions</b>	<b>Literature</b>
Where are you from?	ICSE Academy
What are you teaching and for how long?	ICSE Academy
Do you teach in a city or a village?	Gorard & See, 2009
Why did you decide to become a teacher?	ICSE Academy
What are your most important goals as a teacher now and in the future?	ICSE Academy
Why did you sign up for the inclusion cluster?	ICSE Academy
What means inclusion for you?	O'Leary et al., 2020, Dewsbury & Brame, 2019, Ainscow, 2020
Would you describe yourself as an inclusive teacher?	Blackburn, 2017, Starr & Simpkins, 2021, O'Leary et al., 2020, Bhopal & Rhamie, 2014, Tuitt, 2016
Do you think you have biases/stereotypes?	Starr & Simpkins, 2021, Lavy & Sand, 2015
Do you think that your lessons are already as inclusive as possible? - Why or why not?	ICSE Academy, Dewsbury & Brame, 2019, Bhopal & Rhamie, 2014, Nagda et al., 2009
Do you think STEM is inclusive enough?	Starr & Simpkins, 2021, McGee & Bentley, 2017, Lawrie et al., 2017, Tuitt, 2016
What do you want to learn during the inclusion cluster?	ICSE Academy, Dewsbury & Brame, 2019
Do you see the multinational context as something positive/negative or neutral?	ICSE Academy, Lawrie et al., 2017



**B: Post-interview scheme**

<b>Questions + subquestions</b>	<b>Literature</b>
<p>What are your overall views about the session about inclusion and diversity?</p> <ul style="list-style-type: none"> <li>- What did you think about the length of the session?</li> <li>- What did you think about the content of the session?</li> <li>- What do you think about the style/method adopted?</li> </ul>	<p>ICSE Academy</p>
<p>What does inclusion mean to you?</p>	<p>O’Leary et al., 2020, Dewsbury &amp; Brame, 2019, Ainscow, 2020</p>
<p>Do you think you are an inclusive teacher?</p> <ul style="list-style-type: none"> <li>- Do you have any ideas after the cluster how you will become more inclusive?</li> </ul>	<p>ICSE Academy, Blackburn, 2017, Starr &amp; Simpkins, 2021, O’Leary et al., 2020, Bhopal &amp; Rhamie, 2014, Tuitt, 2016</p>
<p>Do you think you have any biases/stereotypes?</p> <ul style="list-style-type: none"> <li>- Maybe more than before the cluster started?</li> <li>- Do you think the cluster gave enough attention to it?</li> <li>- Why do you think it is important to be aware of them?</li> </ul>	<p>ICSE Academy, Starr &amp; Simpkins, 2021, Lavy &amp; Sand, 2015</p>
<p>Would you consider inclusion and diversity as more important in your way of teaching than before the cluster?</p>	<p>ICSE Academy, O’Leary et al., 2020, Dewsbury &amp; Brame, 2019, Ainscow, 2020</p>
<p>How do you see the relation between STEM and inclusion and diversity?</p> <ul style="list-style-type: none"> <li>- What do you think will be the biggest challenge concerning STEM and D&amp;I for you teacher practice?</li> <li>- Do you think that inclusion helps to improve STEM teaching for teachers? <ul style="list-style-type: none"> <li>o Do you feel more confident and competent in inclusion and diversity in STEM now?</li> </ul> </li> <li>- Do you think that inclusion is likely to improve STEM learning for students?</li> <li>- Would you consider a multicultural perspective in your lessons (more often)?</li> </ul>	<p>ICSE Academy, Kricorian et al., 2020, Ainscow, 2020, Lawrie et al., 2017, Ash &amp; Wiggan, 2018</p>

<ul style="list-style-type: none"> <li>- Would you consider inclusion and diversity as more important in your way of teaching than before the cluster?</li> </ul>	
<p>Do you think something changed in your awareness towards inclusion and diversity?</p>	<p>Bakkenes et al., 2010, Lawrie et al., 2017</p>
<p>What are your views about the collaborative aspect implemented during the session?</p> <ul style="list-style-type: none"> <li>- What do you think about the collaboration across disciplines?</li> <li>- What do you think about the collaboration between different countries? <ul style="list-style-type: none"> <li>o How did you feel about the English language?</li> <li>o Is it something you want to experience more?</li> </ul> </li> <li>- How did you experience the collaboration in the online environment?</li> <li>- Do you think the cluster itself was inclusive enough? <ul style="list-style-type: none"> <li>o Why, why not?</li> </ul> </li> </ul>	<p>ICSE Academy, Ainscow, 2020</p>
<p>To what extent do you feel that the session targeted your needs?</p>	<p>ICSE Academy</p>
<p>Do you feel equipped enough with a broader range of strategies to ensure the inclusion of all students?</p> <ul style="list-style-type: none"> <li>- Why or why not? <ul style="list-style-type: none"> <li>o Do you think that you could address all students?</li> </ul> </li> <li>- What are you going to do to make your lessons/assignments inclusive?</li> </ul>	<p>ICSE Academy</p>
<p>After this cluster, would you educate yourself more on inclusion and diversity? Or is it, for now, enough?</p>	<p>ICSE Academy, Lawrie et al., 2017</p>
<p>What is the most important thing you have learned during this cluster?</p>	<p>ICSE Academy</p>

### C: Observation scheme

What do I want to observe?	Why?	Literature
Questions asked	Seeing what kind of questions people ask can say a lot about how they think about the subject.	
Who says something	Does everyone feel included? Do they dare to say something?	O’Leary et al., 2020
Is the teacher inclusive	Be aware of the influence a teacher could have.	O’Leary et al., 2020, Dewsbury & Brame, 2019, Ainscow, 2020
Stereotypes	It is important to be aware of stereotypes participants could have and if they know about them.	Starr & Simplins, 2021
Active participation	Are they interested enough to take it seriously?	Tuitt, 2016, McGee, 2017
English language	If some people are left out because of the language this has a major influence on the inclusivity of the workshop.	Ainscow, 2020
Reactions on each other	Does everyone respect each other and feels safe? Only then you can create a safe and inclusive environment.	O’Leary et al., 2020
Knowledge of participants	It is good to notice change in the teachers’ knowledge throughout the cluster. But also to spot who already know more about the subject.	