Culture, Equity and Diversity in the STEM classroom

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Executive Summary

“We are diverse individuals, we learn in diverse ways, and some of that diversity reflects intersecting patterns of how key demographic factors like race, gender, and social class are situated inequitably in our society” (Scott, Sheridan, and Clark, 2015, p. 431).

This catalogue of possibilities offers a collection of useful practice-oriented research literature (short summaries and references) and provides insight into individual learning experiences the Science Math and Technology (STEM) Professional Development (PD) network (Net) members have gathered in course of a three year Erasmus+ project (2016–2019).

The aim is to inspire STEM professional Development Centres all over Europe to explore ways how to improve science, mathematics and technology education to engage increasingly diverse learners.

Although “meeting the needs of a diverse range of students and the different interests of boys and girls are important for motivating students to learn, ‘dealing with diversity’ was the least addressed competence in both the generalist and specialist teacher education programs according to the survey responses received” (Education, Audiovisual and Culture Executive Agency (EACEA), 2011, p. 118).

So far, recent OECD PISA 2015 results show that “on average across OECD countries, and after taking their socioeconomic status into account, immigrant students are more than twice as likely as their non-immigrant peers to perform below the baseline level of proficiency in science. Yet 24% of disadvantaged immigrant students are considered resilient” (OECD, 2016, p. 4).

However, a diverse society is a source of inspiration and thus diverse learners in a classroom are an advantage not an obstacle for good STEM teaching. STEM education provides a wide range of opportunities for all students so every learner should have equal opportunities to access it.

Learners diversity can be both visible (gender, skin colour, physical handicap etc.) and invisible (family heritage, culture, sexual orientation, learning difficulties etc.). STEM Teachers and teacher educators therefore should always prepare their lessons with the assumption of a diverse student population. **STEM PD Centres all over Europe are expected to accept the challenge and offer research informed professional development courses which are not only particularly designed to address issues of diversity in the STEM classroom but they have to include diversity sensitive teaching and learning as a generally valid principle into all their training activities.**

This catalogue represents a collection of useful, practice based research literature addressing various aspects of diversity relevant in STEM education settings. Short summaries/abstracts and reference are grouped into categories so that one can use this information as a starting point to dig deeper into a particular field of research. It is designed to offer insight into practice oriented research and does not aim to be complete. We offer a range of possibilities to deal with diversity issues from different perspectives. We assume that STEM PD centres in Europe are as diverse as individual teachers and their students are and thus equally proficient to pick what is most important for a given situation.
This catalogue (STEM PD Net Intellectual Output 3) comprises six chapters and is based on a profound literature review supported by STEM PD Net partners.

1. Introduction
2. Current Challenges in Dealing with Diversity in STEM Education
3. Possible Ways of Dealing with Diversity in STEM Education
4. Examples for Dealing with Diversity in STEM Classroom
5. Examples for Professional Development Activities Preparing Teachers in Dealing with Diversity
6. References

Literature was collected via a literature search (Thomson Reuters Web of Science).

The focus was put on literature addressing socio-cultural aspects of diversity in STEM classrooms and some studies are briefly presented (shortened abstracts) in this report as they appeared to be useful for STEM-PD purposes in particular.


We strongly recommend this book and fully agree to Pauline Chinn’s (2017) book review statement: “Overall, Science Education for Diversity is valuable reading for a wide audience of science educators, researchers, and policy-makers as it offers a clear-eyed, critical look at the inability of mainstream science education to recruit a diverse ST workforce while preparing all citizens to be scientifically literate, lifelong science learners. Contributions that present a range of theoretical approaches and practices, highlight tensions, and provide possible solutions across a range of implementation sites promise to provide useful insights” (p. 111)

In addition, the final report published by “The Science Education for Diversity Project” EU, 2012; (http://cordis.europa.eu/project/rcn/94405_en.html) was taken into consideration.

As empirical research studies on supporting STEM teachers to become proficient in teaching a diverse audience are rare, we consider this review a first step to bring together research knowledge and day-to-day experience and practices. We want to encourage any STEM PD centre to research, publish and share its work addressing diversity issues in STEM PD.
1. Introduction

The primary aim of this catalogue is to demonstrate the depth, breadth, and international nature of students’ diversity in STEM education. This work is the first attempt to catalogue issues of students’ diversity relevant to STEM education practice in professional development for STEM teachers within the academic literature and STEM PD Net partners’ practice based experience.

Children always have been different in their abilities, talents ideas, and family backgrounds. However, the student body is becoming increasingly diverse in terms of language, nationality and cultural background (Bruen and Kelly, 2015). Approximately 175 nationalities live within the borders of the European Union and in 2012 alone, an estimated 1.7 million immigrants entered EU countries from outside the EU (Statistical Office of the European Communities, 2017). In her keynote talk about linguistic and cultural diversity in Europe at the ECER Conference in Lisbon in 2002, Ingrid Gogolin has already emphasised that this is a challenge for educational research and practice:

“But European educational systems do not adapt very well to this reality. It can be observed that a linguistic and cultural background different from the respective national one serves as a means of exclusion, of prevention from equal access” (2002, p. 123).

Recently, Anne Lin Goodwin summed up, “Fourteen years ago I wrote an article about this very same imperative, which looked ‘at the issue of teacher preparation in light of changing demographics as a direct consequence of increased immigration’ (2016, p. 156). The article concluded ‘that conversations about the unique needs of immigrant children and recommendations for better teacher preparation are futile, if society and educators do not have the will to do the right thing’ (2016, p. 170). A decade and a half since that article was published, it is troubling to find it necessary to engage in the same examination and assessment of the same issue” (p. 1).

Chinn (2017) suggested a short while ago: “Transnational migration, climate change, economic and educational disparities impel science educators to refine science literacy and explore ways to reform science education to engage increasingly diverse learners” (2017, p. 109). Besides an increasing focus on linguistic and cultural diversity a growing impetus towards full inclusion is globally observed (Evans and Lunt, 2010).

Thus, the challenges science teachers face in their STEM classrooms are increasing continuously. Teacher education, in-service and pre-service alike, needs to face these challenges and develop strategies on how to address them. PD centres urgently need to adopt an attitude to consider very heterogeneous target groups in every PD courses offered to teachers regardless to the subject-specific content.

Teacher educators need input supporting teachers to develop a professional attitude towards teaching STEM subjects in heterogeneous classrooms and how teachers become proficient in finding out whether their lessons are helping students with learning barriers to fulfil a given learning goal (see chapter 3).

Although PD centres are asked to address these challenges in their PD courses and to support teachers in adapting new approaches to teaching STEM subjects in extremely heterogeneous classrooms, empirical
research studies or tested materials that support STEM teachers to face these challenges are rare (see chapter 2). Consequently, there is an urgent need for an European exchange on these issues, allowing PD centres with different expertise (e.g. partners from Sweden and Germany already have experiences in providing professional development as regards diversity in learning groups involving refugees and migrants) to learn from each other (see section 3.6).

1.1 What do we mean by Diversity?
The concept on human diversity observed in formal and informal learning environments is fuzzy and the umbrella term comprises many different perspectives. How the concept of diversity is used in science education literature reflects the ambiguity between pre-determined features such as e.g. skin colour or age and changeable features such as e.g. language or worldview. However, what is considered changeable or pre-determined is a matter of discourse (Mansour and Wegerif, 2013). We take inspiration from Wegerif et al. (2013) and adopt a socio-cultural perspective. We are aware about tensions and dilemmas between cultural groupings and individual differences. We consider it most important that students need to be treated as individuals who are influenced by their environment, before treating them as part of a larger stereotyped group. This is equally true in special needs education.

1.2 What do we mean by Diversity in STEM Education?
So far, science education research literature emphasises rather obvious groupings when addressing diversity in the classroom. Cultural, gender and language diversity, socio-economic inequalities, diversity of subject performance level as well special needs education are frequently addressed topics. However, we are aware that when it comes to putting theory into practice educators need to first develop skills to identify individual as well as group differences and then adapt instructions to their pupils’ needs.
2. Current Challenges in Dealing with Diversity in STEM Education

Professional development offered in STEM teacher education is supposed to rely on recent research findings. Thus, we searched for studies on diversity in the STEM classroom. We narrowed down our search to literature published between 2012 and 2018. Also, only English literature was chosen to make this report equally accessible to all partners. A number of studies are highlighted by a shortened version of their abstracts. Most studies have been published open access. Thus, we recommend reading this publication to achieve a detailed understanding.

In this catalogue we focus on studies which cover possible implications for European teacher education institutions offering pre- and in-service training on the primary and secondary level. The literature was searched for keywords such as cultural diversity, inclusion, language, learning difficulties, socio-economic inequalities and teachers’ professional development. These keywords were considered most important by STEM PD Net partners during their first meeting.

The first section presents three papers on cultural diversity and integration of immigrants, the second and the third refer to four studies each on gender diversity and special needs education. Three papers address language diversity and four the diversity of subject performance level. Socio-economic inequalities and teaching concepts for diverse STEM classrooms are addressed by two studies each. Finally, one paper refers to empirical research on approaches to provide PD concerning diversity.

2.1 Cultural Diversity and Integration of Immigrants

Cultural studies of science education emerged in response to the recognition that diversity issues such as language or sociocultural background can be explained by the given that science education is a cultural phenomenon and as such part of the amalgam of movements and processes in society.

Blanchet-Cohen and Reilly (2013) observed a variety of changes when incorporating environmental education into multicultural diverse classrooms. These changes included value clashes, a lack of common lived experiences, and reconciling contradictory educational perspectives and political policies, which often placed teachers in paradoxical positions. Their findings suggest moving towards practices of culturally-responsive environmental education that demand more than awareness but include interactive dialogue. Teachers need support from beyond the classroom and the capacity to develop curriculum facilitating the inclusion of students.

De Carvalho (2016) describes a complex scenario of super-diversity in UK classrooms and argues that teachers need to be particularly educated to face the challenges of multi-religious and globalized science classrooms. In order to cope with this dynamic and thought-provoking environment, science initial teacher education (SITE) — especially those catering large urban centres — must evolve to equip science teachers with a meaningful understanding of how to handle a super-diverse science classroom, taking the discourse of inclusion beyond its formal boundaries.

Fine-Davis and Faas (2014) did a cross-cultural comparative study concerning the attitudes of secondary school students and their teachers in six European countries: Ireland, the UK, France, Latvia, Italy and
Spain. The authors compare attitudes towards non-national students, ethnic and religious minorities and disabled students, as well as gender issues, bullying and general perceptions of equality and diversity. Although this study does not focus on STEM classrooms in particular, the conclusion may as well be relevant for STEM teacher educators. Fine-Davis and Faas conclude that comparing students with teachers identified consistent gaps in perceptions, with teachers having greater estimates of difficulties posed by diversity, together with smaller estimates of bullying behaviour. The study demonstrated that there is a need for teachers to have enhanced skills and competencies to deal with this new environment effectively and thus facilitate a more inclusive classroom.

2.2 Gender Diversity
Gender equity is still an issue in science and math education. Recent studies in the Vision Science Society, in math intensive STEM fields and in technology related areas mirror a huge number of research that came to quite similar results. There is still a gap between gender equity in STEM related fields, however, this gap appears to become smaller.

Wang and Degol (2017) reviewed research from the fields of psychology, sociology, economics, and education over the past 30 years and summarized six explanations for US women’s under-representation in math-intensive STEM fields. After describing potential biological and sociocultural explanations for observed gender differences on cognitive and motivational factors, they refer to the developmental period(s) during which each factor becomes most relevant. Finally, the authors propose evidence-based recommendations for policy and practice to improve STEM diversity.

Cooper and Radonjic (2016) report on gender representation of a large sample of attendees of the Annual Meeting of the Vision Sciences Society (VSS). Analysis shows that the majority of scientists at all career levels are male. This imbalance is most pronounced for the senior scientists, whereas pre-doctoral students are nearly balanced between the genders. Historically, the gender imbalance was larger than it is at present, and it has followed a slow-but-steady trend towards gender parity over the past decade. A longitudinal analysis based on tracking individual attendees shows a larger dropout rate for female than male pre-doctoral trainees. However, among the trainees who continue in the vision science field after graduate school, evidence suggests that career advancement is quite similar between the genders.

Witherspoon, Schunn, Higashi, and Baehr (2016) studied the impact of robotics competitions on the engagement of students in computer science. They reveal that gender gaps persist in these learning environments and appear to widen as students grow older and enter more advanced competitions. This study conducted to over 500 elementary, middle, and high school robotics competition participants examines whether programming involvement in these competitions is associated with motivation to pursue additional programming experiences and whether opportunities to learn programming varied by gender, age, and competition type. Results show a significant association of students’ programming involvement with their motivation to learn more programming. Interestingly, in the youngest groups/entry-level competitions, girls are heavily involved in programming. Unfortunately, in older/more advanced competitions, girls are generally less involved in programming, even after controlling for prior programming experience. Therefore, addressing gender imbalances in programming will likely require
greater attention to particular curricular and pedagogical characteristics of robotics competitions that support girls’ interest and involvement in programming.

Kimani and Mwikamba (2011) discuss the gender dynamics in science and technology and conclude that the “awareness of the gender dynamics in the participation of science and technology, based on cultural beliefs and practices should lead to question the inclusion of all stakeholders of the economy at the household, local and national levels. This means being analytical and critical at all disempowering processes that block the road to the development of full potential of any group of human population. At the personal level, women and men need to question themselves as to what influences what they do with a view of developing strategies to overcome cultural barriers and begin to see changes in their own lives. Negative attitudes and perception of the people towards girls and women must also change to allow them to have equal opportunities and status with boys and men respectively” (p. 78).

Professional Development Programs could have an important role to reduce the gender gap in science, mathematics or computing at all levels of education. Teachers could encourage girls and increase the visibility, participation and respect of girls in these subjects.

2.3 Special Educational Needs

Markic and Abels (2014) provide an overview of research on heterogeneity and diversity in German chemistry classes. The different facets of heterogeneity and diversity are asserted and the focus was put on language and special needs since both of these dimensions are frequently discussed in the German context. A comparison between international and national research is given. The authors conclude that the transferability of results between countries is not possible in most cases when it comes to language issues in particular. In terms of special needs, there is a severe lack of science teachers, who have studied or received special training to teach and correctly handle inclusion in sciences classes in Germany. Furthermore, in-service teacher training programs in this direction are almost non-existent. Science educators mainly work with an eye towards science teaching and learning; special education educators work with a focus solely on special education teaching.

Pfister, Moser Opitz, and Pauli (2015) report on a video study of 36 inclusive classes (3rd grade, aged 9 years) aiming at examining how classroom teachers and special education teachers implemented a remedial mathematics program in a classroom setting. This study shows that it is possible to encourage the use of scaffolding in inclusive classrooms. However, the disparate results for the different facets imply that scaffolding in classroom situations is a competency that cannot simply be adopted from a “program”, and more intensive teacher training programs seem to be necessary.

Villanueva, Taylor, Therrien, and Hand (2012) argue that in science, effective learning for students with special needs appears to be hindered partly because of issues related to teachers’ experience or ability to make appropriate modifications based upon the needs of the student, and also in part because of the instructional methodologies and resources used in most general education classrooms. The practicality of instructional adaptations and inclusion appear to be a considerable task for which science teachers are ill-equipped to undertake. Drawing from the literature in science and special education, the third
section of the paper delineates the types of instructional supports and scaffolds that students with special needs may require for successful science learning. Within that section, the authors also provide practical examples of how these supports have been applied in grades 3 through five classrooms using an ABI approach. Finally, the authors offer implications that the ideas proposed in this article may affect research and pedagogical practices in science education.

Humphrey, Wigelsworth, Barlow, and Squires (2013) analysed the role of the school and individual differences in the academic attainment of learners with special educational needs and disabilities within a sample of 15,000 students attending 400 Schools across England. They found that at the school level, inclusivity, attainment, free school meal (FSM) eligibility, behaviour (in primary schools) and linguistic diversity (secondary schools), and at the student level, age, sex, FSM eligibility, students with special educational needs and disabilities (SEND) provision, SEND primary need, attendance, behaviour and positive relationships each contributed to the distribution of academic attainment. Implications of these findings are discussed and study limitations are noted.

To make science lessons inclusive, teachers need to know whether and how particular teaching strategies create hurdles for individual pupils to learn notwithstanding they are marked special need students or not. Continuous Professional Development should help them to develop skills to minimize or reduce those barriers so that all students can fully take part and learn.

2.4 Language Diversity
Changing demographics in the world have triggered discussion on language diversity and its impact on science learning.

Van Laere’s, Aesaert’s, and Van Braak’s (2014) study takes into account both the home language and literacy in the language of instruction in relation to student achievement in science subjects. Questionnaires, reading performance tests, and science achievement tests were administered to 1,761 fourth-grade students from 67 schools across Flanders (Belgium). Multilevel hierarchical regression analyses show that the home language and literacy in the language of instruction play an important role in science achievement at the student level, next to gender and socioeconomic status. Students with a home language that is different from the language of instruction experience difficulties with science subjects. Moreover, the higher students’ performance on reading comprehension and self-assessed proficiency in the language of instruction, the higher their score on science achievement tests.

Meyer, Prediger, César, and Norén (2016) are discussing the use of multiple (non-shared) first languages to increase performance in mathematics. They argue that wide empirical evidence and theoretical explanations show that first languages are important resources for increasing the access to mathematics for learners whose first language is not the language of instruction. Whereas including the first language is well established in many countries outside Europe, especially those with shared first languages, most European classrooms deal with five or more (non-shared) first languages without making use of them. This article explores the specific European language context and its cultural, political, and institutional dimensions.
Prediger, Clarkson, and Boses (2016) discuss the importance of developing teaching strategies for bilingual learners based on an integration of three traditions. Starting from revisiting three traditions of reflecting on linguistic transitions between registers and representations, the authors suggest the integrated approach of purposefully relating registers. The result is likely to enhance language sensitive teaching strategies in multilingual classrooms that aim at a conceptual understanding. Two empirical snapshots from design experiments illustrate this potential for teaching and learning. Teachers need to be prepared to be effective instructors of culturally and linguistically diverse student populations. As language and cognition are closely linked, language diversity must be acknowledged as a key element of cultural diversity.

2.5 Diversity of Subject Performance Level
Gifford and Rockliffe (2012) review the nature of learning difficulties in mathematics and, in particular, the nature and prevalence of dyscalculia, a condition that affects the acquisition of arithmetical skills. The results suggest that younger children (under the age of 10) often display a combination of problems, including minor physical difficulties that can create a downwards spiral in their confidence with mathematics. The article then considers the range of recommendations for teaching children with mathematics difficulties, focusing in particular on an approach developed over time at Emerson House (EH). The conclusion is that the EH approach might be effective for children with varied difficulties.

Secher Schmidt (2016) presents four analytical positions: the diagnostic, the structural, the interventionist and the complementary to answer the question what should be done about pupils who perform poorly in mathematics and what causes the problem. The literature examined includes academic articles on math pedagogy and scholarly journals for math’s teachers from the period 1995–2014. 103 articles were analysed. The results show that a context-oriented rationale dominates, but that a less prevalent, competing rationale emphasizing individual causal explanations is also present.

2.6 Socio-Economic Inequalities
Blums, Belsky, Grimm, and Chen (2016) examined whether and how socioeconomic status (SES) predicts school achievement in science, technology, engineering, and math (STEM) using structural equation modelling and data from the National Institute of Child Health and Human Development Study of Child Care and Youth Development. The results indicate that maternal education predicts the child’s early environment, which itself predicts the development of executive function (EF) and language, and thereby, STEM achievement. Moreover, children’s language ability and EF development influenced higher-order cognitive skills, such as relational reasoning, planning, and basic calculation skills. However, only relational reasoning strongly predicted high school math and science achievement, suggesting relational reasoning, but not planning and calculation skills, was central to STEM thinking and learning.

Morgan, Farkas, Hillemeier, and Maczuga (2016) draw a quite similar picture and argue that science achievement gaps begin very early and they persist. The analysis of a longitudinal sample of 7,757 children indicated large gaps in general knowledge already evident at kindergarten entry. Kindergarten general knowledge was the strongest predictor of first-grade general knowledge, which in turn was the strongest predictor of children’s science achievement from third to eighth grade. Large science
achievement gaps were evident when science achievement measures first became available in third grade. These gaps persisted until at least the end of eighth grade. Most or all of the observed science achievement gaps were explained by the study’s main predictors. Efforts to address science achievement gaps in the United States likely require intensified early intervention efforts, particularly those delivered before the primary grades. If unaddressed, science achievement gaps emerge by kindergarten and continue until at least the end of eighth grade.

2.7 Concepts for Teaching in Diverse STEM Classrooms
Moser Opitz et al. (2016) report on an intervention to reduce learning deficits of low achievers in mathematics at the secondary level effectively. In addition, the authors observed whether the type of instruction influences students’ progress. Over a period of 14 weeks, students were taught basic concepts, such as place value and basic operations. In addition, they practiced fact retrieval and counting (in groups). Multilevel regression analyses demonstrated that the interventions can be used to reduce given deficits.

Scherer, Beswick, DeBlois, Healy, and Opitz (2016) discuss the question how research can support practice and suggest to concentrate on the problem of labelling the group of students having mathematical difficulties first as there does not exist a single definition. Research results with respect to concepts and models for instruction are multifaceted based on the specific content and mathematical topics as well as the underlying view of mathematics. Taking into account inclusive education, a closer orientation to mathematical education can be identified and the potential of selected teaching and learning concepts can be illustrated. Beyond this, the role of the teachers, their attitudes and beliefs and the corresponding teacher education programs are discussed.

2.8 Approaches for Providing PD Concerning Diversity
Schnell and Prediger (2017) address the issue of equity in math-education via noticing and enhancing the mathematical potentials of underprivileged students. An extended research review theoretically and empirically grounds the presented approach for uncovering and enhancing (possibly underprivileged) students in design principles for the instructional design and the ways in which teachers notice students’ and situations’ potentials. Dual design research methodology on students’ and teachers’ level is adopted to develop whole class enrichment settings with rich tasks and to empirically study the initiated processes. The empirical investigation of the classroom processes shows that the chosen design principles can enhance the intended enrichment processes on the student side, but need to be strongly supported by teachers’ expertise in noticing and fostering students. An important outcome is the perspective model for teachers’ necessary diagnostic perspectives for noticing and enhancing the potentials. Consequences are formulated for professional development programs.
3. **Possible Ways of Dealing with Diversity in STEM Education**

The OECD Report (Dumont, Istance, and Benavides, 2012) recognises increasing demands on schools and teachers as their range of tasks is becoming more and more complex. Society now expects schools to deal effectively with different languages and student backgrounds, to be sensitive to culture and gender issues, to promote tolerance and social cohesion, to respond effectively to disadvantaged students and students with learning or behavioural problems, to use new technologies, and to keep pace with rapidly developing fields of knowledge and approaches to student assessment. Teachers need to improve their knowledge and skills in working with a diverse audience continuously. Therefore, Professional Development offers need to support teachers to gain a diversity inclusive knowledge base, and learn diversity responsive methods to craft diversity responsive lessons.

A variety of theoretical approaches intend to explain why students have difficulties to exploit the full potential of a given learning environment. Mansour and Wegerif (2013) mention amongst others cultural border crossing and socio-cultural learning as obstacles which are often overlooked. In terms of strategies to overcome or improve teacher performance Culturally Responsive Teaching and Diversity Pedagogy Theory appear to be well-established theoretical frameworks for STEM education practice.

### 3.1 Cultural Border Crossing

In European science classrooms, many cultural issues interfere with the teaching and learning of science, such as those related but not limited to language, globalization, and immigration. In urban regions, many science teachers increasingly find themselves in science classes with students from many different nationalities. Many of such settings are becoming the norm rather than the exception in “mainstream” science education. The theoretical construct of cultural border crossing describes how students move between their socio-cultural everyday life-world and the world of school science and how students deal with cognitive conflicts between those two worlds. While this alienation is only more acute with students whose worldviews, identities, and mother tongues create an even wider cultural gap between themselves and school science, cultural border crossing is equally applicable for “mainstream students” (Van Eijck, 2013).

### 3.2 Socio-Cultural Learning

“Over the past three decades, socio-cultural theory has become a powerful influence in educational psychology, developmental psychology and early childhood education in English speaking countries including Australia” (Van Eijck, 2013, p. 198).

Central to this theory is the idea that knowledge is co-constructed between the individual and the social process in which it takes place. Emphasis is put on Vygotskys concept of the zone of proximal development which is the space between what a learner can do without and what he or she can do with the help of a more experienced person or a teacher. In terms of social interaction, language and other symbolic systems play an important role. The word meaning in conceptual thinking, which is influenced by culture as well as the relationship between elementary and higher, mental functions are considered influential in the development of psychological processes (Dixon and Verenikina, 2007).
Vygotsky showed that cognition (thought) cannot be considered independently from the culture in which one participates and that manifests itself by the language of its participant (Vygotsky 1986, cited by Van Eijck, 2013). Yet, science educators continue to conceptualize cognition separately from culture. Many quantitative studies lack a cultural frame of reference by which the differences detected between groups can be explained. “This means that quantitative data facilitate characteristics of the typical—but inevitably at the expense of the particular” (Sjøberg and Schreiner 2006, p. 5 cited by Van Eijck, 2013).

3.3 Cultural Responsive Teaching

Rhodes (2016, p. 216) refers to Gay and recapitulates “culturally responsive teaching places students’ cultures at the core of the learning process and utilizes the ‘cultural knowledge, prior experiences, frames of reference, and performance styles of ethnically diverse students’” (Gay, 2000, p. 29).

By creating classroom norms reflective of the students’ identities, and not of mainstream culture, the culturally responsive educator mitigates the challenges of overcoming “cultural mismatches” between the home and school cultures. Culturally responsive teaching is distinguished by its emphasis on validating, facilitating, liberating, and empowering minority students by “cultivating their cultural integrity, individual abilities, and academic success” (Gay, 2000, p. 44) and is based on the four pillars of “teacher attitude and expectations, cultural communication in the classroom, culturally diverse context in the curriculum, and culturally congruent instructional strategies” (Gay, 2000, p. 44).

When it comes to teacher education, Gay (2010) suggests that examining beliefs and attitudes about cultural diversity, along with developing cognitive knowledge and pedagogical skills should be essential elements of teacher education. Beliefs and attitudes are “deeply connected, interactive, and complementary. One cannot be fully realized without addressing the other in both teacher professional preparation and classroom practice for teachers and teacher educators” (p. 151).

3.4 Diversity Pedagogy Theory (DPT)

Sheets (2009) points out that there is a natural and inseparable connection between culture and cognition. Diversity Pedagogy Theory (DPT) “views culture and cognition as key to incorporating multiple factors of diversity in the teaching-learning process. It acknowledges the indissoluble, joint-role of culture and cognition in the human developmental process” (p. 11). In this respect, teachers and teacher educators need “to perceive diversity as the norm, and, as such, fundamental to all aspects of the teaching-learning process, and [...] to understand the importance of gaining knowledge about the diverse cultures represented in their classroom” (p. 11) or training course. STEM educators need to be familiar with the Nature of Science, Math and Technology and thus able to evaluate the cultural origin of activities as well as familiar routines they implement in class. Thus, a professional teacher is consciously aware that his/her teaching decisions simultaneously benefit some children while disadvantaging others. “DPT has two paired, side-by-side, tightly interconnected dimensional elements in eight dimensions that serve to guide teacher and student behaviours” (p. 12). Each dimension has two perspectives, one is explaining how teachers think and act in class (Teachers Pedagogical Behaviour, TPBs) and the other highlight ways how children show who they are and what they know (Student Cultural Display, SCDs). Teachers need to develop skills to identify SCDs and critically reflect on their own pedagogical behaviour.
Fundamental to DPT is the assumption that new knowledge acquisition requires a connection between “the child’s prior cultural knowledge and the new knowledge being taught and learned” (p. 13). Children need to figure out what is going on and what choice they need to make so that they can learn at their best first. Later, they select the most appropriate cultural tool for the context and situation from their repertoires of prior knowledge such as “language, prior experiences, and knowledge, which students use in the process of reshaping a situation so they can enter effectively [...]. Thus children use tool from their repertoire of prior learning knowledge and skills to gain new understandings” (p. 14). A diversity sensitive teacher is able to encourage students to learn through multiple approaches. He or she is able to determine what students know and what they are able to do as well as to evaluate how student performance matches his or her expectations and standards.

3.5 Universal Design for Learning (UDL)

Anne Meyer, David Rose, and their colleagues introduced Universal Design for Learning (UDL) in the 1990s. This pedagogical approach assumes that students are individuals from the beginning. Therefore, it is important to develop and plan teaching and learning activities while considering this knowledge.

UDL focuses on three principles:

1. Multiple methods of delivery
2. Multiple means of representation
3. Multiple means of action and expression

Students are considered to be active learners, exploring and analyzing content while experiencing options for expressing what they know. Alongside this process scaffolded learning through multiple practice opportunities is provided (Meyer, Rose, and Gordon, 2014).
4. Examples for Dealing with Diversity in STEM Classroom

Student engagement, active thinking and individual learning progressions are given more emphasis in modern STEM education. Research has shown that particularly student centred instructions which emphasize active thinking have the potential to increase conceptual understanding (Minner, Levy, and Century, 2010). However, student centred approaches presume that all students are equally able to acquire self-regulation strategies and learn to filter select and process incoming information successfully. Taking into account that students make different demands on any learning environment it is important not to make the same mistake and advertise one instructional approach as a panacea for all students.

4.1 Inquiry-Based Learning

Dialogic Inquiry Based Teaching (Wegerif et al., 2013, p 17)

“Dialogic pedagogy teaches students how to engage in dialogue for learning together as well as teaching content matter through dialogue and implies that all members of the class have a voice and that they expect to respect, listen to, discuss and develop a range of views including partly formed, tentative points of view. Such pedagogy provides one means of respecting the range of cultural explanations and the whole set of students’ alternative frameworks, including misconceptions, held by members of the group” (p.17).

Inquiry based science education (IBSE) is an umbrella term used for different ways of teaching science through inquiry and thus is not a uniform method which is equally successful. However, teachers can use these approaches to get into a dialogic way of communicating with their diverse audience. “Teachers need to listen to and respond to the voices of students taking up ideas from students and building on them, thereby allowing students to participate in a shared construction of knowledge. This dialogic approach to IBSE rejects the opposition between teacher-led and student-led science education [...]. The literature suggests that IBSE offers one way to engage young people in a way that allows them to express their own voices and find themselves recognized and valued within the construction of scientific knowledge. However, this is not a simple or easy solution, since, as Polman and Pea bring out, to be effective it requires contingently responsive and creative teaching” (p. 13–14).

Learning Outside the classroom (Parker and Krockover, 2013)

Museums, science centres, zoos, and aquariums often serve as the face of science in the community where they operate. They are an important place for diverse communities to learn about and be excited by science and, subsequently, are in a position to serve as facilitators of communication, cooperation, engagement, and activism among the public, K-12 school science authorities, and science research institutions (both public and private) (p. 79). However, it is important to offer multiple ways of meeting the diverse needs of informal education visitors in order to help them achieve their goals. Exhibits should offer multiple opportunities for visitors to utilize information in order to answer their own questions. “Visitors treasure their direct experiences and value opportunities to inquire into informal education. Visitors also need to recognise that they bring diverse and cultural experiences with them to the informal
setting. Text, observations, interactions, direct experiences, and the use of artefacts and models all contribute to the opportunity to provide diverse experiences for successful informal education experiences” (p. 95).

4.2 Individualized Learning

Gender sensitive teaching: (Hussenius, Andersson, and Gullberg, 2013)

Gender and feminist research is an extensive field and it is not possible to address all or even the most important aspects in this section. Hussenius et al. (2013) used Gender Theory for analysing the science education research field and argue, “very few peer-reviewed articles within science education research’s main topics considered aspects of gender, feminism or equity” (p. 308). However, science education research in German speaking country addresses gender aspects in science and math education rather frequently (see links from partner’s chapter 7). Hussenius and colleagues argue that concepts, laws, and theories are commonly presented in science classrooms as rigid truth and thereby convey a stereotyped positivistic view of science. “Moreover, while the curriculum in school addresses the scientific phenomena and concepts explicitly, it also mediates an implicit message of a hierarchy of science practices and who can access and participate in that practice” (p. 310). Hussenius and colleagues ask for more research, which puts focus to a symbolic level and analyses why science has developed a culture that is alien to the students. We also need to know more about what knowledge is considered important in science and why. Finally, the authors assume “when researchers have identified the obstacles, it will be possible to find more effective instructional strategies and challenge the stereotypic image of science that may hinder students’ development of their scientific knowledge. If science education researchers could expand their studies to include a gender theoretical framework and use a gender perspective to analyse the power dynamics, then by doing so, we could begin to see a complete sky” (p. 310).

Cultural responsive technology (Scott et al., 2015)

Culturally responsive teaching (CRT) was developed as a pedagogical strategy to engage culturally and linguistically diverse students. CRT stands in stark contrast to deficit models of thinking. Teachers are seen as instrumental in the process of effectively implementing CRT by creating an integrated learning context (p. 414). Culturally responsive practices require teachers to be reflective, “engaged in a continual process of examining the ways in which our privileges and constraints shape our worldviews” (Ulman and Hecch 2011, p. 605 cited by Scott et al., 2015). Digital technologies are deeply embedded in contemporary youths’ school, play, and future work. As such, they have unique potential both to amplify existing longstanding inequities that are situated at the intersection of race, gender, and social class, and to propel us towards a more equitable future (p. 431). To this end, we offer the Culturally Responsive Computing framework to guide thinking in the design of digital media educational contexts. We suggest that, on a case by case basis, program designers, educators, and students collaboratively reflect on the intersection of their experiences and identities with digital technologies, discover and build the assets of the participants, and build connections with each other and outside communities. We believe that environments should conceive of digital access in terms of opportunities to create and innovate with
digital technologies and work to provide the culturally responsive contexts to support this pathway to digital equity (p. 431).

### 4.3 Cooperative Teaching Methods

**Ethical Dilemma Story Pedagogy (Germain-Mc Carthy and Owens, 2013)**

“Education for sustainability has strong links to sociocultural perspectives due to its connection to human activities, interests and cultural values” (p. 98). Making sound ethical decisions requires informed decision-making skills based on sound scientific knowledge of the environment, high-level awareness of the environmental impact of science and technology and an ability to engage in critical thinking and critical reflection, thus being able to distinguish between beneficial and potentially detrimental policy decisions (p. 99). “Ethical dilemma stories are stories with characters and a storyline that contain one or more ethical dilemma scenarios. The story is best told freely by the teacher who breaks the storyline at appropriate junctures to pose ethical dilemma questions. Students are instructed to engage with each dilemma question, thereby making a series of ethical decisions on behalf of the story’s character. Ideally, the story has direct curricular links to specific concepts or skills as well as perceived relevance to students’ lifeworlds” (p. 102).

### 4.4 Language Support for Pupils

**Including first Language in Mathematics (Meyer et al., 2016)**

Wide empirical evidence and theoretical explanations show that first languages are important resources for increasing the access to mathematics for learners whose first language is not the language of instruction. Whereas including the first language is well established in many countries outside Europe, especially those with shared first languages, most European classrooms deal with five or more (non-shared) first languages without making use of them (p. 1). As this analysis on the state of discussion has shown, there is a huge need for further research and development on multiple first languages in European mathematics classrooms. In the cultural and political dimension, it can be shown that monolingualism has become an unrealistic fiction in many European classrooms due to increasing rates of migration and multiculturalism. However, the unequal distribution of achievement between native speakers and those students whose first language is not the language of instruction indicates that the European school systems have not yet found adequate answers to this multilingual reality. Making more use of students’ first languages is one of the approaches for dealing with multilingual students’ challenges, particularly in classes with few first languages among students. In the practical dimension, different mathematics classroom practices are reported of how the inclusion of multiple first languages might be put into practice. The presented “ideal maximum model” and the systematization of different settings for written versus oral language and language production versus reception might offer orientations for decisions and reflected application of languages in classrooms (p. 12–13).
5. **Examples for Professional Development Activities Preparing Teachers in Dealing with Diversity**

Teachers’ diversity deserves respect both on human grounds and for the sake of effective teaching. The diversity that is the concern of this chapter is not that of ethnicity, gender, or age. It is the diversity of teachers’ beliefs about teaching and learning, beliefs that guide the way we think about our teaching and the way we teach. In recent years, there has been an exponential rise in more socially and contextually oriented approaches to research, including the study of learners’ beliefs in the contexts in which they emerge.

5.1 **University of Gothenburg**

**Title of the Course:** NYAMA — A Swedish professional development initiative about teaching mathematics to newly arrived immigrants

The triggering factor for initiating the project briefly described here was the recent wave of immigrants coming to Europe, and in particular to Sweden, with a peak in 2016. The model in figure 1 describes three entrances for people starting a new life in a context where they do not know the language: Educational achievement, Language development and Social integration. In the Swedish context at least, society provides opportunities for language development as an important entrance point which can lead to social integration and educational achievement. Similarly, social integration is much focused in the discussions of how to assist incorporation in society, language development and schooling. Our approach was to focus education as an entrance, by supporting school staff in giving learning opportunities for newly arrived students, which in turn could lead to language development and social integration. Our project was further inspired by Swedish national reports on the mathematics education for newly arrived students, lacking challenges and responsiveness to individual needs as well as teachers not trained to deal with language challenges for newly arrived students.

In close cooperation with a municipality close to Gothenburg, the National Centre for Mathematics Education (NCM) at University of Gothenburg carried out a professional development project during the school-year 2016/2017: NYAMA (Newly arrived students’ mathematics education). The overall aim was to give newly arrived students improved opportunities to succeed in compulsory school mathematics. The project aimed at working with teams of staff on participating schools and helping to develop their work with newly arrived students. The teams consisted of mathematics teachers, coaches (speaking the language of the newly arrived students), native tongue teachers, teachers of Swedish as a second...
language, and others. A range of languages were represented among the participants: Albanian, Arabic, Bosnian/Croatian/Serbian, Dari, English, French, German, Greek, Persian, Polish, Somali, Swedish, and Vietnamese.

The intended learning outcomes were that the participants would

- further develop their ability to build on, challenge and develop the mathematical competence of newly arrived students
- further develop their ability to facilitate newly arrived students’ integration into the teaching and learning of mathematics in Swedish classrooms
- increase their knowledge and understanding of the teaching and learning of mathematics in different cultures, including the Swedish
- increase their knowledge and understanding of how other categories of staff support newly arrived students learning of mathematics
- further develop their ability to cooperate with other categories of staff involved in newly arrived students learning of mathematics.

Before meeting the teams for the first time, almost one year was given to planning the content, activities and schedule for the programme. This was very important for the whole project and this careful planning was a precondition for success. A municipality close to Gothenburg was invited to participate and responded positively. Three school were proposed by the municipality to participate and they were contacted and responded positively to participate. Principals of these schools were very interested and meetings were easy to arrange on all three schools.

The programme consisted of eight 3 hour meetings during one school year. Between the meetings participants were expected to do tasks in the teams they belonged to.

An example of the content of a meeting is given below:

13.30–14.00 Follow up on task from last time, Madeleine and Lena
14.00–14.50 Mathematics from a cultural perspective, Saman
14.50–15.10 Coffee and sandwich
15.10–15.50 Mathematics from a cultural perspective continued, Saman
15.50–16.25 Task until next time, Madeleine and Lena
16.25–16.30 Concluding remarks, Elisabeth

On this particular occasion, the previous meeting had focused the use of hands-on materials for mathematics education and particularly for students who cannot communicate in Swedish, and a short version of the task that teams had been working on was:

What manipulatives (hands-on material) for mathematics education do you have at the school? Choose an activity based on manipulatives and discuss the aim of the activity. Carry out the activity with a few students and discuss how it worked out.

The task that teams were expected to work on until next meeting was:
Share and discuss examples of situations where you have experienced cultural diversity in mathematics education. Interview a few students who you think could have an opinion about similar situations. What could you learn from the students’ views?

A webpage was set up (http://ncm.gu.se/nyama), with open access, where all materials and presentations from the meetings could be found together with other resources. In addition to using materials from different sources (for example other materials already developed at NCM) three materials were specifically developed for the project: A template for planning how the teams could work together to support each newly arrived student, a template for creating mathematics dictionaries relevant to the languages used in specific classrooms, and a document describing a process for mathematics teaching with language development in mind.

In total, 36 participants attended at least 5 of these meetings. As part of the evaluation participants were asked to evaluate how far they reached in relation to each learning outcome, on a scale from 1 to 10. The mean values for the different outcomes range from 6 to 8, with an overall mean of 7.4. The evaluation results were published on the website. NCM also evaluated a range of other aspects of the project, which gave valuable insights to use in future projects.

### 5.2 University of Duisburg-Essen

**Title of the Course:** Diagnostic Competencies in Mathematics Education

<table>
<thead>
<tr>
<th>measure</th>
<th>target group</th>
<th>number of unit</th>
<th>duration (diagnostic methods)</th>
<th>number of participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - dealing with diversity</td>
<td>consultant (Fachberater)</td>
<td>intensive course plus (10 days)</td>
<td>1 day</td>
<td>15</td>
</tr>
<tr>
<td>- diagnosis and design of learning offers’</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 - didactic and methodical concepts to promote mathematical competences</td>
<td>special managers of special education (FachleiterInnen der Sonderpädagogik ZfsL)</td>
<td>standard course (2 days)</td>
<td>2,5 hours</td>
<td>3x25</td>
</tr>
<tr>
<td>3 - training day, mathematics lessons competence-oriented develop</td>
<td>teachers (special school, primary level, secondary level I)</td>
<td>impulse course (1day)</td>
<td>90 minutes</td>
<td>25</td>
</tr>
</tbody>
</table>

Which aspects of equity/diversity are addressed in this course?

In dealing with all diversity facets, the diagnostic competences are of particular importance and make complex demands for teachers. Schrader and Helmke (2014) distinguish between two types of diagnostic activities: On the one hand, formal diagnoses are based on appropriate information (e.g. class work,
tests) with the goal of explicit assessments (pp. 45 f.). On the other hand, diagnoses for controlling educational decisions and actions are rather informal (ibid.). On the other hand, diagnoses for controlling educational decisions and actions are rather informal (ibid.). Finally, on the basis of these implicit assessments, which often come under the pressure of time and action, teachers create learning opportunities for learners that take into account their existing knowledge as well as their potential difficulties. For the extension and deepening of diagnostic competencies, the Department of “Inclusion and Risk Students” in the German Centre for Teacher Education has developed mathematics (DZLM) developed a training concept that is already available in various formats different framework conditions and implemented for different groups of addressees has been. For example, measure 1: The aim was to deepen specialized didactic competences and implement ability content in teaching and consulting. A presence day of the course became the topic “diagnosis, study status analysis and handling of empirical school performance studies” designed and included the discussion and reflection of standardized and semi-standardized teaching-related diagnostic methods. For the distance phase, the participants received a work assignment for in-depth discussion, whose processing was picked up and reflected on the following presence day has been.

Please name one activity (best practice example) how you address diversity in STEM Education in this course

Depending on the amount of time and the group of addressees, a training offer must be flexible which is why standardized and rather semi-standardized diagnosis methods with different scope and weighting are reflected and compared. As an example, the participants have to observe a lesson under mathematical didactic and educational didactic perspective. Selected results of comparative work (VERA 3) from 2013 and related context-related tasks (see copy template 1 in the appendix) were discussed and analysed in particular taking into account the language requirements. The participants were invited to participate in small groups to deal with the tasks and the findings afterwards to discuss and reflect in plenary. What participants might go through: Learners need recognizing, producing, using and transferring correlations to similar situations. For processing the task, the important information has to be taken from the text and the table and put into context by what the use of different sizes (times, lengths), different units within a size range (metres, centimetres) and different spellings (mixed spelling, decimal notation) is difficult. In addition, have different adjectives are interpreted as operations, such as B. the comparative “slower” as a subtraction.

How did participants experience this course: (participant feedback/ evaluation results)

The evaluation regarding the diagnostic competences of the teachers or their competence development was only in the more extensive training measure made in Rheinland-Pfalz (German federal state). By way of example, some results are to be presented: For example, the participants rated the entire measure as good to very good as well as the participant orientation as well as opportunities for cooperation were seen as particularly positive.
I know different diagnostic measures for the mathematics classroom and evaluate their relevance.

![Bar chart before PD](image)

![Bar chart after PD](image)

I can evaluate diagnostic methods and diagnostic tasks relevant for teaching and I can advise colleagues accordingly.

![Bar chart before PD](image)

![Bar chart after PD](image)

Figure 2 Competence development regarding various diagnostic methods (thankfully provided by Hoffmann and Scherer, 2017, p. 84)

Website-Link: Hoffmann and Scherer (2017)

5.3 Institute of Mathematics and Informatics at the Bulgarian Academy of Science

Title of the Course: The Inquiry Based Mathematics Education

School subject/s addressed: Mathematics

Number of teaching units: 21

Number of teaching hours/unit: 128 (32 face-to-face + 96 distance)

Duration (Time span covered): 3 months

Which aspects of equity/diversity are addressed in this course?

Diversity of didactical means of presenting a mathematical object, of applying knowledge about the object; diversity of interactive educational methods, of location of delivery; diversity of the assessment instruments; diversity with regard to the intellectual and cognitive specifics of the students for whom the didactical model is developed; diversity with regard to the special needs of the students

Please name one activity (best practice example) how you address diversity in STEM
Solving a didactical problem by means of which the teachers are experiencing the inquiry process and the aha-effect, together with the accompanying reflection, including the pre-post reflection questionnaire.

**How did participants experience this course: (participant feedback/ evaluation results)**

Review of a colleague’s Course Project

- Intermediate – smiles and thank-you words
- At the end of the training – The results of the questionnaire showed that the participants were completely satisfied with the course
- After 2-3 years - 93% of the participants in the course in 2014 have indicated the highest degree of satisfaction of the course. Just one participant in the course under question has indicated that he has not been using the Virtual Math Lab directly but has modified some of the files in it. 93% of the participants are using other dynamic resources as well. The prevailing part of them has participated in more than 4 seminars (workshop, conference). The questionnaire shows that there are teachers needing a support, for instance technical one or for working with adults. The prevailing part are teachers who feel confident and well prepared: “I got all the support I needed”; “Everything needed is available – contacts for comments and feedback, resources in the Virtual Math Lab, skills and competences acquired during the course, workshops, conferences; encouragement and approval.” Over 70% of the participants have received awards, including the most prestigious awards for teachers in Bulgaria. The number of awards their students have achieved is also significant.

**Literature**


5.4 Hacettepe University

Title of the Course: Gender Equality in STEM Education

School subject/s addressed: Science, Mathematics (number of teachers participated=25)

Number of teaching units: Here is the program of the course:

PROGRAM (26-27 March 2016, Ankara, Turkey)

A PD Course on Gender Equality in STEM Education

- Welcome
- Introduction to Gender Equity
- Activity: Task Preferences
- Assessment in STEM Education
- Activity: who is the scientist?
- Activity: Make collage / magazine
- Science show
- Activity: Tips & Tricks: Improve your gender awareness in the classroom,
- Activity: Perception quiz
- Participants’ short presentation of on their classroom practices
- Activity: SMART Technology
- Reflection on resources for diversity and gender equality

Number of teaching hours/unit: 12 hours

Duration (Time span covered): 2 days

Which aspects of equity/diversity are addressed in this course?

Here are the objectives of PD course:

Teachers will:

- Appreciate the need to build gender into educational practice.
- Know that women are under-represented in STEM career subjects.
- Raise gender awareness in teaching and learning and subsequently influence classroom practice.
• Build gender considerations into professional practice.
• Reflect on the inclusive nature of their STEM teaching and learning.

Please name one activity (best practice example) how you address diversity in STEM Education in this course

**Make a collage / Magazines**

Make participants aware of their own biases and of the biases of the general public, so they can address them in their everyday lives. The aim of this activity is to be thought-provocative.

**Objective:**
To reveal some of the gender biases that participants see, hear and experience all the time.

**Materials:**
Copies of typical girls’ boys’ and gender-neutral science magazines, sheets of A4 or A3 paper, scissors & glue, printed work sheets (one A4 per participant and one A3), computer with sound and screen, flipchart with markers.

**Preparation:**
Take time to gather magazines and be critical about which magazine to use, some could be more interesting than others.
Option 1 (with students): Make groups of 2 to 4 participants per table and give them a variety of magazines (make sure to have a diversity of girl/boy/science/gender neutral magazines)
Option 2 (with teachers): Put all the magazines on two tables, each in opposite ends of the room, and leave them to choose.

**Duration:**
45 minutes

**Description:**

«Very interesting. The more the time there is for this, the more interesting are the answers.»

*Figure 3 STEM Teacher Training Innovation for Gender Balance TOOLKIT, CC BY SA 4.0, STING project, p. 30*
OPTION 2 (with teachers):

1. Introduction (2 min)

Tell the participants what they are going to do:
Discuss the issues of bias and stereotypes within youth and children’s magazines:
- Typical girls’ magazines (according to the publisher).
- Typical boys’ magazines (according to the publisher).
- Science magazines for the target group you’re working with.
- Gender-neutral magazines.

*Work in small groups of 2 or 3 persons.*
*Take one magazine of each category (girl/boy/science/gender neutral). Make sure at least one person of your group can read the magazines.*
*Go through the magazines and focus on... (see worksheet).*

2. Main part (25 min)

Give the groups 20 minutes (5 minutes for each kind of magazine) to go through the magazines on their table.
Each group takes notes on what they see and what strikes them, and makes a collage based on the notes. Use the worksheet to focus on:

3. Reflection (7 min)

Compare the notes and write them on the poster page.
Reverse the chart from the worksheet. Ask for a volunteer to write down the conclusions on the printed A3 worksheet.
- What are the differences of behaviour in the people portrayed?
- What are the differences of mood in the people portrayed?
- What are the differences of attitude in the people portrayed?
- Are there differences between the kind of magazines and the use of colours?
- Other differences? Are there others things that were striking? For example, positive features?

4. Summary

Summarise your reflections based on the identified differences (overleaf).
Discuss your reflections with the whole group.
Other activities are available here:

How did participants experience this course: (participant feedback/ evaluation results)
At the end of the PD course each participants wrote their views on each of the activity carried out during the course.

Website-Link: http://www.hstem.hacettepe.edu.tr/tr/sting-17
Project website: http://stingeuproject.com
6. References


