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Editorial

Diversity in Science Towards Social Inclusion

Working towards greater equality of opportunities means striving for the sustainability goals put forward by the United Nations, which also play a central role in European Union sustainability policy. One of the most frequently named goals can be subsumed under Sustainability Goal 4.1 to 'ensure that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and effective learning outcomes' (UN General Assembly, 2015, p. 17) with a special focus on the appreciation of cultural diversity (4a) and educating teachers to ensure an effective inclusive education system (4c). In a wider perspective, this contributes equally to Goal 10.2: to 'empower and promote the social, economic and political inclusion of all, irrespective of age, sex, disability, race, ethnicity, origin, religion or economic or other status' (UN General Assembly, 2015, p. 21). In particular, the European Commission's expert group for science education has conceptualised responsible science education as 'inclusive in terms of gender, social, economic and cultural diversity' and, therefore, has adopted a broad definition of inclusive education.

The EU recommendation *Science Education for All* expresses the need to focus on students currently disadvantaged in science education because of poor linguistic skills, cultural and ethnic differences, lower socio-economic status, or giftedness. For this purpose, the quality of teaching should be enhanced to improve the depth and quality of learning outcomes. In addition, educators working in formal, non-formal, and informal settings should collaborate to ensure that effective measures in the science education sector are taken in a joint approach. This can increase the uptake of science studies and science-based careers to improve employability and competitiveness. Taking into account societal needs and global development, innovation and science education strategies should be connected at local, regional, national, European, and international levels.

Currently, career decisions in science are influenced by gender, class, and cultural background, as shown in numerous studies (e.g., DeWitt et al., 2011). Evidence comes from a large body of research investigating the role of socio-economic status, ethnicity, and gender in science-related career decisions. It is well documented that students with a strong socio-economic background are much more likely to choose science subjects in school. Science fields tend to be not only gendered in favour of males but also associated with white middle-class students. For example, young women with migration backgrounds could thus be facing a twofold disadvantage, being both female and belonging to an ethnic minority.

One of the main goals of science lessons is gaining content knowledge. However, science knowledge and access to this important sector of the job market are unevenly distributed. A major challenge in science education is to support every student so that he or she can learn science in the best possible way. This has been emphasised by the European Commission's expert group for science education, which stated that it 'should be an essential component of a learning continuum for all'. The expert group defined a need for 'innovative teachers' strategies to address the diversity of students'. If diversity is insufficiently addressed, this results in 1) social inequalities in the access to a wide range of well-paid jobs, leading to social tensions, 2) low-achieving students who do not acquire scientific literacy, which is central for becoming responsible citizens in our society shaped by science and technology, and 3) gifted students who cannot fully contribute to society.

The especially disadvantaged students in science are those who differ from the 'norm'. This is true for students with a lower socio-economic status, those who speak other languages at home than the language of instruction, or who belong to ethnic minorities. Unexpectedly, gifted students also tend to be disadvantaged and underrepresented in science.

One challenge for inclusive teaching becomes clear in this discussion: in most cases, interventions seek to support one disadvantaged group. Very often, this group is separated from the other students. Thus, these practices are not inclusive in the sense that all students learn together and are equally well supported.

Starting from this idea, Rachel Mamlok-Naaman, in the first paper of the issue, *Diversity and Inclusion in Science Education: Why? A Literature Review*, discusses the relevance of diversity and inclusion. The paper is based on a literature review of existing knowledge on the subject; different studies are discussed, and the author investigates why inclusion and diversity are a topic in science education.

The second paper, by Sarah Kieferle and Silvija Markic, *Language Support in a Student Laboratory for Chemistry in Secondary School*, focuses on dealing with language diversity in non-formal education. A study presented in the paper shows the way of dealing with diversity in students' language skills. This topic is important since students whose first language is not the language of instruction face difficulties in acquiring science knowledge. This has been shown, for example, in the TIMSS 2007 study and other studies, in which students who spoke the language of instruction only seldom at home achieved lower levels in science than those who spoke the language of instruction at home on a regular basis. These students have to learn science content and linguistic structures at the same time. However, not only these students perceive the language in science as difficult. Many students whose parents have little formal education are also disadvantaged, because the subject-specific languages in science are very different from everyday language.

In science education, the consideration of cultural diversity is relatively new. This means that existing teaching approaches for addressing cultural diversity are rare, and there is a lack of concrete teaching material. However, it is widely known that students from minority groups tend to be disadvantaged in science. Racism is performed in science classrooms (Sheth, 2019), and the science achievement of many ethnic minorities is significantly lower than that of students of the ethnic majority (e.g., Norman et al., 2001). Students whose parents are immigrants achieve lower scores than students whose parents were born in the country. In this issue, *Innovative Learning Activities for Ethnically Diverse Students in Macedonian Science Education*, written by a group of science education researchers from University of Skopje (North Macedonia) led by Katerina Rusevska, presents different innovative learning methods for ethnically diverse groups. Following this, *Someone Like Me: A Trial of Context-Responsive Science as a Mechanism to Promote Inclusion*, written by Jane Essex, Kirsty Ross and Ingeborg Birnie, discusses two studies that involve science activities that were designed, implemented, and evaluated to show culturally contextualised science.

The TIMSS and PISA studies showed that achievement in science is strongly linked to the students' social background, especially the parents' educational level and the socio-economic status. Researchers from the University of Limerick, Genco Guralp and Sarah Hayes, present *Non-formal Science Education: Moving Towards More Inclusive Pedagogies for Diverse Classrooms* on this issue. The study focuses on best practice examples that strengthen the science capital of students, which are applicable across various contexts of diversity.

Finally, Miha Slapničar, Luka Ribič, Iztok Devetak and Luka Vinko focus on the group of students that is often not seen as a disadvantage in *Inquiry-Based Chemistry Education Activities in a Non-formal Educational Setting for Gifted Students.* Gifted students tend to be neglected in discussions about inclusive teaching. However, these students need special attention in science teaching, and underperformance can occur if their needs are not addressed. If specialised support for these students exists, it often consists of a separation of these students in terms of ability grouping. They attend specialised classes for high-performing students or are asked to participate in a science club. Although these can be very useful strategies, they do not follow the idea of inclusive teaching. The researchers present a study that discusses the evaluation of inquiry-based science education (IBSE) learning activities from the perspective of gifted and non-gifted students. Individual interest, autonomous and controlled motivation between different groups of students, and how these activities affect their attitude toward IBSE, situational interest, and interest in science careers are presented.

Three varia papers complete this issue. Rooserina Kusumaningdyah, Iztok Devetak, Yudhi Utomo, Effendy Effendy, Daratu Putri, and Habiddin Habiddin, in *Teaching Stereochemistry with Multimedia and Hands-On Models: The Relationship between Students' Scientific Reasoning Skills and The Effectiveness of Model Type*, discuss a study on the influence of multimedia and hands-on models on university students` understanding of stereochemistry. The study concludes with the influence of different models and students' skills.

The second varia paper, by Maja Kerneža and Igor Saksida, focuses on a study of *Slovenian Language Teachers' Attitudes Towards Introducing Comics in Literature Lessons in Primary School* and shows the great need for teacher training about the value and possibilities of usage of comics in primary schools.

The last paper in this section, written by Monika Mithans, Joca Zurc and Milena Ivanuš Grmek, discusses *Perceptions of Didactic Strategies among Pupils and Teachers in Primary School* and shows that problem-based learning and research-based learning as the most commonly used didactic strategies seen both by teachers and students. However, some differences in teachers' perceptions about how they teach and students' experience of teaching are seen.

To round out the work on inclusion, a book by Jane Essex, *Inclusive and Accessible Secondary Science: How to Teach Science Effectively to Students with Additional or Special Needs*, published by Routledge in 2023, is reviewed by Elisabeth Hofer. The book can be divided into two parts: the theoretical and the practical. The book emphasises the importance of inclusive education and shows possible ways for inclusive science education, summarised after more than a decade of the author's work on this topic.

The authors of this issue and I worked on the same goal in the Diversity in Science towards Social Inclusion (DiSSI) Project, the overarching purpose of which is to contribute to the equality of opportunities in science teaching. DiSSI focuses on science learning since science knowledge is a key competence for a wide range of jobs in engineering, industrial research, and many other fields that form the heart of the economy. As defined in the EU report, this can be conceptualised as a contribution to Science Education for Responsible Citizenship. This will help teach students to shape our future responsibly based on scientific evidence, as requested in the Paris Declaration.

We hope our contribution will enrich your teaching and motivate you for further work in this field.

Silvija Markic

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