Supporting Mathematics and Science Teachers in addressing Diversity and promoting fundamental Values

THREE YEARS OF COOPERATION
IN THE MASDIV PROJECT

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Colophon

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ICSE
International Centre for STEM Education

Erasmus+

The MaSDiV Project (2017-2020) was developed through a partnerschip between

- University of Education Freiburg, Germany (Project Coordinator)
- Ministry for Education, Youth and Sports Baden-Wuerttemberg, Germany
- University of Nicosia, Cyprus
- Ministry of Education and Culture, Cyprus
- University of Jaen, Spain
- Ministry of Education and Vocational Training, Spain
- University of Malta, Malta
- Ministry of Education and Employment, Malta
- Utrecht University, Netherlands
- Ministry of Education, Culture and Science, Netherlands
- Hacettepe University, Turkey
- Turkish Ministry of National Education, Turkey
- IPN – Leibniz Institute for Science and Mathematics Education at Kiel University, Germany (evaluation institution)

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Foreword

Dear reader,

Making students experience the fundamental values of our multicultural society, preparing them for responsible citizenship and enabling them to make informed decisions is becoming more and more important. You will, most likely, agree to this, but maybe you ask yourself what the connection between mathematics and science education on the one side and citizenship education on the other side is. Aren't mathematics and science neutral subjects? Although most people do belief that, it is a misconception.

For example, if we want to decide on whether measles vaccination should be obligatory or not, this decision is not only influenced by facts from natural sciences but also by ethical and moral values and by parents' autonomy on deciding for their child. The decision on reducing plastic waste is surely also influenced by the rules of labour market and economical aspects. Students as future members of our democratic societies should be prepared to engage in such discussions, they should be enabled to analyse different sources of information and be supported to come to an informed decision in terms of responsible citizenship.

In addition, although mathematics and science are often considered as culturally independent, they are not. Different cultures use sciences differently, see different connections to their religion and have advanced science and mathematics knowledge through their researchers and experts. For example, the triangle made famous by Blaise Pascal in the Western world has been known many years before in the Arab and Chinese world. Also, we have to acknowledge that students educated in different cultural areas use different algorithms and different terminology. These aspects all influence science and mathematics teaching and should be considered when planning lessons.

As members of our multicultural society students need to learn how to use mathematics and science knowledge in real situations and apply it to solve real problems. With it, they have to be able to deal with potentially controversial and big data and make informed decisions, and they need to understand the multicultural background of mathematics and sciences.

This book aims to support you and other teachers in including these aspects into your teaching. It shows you interesting examples of classroom materials which engage students in dealing with controversial real life situations and in decision-making as well as in the multicultural character of mathematics and science. We developed this book within the EU funded Project MaSDiV (Supporting Mathematics and Science Teachers in addressing Diversity and promoting fundamental Values, 2017-2020, masdiv-project.eu), in which Universities and Ministries of Education from six European countries cooperated.

We belief that this book provides you with useful, practical information, new classroom ideas and innovative teaching approaches and stimulates your inspiration for your invaluable work with today's students and tomorrow's responsible citizens.

Katja Maaß

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I. Introduction

Changing societies, increased migration and changes in the aims of science, technology, engineering & mathematics (STEM) education result in an urgent need for inclusive education that promotes learning in groups with different competence levels and cultural backgrounds. Our approach in this Erasmus+ project MaSDiV is called inclusive science education, and we built this approach on three important aspects of inclusive science education: Inquiry-based learning, the role of the context, and the influence of culture and fundamental values.

Inquiry-based learning

The fundament of this approach is inquiry-based learning (IBL). In IBL lessons, students work at their level of competence 'to do inquiry' on unstructured problems. Teachers facilitate students' learning processes. With IBL we refer to a student-centered teaching approach that is inspired by one or more phases from the inquiry cycle (e.g. questioning, hypothesising, experimenting systematically, analysing, evaluating, communicating). In contrast to exposing content and concepts in mathematics and science, IBL expects students to be more active and take more responsibility for their own learning as they learn to work individually or in groups.

IBL can be used for addressing different achievement levels, because all students get the opportunity to participate at their own level to prevent labelling and creating fixed mindsets towards science or mathematics. This approach requires activities that have a low entrance level and challenges for all.

The role of context

Grounded on this IBL fundament, the second important characteristic frames science within real-life contexts, thus enabling students to see the relevance and implications of science. Science in real-life contexts can motivate both low and high achieving students to fully develop their talents, and foster scientific literacy and students' development of civic competences (e.g. taking informed decisions, reasoning and elaborating on a decision's implications). This is particularly true for science-based contexts bearing ethical and cultural dimensions.

The careful choice of contexts is important since these contexts determine the kind of knowledge that is needed to enter the task and they provide opportunities to involve diverse cultures and to address rich socio-scientific issues.

Influence of culture & fundamental values

Our approach further expands IBL by incorporating cultural dimensions and promoting intercultural learning. Science is culturally situated (Lemke 2001, Ascher 1991): e.g. applications refer to a cultural context, there are different methods of doing basic calculations and countries refer to different scientists. A multicultural approach to science can establish the dignity of all students by respecting their different cultural roots and also support students with migrant backgrounds. Additionally, multi-cultural perspectives promote intercultural learning with students experiencing tolerance and non-discrimination. Here we come in the area of fundamental values, values like fair sharing of food, the availability of clean water and equal professional opportunities. These can be addressed in science education with problem situations like energy use and availability in different regions, the origin of resources and the costs of clean water.

Inclusive science education (1) introduces IBL as a means for addressing achievement-related diversity; (2) expands IBL to realistic, relevant contexts and (3) embeds IBL in multicultural settings.

Overview of the central issues		PD Module
Inquiry-based learning (IBL)	Inquiry learning is a form of active learning, where progress is assessed by how well students develop ex-perimental and analytical skills rather than how much knowledge they possess	
Achievement	Something accomplished, by ability and effort (PD)	**1**
Context	The context is the general situation in which something occurs. In education contexts are used to embed a ques-tion in a situation from daily life or from a special workplace situation etc.	**2**
Cultural diversity	Characteristics that can affect the specific ways in wich developmental potential and learning are realised inclu-ding cultural, linguistic, ethnic, religious and socio-economic differences	**3**
Socio-scientific issues (SSI)	Controversial social issues which relate to science. They are ill-structured, open-ended problems which have multiple solutions.	
Fundamental values	Fundamental values and beliefs are principles by which we live, operate and structure our lives.	

Lessons

Professional development will have more impact when it is accompanied by examples of classroom materials, so we designed classroom activities. For each of the lessons (see chapter 3) it administrated whether it connects to one of the topics of the professional development course: Achievement (1), Context (2) and Cultural diversity (3). Furthermore, for each lesson can be seen in what country it is developed, the main subject and the connection with curriculum content.

The process

The MaSDiV project started with a consortium meeting in May 2017, and we agreed on the above mentioned dimensions that define inclusive science education, and the way how to deal with the different approaches in the partner countries. That 2017 meeting was the starting point for the development of STEM learning and teaching materials for lower secondary education. Three modules for teacher training were developed (see Chapter 2), and we started to design and collect classroom materials (see Chapter 3). In 2018 we also started research on the effectiveness of both learning and teaching materials, the so called policy measure. The results of that research part of MaSDiV are not part of this book, but will be published (2020) on the website.

Chapter 2 gives a brief summary of the professional development approach, and Chapter 3 gives 10 examples of MaSDiV classroom materials.

For further information, PD materials and the full range of classroom activities, please visit masdiv-project.eu

II. Professional development

The rationale for the MaSDiV professional development (PD) course can be found in the 2007 EU framework for key competences. Science, as a vital prerequisite for active participation in society, belongs to the eight key competences outlined in this framework. The need for inclusive science education that promotes learning in groups with different competence levels and cultural backgrounds has grown ever since, and in this chapter we will highlight the key characteristics of the PD materials developed.

The MaSDiV PD course provides an evidence-based approach to tackle current challenges in STEM education: the underachievement of particular student populations; linking science competences with social and civic competences and effectively supporting teachers as they face increasing social, cultural and competence-related diversity in their classrooms. It thus aims to support the teaching of science and mathematics in diverse and multicultural contexts for the benefit of all students, regardless of their cultural or socioeconomic background. We call this teaching approach "inclusive science education".

The course aims to realize the following objectives.

- To strengthen *beliefs* and self-efficacy about using inquiry-based learning (IBL) to address diversity; showing the relevance and implications of mathematics and science and promoting fundamental values and taking into account cultural differences;
- To enrich *knowledge* focused on ethical and cultural dimensions of mathematics and science to promote fundamental learning;
- To acquire *knowledge* and understanding of the main challenges related with teaching in multicultural science and mathematics classrooms, such as dealing with controversial issues;
- To gain *skills* to apply the course knowledge into a practical knowledge related to interventions in multicultural science and mathematics classrooms;
- To develop teachers' self-reflection on their classroom teaching as regards *inclusive science education* (thereby indicating their knowledge of science education and their skills).

The PD course covers three modules in a connected way, each presenting inquiry-based learning (IBL) with a different emphasis:

- as an approach for addressing achievement-related diversity (module 1);
- in real-life, relevant contexts so as to promote fundamental values of our societies (module 2);
- as a tool for intercultural learning (module 3).

Each of the modules consists of a set of activities. The first module covers IBL as an approach to dealing with achievement related diversity. Participants design a teaching activity for this. Building on this exemplary teaching activity in module 2 the use of (real-life, relevant) contexts is addressed as a way for taking into account other aspects of diversity, focusing on fundamental values. Participant either adjust their teaching activity to employ contexts for these aims or design a new activity. In the last module the focus is on approaches and tools for intercultural teaching and learning in culturally diverse classrooms. Participants finish the teaching activity and lessons plan to incorporate this aspect as well. See figure 1 for an overview of the PD course.

For each module an outline is available for the educator. It includes the specific aims, a description of the activities and homework and a list with references to literature. Presentations (ppt) and worksheets for participants are provided separately. We suggest a teaching method for each activity, but these can be replaced by others. The ways of working with participants in the course reflects the 'values' and practices addressed in the course: inquiry, collaborative work and active learning are promoted in the activities. Participants will be inspired to use these methods with their students. The ways of working thus include:

- Reflecting on existing beliefs and practices regarding addressing diversity and IBL

- Providing and discussing concrete subject-specific examples

- Developing and reflecting on important principles for addressing diversity in science and mathematics classrooms
- Experimenting with and reflecting on teaching methods for diversity

To enhance the impact on the teaching practice, classroom worksheets (lessons) are part of the course. These classroom worksheets are specifically designed by the MaSDiV partners, to illustrate how IBL can be used to address achievement related diversity, to promote fundamental values or serve as a tool for intercultural, inclusive teaching. Ten of these lessons are presented in this booklet in Chapter 3.

Figure 1. Overview of PD course.

Supporting Mathematics and Science Teachers in addressing Diversity and promoting fundamental Values

PD Modules

Achievement

1. Introduction and exploring experiences with diversity
2. Characteristics of inclusive education
3. Collecting information to build on what students know
4. IBL and diversity in achievement
5. Teaching methods that support IBL and involve all students
6. Addressing diversity through IBL by providing students sample work
7. Design and prepare a lesson for your diverse classroom

Context

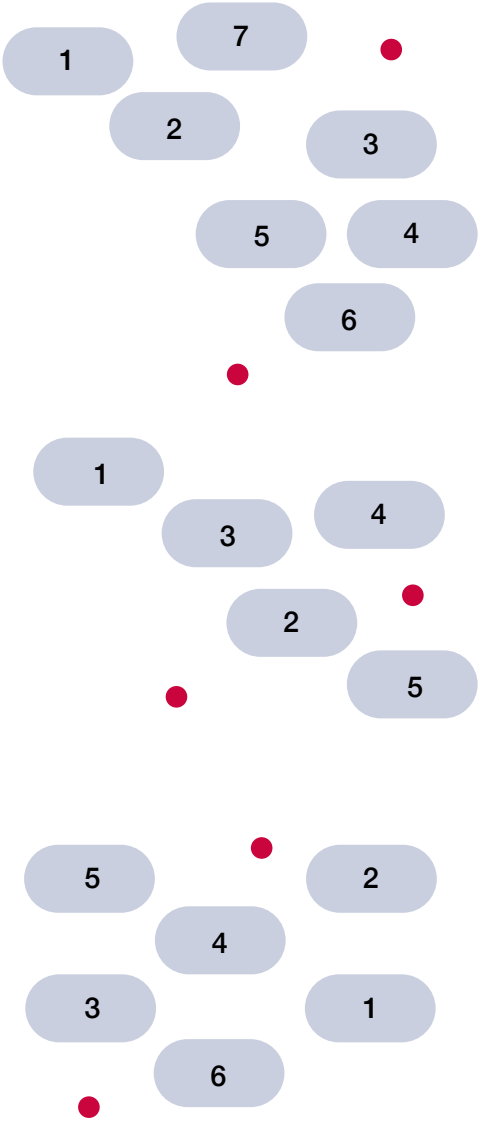
1. Context based teaching of mathematics and science
2. Examples of contexts
3. Contexts, socio-scientific issues and fundamental values
4. Designing and presenting a SSIBL lesson plan
5. Context-based education and overcoming drawbacks

Culture

1. Teaching your own diverse class
2. Cultural roots
3. Dilemma cards
4. Different solution strategies
5. Students as scientists
6. Language in multicultural classrooms

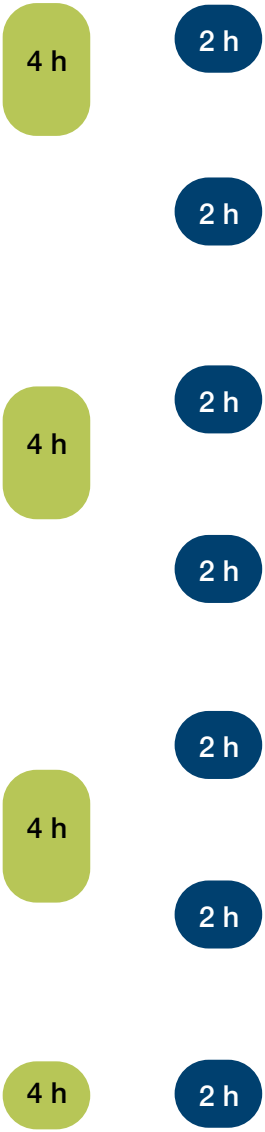
PD Activities

● Example Classroom Worksheets.



PD Meetings

Choose your own time flow for the PD Course.
Or in any case 14 hours.



III. Classroom materials

In the process of designing the MaSDiV Professional Development it became obvious that students, teachers and teacher trainers could benefit from a rich set of examples of classroom materials for immediate use. The first focus is lower secondary education, age 11 to 15, and on the next page all examples of classroom materials are labeled according to the central key principles of MaSDiV.

Each example gives an overview of the content of the classroom activity, and possibilities for implementation. The actual worksheets and other materials are located on the MaSDiV website.

Feel free to use the examples in your own classroom, or your teacher training course. And if you have remarks and observations, please contact us to share your thoughts and expertise.

Title	IBL	Achievement	Context	Culture	SSI	Fundamental values	Country of origin	SUBJECT: Biology	SUBJECT: Chemistry	SUBJECT: Mathematics	SUBJECT: Physics
Can the earth feed us?	x	x	x	x	x	x	NL	x		x	
Fireworks	x		x	x			MT	x	x		x
Fishery	x	x	x	x	x	x	NL	x	x		x
International language of elements	x		x	x	x		NL/MT		x		
Math in trials	x		x		x		DE	x		x	
Mirror, mirror	x	x	x	x	x	x	DE				x
Mosaics	x	x	x	x		x	CY			x	
Multicultural meal	x	x	x	x	x	x	NL	x			
Plastic soup	x	x	x	x	x	x	DE	x		x	
Road safety	x		x	x	x	x	CY				x
Safe slime	x	x	x		x	x	ES		x	x	x

Can the earth feed us?

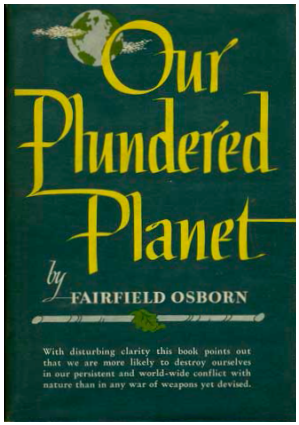
Abstract

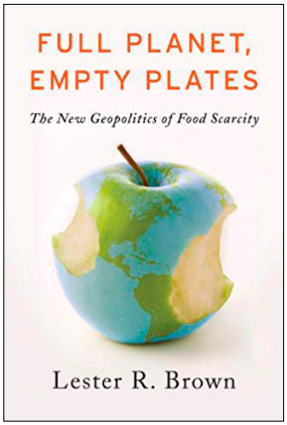
Shortage of food on a global scale is increasing every day as the size of the worlds' population grows. In addition, climate change raises new and future problems for local food production. Food shortage has no simple, straight forward solution. Possible solutions should encompass not only political and environmental issues, but also multicultural issues such as differences in culture, religion and diet.

Food is a necessity in the life of every student and therefore relevant and easy to relate to. The context promotes students' multicultural thinking and fundamental values.

Curriculum Content

- Food shortage
- Climate change
- Food production
- Dietary choices





Lesson implementation

Introduction

Texts or videos about food shortage or adequate food supply.

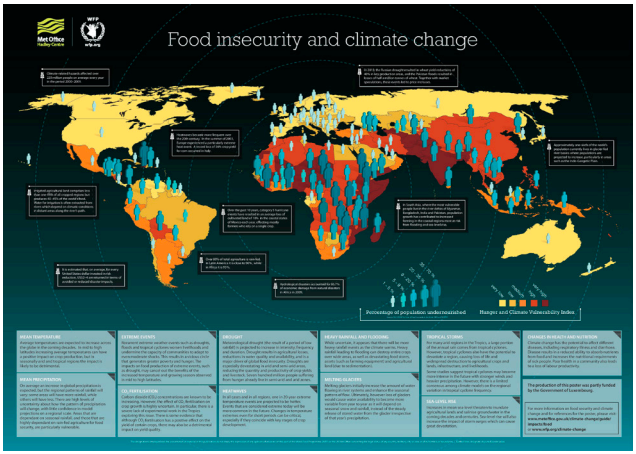
Activities for students

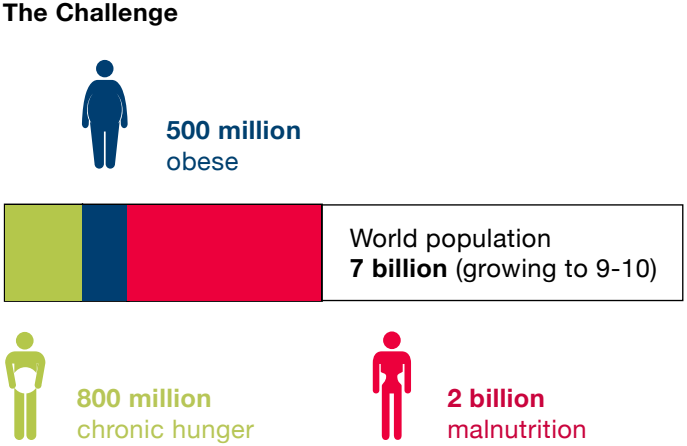
- Try to understand the provided examples and the underlying ideas/theories of the authors from the book “Can the earth feed us?”. Let the students investigate this topic in recent, local or alternative publications
- Role-play debate: Take on a role in the local governing body. Issues up for debate are for example more vegetarian food in the Towns schools, or mandatory vegetarian canteens for environmental reasons.
- Research on the equal distribution of food across the planet. [1]
- Research project combining climate change to areas at risk of food shortage. [2]

[1] www.wur.nl/nl/Onderwijs-Opleidingen/pws-scholieren/Wereldvoedselvraagstuk.htm

[2] https://awfw.org/food-insecurity-climate-change

Credits:
Claire Boerée and Amy Mol,
Utrecht University





Fireworks

Abstract

Fireworks are used throughout the world to celebrate important events such as new year's eve.

National legislation for fireworks differs due to religion and culture, as well as considerations on pollution, dangers and expenses.

Fireworks are very well known and appreciated amongst children of all ages. Because of the differences across countries, this realistic context fosters cultural diversity in chemistry education. Furthermore, when examined from an environmental or communal perspective, fireworks give rise to many different views and opinions on its use and impact.

Curriculum Content

- Fireworks
- Pollution
- Combustion
- Composition

Note from the designer

This lesson activity was designed by Julia Alexander, a teacher from Malta. In designing this activity she had the following intention:

"I used to hear my students talking about village feasts passionately as summer would be approaching. I want that same passion about science. Using events and activities which are important to students on a cultural or social level such as fireworks is an effective skeleton to teach big ideas in science and help students acquire skills needed to develop arguments and debate, skills needed to explore diverse views and make decision."

Lesson implementation

Introduction

Texts and/or videos about fireworks and related issues.

Activities for students

- Explore the metal ion component in fireworks by using spray bottles with salt solutions and a Bunsen burner.
- Investigate the environmental consequences of the use of gunpowder.
- The composition of fireworks has changed through the ages. Try to find some of these changes and explain the reasons for this change (i.e. potassium perchlorate by potassium chlorate).

The following activities for students are set in a hypothetical case: *In a city the request has been made to introduce fireworks at a feast. Some residents have however objected.*

- Investigate the possible opinions of town residents. Potential views may include: storage and handling, noise pollution, chemical pollution, danger of explosion, treatment of waste, expense, celebratory feature and tradition.
- Role-play debate: with your peers take on the roles of city council, city residents and/or scientists. Try to find a solution that suits everyone's goals and needs.

Credits:
Julia Alexander and Josette Farrugia,
University of Malta

Fishery

Abstract

The ocean is a valuable resource for food and income. All countries and cultures have their own traditions when it comes to eating fish or fishing. Overfishing has led to a decrease in the diversity of sea life; damaging coral and diminishing certain types of fish and other sea animals. Fishing links very closely to the daily lives and diets of students. In this activity students are asked to investigate the case of dynamite fishing in Tanzania.

This activity is multi- and interdisciplinary with a base in physics, chemistry and biology. During the tasks students will find out more about sound waves, connect biological consequences to physical changes and understand how chemical characteristics attribute to physical phenomena.

Curriculum Content

- Dynamite
- Shock waves
- Combustion
- Sustainability

Lesson implementation

Introduction

Students investigate their prior knowledge by looking at their own fish consumption and listing methods of fishing in different countries. Dynamite fishing is then introduced with a video. [3]

Activities for students

- Explore blast waves under water by drawing, lab experiments, slow-motion video examination etc.
- Investigate why and how dynamite kills fish. Which factors define the perimeter of the area in which the fish are killed?
- Watch the online science video of “How stuff works” about dynamite: https://science.howstuffworks.com/question397.htm
- Investigate where dynamite comes from and how it works. Determine which substance makes it possible for dynamite to explode under water.
- Design a solution for dynamite fishing in Tanzania. Think about the needs of the fishers (food, money, care for their children) and try to be creative in using the possibilities of their surroundings (for example sustainable coral reef exploitation by tourism).

[3] Dynamite fishing (Dutch subtitles): www.youtube.com/watch?v=n75prj6hyus or in English: www.youtube.com/watch?v=gOyusJVKxvc

Credits:
Claire Boerée and Amy Mol,
Utrecht University

International language of elements

Abstract

The periodic table is used by all science related subjects. Although it looks like a product of modern science, it has a very long, rich and multicultural history.

Every day in students' lives is influenced by topics related to the elements in the periodic table. Within this abundance of topics one finds several social scientific issues that are key to the 21st century such as: smart-phone usage, plastic usage and recycling, pollution and pesticides.

This lesson gives handholds for the introduction and investigation of elements in the periodic table with a multicultural perspective and their connection to smartphones.

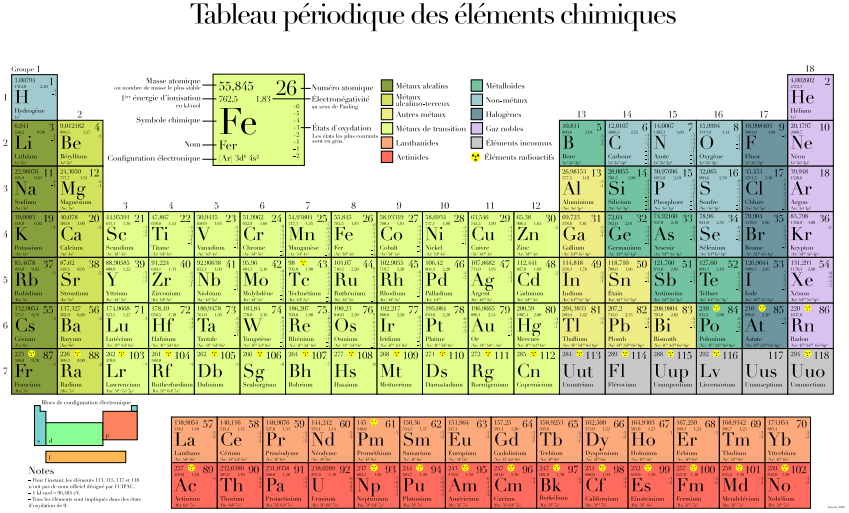
Curriculum Content

- Periodic table
- Natural resources
- Sustainability

Note from a teacher

This lesson activity was used by a teacher from Malta during the course. She considered the activity very useful in productively using the multicultural differences between students:

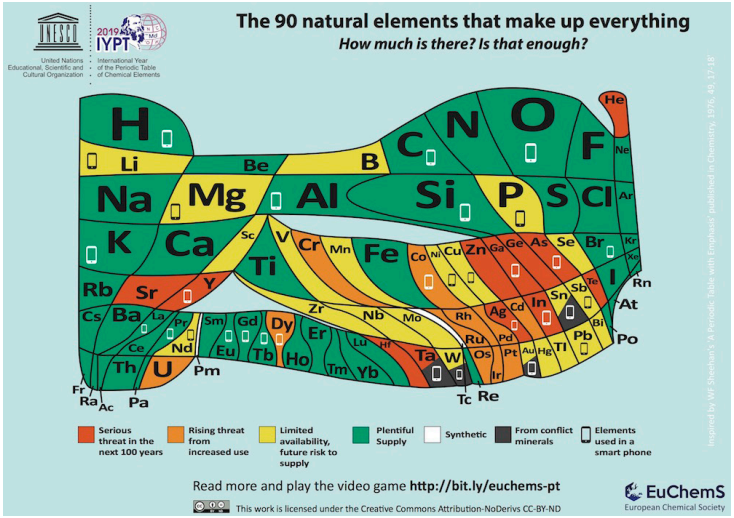
"I can identify there are differences between students, but sometimes I see it as a challenge, while at other times I see it as an opportunity and try to incorporate it into the lesson. A very good example where this can be used is when doing the Periodic Table and naming the different elements. Students can choose an element which they know of and write its name on the board in their language, using the activity to identify the origin of the name of the element."



Lesson implementation

Activities for students

- Using the picture on this page, investigate elements that can be found in a smartphone. Think of: place of discovery, mine locations, everyday usage, sparsity and related social and economic issues.
- Exchange your findings in a poster market.
- Organise a student debate on sustainability and use of certain “conflict” elements.
- Think of a plan to make smartphones more sustainable. Which elements should we try to avoid, replace, re-use etc.
- Class discussion: how can you use this knowledge to improve sustainability in your own life?



- www.nature.com/immersive/d42859-019-00001-7/index.html?fbclid=IwAR2as8LqIVR-jItPIsm-44WpBZq8HuX-IDPZypV7ITr2Zcvd0ivTXw-CzYM&utm_campaign=coll-interactive_iypt&utm_content=paid&utm_medium=social&utm_source=facebook interactive_iypt&utm_content=paid&utm_medium=social&utm_source=facebook

Credits:
University of Malta and
Claire Boerée (Utrecht University)

Math in trials

Abstract

People's intuitive feel for statistical reasoning is often biased and/or incorrect, which can have large detrimental consequences. During this activity the courtcase of Sally Clark is used to raise students' awareness of their biases in statistical reasoning.

Student's ability to assess such statistical situations in a mathematically grounded way is an important part of their citizenship education. This social context emphasises the meaningfulness and importance of mathematics in everyday life. When desired, the topic can be connected to the biology lessons by investigating the underlying genetics and the link to probability.

In Great Britain, November 1999, the respected lawyer Sally Clark has been wrongly accused of and imprisoned for the murder of her children. Clark came under suspicion of murder after her two sons (*1996, *1997) died within a short period of time after their birth.

Curriculum Content

- Statistical reasoning
- (In)dependent events
- Probability
- Coincidence
- Genetics

Maths professor challenges double baby murder case

A SALFORD University Maths professor will challenge evidence used to convict a solicitor of murdering her two baby sons at a conference on cot-deaths next week.

Prof Ray Hill, from Eccles, head of the university's Applied and Discrete Mathematics Research Unit said statistical evidence used to convict Sally Clark, from Wilmslow, in October 2000, was not only quoted out of context and unfairly used to imply guilt, but was actually wrong.

Watching the trial on the TV he became furious and told us: "I shouted at the screen 'that figure's wrong!' They took an estimated figure for the likelihood of one cot death and then just squared it to get this one-in-73 million chance. That's not allowed unless you're sure the events are independent. A bookie wouldn't give you those odds."

He has now studied the Confidential Enquiry into Stillbirths and Deaths in Infancy (CESDI) report, which gives detailed figures on the number of deaths from 1993-1996.

He said: "It seems the chances of two cot deaths in the same family are much higher than the prosecution led the jury to believe."

Prof Hill has written to several national newspapers and is working with Sally Clark's defence team on the campaign to free her.

He will present his full criticism of the evidence at a Developmental Physiology Conference on cot deaths organised by Leicester University on June 28.

The Criminal Cases Review Commission has been looking at the case and is expected to report within the next few weeks. With their report imminent, Sally Clark's defence team and family do not feel it is appropriate to comment.

For more information on the Sally Clark campaign visit www.sallyclark.org.uk

Lesson implementation

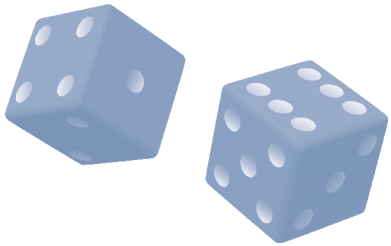
Introduction

Texts or videos about the case of Sally Clark.

Activities for students

- Try to understand the statistical reasoning behind both the conviction and the (three year later) acquittal of Sally Clark.
- Explore the difference between dependent and independent events with dice and a marble-draw. What are the similarities with the case of Sally Clark?
- Organize a (large) lottery in which there is one winner. Discuss with the group why the winning feels like luck instead of coincidence. Draw similarities with the case of Sally Clark.
- Debate with the class whether mathematics should really play an important role in the mediation and evidence of
  a crime, because of the risk of misinterpretation.
- Role-play court case: With your fellows take on the role of offense and defence in the case of Sally Clark. Make sure you statistically ground your arguments.

Credits:
Katharina Flößer and Katja Maaß,
University of Education Freiburg



Mirror, mirror

Abstract

Outer appearance is very important in our society. This importance has grown even more with the emergence of social media. Scientists have long since known that how we perceive our outer appearance relies mainly on seeing our reflection in the mirror. But does a mirror really accurately reflect our looks, or can even a mirror make mistakes?

Students are often very focused on their outer appearance. In this activity they investigate the truthfulness of mirrors by using physics creatively. Thereafter they focus on the impact of mirrors on society in history and the present.

Curriculum Content

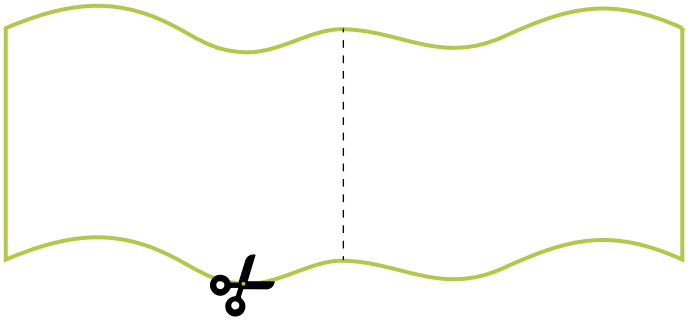
- Reflection
- Mirror
- Appearance
- Social media

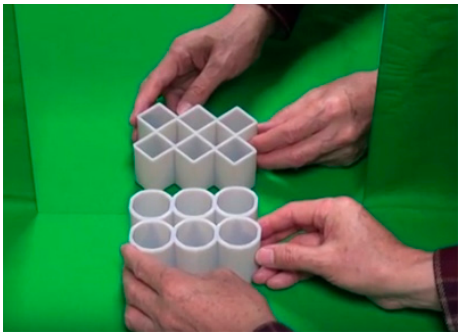
Lesson implementation

Activities for students

- Build and test the design made by Kokichi Sugihara. Explain how the reflection of a rectangle can be a circle.
- Design and build a 3D-model of such an object.
- What does this imply for your own reflection in the mirror? Could your perception of you own appearance be faulty? And how about camera's?
- In history, mirrors have often been attributed magical properties. Investigate the role of mirrors in history. Present your findings to your peers.
- With social media we have become accustomed to exhibiting ourselves and our lives through visual imagery. Describe how this influences your life on a daily basis. How does it influence society?
- Classroom debate: take on the role of either government or management of a social media coorperation. Debate whether regulations on the use of visual imagery on social media should be changed.

Credits:
Oliver Straser, University of Education Freiburg and Amy Mol (Utrecht University)





Design of Kokichi Sugihara and it's reflection

Mosaics

Abstract

Throughout history the combination of mathematics and arts has led to the development of remarkable masterpieces. These masterpieces often serve as important ceremonial and religious artefacts, which reflect the uniqueness of the civilisation of origin. This activity focusses on mosaics and the role of geometry in art.

Students are often unaware of the relation of mathematics to history, art, religion and culture. By studying and designing mosaics students get a more interdisciplinary view of mathematics which transcends the typical subjects taught in schools. Furthermore, mosaics provide a visual and tangible context for students to study transformation geometry, including translation, rotation, and reflection.

Curriculum Content

- Transformations
- Geometry
- Mathematical terminology

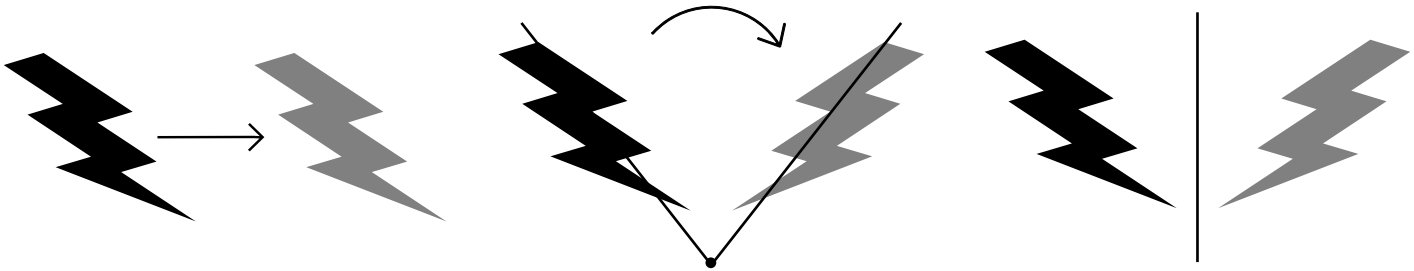
Lesson implementation

Introduction

A historical description of mosaics using video's and/or texts.

Activities for students

- Using examples of mosaics provided by your teacher identify the unit-shape of each pattern (this is the unit that is repeated in the pattern).
- Explore which types of transformations can be identified. Try to describe them using accurate mathematical terminology.
- Design your own mosaic by starting with a unit shape and applying multiple transformations. Use colours to emphasize the geometrical properties and to improve its aesthetics.
- Describe the geometry in your mosaic in a poster. Make sure to describe the unit-shape, the relevant transformations and the process you went through. Walk around and view each other's posters.
- Group the day's mosaics according to types and combinations of geometrical transformations that are used. Make sure to represent both the mosaics provided by the teacher and the mosaics designed by your classmates.



Translation Rotation Reflection

From the designer

This lesson activity was designed by Eleni Papageorgiou and Constantinos Xenofontos. In their article the designers describe their approach and the results:

"Our aim was two-fold: first, we intended to help students recognise and distinguish between different types of transformations which appear in mosaics, and second, we wanted them to be able to apply these transformations to design their own mosaics. As instructional tools, the cultural context of these ancient mosaics seemed to motivate students in the exploration of geometrical concepts and properties, while the design of their own mosaics contributed to a better understanding of various geometrical transformations."

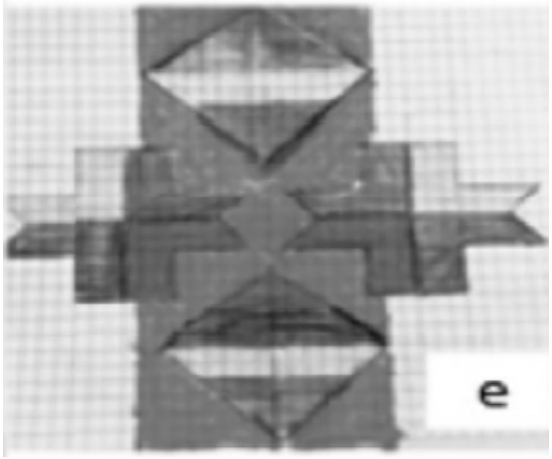
This understanding is elaborated by the designers with the citation below. In this citation we see that the student understands both an the three types of geometrical transformations and the correct use of mathematical terminology.

[Student referring to picture on the bottom left:] *"I drew something like a capital L in English while looking from the other side. Then I drew its reflection over an imaginary vertical axis, and coloured it blue. After, I reflected the whole shape over an imaginary horizontal axis, and coloured it green and red. Finally, I reflected the whole shape over a new vertical axis passing from the middle of the paper."*

Reference

- Papageorgiou, Eleni & Xenofontos, Constantinos. (2018). Discovering geometrical transformations in the ancient mosaics of Cyprus: An instructional approach to Grade 6. *Australian Mathematics Teacher*. 74. 34-40.

Credits:
Eleni Papageorgiou, Constantinos Xenofontos and Nicholas Mousoulides, University of Nicosia and Amy Mol (Utrecht University



Multicultural meal

Abstract

Food is a prime necessity in life. Meals vary greatly between countries but also between individuals due to differences in religion, culture, climate, food supply and taste. Acquaintance with these differences and their origins supplies both an opportunity for respectfully handling each other's eating habits as well as an opportunity for expanding one's own eating habits.

Within most schools there is much variety in students' eating habits at home. This however often does not surface because students eat the meals provided at school. Investigation of these differences promotes social cohesiveness at school and students' citizenship development.

Curriculum Content

- Dietary choices
- Religion
- Citizenship
- Food production

Lesson implementation

Introduction

Texts or videos about school lunches around the world.

Activities for students

- Conduct a small survey about what students at your school eat for lunch at home.
- Investigate which different cultures and religions are represented in your class/school. Are students' eating habits connected to these backgrounds?
- Make groups with similar cultural eating habits. Make a poster about what you eat, what you do not eat and why.
- Read a text about healthy food and study the five food groups.
- Develop a healthy meal plan for your school. Make sure the different cultures and religions present at your school are respected and represented. Calculate the costs, using information from shops, folders, etc.
- Present your meal on a poster or flyer or menu.

Credits:
Monica Wijers,
Utrecht University

Plastic soup

Abstract

Plastic pollution of sea and land is a worldwide problem that is key to the 21st century. The consequences give rise to a wide variety of biological, social and political issues. Therefor possible solutions ask for a multidisciplinary, multicultural and multifaceted approach.

The use, recycling and litter of plastic is very prominent in students' daily lives and therefor relevant and easy to relate to. Furthermore, the global scale of the issue of plastic soup offers many possibilities to promote students' multicultural thinking.

Curriculum Content

- Quantity calculation
- Data representation
- Prediction by data
- Taxes
- Plastic composition

Lesson implementation

Introduction

Texts or videos about plastic pollution. Relevant numbers for the below described activities can either be provided by the teacher or looked up by the students.

Activities for students

- Try to reason how much garbage your class can reduce.
- Using numbers on the amount of plastic pollution in the past and present, try to make a prediction about the future amount of plastic pollution.
- Try to reason how much garbage you can save by buying in an unpacked store. How do their prices relate to those of normal stores?
- Categorize the different types of plastics. Investigate the recycling-processes of these plastics and the related financial and environmental costs.
- Plastic pollution can be reduced by introducing taxes on plastic packaging. How high would you set such a tax? Found these numbers.
- Role-play debate: Take on a role of the local governing body. Issues up for debate are for example taxes on plastic, governmental waste management of plastic, supermarket policies with respect for plastic, etc.

Credits:
Katharina Flößer (University of Education, Freiburg) and Amy Mol (Utrecht University)

Goods in an unpacked store

Road safety

Abstract

In an article (2006) based on findings by the Worlth Health Organization Heidi Worley states: *"Road traffic accidents—the leading cause of death by injury and the tenth-leading cause of all deaths globally—now make up a surprisingly significant portion of the worldwide burden of ill-health. An estimated 1.2 million people are killed in road crashes each year (…)."* [4] Road usage increases every year, making road safety one of the leading social scientific issues of the present and the future.

Students are daily users of our roads, both passive and active. Therefore, investigation of road safety is both relevant and part of their citizenship development. The topic is multicultural because of the differences between road construction and usage between countries.

[4] www.prb.org/roadtrafficaccidentsincrease-dramaticallyworldwide

Curriculum Content

- Newton's laws
- Collision
- Speed
- Safety

Lesson implementation

Introduction

Texts or videos about road safety and car crashes.

Activities for students

- Build a simulation of a car crash using the slope, the toy car, the road obstacle and the doll provided by the teacher.
- Plan and execute your simulation and record your results. Can your results be explained by Newton's laws? What are the limitations of your simulation?
- How does the simulation you just built relate to road safety? Read the article1 and discuss with your group.
- Investigate laws for roads and road usage in different countries, such as road design, maximum speed, overtaking, airbags and seatbelts. Make an overview of the differences that are most likely to impact road safety.
- Choose one of the road safety factors from your overview to investigate further using Newton's laws. Make a poster and share your findings with your classmates.
- Role-play debate: suppose part of your class is the governing body of a country trying to decide if a road's maximum speed limit should be raised from 120 km/h to 130 km/h. The other half can take on roles as—for example—scientist, civilian and environmental activist. Debate the decision using arguments that are grounded and just.

Credits:
Nicholas Mousoulides, University of Nicosia and Amy Mol (Utrecht University

Safe slime

Abstract

SLIME is popular amongst kids and adults because of its texture and the possibilities to manipulate it in a playful way providing a unique sensory experience. There are plenty of recipes for making homemade slime but not all them are equally good, since some contain borax that can cause skin, eye or respiratory irritation and other health problems.

This activity challenges students to investigate the possible ingredients and the best procedure to make a safe slime. They will have to meet the challenge in groups, discussing alternative strategies, describing observations and searching for explanations.

Keywords

- Chemical mixtures
- Physical properties
- Substances and health
- Calculations and Estimations

Lesson implementation

Introduction

News about the risk of making homemade slime: www.ctvnews.ca/health/why-homemade-slime-could-be-dangerous-for-kids-1.3359013

Activities for students

- Classroom discussion on the dangers of homemade slime for kids.
- Investigate the best ingredients and procedures to make a safe slime.
- Make your safe slime. Write down your recipe, procedure and findings.
- Calculate the costs of your slime and compare this to store-bought products.
- Presentation and judgment: Present your slime in a poster-presentation. Judge each other's slime on safety, costs and the quality of its texture.

Credits:
Marta Romero,
University of Jaen

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Mosaics
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Plastic soup
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Safe slime
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